Women in Industry

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SUMMARY:

The number of women, including the number of technically trained women, moving into industrial positions is slowly increasing. Although they have historically had difficulty rising through the ranks, the scene is now changing. Several women are at the highest executive ranks, and have an ever-expanding group rising behind them.

The global economy of today and the rising awareness of the role of technology in the competitive positioning of companies and countries has created an anxiety about our technical work force. This, in turn, has caused an examination of school system-s and their ability to attract students into math and science programs. Both in Europe and the United States, the number of science and engineering students in the university, and school children interested in science and math, are declining at this time of perceived need. Thus, the encouragement of more women and ethnic groups under-represented in science and engineering becomes more urgent. To facilitate that participation. we need to understand the barriers and inhibitions which have caused the current under-representation. Science and engineering graduates find employment and careers in a variety of environments including academic institutions, government laboratories, general business, service industries, and industrial firms. The largest number, particularly in chemistry and chemical engineering, find employment in the industrial sector, in research and development, and in technical support positions such as sales and technical service. The issues for women are both at the entry level for access to attractive positions, and at later career stages for

Opportunity for upward mobility and promotion. Thus, it is timely to review the current status of technically trained women in the industrial work place and to assess the future attraction of this environment.

Since technical opportunities for women will depend on the overall climate and atmosphere in the industrial scene, I would first like to look at the position of women in industry overall. There have been many studies done in recent years on the women in the corporation and on the reality of the "glass ceiling", that subtle barrier to the entry of women to the corporate executive suite and their access to power wielding positions. One of the early studies was the book entitled, "Men and Women of the Corporation", written in 1977 by Rosabeth Moss Kanter. This book not only provides a thorough examination of the mores and culture in major corporations, it also serves as a baseline for comparison to measure what progress has been made during the past fifteen years where massive numbers of women have joined the work force. Kanter points out that in 1970, 96% of all managers and administrators were earning $15,000 per year and 98% of those earning over $30,000 were men. Further up the ladder, women were even more invisible. She reports that a survey of 163 U. S. companies indicated that "in three-fourths of the companies, women held 2% or less of the middle management jobs and in over three-fourths of the companies, they held none of the top management jobs." Her conclusion was that managerial and clerical jobs were the major sex-segregated, white-collar occupations in the United States. However, she clearly thought that neither the jobs themselves nor the men and women occupying the jobs had any inherent sex-related qualities. The structure developed as a result of the sociology of the organization rather than as a consequence of the sex orientation of the employees.

In 1977, this problem would have been particularly difficult in technical areas since women represented such a small percentage of the technical work force. However, Dr. Kanter postulated that since the organizational behavior is a function of organizational structure and not intrinsic character that the system can be interrupted and the consequences of job relationships changed. She particularly focused on power, which conveys autonomy and freedom of action. The key was to change the condition which trapped women in "cycles of powerlessness" in the organization. For example, most of the few successful women had strong technical backgrounds and had been "token" women among male peers. The other positive factor was the presence of a mentor. A study by Cussler and Hennig showed clearly the importance of sponsorship, and a British study indicated the importance of an "office uncle" to a woman's career.

Kanter's study was followed by a Korn/Ferry "Profile of Women Senior Executives7Jin 1982. The change from 1977 was encouraging - they identified 600 women listed as Executive Vice Presidents, Senior Vice Presidents, and Functional Vice Presidents in 800 corporations from the Fortune 500 companies. The composite woman senior executive was a Vice-President and earned an annual average compensation of over $92,000. Interestingly, one third of the respondents began as professional technical or marketing/sales positions where 51 % of the equivalent male executives began in these job classifications. Again, this points out the low number of

Women in these technically-oriented positions, but it also indicates the utility of a technical position as a stepping stone to an executive position. It is interesting to note that the Korn/Ferry executives felt that the major obstacles to overcome were being a woman and a lack of self-confidence.

As follow-ons, there have been two recent studies on women in industry. A study entitled, "Women in Corporate Management: Results of a Catalyst Survey" was published in 1990 by Catalyst, an organization involved in promoting the status of women in American corporations and professional firms. The results are encouraging in that women now constitute over 5% of the senior managers, up from about 2% in the mid-1980's. Kanter's concept of intervention was seen to be vindicated since the interviews showed clearly that the commitment of the Chief Executive Officer to take aggressive action to move women forward was critical to the advancement of women to top positions. Surprisingly, 91 % of the CEO's agreed that it was the company's responsibility to change to support the needs of women in management and professional positions. The catalyst report also identified the five skills and characteristics that seem to be most critical for success - technical skills and education, managerial ability, career commitment, and experience.

The second 1990 report by Russell Reynolds Associates entitled, "Men, Women, and Leadership" is an interesting study of the differences between men and women in their leadership versus management skills. Surprisingly, they found more women in executive positions with leadership qualities than their male counterparts. However, although the number of women had increased, the perception remained that women face hostility and resentment on the job. Over 67% of the leader-style women and 30% of the manager-style women believed that this adverse climate still exists. However, only 2% of the leader-style males and 25% of the manager-style males felt that these conditions existed. So, even in the face of significant gains, many women still feel that the barriers are high for upward mobility in the current corporate structure. As Jaclyn Fierman noted in a July issue of Fortune magazine, this perception has caused many able women to abandon the fast track. They are taking time off for children, they find better opportunities in smaller firms, they start up their own businesses or consulting firms, or they just get tired and relax in place. Ms. Fierman quotes Lily Tomlin, "If I had known what it would be like to have it all, I might have settled for less."

Regardless of these less than inspiring studies, women are continuing to come into the work force and many of them have outstanding careers. Their numbers in technical jobs is still increasing and many are succeeding. The successful ones in technical companies include Kathryn Braun, Senior Vice President of Western Digital; Edith Martin a Boeing Vice President; and Lois Juliber, a Division President at Colgate-Palmolive. Some other high-tech leaders include Iva Wilson, President of Phillips Display Components Company, who has a Ph.D. in electrical engineering; Ilene Lang, President of Adelie Corporation, a custom software house: Joanna Jannson, President of Physical Optics Corporation; Janet Baker, President of Dragon Systems, a maker of speech recognition systems: and Mary-Dell Chilton, Executive Director of Ciba-Geigy Corporation. There are also lots of women in the pipeline. At

A T& T, women now make up 5% of the scientific managers and 10% of all managers who earned more than $100,000. At Hewlett-Packard, 21 % of the engineers are now women.

The bottom line today for technically-trained women is that the access problem is essentially solved. Women now get entry-level jobs and beginning salaries comparable to men. In spite of the continuing existence of some subtle barriers and the problem of balancing work and family, women are being promoted and empowered. As the need for technical talent escalates, and more and more role models appear, women will continue to make steady progress up the ladder. In the technical fields, their work will also be exciting and rewarding.

We should encourage our young colleagues and students to join us in one of the most satisfying careers around. We also have an obligation to help each of them reach their potential by our mentoring and support.

Harbour Channels

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SUMMARY

Two major problems associated with port and harbour approach channels are discussed - wandering course and fluctuating depth. Three examples, drawn from the UK, the USA and Indonesia, demonstrate that before undertaking civil engineering works intended to provide a stable navigation channel, it is essential both to identify those factors responsible for the problems and to investigate the likely impact on channel and environment of the remedial works proposed.

INTRODUCTION

One of the earliest means of communication between primitive communities was by water transport, usually requiring less effort than transport by land. In the beginning the wide variations in the design of craft reflected local differences in natural conditions such as the prevailing state of winds, waves, tidal currents, river flow, and the availability of building materials such as wood, reeds or animal skins. As navigators ventured further and further a field and inter-continental trade became established ships needed to be more robust, the wooden sailing ship, characteristic of European maritime nations from the fourteenth century onwards, eventually giving way to the steel steamship during the advance of the Industrial Revolution.

The present century has seen the rise and fall of the large ocean-going passenger liner and the development of the container ship and the bulk carrier, a super tanker of some 300,000 tonnes (dwt) having a length, a beam and a draught of about 345 metres, 55 metres and 22 metres respectively. This increase in vessel size has meant that the approach channels to many long-standing ports and harbours, originally perfectly satisfactory for the craft of the day, became too narrow, shallow or tortuous for the new large ships. Harbour authorities met the challenge by carrying out various civil engineering works such as dredging to deepen and straighten the channels, or training wall construction to stabilize channel position and increase bed scour by concentrating the available flow. Sometimes these measures were successful: sometimes they created new and greater problems.

Using examples drawn from the Old World, the New World and the Developing World there follows an account of some of the problems investigated and remedial measures taken.

LIVERPOOL BAY

The first example is of the approach channel to the Port of Liverpool which crosses Liverpool Bay through an area of sand banks which dry out at low water of spring tides.

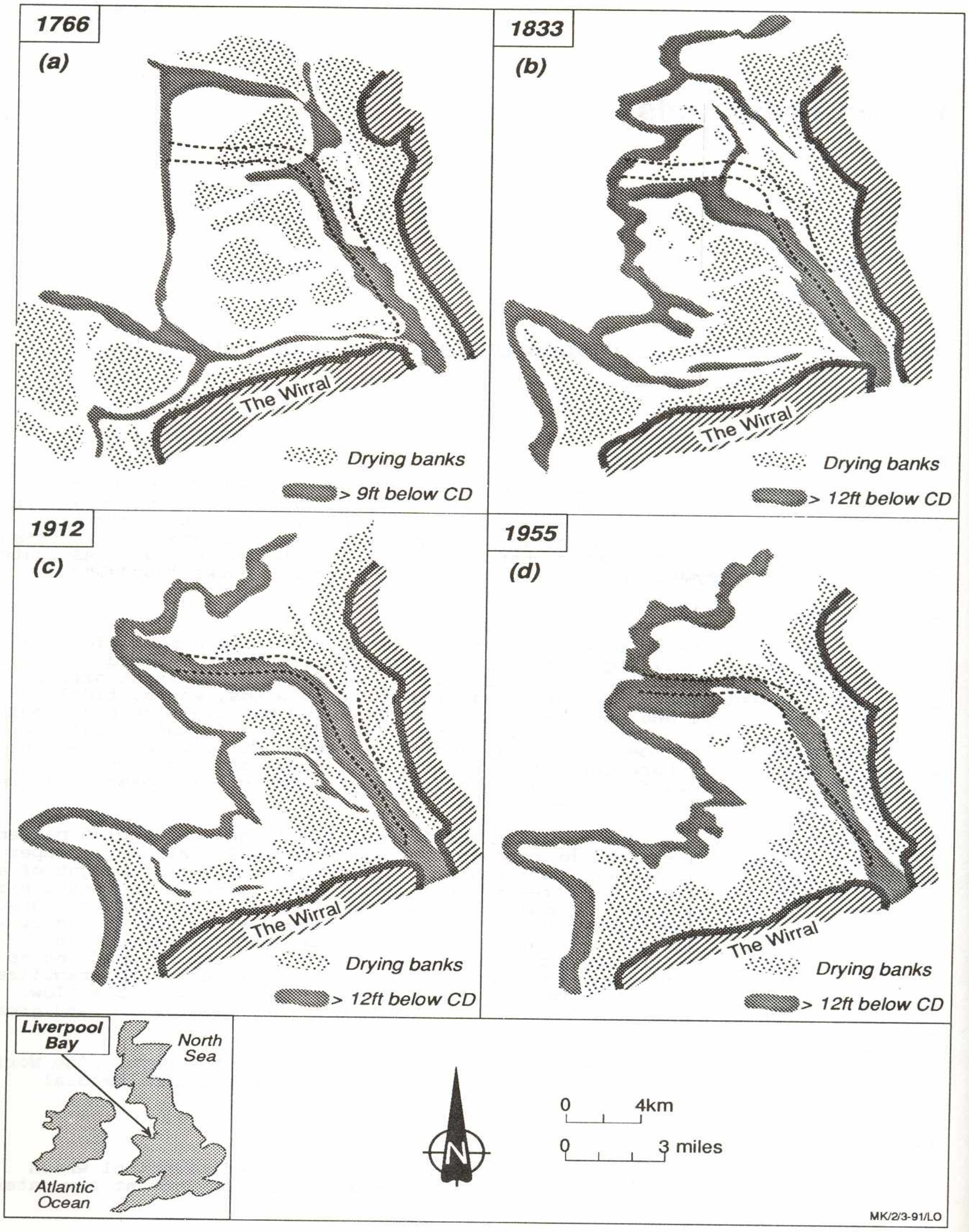

Figure 1. Liverpool Bay - changes since 1766

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Figure 1(a) shows the banks & channels in Liverpool Bay as surveyed in 1766. ('Feet', the sounding units of the time, have been retained). At that time there were two navigation channels, one from the north and one from the west along the coast of the Wirral. The difficulty was that sea bed levels in the Bay were not stable - one month's deep water channel could well be next month's sand bank. Figure 1(b) shows how, by 1833, the channel from the north had disappeared, that from the west was shoaling, and a new channel had developed from the north-west which then became the main route to Liverpool. By 1912 (Figure 3(c» the northwest approach had shifted bodily to the north and the old west channel had dwindled still further. Such a situation was much too unreliable for a port developing its overseas trade.

Dredging to keep pace with the increasing draught of ships had begun in the 1890's and between 1909 and 1939 (with a nine-year break which followed the onset of the First World War) thirteen miles of revetment, or training walls, were built flanking the channel. They reached a height about 4 feet above low water level of spring tides. The walls are shown as broken lines on Figure 1. The survey for 1955 (Fig 1(d» shows the channel to be well established between the training walls, the old west channel having completely disappeared. The situation in Liverpool Bay is much the same today as in 1955. The works can therefore be said to have successfully achieved the stabilization of the port approach channel. Unfortunately, however, the story does not end there.

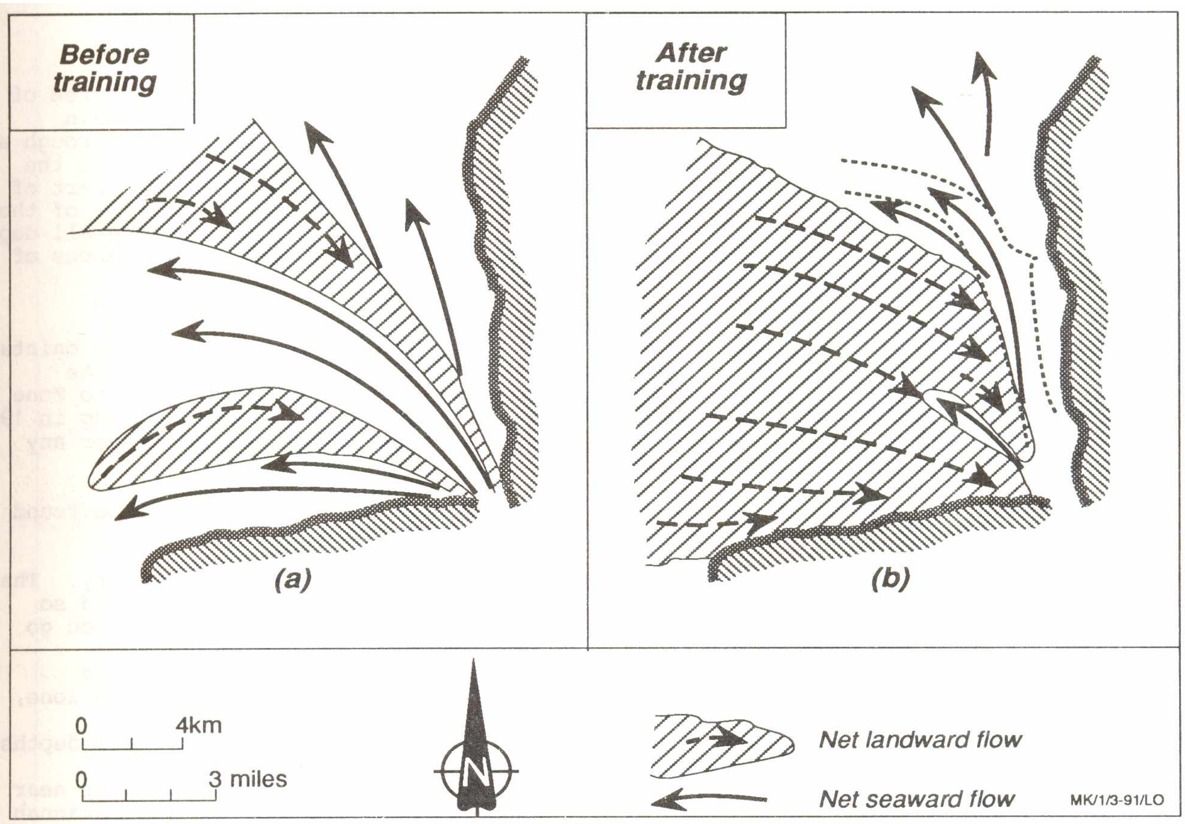

Figure 2. Liverpool Bay - effect of training walls on flow

During studies undertaken at Hydraulics Research by former colleagues and myself to explore reasons why siltation amounting to 70 million cubic metres had occurred in the Mersey estuary during the first half of this century, it was established that the training walls had significantly changed the distribution of flood and ebb tidal flow in Liverpool Bay [1]. Measurements of flood and ebb flow throughout a tide were made just above the seabed at a number of fixed positions on a hydraulic model of the area both before and after the installation of training walls. The difference between the amount of water moving past each position on the flood and on the ebb gave the net movement of water per tide at each point. Since most of the sand eroded and transported by flow is carried by near-bed rather than surface flow, the behaviour of bed water is a good indicator of the direction of movement of the sediment.

Figure 2 depicts the effect of the training walls on net flow per tide. Before training (Fig 2 (a)) the whole of Liverpool Bay was fairly evenly divided between net flow landwards towards the mouth of the Mersey estuary and net flow seawards. After training (Fig 2(b)) the direction of net flow over the entire area of sand banks to the west of the navigation channel (Fig 1) had become landward, net seaward flow being mostly confined to the channel itself. Sediments gradually built up the level of the sea bed behind the wall until sand began to be carried over the top into the channel. The increased supply to the flood tide entering the estuary meant that more sediment per tide was being transported into the Mersey to deposit at slack high water than before. This high level of accretion continued until a new balance, or dynamic equilibrium, was reached which reflected the changed flow conditions.

SAVANNAH HARBOUR

In the previous example the prime need was to stabilize the wandering course of the approach channel through Liverpool Bay. With Savannah Harbour the main requirement was to keep pace with the ever-increasing draught of ships through a continuing programme of channel deepening. Fortunately, implementation of the necessary dredging was accompanied by painstaking record-keeping on the part of the engineers responsible. Between 1923 and 1953 the lower 37 kilometers of the Savannah River were dredged on four separate occasions to provide an overall depth increase of 3 metres. The location of Savannah Harbour and the consequences of the deepening are shown on Figure 3.

In 1923 the main siltation area was Zone A, a stretch of estuary needing maintenance dredging at a rate of about 11/2 million cubic metres a year to maintain navigation at the required depth. By 1953, after successive deepening, the siltation area had gradually been displaced some 20 kilometers up-river to Zone B. Here the average annual maintenance dredging had risen from almost nothing in 1923 to over 31/2 million cubic metres in 1953. By this time there was no longer any need to dredge in Zone A (Fig 3(b)).

Why should channel deepening have had these effects? The answer is to be found in the way in which the fresh river water and the salty tidal water mix.

Savannah Harbour is what hydraulic engineers call a 'partly-mixed' estuary. That means that the vertical mixing of fresh and salt water is not complete and so instead of water throughout the depth becoming uniformly more saline as you go from river to sea, surface salinity at a given position in the estuary is significantly lower than near-bed salinity at that position. Most of this salinity difference occurs over a small increment of depth, or transition zone, which behaves like an interface between two liquids of different density. Upstream of this transition zone the net flow of water is seawards at all depths: downstream of the zone it is landwards. Transported sediments therefore accumulate near the upstream limit of the zone since the net flow of water near the bed is to this region from both directions. As the channel of the Savannah River was successively deepened the tide could penetrate further and further into the estuary, and the transition zone, with its associated area of siltation near the upstream limit, was gradually displaced landwards.

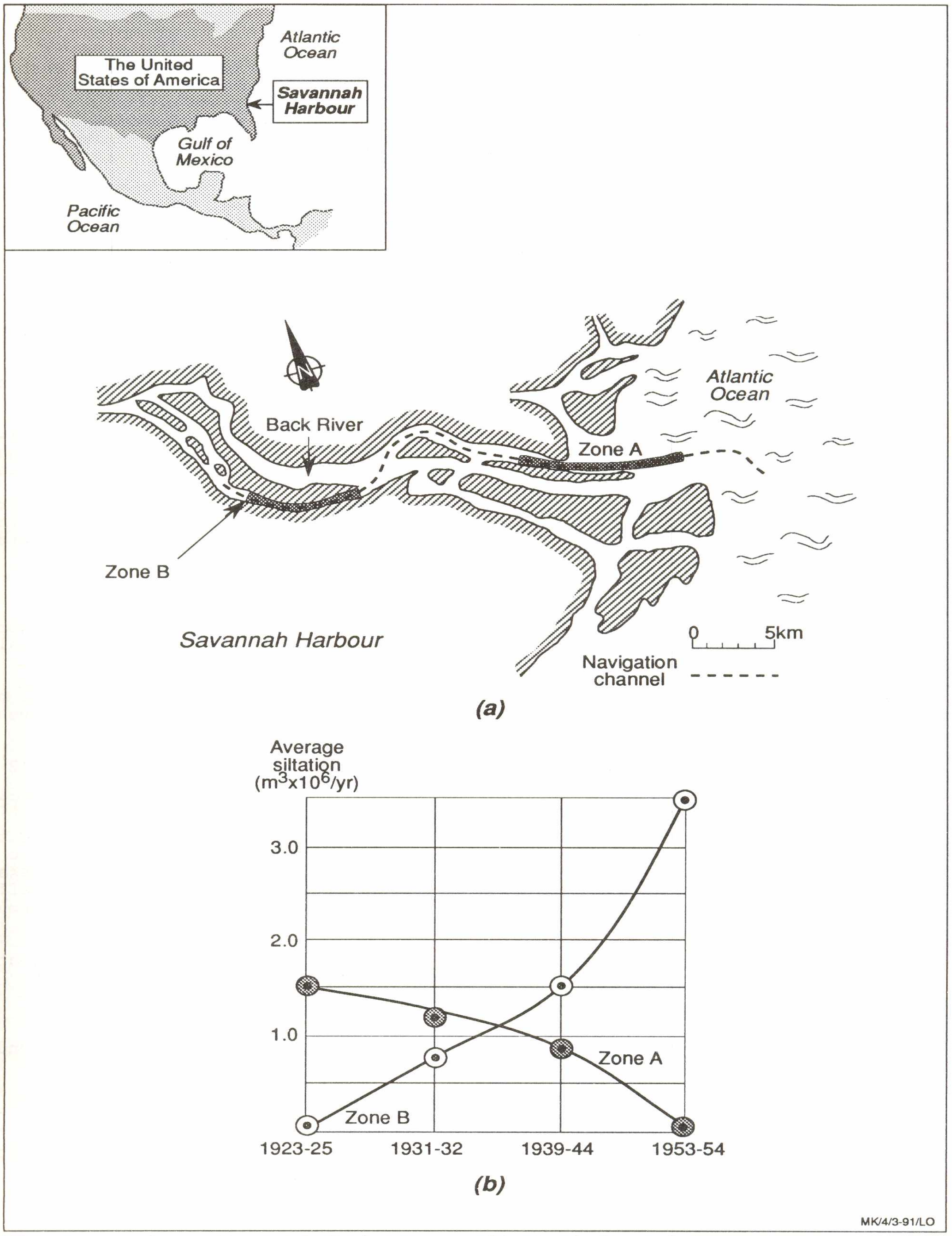

Figure 3. Savannah Harbour - effect of channel deepening

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As in the case of Liverpool Bay, the civil engineering works in Savannah Harbour had the desired effect of improving navigation. Also, as in Liverpool Bay, they had unforeseen, undesirable side-effects, for the new, up-river siltation area (Zone B on Fig 3(a)) was located in a highly inconvenient reach of the Savannah River. Not only was it adjacent to the main port area of the City of Savannah, it was also some distance away from the spoil disposal grounds.

In an investigation into possible ways of re-locating the siltation zone without further jeopardizing navigation channel depths, the Waterways Experiment Station, Mississippi carried out hydraulic model tests as a result of which they made the following recommendations [2]:

I. a deep sediment trap be dredged in Back River Just above its confluence with the navigation channel;
II. a dam with one-way tide gates be constructed in Back River just above the sediment trap;
III. a new cut be dredged to link Back River to the navigation channel near the small island upstream of Zone B.

During the incoming tide, water with its sediment load would flow into Back River in the usual way, depositing sediments in the deep trap. Just after slack high water, the ebbing tide would close the gates damming the water above and forcing it to flow back into the navigation channel via the newly dredged cut. The higher-than-usual ebb flow down the navigation channel would carry sediments from Zone B to a new deposition area near the entrance to the sediment trap where they could be more conveniently dredged and deposited on the spoil grounds immediately to the north of the trap.

BELAWAN

The two case histories described above illustrate how major harbour channel works, undertaken without the benefit of an understanding of those factors which locally influence the behaviour of flow and sediments, can create serious unforeseen problems. The third example, from Indonesia, has been selected because it represents a more recent port development proposal in which channel deepening has been preceded, rather than followed, by a detailed investigation of the relevant factors [3],

The Port of Belawan is approached from the Straits of Malacca by a channel, 12 kilometers long and 100 metres wide, which runs through an extensive area of shallow mud banks and is maintained at a depth 9t metres below low water of spring tides by dredging at a rate of 4 million cubic metres a year (Fig 4). The proposed creation of new berths for larger vessels and the extension of the Citra Basin involve dredging and maintaining the approach channel 3 metres deeper to allow passage for ships at all states of the tide. The government of Indonesia and the port authority needed to know how implementation of the works would affect the port, estuary and sea channel and what their future dredging commitment would be likely to be.

To obtain an idea of the magnitude of the additional maintenance dredging that would be required to keep depths in the approach channel and port at the new deeper levels, it was necessary to determine the existing siltation mechanism. This was done utilizing:

I. analysis of records gathered during 21 months at numerous sites under a variety of conditions;
II. calculations of fluvial sediment loads from continuous records of turbidity and water level;
III. determination of sediment fall velocity and bed density from in-situ measurements;

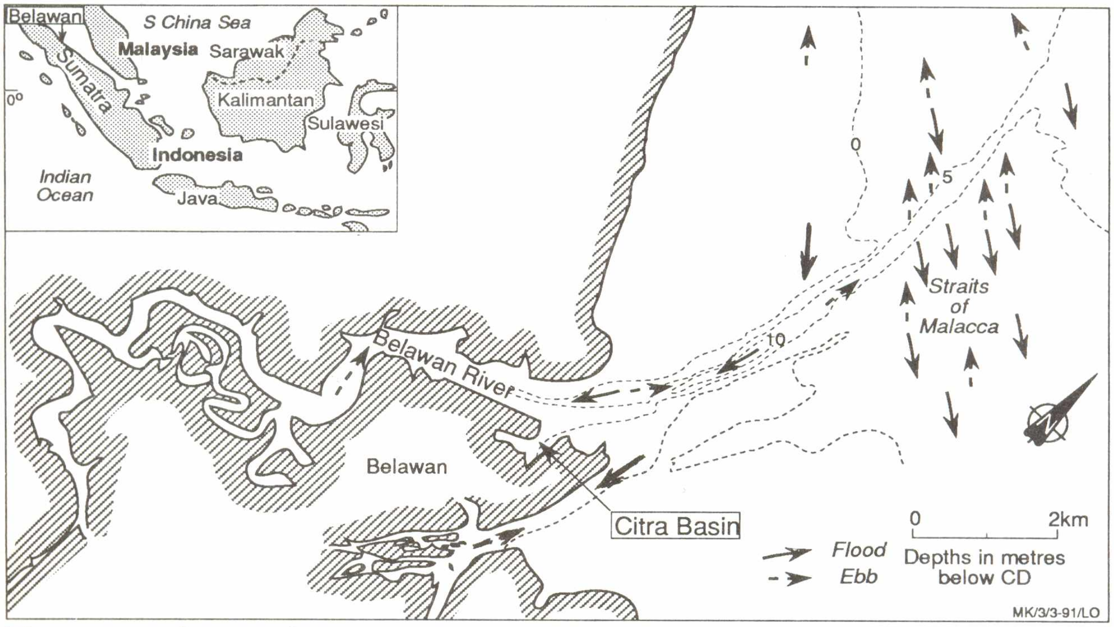

Figure 4. Belawan - approach channel to port

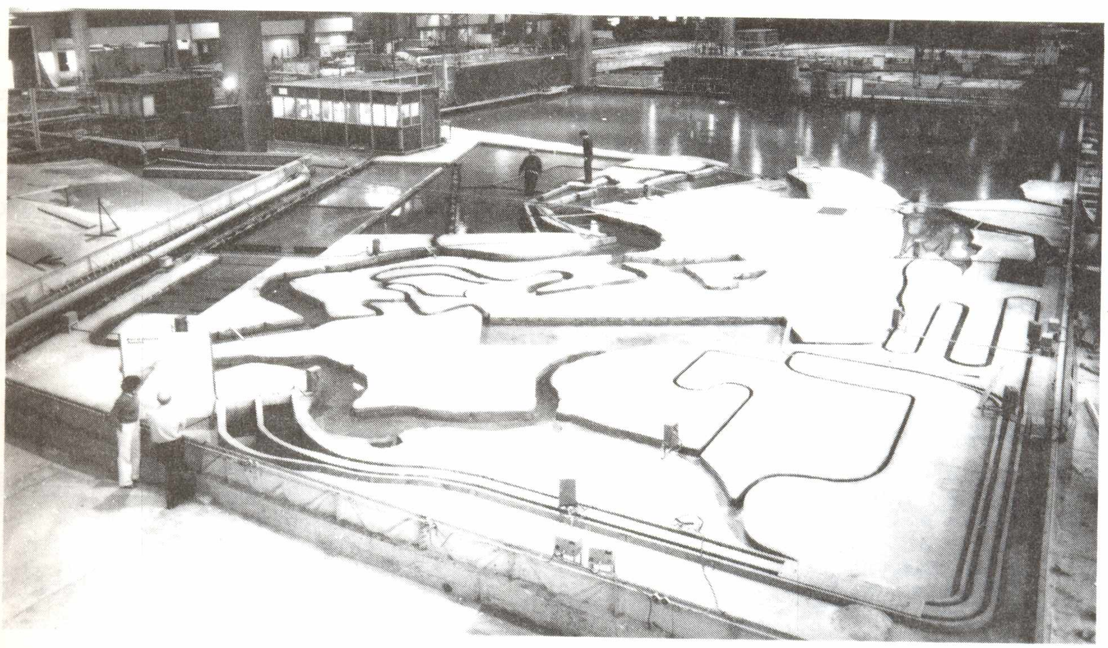

Figure 5. Hydraulic model of Belawan and approaches

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iv. analysis of wind/wave observations;
v. results of flume tests on Belawan mud to establish its erosional behaviour in currents;
vi. Results of laboratory experiments on Belawan mud to determine its behaviour under different combinations of waves and tidal currents.

Before these studies were carried out there had been much, speculation on the part of the consultants, both European and Asian, as to the reason for the existing siltation at Belawan. The most popular conclusion was that it was due to silt transported down the two main rivers to deposit in the approach channel.

Contrary to expectation the results of (ii) indicated that only about 17% of the total volume dredged annually could be attributed to river-borne sediments. The implications of the measurements in (iii) and the tests in (v) were still more surprising when considered in the context of the strength of the currents measured in the Belawan channel. They showed that any sediment which managed to deposit on the bed during the slack water periods between the flood and ebb of tides would be quickly re-entrained by the flow on the following part of the tide. Some other factor (or factors) was clearly having a major effect and its identity emerged from the analyses in (i) and (iv) and the results of (vi).

(i) And (iv) indicated that throughout the day, the near-bed concentration of suspended sediment over the mud banks flanking the approach channel increased significantly with the increase in wave activity which occurs for a few hours on most days of the year. (vi) demonstrated that waves having combinations of wave height, wave period and water depth equivalent to those experienced at Belawan and giving a wave orbital velocity near the bed of O.26m/s created a highly turbid layer, several centimetres thick. This layer could be transported virtually intact, without being mixed with the upper layers of water, by the modest tidal currents which flow over the offshore mud banks and obliquely across the seaward end of the channel (Fig 4). Once in the deeper water of the channel the turbid layer would remain there, beyond the influence of waves and subject only to the prevailing balance between near-bed river and tidal flows along the channel.

Given a knowledge of the siltation mechanism it was possible from the field, laboratory and model results to calculate the existing annual distribution of shoaling in port and approach channel. The agreement with available dredging records for various locations was good, so repeat calculations were carried out using new flow data obtained from a hydraulic model (Fig 5) in which the approach channel was successively deepened by 3 metres.

In addition to revealing the existing siltation mechanism at Belawan and demonstrating how tidal penetration and saline intrusion of the estuary would be affected by the civil engineering works, this study established the optimum alignment for the new berths and indicated the future maintenance dredging commitment. The proposed development is now gradually being carried out at Belawan and we await the results of field monitoring with interest so that we may check the accuracy of the predictions.

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Flap Setting Estimation for Optimum Lift to Drag Ratio of an Aircraft

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SUMMARY

Contemporary aircraft are being equipped with multiple control surfaces in each axis leading to non-unique steady state trim solutions. This redundancy in control effectors can be successfully employed to, derive optimum trim strategies. In the present paper, optimization of the Lift/Drag ratio of an aircraft using multiple longitudinal control surfaces is illustrated. In contrast to conventional methods of optimization using aircraft planform data alone, the control surface schedules are derived using a six degree of freedom simulation tool. This result in deriving realistic control surface schedules taking into consideration limits imposed by thrust and actual maneuver conditions.

Introduction:

Improvement of the trimmed Lift/Drag (L / D) ratio of an aircraft has a direct bearing on its maneuverability. Additional control surfaces such as flaps, leading edge slats are used to achieve this improved aerodynamic efficiency. Optimum deployment schedule of these surfaces can generally be established using basic aircraft lift, drag and moment (planform) characteristics [1]. However in this type of analysis, constraints imposed by actual aircraft thrust and maneuver boundaries cannot be incorporated. Thus a six degree of freedom simulation setup with flexibility to implement different trim strategies [2, 3, 4] has been used to generate realistic optimum control surface deflections to maximize the Lift/Drag characteristics over the maneuver range of interest.

Aircraft Example:

For illustration purposes, an aircraft having a primary trim control surface and a leading edge vortex flap (Slat) as a secondary surface is considered. The simulation software [2] requires as its input the aircraft's, (i) mass and geometry data, ii) aerodynamic data, iii) engine data and iv) control excursion limits. The simulation program [2] can trim the aircraft to different steady states and the following ~rim conditions are used in the present study;

1) Straight and Level

In this condition all translational and rotational accelerations of the aircraft are zero for a prespecified aircraft velocity and altitude. The engine thrust balances the drag force and the control surfaces are deployed to achieve the remaining force and moment balances.

2) Push-over I Pull-up Maneuver

In this condition a wings level flight condition results at a specified 'load factor' defined as the ratio of lift I weight. Load factor greater than unity results in a pull-up maneuver and 'load factor less than unity corresponds to a push-over maneuver. The trim state defined results in a non-zero steady state pitch rate depending upon the trim load factor. The remaining angular rates are zero [2].

3) Level Turn

I n this condition for a specified aircraft velocity, altitude, bank angle, direction of turn and load factor, trim is achieved. The resulting steady state angular rates are discussed in [2]. Using these reference trim conditions, the aircraft Lift I Drag ratio is computed for a mach number range of 0.5 to 0, 19 for Slat retracted and extended conditions. The different trim conditions enable the aircraft to be operated over a range of angle of attack.

Results

Figure 1 shows the variation of LID of the aircraft for different maneuvers as a function of slat deployment. These variations were computed for a fixed center of gravity of the aircraft and trimming the aircraft over a range of Mach numbers. In the case of level turn and pull-up maneuvers the load factor was also varied. From the figure it is seen that for the straight and level flight condition it is inadvisable to extend the slats. In the level turn and pull-up maneuvers, there is a range of angle of attack, typically 6 to 10 deg, in which improvement in LID can be achieved by extending the slats. Indeed both the maneuvers have similar LID variations as a function of angle of attack. Optimum slat deployment is thus dependent both on angle of attack and maneuver. Since it is inadvisable to derive a slat extension schedule based on maneuvers, additional scheduling parameters which capture the aircraft maneuver state can be investigated.

Figure 2 shows the dependence of the LID on Mach no in the typical maneuver Mach number range. From the figure it is seen that the transition angle of attack at which the slat deployment becomes effective varies as a function of Mach number. Thus Mach number is a good candidate as an additional slat scheduling parameter.

Figure 3 shows the slat deployment transition boundary as a function of angle of attack and Mach number. A cubic polynomial adequately defines this boundary and the following slat deployment algorithm can be postulated in the maneuver Mach no range (0.7 - 0.9).

Variable Definitions:

M	:	Mach No
ALPHA	:	Angle of Attack (Deg)
ALFT	:	Transition Angle of attack

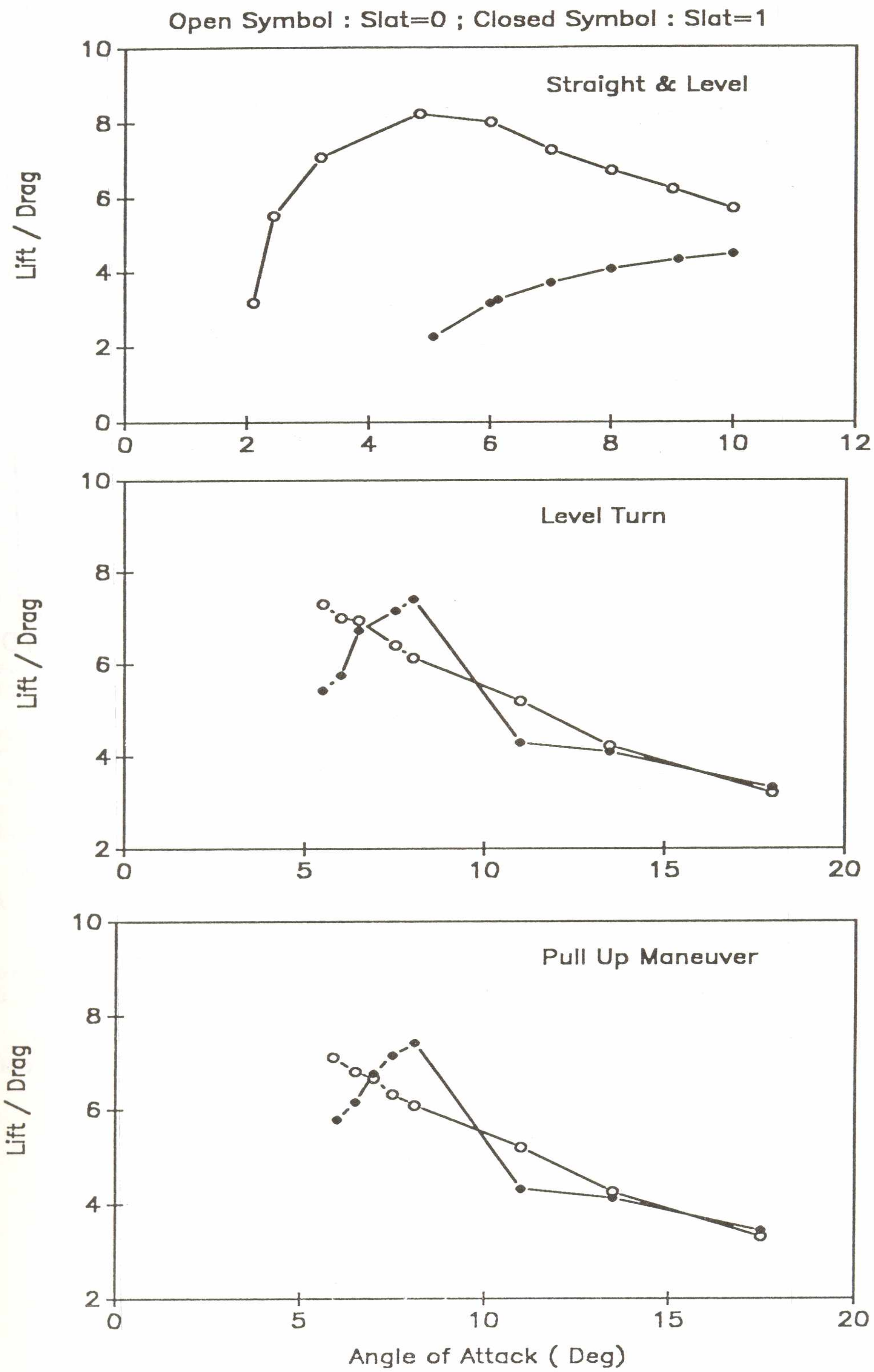

Figure 1. Maneuver dependent L / D Characteristics
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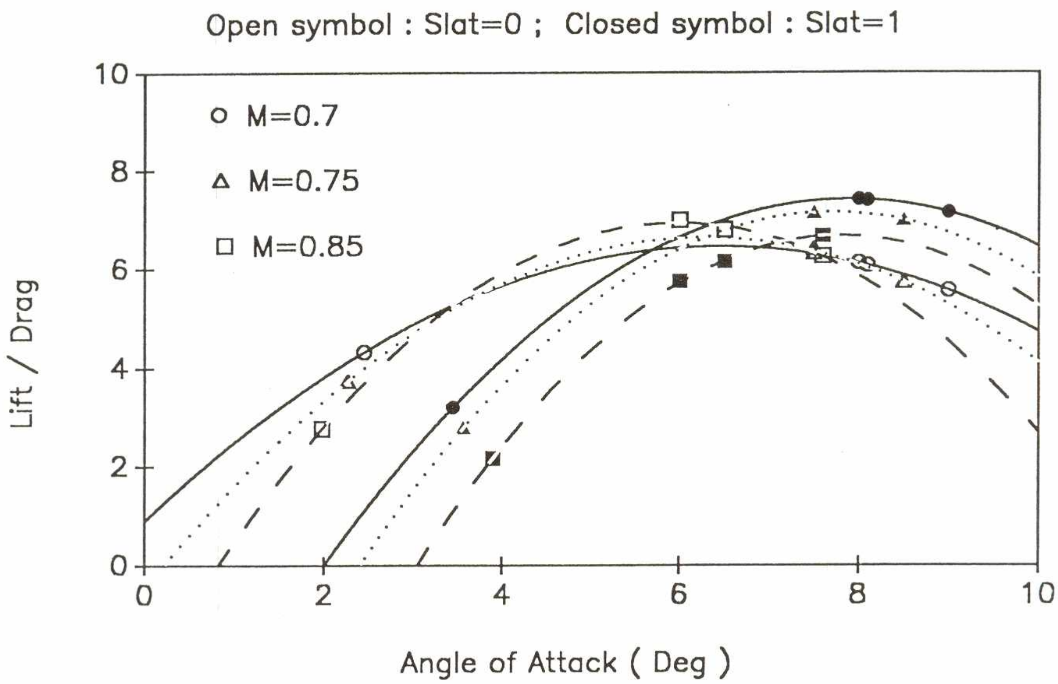

Figure 2. Mach No dependent L / D Characteristics

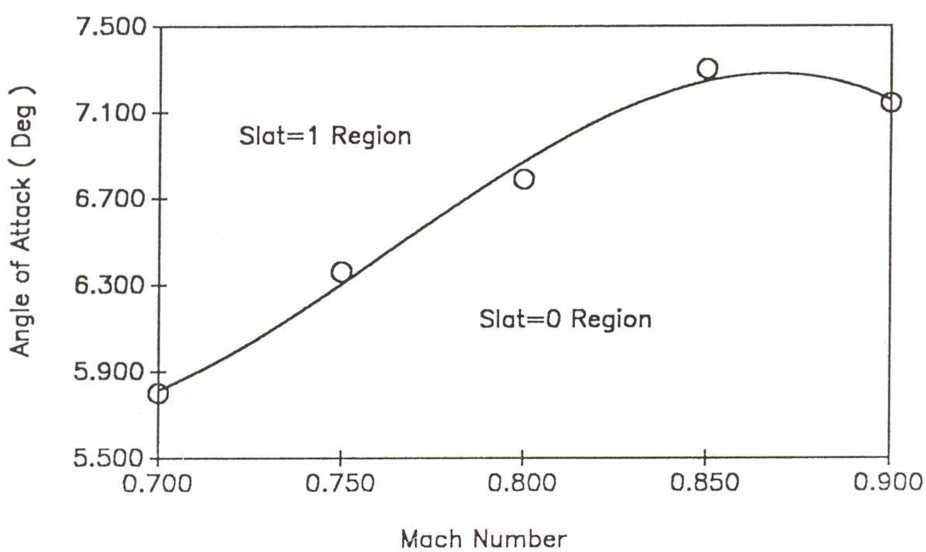

Figure 3. Slat Deployment Boundary

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1. FOR M = 0.7 to 0.9,
   ALFT = 100 * (1.58 - 6.19*M + 8.25* M**2 -3.6* M**3)
2. IF ALPHA < = AL FT, THEN SLAT = 0 ELSE SLAT! = 1
   ENDIF

From practical implementation considerations, this algorithm must be modified to build in a hysteresis function which prevents chatter of the slat control surface if the operating angle of attack is close to the transition boundary.

Conclusions

A method of computing the optimum trimmed L / D of an aircraft equipped with multiple longitudinal control surfaces is illustrated. It is shown that use of a six degree of freedom simulation tool facilitates in deriving realistic control surface schedules taking into account thrust and maneuver boundaries. Simulation studies reveal that the maneuver conditions of the aircraft can be adequately parameterized by a combination of angle of attack and Mach number leading to a slat schedule which is a function of both these parameters. Since the vortex slat used in the aircraft example is not an independent trim surface, substantial L / D improvements are not achievable compared to configurations having canard / wing / tail control surface combinations.

Acknowledgements

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Multicriterial Evaluation Techniques for Urban Transportation Systems - Methodology and its Application to a Case Study

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SUMMARY

A brief description is presented of the stages of a multicriterial evaluation procedure and a recommendation of suitable techniques for each stage which is being used by the Institute of Transportation & Traffic Engineering, Prague as a result of the research work performed recently under the author's leadership.

INTRODUCTION

The design of an urban transportation system is usually being prepared in alternative solutions. The transportation engineer's task is to choose from a number of proposed alternatives one which represents the ' best solution with respect to the socio-economic, environmental and political constraints and which simultaneously fulfils all the transportation engineering requirements. The multicriterial evaluation technique is the tool needed which enables to take all the aspects mentioned into consideration to achieve an optimal solution. A broad variety of multicriterial evaluation methods exists. Their characters are very different, varying from highly abstract and sophisticated procedures to quite primitive, pragmatic solutions. The methodology proposed was verified in all steps by solving a case study of multicriterial evaluation of the proposed Prague mass transit network for the year 2010. Six alternatives of Metro network were chosen from more than 20 preliminary proposals for further more detailed processing. Each of them represented a certain group of preliminary proposals. Their mutual differences were large enough to secure a positive effect to the verification of the proposed evaluation methodology itself. The proposed multicriterial evaluation process consists of the five stages described in the following paragraphs.

1. FORMULATIN OF THE PROBLEM

The problem formulation is the first crucial part of the procedure. The problem has to be formulated so as to avoid ambiguities. By this, any subsequent misunderstandings are avoided which might cause emphasizing irrelevant answers. The definition of the goals of evaluation is closely connected with the formulation of the problem. It represents the base for criteria set creation and composition. In practice it means that it is necessary to clearly define for each particular case which needs or functions have to be guaranteed by the assessed alternatives.

2. THE DEVELOPMENT OF THE CRITERIA SET

The main requirement is that the criteria set has to fulfil the whole spectrum of goals. Then it is restructured according to the principal aspects. Formulation which could concentrate, in one criterion, incongruous or contradicting aspects must be avoided.

It is recommended to formulate rather larger number of criteria and later to eliminate them, if necessary. In the case of a transportation system evaluation the set of criteria should cover the three main aspects: the system users' point of view, the operators' (operational technology, economics, the use of capacity) and the impact on environment and community as a whole. A correct balance of criteria set plays a very important role. Each criterion should have but one meaning, be unambiguous, computable, the units and/or the scale of measurements clearly specified and overlapping or duplicity avoided. The set of criteria arranged hierarchically in to a tree represents a considerable help for the decision maker, namely in the stage of the criteria weights assessment. When the tree is being designed, the aspect of logical connection of criteria is of high importance. The goal of evaluation is identical with the hierarchically highest criterion, is represented by the top of the tree and establishes its zero level. The criteria originated by the disintegration of this hierarchically highest criterion create the first level of the tree. Generally the k-th level of the tree is created by the integration of criteria originated by disintegration of (k-1)-th level of the tree. On the top of the tree there are mostly the qualitative criteria. Way down the criteria become more specific which makes possible to express them quantitatively. The fulfillment of criteria at a higher level of hierarchy is only possible through the fulfillment of the lower level criteria.

3. WORKING OUT OF THE ALTERNATIVE SOLUTIONS

The stage of working out of alternatives relies almost entirely on the creative ability of the engineer and his grasp of the problem being solved. This stage and the creation of criteria are closely related.

4. THE.EVALUATION OF ALTERNATIEKS AND PREFERENCE ORDER DETERMINATION

4.1 THE ASSESSMENT OF THE IMPORTANCE OF CRITERIA BY THEIR WEIGHT RATING

The criteria weights assessment is based on the expert team statement. It is not recommendable to use too complicated methods mainly because of the time required for ranking. In the work highlighted so called direct methods of weights assessment had been used, where the knowledge of the consequences of alternatives to the individual criteria are not required. A short explanation of the methods used follows:

The assignments of points from the selected points scale:

An expert assigns a certain number of points from the selected points scale to each criterion at the given level according to the importance of each criterion. For easier orientation it is recommendable to describe the point scale, for

Example:

number of points	descriptor
1	criterion has nearly no importance
3	criterions is slightly important
5	criterions is of mean importance
7	criterions is very important
9	criterions is extremely important

Point values 2,4,6,8 could be used for more detailed scaling.

Metfessel's allocation:

The expert has 100 points to distribute between individual 8riteria in each tree level according to their importance. The advantage of this method when compared with the previous. One is its finer scale.

The evaluating scale:

The set of criteria for each tree level is placed next to the evaluating scale and an expert connects each criterion to a point of the scale which, according to his opinion, corresponds to its importance. The evaluating scale can be linear or nonlinear in the interval <0; 1>, associated with descriptors defining the start of the scale and its increments.

The comparison of criteria importance based on their preference order:

The weight rating is performed in two stages:

i/ the preference order of individual criteria in each tree level is set

ii/ the weight rating (non-standardized) follows; all criteria are compared with the least important one which stays last in the preference order. The expert determines how many times more important is the last but one criterion in preference order than the last one. This procedure is performed successively for all criteria. The established coefficients of importance represent the non-standardized weights of criteria.

Some observations on the expert team work:

The assessed tree of criteria was obtained through an expert team work. The relative 'importance of individual criteria was expressed by averaged weights and their standard deviations derived from the whole set of experts assessments. The case study proved that the above methods are not accepted by all experts in the same way. The opinion of an expert may differ when using different methods. That's why it was recommended to use at least three of the above methods at once for assessment of the same criteria set. The reliability of the weights obtained in such a way is higher.

When an expert team is to be appointed it is useful to take account of the following aspects influencing the subjective opinion:

- a person without a certain amount of professional enthusiasm will not approach the problem with proper responsibility; on the other hand, people who are too enthusiastic tend to exaggerate the significance of their own professional field and they are not prepared for the compromises needed from the point of view of the solution as a whole. A team composed entirely from personalities of this kind cannot be expected to reach mutual understanding, even if all are highly qualified professionals
- a motivation should not be forgotten; not necessarily it needs to be a material motivation, very often the professional pride is sufficient
- Members of the expert team should be able to take a global view of the problem considered and should represent the related professional fields
- a broad age spectrum among the experts is an advantage
- Where possible, the expert team should be composed of people who reached their Experiences and knowledge at different schools /posts
- the expert team should be familiar with the problem being evaluated, especially with the specifications of proposed alternatives and the set of criteria composition to great detail, the information given as to the conceptual intentions and local conditions should be of the same details for everybody
- after the results of criteria assessment have been worked out, the expert team should be assembled once again and shown the results; the differences in the assessment of individual criteria should be analyzed and a consensus reached
- the consistency of the team's assessment should have be analyzed by cluster analysis, to find the core of cluster representing the opinion of the whole expert team as well as the extreme opinions for the further sensitivity analysis of results.

4.2 THE METHODS OF THE DETERMINATION OF THE PREFERENCE ORDER OF ALTERNATIVES:

This is the crucial Point of the decision-making procedure. There are different approaches to the multicriterial evaluation of alternatives and they differ considerably in relation to the nature of set of alternatives and set of criteria. When the study of individual methods had been undertaken, the aspects of practical serviceability were respected. The following have been chosen and used: the basic alternative method, PATTERN method, a linear partial utility function method and a method of the distance from the ficticious alternative. A detailed description can be found in [1] and [2].In all methods it is assumed that the total assessment of alternatives is expressed. as a weighted sum of partial assessments of alternatives according to the Individual coterie, I.e. In the form $H = \Sigma_{i=1} vi .hi$

Where n is the number of criteria

H^j is the total assessment of j-th alternative

$h^j{}_i$ is the partial assessment of j-th alternative as to the i-th Criterion

m is the number of alternatives

V_i is the weight of the i-th criterion

Then the preference order is determined on the basis of the total assessment of all alternatives.
Simplifications considered:

a/ the validity of the assumption of mutual criteria independence is not being verified while the total assessment of alternatives is being worked out

b/ the criteria weights are determined without regard to the knowledge of consequences of alternatives as to the individual criteria

c/ the partial utility functions are assumed linear

It must be emphasized that the methods mentioned have different algorithms for calculation of the partial utility functions. It is therefore advisable to use more than only one method for the preference order determination. Some weak points of these methods should be mentioned: when the basic alternative method is used, it is necessary to be well aware of the different ways of calculation of the utility function of the alternatives having criteria with both increasing and decreasing preferences. The partial utility function for the criteria with increasing preferences is linear. For criteria with decreasing preferences it is a hyperbola in the interval <xj, xi> where xi is the best value of consequences of alternatives and xi is the worst value of consequences of alternatives. Hence an equal increase of contribution is being considered where there are equal increments of consequences values. While for criteria with decreasing preferences there is the regressive fall of contribution while the increments of consequences values are equal. Then there could occur a change in preference order compared with that obtained by other method. The PATTERN method cannot be used when the extreme values of the consequences of alternatives reach 0 (division by zero).

As a conclusion it can be said that the choice of a suitable method is closely related to the character of criteria set. Methods of linear partial utility functions and the distance from the ficticious alternative appear a broadest usability.

5. SENSITIVITY ANALYSIS

It represents the closing but a very important stage of the multicriterial evaluation technique. One its task is to find out if the derived preference order of alternatives is sensitive to the criteria weights. It is verified by providing calculations with unit weights as well as with weights assessed by an expert team. The other task is to find out if the preference order is dependent on methods used for its establishment. The cause of possible discrepancies are analyzed showing -the particularities of the criteria set. For the purpose of sensitivity analysis the extreme opinions of experts determined by means of cluster analysis serve to show how the preference order could have been influenced when the evaluating aspects differ.

Finally, it should be emphasized that the particular stages of the evaluating procedure may be repeated by means of backward bond. The process then goes in cycles: definition of goals of evaluation - development of criteria set -criteria weights assessment - revision of criteria set or goals etc.

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Noise Standards for New Railways

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SUMMARY

This paper describes the current situation in the UK relating to the introduction of a noise insulation standard for new railways. The research leading to the recent recommendation for a standard is discussed, and the proposed British standard compared with international standards for railway noise.

INTRODUCT'ION

At present there is no national standard governing railway noise in the UK, although many local authorities employ their own guidelines on acceptable levels of railway noise. Until very recently no new railway lines had been opened in this country since 1902, so increased noise due to the presence of a new railway has not been an issue. However, several new urban light rail systems are currently being developed in towns around the UK, and the British Rail Channel Tunnel high speed rail link is due to open in a few years time. With the increased awareness of environmental issues among the general public, and the realisation that noise is an unnecessary pollutant, the British Government has recognised that a standard to control noise from new railways is a urgent necessity.

Since 1973 road traffic noise in this country has been subject to the Noise Insulation Regulations which provide sound insulation to dwellings affected by noise due to a new road above a certain noise level. In 1990 the British Government set up a committee to investigate the possibility of setting a standard for new railways comparable to that already in existence for new roads.

NOISE INDICES

Over the years numerous indices have been developed for the purpose of measuring transportation noise. The following table gives the most common noise indices in current use:

Index Definition

LA_{10} The noise level, in dB (A), which is exceeded for 10% of the measurement time.

LA_{90} the noise level, in dB (A), which is exceeded for 90% of the measurement time.

L Amax the maximum noise level, in dB (A), which occurs during the measurement time.

L Aeq The 'average' noise level, in dB (A), which occurs over a particular period. If several events occur during the specified period, their level and duration are both accounted for.

ANNOYANCE DUE TO RAILWAY NOISE

The only major study into people's response to railway noise in the UK was carried out in the early 1970s by Fields and Walker [1]. They concluded that people were less annoyed by railway noise than by noise from road traffic, and that the noise index which best correlated with annoyance was the 24 hour LAeq.

Walker [2] has subsequently suggested that a 24 hour LAeq of 70 dB (A) represents the maximum tolerable level of railway noise. However, at the time of the survey no new railways had been built in this country since 1902, so it inevitably concerned only noise from existing railways. Indeed all the people questioned can be assumed to have either lived near a railway all their lives, or to have moved to their current home in the knowledge that there was a railway nearby. Recent research by the author and colleagues [3, 4, 5] has shown that community response to a noise from a new railway is very different.

The new railways due to be built in this country are either light rail systems or high speed railways. Research has been carried out in this country and elsewhere to try to determine the likely community response to noise from both types of railway.

The only new railway to be opened in this country in the last 90 years is the Docklands Light Railway (DLR) in London. As soon as it opened there were many complaints about noise, and detailed investigations into the sources of the noise and the reasons for the annoyance have been carried out by Shield et al [6, 7]. They found that annoyance is caused at very much lower levels than suggested elsewhere for railway noise, and cite various reasons why this may be so. In the case of the DLR for example, the railway passes very close to dwellings, with stations and track sometimes being only a few metres from bedroom and living room windows. The noise disturbance to residents in such dwellings is obviously very great. The character of the noise of the DLR is very different to that of traditional British Rail trains. In some areas where the track is supported by lightweight steel and concrete structures, high levels of low frequency noise are occurring. This 'rumbling, thunder like' noise causes considerable distress to people living nears the viaducts, keeping them awake at night, waking them early in the morning, and causing general disturbance. Another feature of light rail

Is that the trains run very frequently, and so it could be argued that a light rail system is more akin to a road than to a railway, and that a noise level standard similar to that for new roads should apply.

At present high speed trains operate in France and Japan. Surveys of public response to the noise from high speed trains have been carried out in both countries [8, 9, 10], and it has been found necessary, owing to adverse public reaction, to introduce noise standards specifically for these trains.

INTERNATIONAL STANDARDS FOR RAILWAY NOISE

In addition to the standards mentioned above for high speed trains many other countries already have standards for railway noise. Some examples are shown in the table below. The limit represents either the level at which no new housing is allowed (*), the level at which sound insulation is provided to affected dwellings (#) or a target level for new lines (+).

Country	Noise Index	Limit dB(A)
Denamrk	LAeq (24 hour) LAma	60* 85*
France(TGV)	LAeq (day) (0800-2000)	65 or 70+ (depending on background level)
Germany	LAeq (day) (night)	59* 49*
Netherlands	LAeq (day) (evening) (night)	60* 55* 50*
Japan (Shinkansen)	LAmax	70*

THE CURRENT SITUATION IN THE UK

In January 1988 British Rail stated that they would provide sound insulation to dwellings along the route of the Channel Tunnel high speed link when the sound level exceeded a 24 hour LAeq of 70 dB(A). This figure was based on the recommendations of Walker [2].

In order to build a new railway in the UK the promoters have to obtain permission through an Act of Parliament. The proposal is examined in detail by committees of members of both the House of Commons and House of Lords. In March 1988 a House of Lords committee considered a Bill for an extension of the Docklands Light Railway. Strong representation was made to the committee on the problems of noise affecting the local community [11], and during the passage of the Bill the DLR offered to provide sound insulation to dwellings affected by noise levels greater than 70 dB (A) 24 hour LAeq due to the extension. The author argued before the Committee that because of the differences in response between new railways and existing railways the appropriate level was 65 dB (A). In addition, the author argued for the inclusion of a maximum permitted level, to prevent disturbance particularly at night. The committee amended the Bill to include a clause requiring that sound insulation should be provided when the 24 hour LAeq due to the extension exceeds 65 dB (A) [12]. This was a major breakthrough in the history of railway noise, being the first time that any reference to noise had been included in a railway bill, and set a precedent for any future railways to be built in this country. Furthermore, the needs of the local community were recognised, in that the level for sound insulation chosen be the House of Lords was that requested by the local community, rather than the 5 dB (A) higher limit desired by the DLR.

Following the passing of this Bill the Government set up a committee to recommend a national noise insulation standard for new railway lines. The committee considered all the available research, relating to railway noise and annoyance, and standards used in other countries. The committee reported in March 1991 [13] and recommended that, in the case of new railways, sound insulation should be provided to dwellings where the 24 hour LAeq exceeds 66 dB (A), or the night time (2300 to 0700 hours) LAeq exceeds 61 dB(A). The committee also recommended that the maximum sound level due to a train passing should be considered. It suggested that homes exposed to a maximum sound level of 85 dB (A) LAmax or more should also be provided with sound insulation.

CONCLUSIONS

It seems likely that a standard for railway noise will be introduced in the UK in the near future. This will bring the UK into line with the many countries throughout the world which already have such a standard, although there is considerable variation among those countries both in the unit used to assess the noise and the limits set. The introduction of a railway noise standard, following other recent environmental legislation in the UK, will provide further evidence of recognition by the Government of the need for protection of the environment, and the contribution, previously overlooked, of railways to environmental noise.

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A Brief History of the Midlands Motor Industry

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Summary

This paper covers the history of the British automotive Industry in the Midlands from 1869, with the manufacture of two-wheeled, human-powered transport, to present day motor cars, focusing on Rover Group with its locations in Coventry, Birmingham and Oxford.

* * * * *

Most people now acknowledge that the British motor industry started in Coventry. Building motor cars can be seen as a logical progression from producing motor bikes, and motor bikes from bicycles. Less logical, however, is the progression from sewing machines to bicycles that the Starley family's company made in 1869.

The roots of the British car industry go back to the 1850's when two mechanical engineering entrepreneurs, Josiah Turner and James Starley, set up the Coventry Sewing Machine Company. Coventry was chosen as the ideal site for the company as at this time its traditional industries of watch-making and ribbon weaving were in serious decline due to foreign competition, adverse trade tariffs and strikes.

This meant that there was a large pool of unemployed, skilled labour available and factory premises were cheap. Additionally there was a well established industrial culture in the area and good transportation links through road, rail and canal, around the country.

In 1869, the Starley family became interested in 'Velocipedes' after a nephew returned from Paris on one, and started producing' Boneshakers', as they became known in Britain. Within a few years they also started producing 'Compresses Ordinaries', commonly known as the Penny Farthing. In 1885 the first Starley 'safety I bicycle was produced, called a 'Rover' - the name symbolising that. the tricycle could wonder, or rove, around the countryside.

The Rover Cycle Company Ltd was set up by, John Starley in 1896, and produced 11,000 cycles in its first year for the late-Victorian cycling craze. six years Inter the first Rover motor cycle appeared followed two years later, in 1904 by the first Rover motor car known as the Rover 8(8 h.p.).The decision, by Rover, to start production of motorised vehicles was only taken when Britain's foundling motor car industry was beginning to show signs of stability aided by changes in legislation. (Until 1896 the Locomotives on the Highways Act' permitted automobiles to travel at a maximum speed of 4

M.P.H. in the country and 2 m.p.h. in towns, this was then amended to 14 m.p.h) .

By the turn of the century there were many motor car manufacturers using the decline in the cycle industry to provide labour and machinery in and around Birmingham and Coventry. In Birmingham there was the Wolseley Tool and motor Car Company, set up by Frederick Wolseley and Herbert Austin as a develop rent of Wolseley Sheep Shearing Company; Frederick Lanchester producing up-market, experimental cars under the Lanchester badge; and the Birmingham Small arms Company (B.S.A)) who manufactured cars from 1906, motorcycles from 1910 and took over Daimler in 1912. Herbert Austin later left Wolseley to set up on his own and paid £10,000 for a disused factory site at Longbridge in Birmingham and started producing vehicles in 1905, under his own name.

Coventry's main companies were the British motor Syndicace, which became the Daimler t'10tor Company through buying the rights to make the Daimler engine in uritain; Riley motors, a family owned company who started production in 1898; Humber Ltd., which at that time had the largest factory in the motor industry worldwide at number Road, Coventry and in 1906 produced 1,000 cars to put the firm at the top of the British production league; Singer (from Singer Sewing machines) and Rover.

The other area in the Midlands that must not be forgotten in the context of the car industry is Oxford. William Morris, at the age of 16, set up a bicycle repair business in a building at the rear of his parent’s house in Cowley, near Oxford, as a way of supporting his family when his father became ill. By 1902 the business had expanded to manufacturing bicycles and also selling cars. In 1910 he opened a car repair facility called 'The Morris Garage’ and two years later set up W.R.M Motors Ltd. which bought components from companies in Birmingham and Coventry and assembled the vehicles in Cowley. Morris had hoped to have his car ready for the 1912 motor Show but the engine had not been completed in time. It was only later that he heard the truth: a freelance draughtsman had accidentally drawn the unit half-size and the finished block had been cast looking more like a motor cycle unit than a car engine!

The First World War brought about many major changes, not least to the car industry. Many soldiers were trained to drive and so become used to the mobility of a car. Most factories became involved in war work and were fitted with the latest machine tools while also dramatically improving efficiency. America's neutrality allowed shipment of Ford motor cars into Britain unhindered, and legislation was passed - known as the McKenna Duty to charge a 33 1/3% tax on all imported cars from 1915, which stayed in Force until 1967. During the immediate post-war period, 1919 to 1925, 86 motor manufacturers were set up but by 1929 only 41 manufacturers in total, survived and of these, three (Morris, Austin and Singer) accounted for 75% of production.

Morris concentrated on mass production of smaller vehicles for the working c lasses and looking ahead he said "Until the worker goes to the factory by car, I shall not believe that we have touched more than a fringe of the home market". This philosophy helped keep the company afloat when many others failed through the slump of the 1930's. Bentley was bought by Halls Royce, Daimler took over-Lanchester, Morris bought many o[his component supply companies and also Riley and Wolseley, Singer bought B.S.A's largest factory and Rootes (distributors turned manufacturers) took over lIillman and Humber (both Coventry based) and five years later Talbot and Sunbeam.

In 1935 the Air ministry announced the likelihood of a war with Germany and began making arranger rents with the motor industry to produce Aero-engines. The idea was to build 'Shadow Factories' - copies of the original financed by the Government but managed by the motor companies. The first generation of factories adjoined the car companies own works in Coventry - Daimler shadow at Radford (currently Jaguar Cars engine plant), Rootes shadow at Stoke, Standard shadow at Conley (currently Rover's design and development facility),only the Rover shadow was out of town at A cocks Green, Birmingham, 20 miles away, which until recently still be longed to Rover. As war loaned, requirements were increased and a second generation of factories was built further out in view of the risk of bombing - Daimler's second shadow at Browns Lane, Allesley, (now Jaguars main assembly plant), Rootes factory was on a 60 acre site at Ryton (currently Peugeot – Talbot's assembly plant), Rover's factory, which become operational in January 1940, was, 16 miles away at Lode Lane, so1ihull (now the Land Rover factory). The motor industry made good use of these spacious factories in the post war years when the climate was set for growth, exports and expansion. British car production doubled between 1949 and 1957. In 1950, no less than 66% of cars built in Britain were exported, the highest ever percentage attained by the industry.

Rover's Coventry factory was damaged in the war and they moved entirely to Solihull, with the idea of letting out a portion of the huge site. The Land Rover was announced in 1948 and in 1949 its production overtook car output and the 1 million square feet site was completely utilised with the new production line.

Triumph and Standard merged in 1946 and began making tractor engines for Ferguson. In 1947 they built 47,000 tractors and 37,000 cars and turned over the Banner Lane, Coventry factory entirely to tractors (it is now r, Massey Ferguson's main site in Coventry, still producing tractors).

In 952 Austin and Morris combined to form the British Motor Corporation (B.N.C), the fourth largest car company in the world outside the American 'Big Three' of General Motors, Ford and Chrysler. It produced 236,000 cars in its first year representing 39% of British car production. At this stage it had 5 marques: Austin, MG, Morris, Riley and Wolseley and in 1953 bought out Austin Healey, and was producing no fewer than fourteen models and a total of nine engines.

The 1960's saw a series of mergers. Jaguar took over Daimler, and the following year Standard-Triumph was bought by the Leyland Commercial Vehicle Company. 1966 saw B.M.C. merge with Jaguar, as a lack of forward planning saw profits fall, and subsequently in 1968 it was taken over by the Leyland Motor Corporation (B.L.M.C). Imports gathered momentum as tariffs dropped and labour troubles plagued the industry, with over 8 million hours lost through disputes in 1965. The most important event of these years was the launch of the Mini in 1959 which is still going strong today with over 5 million Minis having been built and many copies produced around the world. Lord Ryder was appointed by the Government to put together a plan to ensure the survival of British Leyland, or as much of it as could be rescued. His report was published in 1975 and recommended that the Government should inject huge and regular amounts of capital into the company which would ensure that they had a controlling share of the business.'

Over the seven years to 1975, B.L.M.C's market share fell from 40% to 30%. The British motor industry slipped from third place in the European production league to fifth having been overtaken by Italy and Spain, and now imports stand at well. Over 509; of the UK market.

The Ryder Report recommended that all the car makers in the group were to be joined together, with the single exception of Jaguar, as Leyland Cars. They were to reduce the range of vehicles to five basic saloon car shells - three as Austin-Morris, one as .Jaguar and one (slightly smaller and less expensive than Jaguar) as Rover. In October 1977 the current BL Chairman, Sir Richard Dobson, was forced out of office after a scandal and it is generally recognised that the company's public standing and the morale of its workers was at the lowest ebb of all time. Following this Michael Edwards was given "carte blanche" to produce a survival plan with full financial backing. We reduced manufacturing plants from 8 to 3 and rationalised the range of vehicles available, killing off the marques of Triumph, MG and Morris. The last vehicle budged as Triumph was the British version of the Honda Ballade, known as the Triumph Acclaim, which heralded the joint ventures between Honda and In..

In 1982 it became known that a second joint project, the 'XX.' model was under way. This was to be a fast and luxuriously-trimmed executive car and BL and Honda were to each make their own version of the design. This would allow Honda to make a large car, for the first time in its history, and the Rover 800 came to production in an amazingly short time. The name British Leyland was dropped in favour of a new title - Rover Group. Graham Day was appointed by the Government as Chairman and given the brief to make the core functions of too group profitable and see it all privatised again.

In the mid and late 1980's the company was rarely out of the news due to talk of buyouts and mergers. Ford made a bid for Austin Rover (the volume car division) and were re-buffed, general motors wanted to buy Land- Rover Ltd, a management buy-out plan for Leyland vehicles failed and it was sold to DAF of Holland. Then in March 1988 British Aerospace announced its interest in taking over the group. The Government sold its 99.8% share holding in Rover Group to BAF. Who in turn agreed not to sell, or close down, any parts of the company within 5 years? In a post-sale announcement Graham Day stated that: 'The two groups are complementary and not competitive. The new alliance with British Aerospace presents us a 1.1 with an exciting opportunity. Let us all make the most of it'.

Currently Rover Group has an annual turnover in excess of £3 billion and produces around half a million cars a year from Long bridge in Birmingham and Cowley in Oxford and has shown the recent trend for rising profits, which hopefully signifies a resurgence in the car industry, Rover and the midlands. Today the British motor Industry is much more streamlined and efficient, QUALITY is the keyword on everyone's 1ips, and the future looks bright. The survival of the lean years has honed the business and manufacturing skills needed to ensure they arc competitive in what is increasingly a world market.

TR6

The Integrated Road Transport Environment

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Transport plays a very important role in the European economy, but traffic problems are enormous: 55,000 people killed on European roads every year, total loss through congestion and detours more than £300 billion and costs through pollution more than £5 billion per year. Worse still: problems are still increasing in Europe as in other parts of the world.

Traditional means, such as increased road construction, can only help to a very limited extent, and therefore major research efforts are going into new technologies based on informatics and telecommunication: IVHS in America, VICS/RACS/ANTICS in Japan, and PROMETHEUS and DRIVE in Europe. Main focus here is not only the development of isolated systems for different applications, but in particular their integration in an, Integrated Road Transport Environment.

See page **54TR** for complete text

TR6

The Integrated Road Transport Environment

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SUMMARY

In view of the traffic problems now prevalent in many areas of the world, major research effort is going into new technologies based on informatics and telecommunication: IVHS in America, VICS/RACS/ AMTICS in Japan, and PROMETHEUS and DRIVE in Europe, all focusing on the development of an Integrated Road Transport Environment.

FACING THE PROBLEMS

Transport plays a central role in the economy of Europe, but traffic problems are enormous. Some 55.000 people are killed on European roads every year, 1.7 million are injured, and 150,000 are permanently handicapped. The total loss through congestion and detours is estimated to be more than £ 300 billion, and the costs of pollution more than £ 5 billion per year.

Worse still: the performances of our transport systems continue to deteriorate both in Europe and in other parts of the world. In Europe, the number of car registrations is still increasing annually by 6 %, the vehicle miles driven by 5 %, and in spite of all efforts to improve traffic safety the number of accidents is increasing by 3 %. At the same time, the road network is growing only by 0.01 %.

SEARCHING FOR A SOLUTION

Facing this situation, major research effort is going into the development of new technologies throughout the world. Innovations and cost reductions in information technology, telecommunications and broadcasting offer both new opportunities and potentially effective solutions to many of the current traffic problems. Integrated to provide advanced communications, control and information systems, they enable not only new, more flexible and responsive forms of traffic management but also supply users with improved means for trip planning, modal choice, route guidance and vehicle fleet utilisation.

USA

In the United States and elsewhere, the development of versatile advanced traffic control and management systems has been ongoing for a number of years. Schemes ahve often been successful in their limited application, but have been widely uncoordinated. It was in 1986 on the Conference on Technology Options for the Future held in Sacramento by the California Department of Transportation that the idea for a unified national programme took off.

The group "Mobility 2000" was formed, based on cooperation between government, academic and industry representatives. The group developed scenarios for the development and implementation of Intelligent Vehicle Highway Systems (IVHS) which paved the way for a new generation of systems to come.

IVHS America is now the name of a public/private organisation which was formed in 1990 to coordinate IVHS activities. It is a non-profit educational and scientific organisation that aims at providing a focal point for discussion and coordination of IVHS goals and at developing a strategic plan for achieving them. Moreover, it is intended to be a clearing-house for IVHS data and information.

One major issue that will be tackled by IVHS America is the development of a common IVHS systems architecture to enable integrated IVHS systems. Of particular interest is the distribution of functions and intelligence between vehicles and infrastructure, as the installation of infrastructure based systems depends normally on the cooperation of public administrations (if not as system operators and data providers then at least as authorizing bodies), while purely in-vehicle based systems can be developed by industry on its own account.

Also from a European point of view it will be extremely interesting to observe the further development in these and related IVHS America discussions.

JAPAN

The technical development of IVHS (or RTI, meaning Road Transport Informatics, as it is called in Europe) started in Japan with the CACS project for driver information nearly a decade ago. Although the CACS field test was technically successful, CACS never progressed to full system implementation. This was to a large extent due to the fact that CACS, like other systems such as ALI in Germany, was too much ahead of and, at that time, too expensive for its potential market.

After CACS, RACS (Road and Automobile Communication System) and AMTICS (Vehicle Information and Communication System) emerged. Both systems aim at improved driver information, and both use nearly identical in-car equipment which includes CD based storage of a digital map, dead-reckoning with map-matching for identifying the current position of a car in the road network, and a map display. While the functions of both systems are the same, they are differ mainly in regard to their communications: RACS uses microwave beacons and AMTICS a cellular-like mobile radio system for business data communications on teleterminals. Moreover, they are coordinated and promoted by different organisations: RACS by the Highway Industry Development Organisation and AMTICS by the Japan Traffic Management Technology Organisation.

A reconciliation was needed. VICS (Vehicle Information and Communication System) is the attempt to coordinate RACS and AMTICS by consolidating traffic information for roads under the control of the different public agencies.However, if you talk to representatives of RACS or AMTICS, you will so far still hear that both projects believe that they can continue their work without major modifications.

EUREKA

In Europe, the need for coordinated development of Integrated Systems was also recognized several years ago. European problems are even more complex than those of the US or Japan, as in Europe not only interindustrial and interdisciplinary but also international cooperation is required.

One R&D programme launched at a summit of European ministers was the EUREKA programme which provides the umbrella for a number of projects some of which are traffic related, including the French CARMINAT project for the development of integrated driver information systems, and DEMETER for the development of standards for digital maps which are essential for many driver information systems.

Certainly the most important of the EUREKA traffic projects is PROMETHEUS (Programme for European Traffic with Highest Efficiency and Unprecedented Safety). The title makes clear that this project (or programme) is very ambitious. It was initiated by the European car manufacturers and comprises a number of subprogrammes such as:

- PRO-CAR: in-vehicle systems, based on sensors, to keep cars in lane and to avoid collision with other vehicles or any obstacles on the road,

- PRO-NET : driver assistance and collision avoidance systems based on the development of a network of direct communication between in-vehicle computers of neighbouring vehicles,

- PRO-ROAD: driver assistance based on communication between the in-vehicle computer and the infrastructure.

Finally, PRO-GEN endeavours to evaluate the system components and more importantly, it looks at the possibilities for the integration of these components and for their integrated use in urban and interurban road traffic.

DRIVE

The last programme to be mentioned, but certainly not the least important, is the DRIVE programme. DRIVE (DedicatedRoad Infrastructure for Vehicle safety in Europe) is a Research & Development programme for RTI set up by the Commission of the European Communities in 1988 with an overall volume of 80 *Mio* £. DRIVE aims at improving road safety, maximizing road transport efficiency and contributing to environmental improvements.

The programme comprises 72 projects which are divided into four groups:

1. General approach and modelling (comprising also systems evaluation, and systems implementation aspects)
2. Behavioural aspects and traffic safety
3. Traffic control
4. Services, telecommunications and databases.

One of the focal points in the DRIVE research is the development of driver information systems which are based on the communication between "intelligent" vehicles and the road infrastructure.

DRIVE will be finalized by the end of this year but, in the meantime, plans for a follow-up programme are going ahead. As this new programme has not yet found its name, it is normally referred to as DRIVE II. DRIVE II deals with R&D in ATT, a new term that stands for Advanced Road Transport Telemetric (but meaning nothing else than RTI or IVHS).

The Community contribution to DRIVE II will be 80 Mio £, but as DRIVE II only finances up to 50% of the overall effort, the total volume will be more than 200 Mio £. DRIVE will focus on pilot projects in the following 7 areas:

- Demand Management
- Travel and Traffic Information
- Integrated Urban Traffic Management
- Integrated Interurban Traffic Management
- Driver Assistance and Cooperative Driving
- Freight and Fleet Transport
- Public Transport.

In other words, DRIVE II looks at a complete range of road transport and traffic control systems. Test sites will be found throughout Europe, both in cities and in major interurban and even international corridors. The likely starting date for DRIVE II is January 1992.

SYSTEMS INTEGRATION

All of the R&D programmes mentioned above are trying to some extent to develop integrated systems, but for IVHS and DRIVE this is a main focus. DRIVE in particular envisages what it calls the IRTE, the Integrated Road Transport Environment. This means not only that the different DRIVE projects have to work together, but also that cooperation with the EUREKA projects is needed, in particular with PROMETHEUS. This collaboration is underway and has already brought European researchers with different backgrounds closer together.

It is therefore more than just a scenario that in ten years time a driver might start a trip in the city of Birmingham, cross the Channel, travel through France and Spain to Portugal and, while trying to find his hotel in Lisbon, continues to receive route guidance advice and traffic information in his own English language by the same in-car equipment and via the same communications technique, while using one single Smart Card for all road toll and similar payments throughout the trip.

The Work of the Traffic Management Systems Working Party

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Traffic congestion is choking London and other cities. The number of cars on Britain's roads is projected to increase from 21 million in 1989 to 27 million in the year 2000. The National Economic Development Council' s Traffic Management Systems Working Party was set up by NEDO** in January 1990. The Working Party has a life of fifteen months and its aim is to identify ways in which action can be taken to achieve a reduction in urban congestion over the next five to seven years. It is using London as a model, but hopes that any solutions that it recommends can be applied to other cities.

Since the brief of the Working Party; is to concentrate on short term solutions, this precludes the recommendation of any new substantial capital investment such as new roads or underground lines. The group is concentrating its work into four areas: Economics, Public Transport, Regulatory Matters and Technology. Within each of these areas various solutions such as congestion charging, taxing company owned parking spaces, priority buses and changes in the handling of parking offences are being studied. The package concept is necessary because, for example, public acceptance of congestion charging will not be achieved without the assurance that the revenue collected will be applied to improving public transport services.

The Working Party will report to the National Economic Development Counci1 in October 1991.

The Rural Access and Minor Roads Programmes in Kenya

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INTRODUCTION

The Kenya Government has succeeded in providing all-weather roads in rural areas by using low-cost labour intensive construction methods. This success has been enhanced by involving the local people in choosing the roads, constructing and maintaining them through the Rural Access and Minor Roads Programmes.

GENERAL

Transportation, particularly the availability of all-weather roads, has perceived as an important component of rural development in terms of stimulating local development in agriculture and industry, marketing agricultural commodities, expanding trade, enhancing tourism, providing access to social services and generally serving to integrate the rural population into the overall economy.

In developing countries, it is in the rural areas that about 90% of the population lives and agriculture is their mainstay. The development of their agricultural activities and welfare therefore depend heavily on the availability of all-weather road access.

THE RURAL ACCESS ROADS PROGRAMME

With a large part of the existing rural road network still consisting of footpaths and tracks that were only suitable for an occassional four-wheel drive vehicle or animal drawn carts, the Kenya Government in 1974 formulated the Kenya Rural Access Roads Programme (RARP) and the actual implementation got underway in 1975.

The heavy investment in road construction in developing countries for the past thirty years or so has been used for the acquisition and operation of equipment. Most road projects in developing countries have therefore been and continue to be constructed using equipment-based techniques. However, the lack of spare parts and the reliance on petrol and diesel are major limitations. The result is that equipment-based construction methods are a major burden on the limited foreign exchange reserves of these countries since major inputs in this technology have to be imported and paid for in foreign exchange. For this reason, the Rural Access Roads Programme was implemented using labour intensive road construction technology.

Due to the lack of previous experience in labour intensive road construction, it was felt that this should be tried on the lowest class of roads and hence the final choice of the farm rural access roads.

Proposals for the roads to be constructed originate from the local people. These are discussed and the selection made by the District Development Committee, which is a project planning and implementing committee, using set guidelines issued by the Ministry of Public Works RARP section.

The selected 'roads, which should be unclassified and connected to classified roads of all-weather standard, should provide access to areas of high agricultural potential, serve areas where other development programmes are either on-going or planned, and serve markets and social services facilities.

The programme is managed at three levels; Headquarters, Regional and District level. The Headquarters is responsible for the overall co-ordination, planning and monitoring of the programme in the country. At the Regional level, the Regional coordinators, each in charge of several districts, monitor and co-ordinate the work of the engineers, inspect the on-going construction and form the link between the headquarters and field staff. At the District level, there may be two or three construction units under an engineer or field supervisor. The engineer or field supervisor is responsible for the financial administration, planning, approval of alignments, procurement, preparation of monthly work and financial progress reports, design of culverts, and organization of efficient maintenance of the roads.

Each construction unit is placed under an Inspector and consists of two earth road construction sites, one gravelling site and one culverts site, each of which is supervised by a Foreman. The Inspector and Foreman go for training in labour intensive road construction, gravelling and maintenance techniques at a labour intensive Training School at Kisii in Kenya. This school has become an international school with personnel being trained from neighbouring countries.

Each unit is supplied with equipment for supervision, transporting of materials and for gravelling. This equipment comprises of two Land Rovers, one seven ton truck, six tractors and eight trailers. For proper maintenance of this equipment, each unit has a workshop with skilled mechanics and supporting staff.

The programme being labour intensive, hand tools are extensively used and their quality is very important. Hence, Standard Specifications have been developed on which tools procured for the programme are based.

To avoid land compensation and major realignments, access roads are constructed following the existing alignment. The horizontal and vertical geometric standards are not considered critical since speed on these roads is expected to be about 40 kph.

The construction of rural access roads is carried out in two stages. First the road is constructed to earth standards, and after use by traffic for some time, is graveled in order to provide all-weather access.

Gravelling is the most equipment intensive activity of the programme. It includes excavation, loading and unloading of the gravel, which is carried out manually, and the hauling of the gravel, which is done with a tractor-trailer combination.

Drainage is a very important consideration in the construction and subsequent maintenance of all classes of road pavements. Apart from the provision of

Sufficient camber so that water is quickly shed from the surface to the side drains, other drainage facilities include mitre drains, cut-off drains, scour checks, culverts and drifts.

For maintenance, the road is divided into sections of between 0.5 and 1 km, I depending on the terrain, soil type and traffic. A reliable former construction worker living close to the section is contracted to carry out the maintenance and is provided with essential tools. He/she works three days a week and is Paid once a month provided his/her section has been satisfactorily maintained. The supervision of the maintenance is provided by an Inspector for every 300 contractors, assisted by a Foreman for every 100 contractors. The Inspector is provided with a Land Rover while the Foreman is provided with a motorcycle, for their supervision duties.

IMPACT OF RARP

Some of the positive consequences of the RARP are:

- Where the programme is in operation, fewer than 5% of the centres are more than one kilometre from an access.
- Seasonal unemployment and underemployment have been alleviated.
- Small scale industries have been stimulated.
- Farm incomes have increased and standards of living have improved.
- The grassroots participation in the planning, construction and maintenance has helped to create skilled supervisory and other personnel who can be utilised effectively on other road and civil works programmes.
- By constructing all-weather roads at lower costs, it has saved the scarce local currency which can be deployed in other development programmes.
- Due to its innovative nature, the programme has attracted external assistance. Apart from the Kenya Government, the programme has been financed by the World Bank, the I.L.O. and bilateral aid from Britain, Norway, Denmark, Canada, Netherlands, Switzerland, and the U.S.A. to mention some.

The success of the RARP encouraged the Ministry of Public Works to extend the techniques and experience got from its implementation to the improvement of the Minor Roads which are higher in classification and have more traffic. The whole programme is now known as the Minor Roads Programme (MRP).

Several African countries have shown interest in labour intensive technology used in the improvement of Kenyan roads and the programme has been visited by engineers from Sudan, Tanzania, Malawi and Zimbabwe, to mention just a few.

WOMEN'S PARTICIPATION

Women's participation in the RARP and MRP was initially very low. A 1988 study showed that women constituted only 16.7% of the labour force. Even when they did participate, there was a tendency to restrict them to tasks categorised as less arduous. This restriction emanated from the belief that they are physically weak and cannot cope with road work. This belief contradicted women' s reality because they have from traditional times been responsible for laborious tasks within the community such as cultivation, collecting firewood, and fetching water.

In 1989 further studies were carried out and a Plan of Action was formulated. Some of the proposals contained in this Plan of Action to increase the participation of women were:

- To make 1nformation about the jobs available to them.
- The place of recruitment to be the proposed road site or Foreman's camp.
- The method of recruitment to be by secret ballot.
- At least 25% of the inspectors training places to be reserved for women.

By November 1990 the number of women in the programme had increased and accounted for 19% of the labour force on the average nationally and was as high as 40% in two districts.

CONCLUSION

The Rural Access Roads Programme and the Minor Roads Programme have had tremendous impact in the rural areas of Kenya. Many previously inaccessible areas are now accessible. The local people, being involved in the selection of the roads, their construction and maintenance, identify fully with the programmes and this has enhanced their success. From a few districts, the programmes have extended to thirty one of the forty two districts in Kenya and are intended to extend to the whole country in the long run.

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Influences on Planning a New Model in the Motor Industry

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SUMMARY

In designing a model to reach the market in four to five years time, there will be pressures to incorporate the best of the developments which have occurred or are foreseen in product technology. The needs of tomorrow's customers must be the main focus for selecting which technologies to chose. Interpreting these correctly could lead to radical shifts in emphasis, for example away from high speed performance, towards fuel economy.

INTRODUCTION

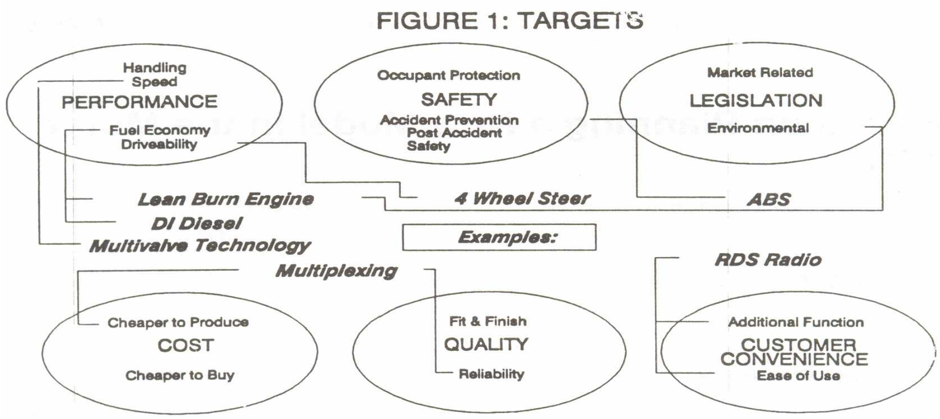
The cornerstone of success in a manufacturing industry is the products produced, and how well these balance the business needs of the company and the needs - emotional, practical, and financial - of the consumer who buys them. Any company in any industry needs to be sure its plans reflect its capabilities and aspirations; broadly speaking that it has the funds and the resource to design products which yield a profit. This is the overall challenge which involves the need to be clever and creative in business terms. Once this planning phase is complete, however, and the broad product objectives are set, there is a further challenge in designing into those products the technologies which will match customers' requirements and maintain a competitive base for the future. This paper discusses what should influence the selection of the appropriate technologies for a new passenger car.

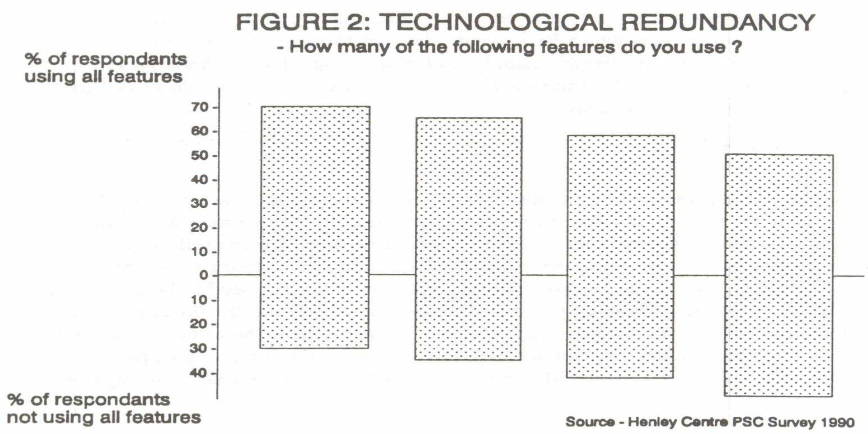
TARGETS

The motor industry can be regarded as being relatively mature, with all the fundamental technological breakthroughs already achieved. Nevertheless there are a wide range of new or existing ideas which could be selected by a motor manufacturer to achieve different aims. There are six major areas in which a manufacturer could be looking to gain improvements, as illustrated in Figure 1.

The first judgment to make is which, if any, of these aims does a proposed new technology address. It is easy to fall into the trap of slavishly copying ideas introduced by competitors or to allow the appeal of clever engineering to override business aims. Figure 2 shows that, outside the motor industry, there are numerous product fields where a technology level has been established which bears little relation to the customers' needs.

As the examples used in Figure 1 demonstrate, many of the best ideas achieve more than one aim. The lean bum engine technologies developed in the 1980's and epitomized in the Rover K Series engine reduced emission levels, ahead of legislation, in recognition of the direction in which European standards and customer expectations were moving. It also improved fuel economy without a sacrifice in performance. Multiplex wiring systems, which centralise the electrical functions and relay the signals down a single wire to units controlling individual functions, are under development for automobile applications. These have both a cost and a reliability advantage, through a reduced number of parts.





On the other hand, it is not always, indeed is rarely, possible to achieve an improvement in one aspect of a car's deign without adversely impacting on another. There is tension, for example, between the provision of better safety and the need to minimise costs to achieve a competitive price. Some aspects of vehicle performance, typically greater speed and fuel economy, tend to involve a compromise on one to improve the other.

It would never be possible to incorporate all new ideas at a reasonable cost, and it would in any event be inappropriate to do so. In order to plan, judgments need to be made and priorities set.

PRIORITIES

It would be easy to assume that planning a new model to incorporate technologies which would deliver:

- Legislative requirements
- Feature and performance levels competitive with other vehicles in the same market sector
- Best design principles

Would be sufficient for success. The pitfalls in this assumption are the failure to take into account:

- Future legislative/government pressure not currently in force or in the planning stage
- Changes in customer requirements for feature and performance

It is tempting to overlook these factors because they are unknown and difficult to forecast. They should not, however, be ignored.

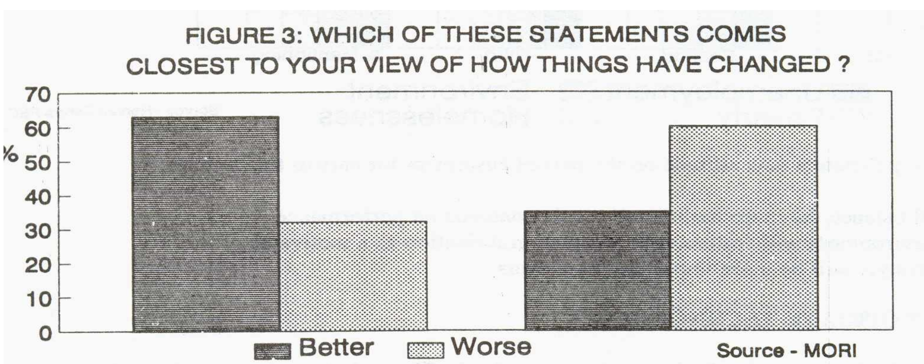
Some aspects of the changes which will affect consumer groups are capable of being forecast, for example predictions are freely available for the age structure of the population, the typical family size and the average income. These changes will affect motoring requirements and will influence future legislation. More importantly, the attitudes and the outlook of societies change over time; different concerns arise, become general and collectively shape the approach that individuals adopt to the decisions they take in their lives. These concerns do not build up over night, and the key changes in emphasis which will be significant in forming the preferences of consumers in five years' time are likely to be present today.

Understanding the relatively predictable changes in the structure of society and the less tangible shifts in its outlook are crucial in designing a vehicle which is going to be appropriate in the environment in which it is launched. It is these factors which should be dictating the priorities for the development of new technologies, for some of them are fundamental.

THE CHANGING FACE OF SOCIETY

In the eighties, in the developed world, the truth of the adage that 'money does not buy you happiness' appears to have been proved to a substantial majority of people (Figure 3). As The Henley Centre put it in their 'Planning for Social Change 1990-1991' [1]:

"The 1990s is shaping up to be the decade when, thanks to their experience, their discretion and their sense of new beginnings, people assess their lives from a new perspective."



Three key factors influence this new perspective which puts quality of life ahead of standard of living - the role of women in society, the growing awareness of the environment as an issue, and the attraction and availability of leisure opportunities. All of these are potentially significant in deciding what technologies to incorporate into a new car.

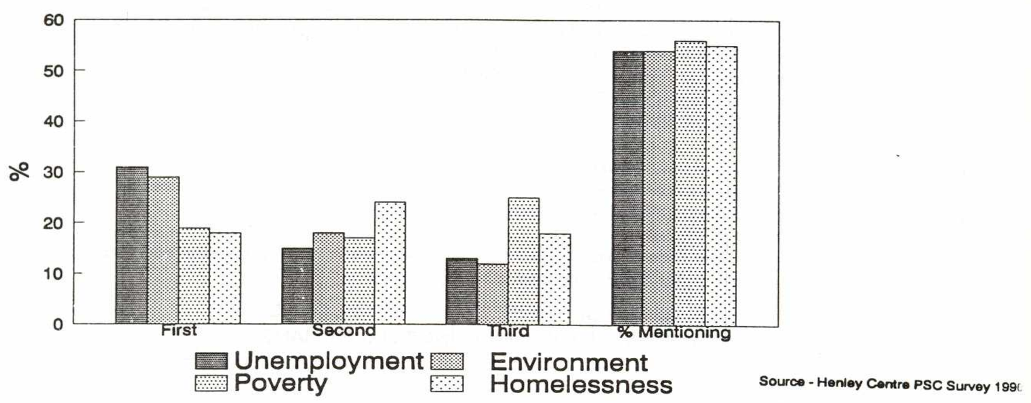
The lives that women lead in Europe have altered dramatically this century. They are generally having fewer children and living longer, which means that the time they have to live their own lives after their youngest child is no longer dependent on them has extended dramatically. Most significantly, more women have jobs outside the home, and this has far reaching consequences on society generally:

... It forces a blurring of the traditional male and female roles in the family, as the lifestyles of both partners become similar

- It introduces feminine attitudes into the workplace, bringing a softer influence into this area of men's lives
- It gives women greater spending power in their own right

This contributes to a softer, more caring attitude on the part of society as a whole, which is reflected in the concern for the environment that is now becoming a major force in consumer markets (Fig 4). The amount of leisure, for men, is generally increasing across Europe, and although women are clearly shorter of time now that household chores have to be fitted in with a job, they are naturally looking for the quality of their leisure time to be improved to compensate them for the additional work effort. The availability of sports and leisure facilities of all kinds is increasing, enticing people to make full use of this area of their lives, and giving it correspondingly greater importance.

FIGURE 4: MOST IMPORTANT CONCERNS



These changes collectively dictate a new attitude on the part of customers for cars in the nineties:

- Female values will balance the more traditionally male concerns on performance
- Concern for the environment will feature with personal gratification as a motivator
- Contribution to lifestyle will be more important than status

SELECTION OF APPROPRIATE TECHNOLOGIES

It is now possible to weight the new technologies used as examples in Figure 1, to arrive at a view of their appropriateness for the next decade. Superficially, a four wheel steer system is more appealing than a direct injection diesel. It offers the customer a function he previously did not have; it is apparent to him, and to his neighbour, that he is buying a technologically advanced feature; it contributes to manoeuvrability. The advances in a direct injection diesel are not visible to him; the gains achieved on his behalf are in fuel economy, which in a period of affluence could be expected to be less relevant than the more exciting aspects of vehicle performance such as speed and handling. Without the sort of longer term view outlined above, the planners could anticipate that the one is a high value feature which will sell cars, the other a technology of interest to the industry but not the customer.

Taking account of insights into the future would cause a re-evaluation of this decision. Four wheel steer offers a marginal customer benefit, which contributes little to the overall enjoyment of driving or the functionality of the car. A high technology diesel appears entirely appropriate in the light of the increasing concern for the environment and the potentially more 'feminine' approach to car

Choice Not only is fuel economy the most effective way of reducing the effect that motoring has on the environment, but the performance advantages of petrol engines are likely to become less appealing, and even less useable, if legislation restricting speed to conserve fuel is introduced.

In other words, in; the future ostentatious high technology can only be justified if it also addresses the concerns of the customer who will buy it. Conversely, functional high technology will not have to be visible to be justifiable, if it is targeted at achieving what the customer wants.

CONCLUSION

Some advances in ,technology represent a step forward in the efficiency of the design or process, and these need to be recognised and adopted early, whether they seem to relate to customer requirements or not, to ensure continued competitiveness. Paint technology in the motor industry, for example, has been through several evolutions which have resulted in an overall better standard of finish and increased corrosion protection, and all companies have adopted the new standards to keep up to date with the quality of product that the customer expects. For those new ideas which are optional, an understanding of changes in the environment is essential.

[1] The Henley Centre for Forecasting, **Planning for Social Change 1990-1991**, Vol 4

TR10

Environmental Considerations in Road Transportation

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SUMMARY: Roads constitute major transportation mode in India. Environmental degradation from construction of roads and plying of vehicles on roads is a major issue of concern. Preventive measures to Mitigate the adverse environmental impacts of road development projects need consideration prior to implementation of such projects.

PREAMBLE: The transportation system in India is both extensive and diverse. Road and rail are the major transport modes which carry 95 % of total domestic freight and passenger movement. Road transportation has become the most dominant mode of transport because of its unique advantages such as mobility, door to door service, flexibility, reliability and speed. Since 1951, the vehicle population has gone up 50 times[l].It is estimated that traffic on roads will increase three to four times in the next fifteen years. In order to increase the efficiency of road transportation systems, construction of new roads and improvements to existing roads are being undertaken in rural and urban areas. The quest for meeting rapidly growing transport needs with insufficient resources has resulted in wide scale environmental degradation.

FACTORS CAUSING ENVIRONMENTAL DEGRADATION

Roadway factors: The construction activities for development of roads involve lasting deforestation, Excavation work and cutting of mountain slopes to improve the accessibility. These actions not only disturb the ecological balance of the area but also the aesthetics and agricultural productivity of the adjoining areas. Bridges with inadequate openings and embankments obstruct the natural water courses causing the degradation of environment. Badly rutted and damaged roads increase the noise level of vehicles and also the dust level.

Traffic factors: Abrasion of road surfaces by motor vehicles generates dust. Traffic resuspends deposited dust particles and transfers them to near the curb or median barrier and or onto adjacent areas. Traffic also contributes many inorganic and organic pollutants such as lead, asbestos, oil and grease in addition to air pollutants. Rstimates of vehicle produced air pollution are based on traffic flow characteristics, vehicle numbers, types and total km of travel [2].

Some of the pollutants which are of prime importance from environmental degradation point are

Lead: The fuel for automobiles is Gasoline. Tetraethyl lead is added to it for effective combustion [3] Wheeler and Rolfe [4] found that lead from highway sources in roadside soil and vegetation follows a double exponential function

$$Pb_s=13.6 + ADT\ (0.187e^{-1.43}\ x + 0.0147\ e^{0.08}\ x)$$
$$Pb_v = 8.9 + ADT\ (0.035e^{-2.75}\ x + 0.00618e^{-0.48}\ x)$$

Where Pbs = pb concentration in soil (ug/g)
Pbv =Pb concentration in plants (ug/g)
ADT= Average daily traffic volume
And x= distance from the highway (m)

Asbestos: Higher concentrations of asbestos near highways originate from the wearing of brake linings. The average emission rates were determined as 17.8 ug/km - car for passenger vehicles and 55 ug/km - car for trucks (5). Concentrate ions of asbestos in areas of considerable vehicular traffic range from 10 to 60 ug/m3 of air [6].

Other Pollutants: Carbon monoxide, hydro-carbons, nitrogen oxides, sulphur oxides, emitted by moving Vehicles form the major environmental pollutants. Kent and Medford (7) found that typical emissions under Australian urban driving conditions could be expressed as

$$[CO] =465\ S^{-o.97}$$
$$[HC]= 21.5\ S^{-o.73}$$
$$[NOx]=2.2+0.008s$$

Where, [CO] is the carbon monoxide emmission (gm km-I.), (HC] the hydrocarbon emission (gm km-l), [NOx] the nitrogen oxides emission (mg km-I) and s the average vehicle speed (km h-I). Similar estimates were also made by Taylor and Anderson [8]. Prediction of street level CO pollution concentration due to vehicular traffic has also been made by Vittal Marty et.al [9]. Assessment of pollutant emissions by road vehicles in large Indian metropolis shows that the air pollution if not controlled now, will increase three fold in the next decade.

Noise: Traffic noise is continuously invading previously quiet places and is prevalent for long hours per day. It has to be noted that. Commercial vehicle of over 3.5 tons provoke a similar auditive disturbance to the flow of 3 to 20 private cars, depending on traffic speeds and the acoustics energy emitted by commercial vehicles over 3.5 tons increases as the cube of speed for speeds over 60 km/hour[IO].

DETRIMENTAL EFFECTS, OF ROAD DEVELOPMENT

Effect of gaseous pollutants

Plants Automobile exhausts are responsible for the destruction of forests field crops and other plants. Air pollutants enter the

Plant cells through open stomata. After crossing the boundaries of cell wall and cell membrane, they react with the chemical constituents of cytoplasm. Retardation of growth, increased permeabilities of cell wall and membrane are the consequences [11]. The plants are contaminated by lead from fallout and through absorption from soil. Lead content in edible vegetation was found to increase in cabbage, potato, corn, radish and barley. High lead inhibits photosynthesis and water absorption in plants and also enters the food chain and undergoes biomagnifications via animals feeding on them [3]. Changes in productivity, death and dieback on a large scale of trees in deciduous and coniferous forests as a combined effect of metal pollution, dry deposition of gases and acid precipitation has been reported [12j. Extensive research has been carried out on the effects of gaseous pollutants on plants including trees [13].

Habitat Carbon monoxide directly passes to the blood and reduces its oxygen carrying capacity. The consequences are headache, palpitations, dizziness, vomiting and in extreme cases, collapse. NOx cause injury to lungs, respiratory tract and eye irritation. S02 acts as an irritant and may lead to bronchoconstriction [14]. Accute lower respiratory tract and lower pulmonary tract diseases and reduced resistance to bacterial and viral infections is common in humans subjected to gaseous pollution for longer periods.

Other effects: Although both NOz and CO are rapidly diluted on leaving the exhaust pipe of vehicles, concentrations in excess of WHO guidelines have been encountered in some urban areas where the traffic density and local topography allows them to build up. Hydrocarbons are also emitted as gases from petrol and diesel vehicles. Volatile hydrocarbons are of special importance in relation to photochemical formation of other more persistent pollutants such as peroxyacetyl nitrates (PAN) are formed by reaction between N02 and the free radicals from hydrocarbons. free radicals can also convert N02 and 802 to nitric and sulfuric acids which in turn may give rise to acid rains[15J.

Effects of Doise - Excessive noise has a negative physiological effect~ on both people and animals. The effects may range from minor to interference with sleep, speech or in the extreme cases, loss of hearing. Noise affects thalamus and hypothalamus in man. Information incident once is masked by noise and it becomes difficult to recall it easily after some time[16]. Exposure to intense noise levels even if intermittent may result in adverse auditory effects[17].

PREVENTIVE AND MITIGATIVE MEASURES: degradation due area, terrain, of traffic etc. would be helpful The extent of environmental to road construction activity depends on the type of land use pattern of the area, type of traffic, volume The following preventive and mitigative measures to minimise the environmental degradation.

Large scale cutting and tree felling should be avoided. as possible cutting and filling should be balanced.

Disturbance in the natural setting as a consequence of construction activity in hilly areas may result in large scale land slides. This should be given a careful attention, right

From the stage of planning, project formulation, construction and subsequent maintenance.

- Wet land, swampy land, wild life habitat and dense forests should be avoided, while acquiring the land for construction of roads.
- Erosion control measures should be adopted in sections susceptible to damage by erosion, rain, streams etc. Planting trees and vegetation in such areas would be beneficial.
- The road alignment should avoid unstable area, avalanche etc. Proper measures in consultation with geologist prerequisites if such areas are unavoidable.
- Proper side drains, intercepting drains and catch water drains are necessary as drainage is an important factor affecting environment.
- Ponding of water should be avoided to provide adequate waterway.
- Proper disposal of surplus construction material should be made to avoid any impact on the immediate environment.
- Inter-alia, appropriate standards with regard to the width of land to be acquired for future roads and the minimum distance of property-line there from needs to be formulated and enforced.

Environmental problems of air pollution by vehicle exhaust emission can be reduced through more efficient vehilcle maintenance. The Indian standard specification for smoke intensity is limited to 65 on the Hartridge scale while CO and HC emissions should not exceed 3 % and 100 ppm respectively as per the guidelines given by Central Pollution Control Board [18] and Indian standards [19]. The achievement of smoother traffic flow and better vehicle maintenance is the key factor in promoting fuel economy and at the same time, limiting pollutant emissions. Development of commercially viable electrical *I* solar energy operated cars could go a long way in reducing the air pollution problem. Improvements to the vehicle exhaust systems could also be useful in this regard. Movement away from the metropolis or a central business district results in fewer traffic events, higher speeds, longer cruise periods and shorter stops. The resultant reduction in root mean square acceleration leads to a corresponding reduction in vehicle emission and consequently air pollution factor [20].

Road design for traffic noise reduction has been suggested by et.al [21]. The Indian standard limit suggested for noise level is 70 dBA[22]. Noise reduction measures have to be considered as integral part of the project depending upon the nature of land through which the roadway passes.

EPILOGUE: In order to assist the authorities in planning and carrying out the transportation projects, Ministry of Environment and Forests Govt. of India has given environmental guidelines. Accordingly implementation of various preventive and mitigative measures as suggested by Environmental Impact Assessment study is essential for any road development project. The management plan should describe the mitigative measures along with the resources required and the manner in which they need to be carried out. A regular environmental monitoring during and after the completion of project is required. It is time now that we pay attention to the environmental aspect which is most important in transportation development projects.

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Inflatable Restraint Systems: The Road to Occupant Protection

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SUMMARY - History, engineering characteristics and future technical enhancements of airbags. Science may measure in light years or in Angstroms; engineering is responsible for the distance from the accelerator to the brake pedal [1]

Even before I became a part of the automobile industry, I frequently used cars as examples of engineering's successes, impacts and responsibility to society. No matter what discipline our technical training focuses on, engineers, like the general public, are familiar with cars, speed, traffic, roads and the effects - positive and negative - of these factors on our lives.

One of the successes in this ubiquitous technology is the inflatable restraint system known as the airbag system.

HISTORY [2]

Today's inflatable restraint systems have diverse beginnings. One facet evolved from the Mae West, the inflatable life jacket of World War II. Like the Mae West, the first airbag patent design (for airplanes) required the user to pull a knob to inflate an air cushion.

A second facet in the airbag's background is the development in the early 1970s of the sodium-azide inflator. Replacing bulky, high-pressure stored-gas systems, a small canister of this solid propellant is ignited to release nitrogen gas into a bag which has been folded with parachute-like precision.

The third technology needed for a viable inflatable restraint system is crash detection sensing. One of the earliest sensors used in automobiles built in the early 1970s is the Rolamite sensor which was developed in the U.S.'s Sandia Laboratory and found early use in helicopters where it turned on a beacon if the helicopter crashed.

The Rolamite is an accelerometer and an electromechanical switch. In this sensor a spring unwraps from around a rolling

Mass in response to deceleration, allowing the mass to move toward and across an electrical contact, closing the circuit to the airbag inflator. Both the spring dimensions and the roller mass can be varied to customize the sensor action the crash characteristics of the car it is used in.

These technologies came together in aribag systems for full sized vehicles: at Ford in a special fleet of 500 cars in 1972, and at General Motors in 1000 cars in 1973. In 1974-76 GM built 10,000 productions Oldsmobile's with airbags as an extra cost option. Some of these Oldsmobile's are still on the road, most with their third or fourth owner who may not even know there's an airbag until its protection is deployed in a crash.

APPLICATIONS ENGINEERING

An inflatable restraint system is not an off-the-shelf item. Each of its components must be tailored to the vehicle.

THE AIRBAG - How big is it and how fast must it inflate? This depends on the interior of the car. How large is the space between the driver and the steering wheel or between the passenger and the dashboard? These determine the size of the bag. The shape of the center of the steering wheel and dashboard must then be jointly designed to accommodate the folded bags. The speed necessary for inflation is investigated in crash tests. Profiles of the motion of the dummies' heads indicate when the airbag's cushioning effect must be in place to prevent impact and injury. These tests are done both with and without seatbelts on the dummies. The propellant module provides the volume and inflation rate necessary to inflate the airbag. Inflation must also stop on time to allow the airbag to deflate immediately after the crash so the occupants can leave the vehicle. '

THE SENSORS - What kind? How many? Where? What activation level? The answers for these questions and many others begin on the test track. Whether the airbag system will be used for 450,000 full sized Chryslers per year or 300 Ferrari Testcrosses, the same procedure is used:

1. Put accelerometers in many locations on a set of vehicles to be crashed. Locations include the engine compartment, the passenger compartment, under the dash, on the hump, and sometimes on the steering wheel.

2. Do a series of crash tests, both "soft" and "hard". The intent is to find locations for mounting where the sensor can be calibrated to sense a difference between "no-fire" events (where there is little likelihood of serious injury and so the airbag should not deploy) and "must-fire" events (higher speed head-on or angle impacts where serious injury is very likely and the airbag must deploy). For vehicles to be sold in the U.S., Federal Motor Vehicle Safety Standard (FMVSS) 208 defines the "must-fire" events.

3. Analyze the data from the crashes and run simulations to determine how a sensor would react in each instrumented location. Some locations may be eliminated in this step. If the crash signal is attenuated as it is transmitted through the structure of the car, there may be little observable difference between "soft" and "hard" events.

4. Select the locations and the sensor type. There are several electromechanical sensors besides the Rolamite described earlier. One uses an eccentric mass on a rotating disc which closes a contact at a specified angle. Another has an inertial

Mass which is a ball sealed in a cylinder. The ball travels within the tube a distance proportional to deceleration. A

Third has a mass which moves against a helical spring and a suction cup. The amount of vacuum behind the suction cup can be varied by a controlled leak, damping out short duration events. This type might be used in trucks of off-road vehicles. Usually two location are selected, one on each side of the engine compartment, such that at least one of the sensors will be able to detect each must fire event. A typical sensor system is shown in Figure 1.

5. Design the calibration, mounting and electrical connection features.
6. Build prototypes.
7. Test.

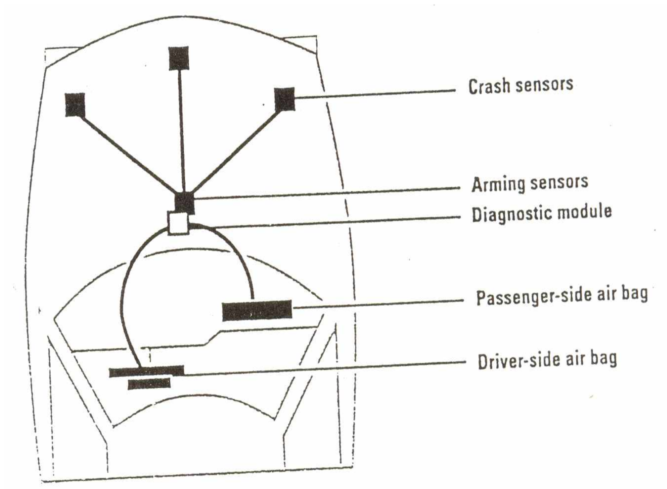

FIGURE 1. A typical inflatable restraint system will have 2 or 3 crash detection sensors, as well as a safing sensor to prevent firing under non-crash conditions.

THE SAFING AND DIAGNOSTIC MODULE [3] - These elements playa key role in establishing the inflatable restraint system integrity. replacing earlier analog circuits which were used to detect faults at power-up, today's custom designed digital/analog hybrids which can blink the driver warning lamp with coded 'information to indicate the suspected source of the fault therey facilitating' service. The safety critical nature of the system encourages the use of a safing sensor to inhibit susceptibility to high g shocks, as well as the inclusion of a redundant energy source for the firing circuit.

THE FUTURE

The next steps in the development of inflatable restraint systems are, like earlier improvements, based on the development of technologies which provide new opportunities. One such area is the development of an electronic airbag control unit based on a micromachined silicon piezoresistive accelerometer and the low cost logic power for the microprocessor combined with an analog

To digital (A/D) converter. This will allow single point sensing from the passenger compartment, removing the sensor from the crush zone, eliminating concerns about sensors being impacted by surrounding structure, placing the sensors in a less hostile environment, and decreasing installation complexity.

The flexibility of the microprocessor allows more sophisticated reporting of possible system malfunctions to aid in service. It also facilitates data retention in non-volitile menory including fault codes and durations to more easily diagnose faults which may occur only intermittantly. Built In Self Test (BIST) techniques developed for use in missiles and satellites will increase system reliability.

The additional capability of the microprocessor can be used to coordinate system enhancing features. One might be a seat sensor to enable the passenger airbag only if the passenger seat is occupied. Another function might pretension seatbelts, or even lower the sensor's must-fire level if the seatbelt is not being used.

Perhaps the most important development, however, is the increasing awareness that occupant restraints added to existing vehicle help, but occupant protection is best when crash characteristics, braking systems, knee bolsters, energy absorbing steering wheel columns, and all the other elements of the host vehicle are designed to perform in conjunction with the seatbelts and inflatable restraints. This challenge in engineering is being met world-wide by the automobile manufacturers and their suppliers.

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TR12

Traffic Incident Detection Using Vision-Based Processors

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The paper describes the work done at UCL for INVAID (EC DRIVE project V1026).

UCL involvement in INVAID ("Integration of computer vision techniques for automatic incident detection") includes the development and laboratory testing of incident detection algorithms for motorway and urban scenarios, adequate integration of single site outcomes in order to assess the state of the traffic in a road network and participation in the design of the man-machine interface.

The incident detection algorithms use a pre-processor developed previously at UCL (IMPACTS) which takes traffic images from a single site and delivers a qualitative' description of the traffic situation at a given time. The output of IMPACTS together with other relevant data that may be available (e.g. SCOOT data, weather information) is analysed in order to decide on the presence of an incident and its characteristics.

Analysis of motorways scenes have already been reported and demonstrated. Urban scenarios are currently being developed. Also in progress are the integration of multiple single site incident detectors and the user interface.

Dimensioning Method for Elastic-Plastic Road Pavement

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The elastic plastic road pavement or flexible pavement design may be classified into three broad groups (empirical methods, semi empirical methods and theoretical methods).

Pavement design consists of two parts: (1) mix design of materials to be used in each pavement component layer; (11) thickness design of the pavement of the component layers.

The various factors to be considered for the design of pavements are: design wheel load, sub grade soil, climatic factors the pavements' component materials and special factors in the design of different types of pavements.

For the purpose of structural design only the number commercial vehicles and their axle-loading are considered. The average number of axis per commercial vehicle varies with the type of road

it is important. For the structural engineer to consider the structural life in years of the pavement. The chosen life will be influenced by the type of road. By it's probable use after the end of the design period.

The advantages of flexible pavement, construction closely match the requirements outlined, and with the continuous development. Over almost a century are able to carry anticipated future traffic toads safety and economically.

Some of the principal characteristics of modern flexible roads are:

1. The method of constructing in layers enables work to proceed at a number of points progressively along the road as required. The materials required are easily obtained and can be laid accurately and swiftly with mobile, relatively and readily available plant.

2. The surfacing on flexible roads can be laid to a high degree of accuracy, by modern paving machinery, providing a smooth--running finish for vehicles.

3. As soon as the construction of a flexible road made with bituminous materials, or any stage of it. Above the sub--base is completed; it can be opened to traffic.

4. The normal slight; movement. Under traffic on a flexible road is a feature which prevents any harshness in tile riding quality of the road

5. The surfaces of all types of roads are subject to wear and tear. The life of a flexible road wearing course can be extended easily, quickly and economically by superimposing a newm wearing course or by surface dressing

Aim of this paper:

The aim of this paper is to submit a method for dimensioning the thickness of road pavement, in function of modulus of elasticity of materials, which make up pavement E, modulus of sub grade soil Eo and design intensity Rn of vehicles with different axial load.

The method is bases on American and Russian methods for designing. Flexible road pavement..

For both methods flexible pavement are commonly designed using empirical design chart; and equations taking into account some of the design factors.

Figure (1) shows the nomogram of the American method for designing flexible road pavement; It shows the relation of commercial vehicles with axial load 80KN (w) [Wn- 365 Rn80, n] where n is the number of life design and Rn80 the designed intensity of vehicles with 80KN axle load, with the relation of modulus of sub grade soil Eo,MPa.

Figure (2) shows the nomogram of the Russian method.

After-much studying-, two basic equations have been worked out. to show the design thickness of pavement for commercial vehicles with an axial load of 80KN and 100RN.

$$H_{80} = \frac{10^4 \quad [0.447 + 1gRn80] \quad (50)^{c-3}}{[77.762 (E / 100) - 3.619 (E / 100)^2 + 0.047 (E / 100)^3] \; 2.748 \; E0}$$

$$H_{100} = \frac{10^4 \quad [1 + 1gRn100] \quad (50)^{c-3}}{[77.762 (E / 100) - 3.619 (E / 100)^2 + 0.047 (E / 100)^3] \; 2.748 \; E0}$$

Where:-

H80 and H100 are the thickness of homogeneous road pavement in cm:

K the modules of elasticity of material which makes up pavement MPs.

Eo modules of sub grade MPa.

Rn80 and Rn100 are the designed intensity of vechicles with axiel load 80KN and 100Kn

Conclusion

1. The thickness of road pavement is affected by the modulus of elasticity of the sub grade and designed intensity of vehicles for different axial lands

2. The designed thickness of a homogeneous asphalt concrete pavement in both the American and Russian methods can be read graphically, while the designed thickness of flexible pavement can be calculated by the above equation

3. This new a method is suitable for applying to all values of modulus of sub grade and good results can be obtained.

4. The results of designed thickness of a flexible road pavement in the American, Russian and new methods are approximately the same.

5. Figure (3) shows the designed thickness of asphalt concrete pavement obtained by the three methods for designed intensity of vehicles with an axial load 100Kn 100 veh/day and different modules of sub grade soil. The new method seems, in general, to be between the American and the Russian methods.

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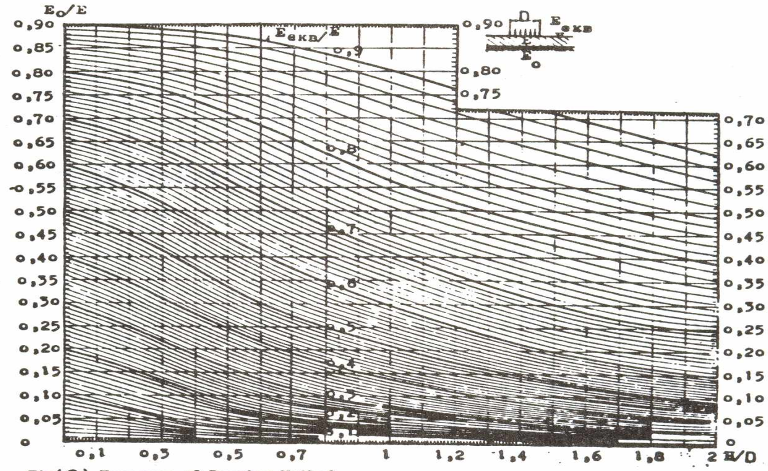
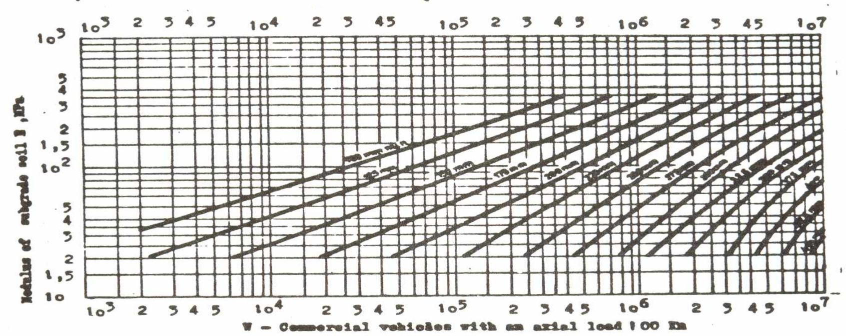
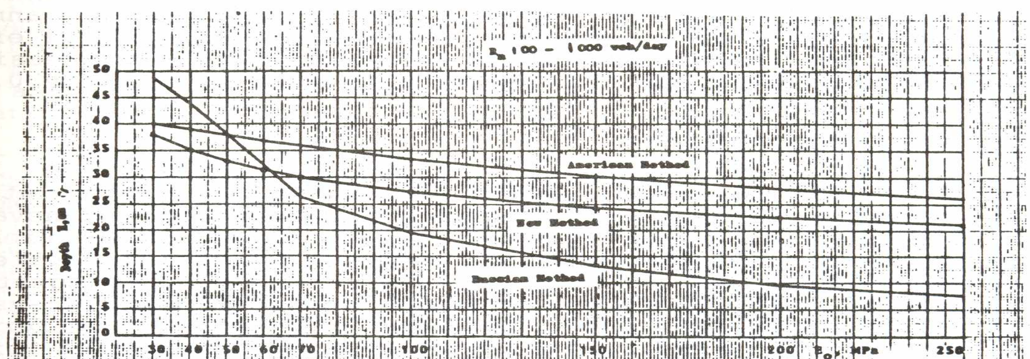


Fig(2) Nomogram of Russian Method



Fig(4) FULL DEPTH ASPHALT CONCRETE



Fig(3) Depth of Asphalt Concrete Pavement for the three method at a given E & R_n 100.

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ST1

European Space Agency

A. M. Hieronimus

No abstract supplied.

Looked at from an economic standpoint, the European space industry is still in many ways a nascent one. Its structures, forms of organisation and methods are not yet fully industrial in terms of the production process.

A small part only of the activities of this emerging industry is carried on under conditions of open international competition, in fact jus,: one-quarter of European space industry sales, and less than 10% of sales by the United States' space industry, Europe's leading competitor in the field. In commercial markets - telecommunications essentially - European industry's most seriol1s handicap has been its late start.

In the past, ESA provided an initial market for the European space industry and supported the industry in its technological development through its experimental telecommunications programmes.

ESA’S role in the telecommunications field in future will need to be adapted to maximise Europe's chances of success in a commercially competitive environment. At the same time, however, there is a risk of a major reduction in government support for experimental programmes in specific space communications technologies. This would lead to a weakening of European space industry in the face of increasingly strong competition. Measures are being taken to avoid such a situation arising and improve the prospects for European industry to win commercial competitions, not only in the world market, but also in Europe, its home market.

The Aerospace Plane - Transport for the Next Century

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SUMMARY

The development of space planes, the next generation of launch vehicles, promises a revolution in transportation for both goods and passengers. This paper outlines the scramjet engines that are likely to propel space planes and the free piston shock tunnel and instrumentation techniques developed by the author for hypersonic model testing.

1. SPACE PLANES AND SCRAMJET ENGINES

The future of space transportation, particularly of that a commercial nature, depends on the development of more economic access to orbit. The space plane with a scramjet engine propulsion system [1] is a technological development likely to enable this. The new concept of propulsion proposed for the US National Aerospace Plane (NASP) is centred around an air breathing engine which renders the traditional liquid oxidizer systems obsolete. The major advantage of the air breathing scramjet over the conventional rockets used at present is an economic one. Present launch vehicles carryon board the liquid oxidiser required for propulsion through the atmosphere. This increased launch mass due to on-board propellant reduces the available payload. The present launch costs with expendable liquid oxidiser tanks, somewhere of the order of US$100m, render most commercial and all tourist space transportation not viable. However, if a more economic launch vehicle can be developed to operate with 10-30 per cent of the present

Launch cost, the level of commercial space activities will be greatly increased. This increase in launch market, it is thought, will eventually extend to tourism.

It is planned that during initial take-off, conventional rockets or turbojet engines will provide the thrust. Then, once the vehicle is travelling at a speed of about Mach 3, the scramjet engine will cut in. The nature of the engine design is such that air is taken in through the inlet and compresed as it flows through an area change. Once the air is at a temperature and pressure hydrogen is injected, combustion takes place spontaneously and the thrust generated by increased pressures in an expanding nozzle propels the vehicle through the atmosphere. The engines are only operational above a certain speed and perform only while the vehicle is in the atmosphere. The system, however, will transport the vehicle close enough to the edge of space that only small rocket boosters will be required to place the vehicle in orbit. Once placed in a suitable orbit propulsion is no longer required. The rockets are needed once again when leaving orbit. The vehicle basically will take off and land horizontally and, in the case of NASP, will be totally reusable. Such a vehicle will be able to transport a much greater payload into space than present launch vehicles and without the high cost of expended parts. With this in mind, space travel becomes a commercial concern and more in reach of the public. It is claimed that a transportation system of this kind could fly passengers half way around the world for little more than the cost of an airline ticket and with the time saving advantage of only a few hours in transit.

2. SHOCK TUNNELS

To assess the strengths and weaknesses of such a proposal it is necessary to test models in simulated hypersonic conditions. Hypersonic means flight speeds above about Mach S. This simulation is achieved by use of impulse facilities. At the University of Queensland, the fastest free piston shock tunnel in the world, T4, is used for such testing purposes [2]. Scaled models of scramjet engines Are mounted in the test section of T4 and instrumentation installed on the models provides information on The aerodynamic performance.

Since the scramjet engine must operate at near-orbital velocities, the test facility must simulate flight at speeds of about 8 km/s. This is achieved by initially heating the test gas to a very high temperature and then converting the energy associated with random motion of the molecules to directed kinetic energy.

As a means of heating the driver gas in T4, a free piston technique is used. Figure 1 displays the principle of a free piston impulse facility. The driver section contains a large tube of helium driver gas at relatively low pressure. The gas is separated by a piston from a reservoir of air at a higher pressure. The piston is propelled along the driver section (compression tube) by the pressure of the reservoir of air behind it. It compresses and heats the driver gas as it advances. When the stored energy in the reservoir is almost completely converted to energy associated with the high pressure and thermal energy of the heated driver gas, the piston comes to rest. At this pressure it is arranged that the steel diaphragm separating the driver section from the shock tube bursts and the shock tunnel is operational. After the diaphragm ruptures the expansion of the high pressure driver gas drives a shock wave through the test gas and along the shock tube. When the shock wave reaches the end of the shock tube it is reflected. It passes once again Through the test gas, compressing and heating it further. At the point of reflection a thin secondary diaphragm ruptures and the test gas is then expanded through the nozzle into the test section and dump tank the model mounted in the test section is thus subjected to hypersonic conditions.

3. SKIN FRICTION GAUGES

One of the limitations imposed by such an impulse facility is an extremely short test time. In T4 the test time is of the order of a millisecond. The instrumentation used must of necessity have a Very short response time. One of the parameters particular interests to hypersonic researchers is skin friction. This is basically the surface drag experienced on the skin of the model. It is of particular interest in the hypersonic regime because viscous effects are more dominant than in the supersonic flight range. They are in fact comparable to pressure drag effects and therefore knowledge of skin friction provides important information as to vehicle performance in this regime. To date a skin friction gauge has not been successfully developed for impulse facilities with such short test times. The author's research at the University of Queensland encompasses the development of such a gauge.

The stringent test time requirements promote the use of piezoceramic materials as the sensing elements. Such materials produce an electrical charge when mechanically stressed. The response of these materials is measured in microseconds. They also have the advantage that transducers of very small dimensions but high levels of sensitivity can be manufactured. It

Is important to minimise interference to the flow. Hence, the gauge is designed to be mounted flush with the surface of the model. As mentioned previously the skin friction tangential to the surface, and that normal to the surface are of a comparable magnitude in hypersonic flows. It is important therefore to be able to decouple these two effects in order to quantify skin friction successfully. A design in which two sensing elements are aligned side by side but with one inverted relative to the other accomplishes this decoupling. If the signals from the two transducers are combined, pressure effects are cancelled but the shear stress which produces the skin friction is reinforced. To date the author has had success at the University of Queensland in measuring skin friction on flat plate models. These gauges when fully developed will be used to examine skin friction drag on the surfaces of scramjet engine models.

4. CONCLUSION

The scramjet engine sets the stage for hypersonic travel in the next century. Current research in the field is perfecting the design to maintain constant combustion and minimse surface drag. The skin friction gauge will playa vital role in providing this data for performance analysis.

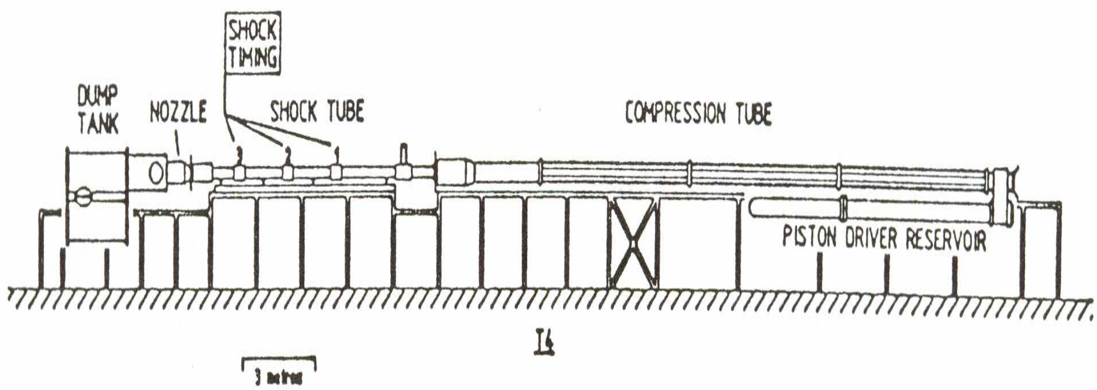

Fig. 1 Hypervelocity Free Piston Shock Tunnel

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Deep Space Communications Network Architecture

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1. SUMMARY

The work discussed in this paper was carried out as pan of a study funded by the European Space Agency (ESA) on a Mission Study of a Space Communications Network, contract number 8641/891F!RD(SC). ESA's present deep space capability is reviewed, as are the predicted RF and optical technology developments in this field. The development of network architectures for Moon, Mars and Solar System missions in the time period 2000 to 2035 are considered. Finally an overall network development strategy is suggested.

2. CURRENT DEEP SPACE NETWORK FACILITIES

ESA's only deep space mission to date is Giotto launched in July 1985 to study Halley's comet. For this ESA made use of the NASA Deep Space Network and the Parkes 64m antenna, with the Weilheim 30m antenna as a back-up. The Perth 15m *SIX* band antenna was the only European Space Tracking Network (ESTRACK) ground facility used for this mission.

Current deep space probes transmit low data rate telemetry using S band. For transmission of higher rate scientific data X band is almost always used. Our interests therefore lie in ESTRACK ground stations with S and X bands capabilities.

ESA plans to install 15m *SIX* band facilities at Maspolomas and to up-grade the ground stations at Kourou and Villafranca to have 15m *SIX* band antenna. However, since these antennas are only 15m diameter, their use for future deep space missions is limited.

There is a limit to the data rate that can be transmitted in X band. Moving to Ka band is one option to allow increase in the data rate. Some Ka technology has been developed by ESA but this is for dedicated missions such as Olympus testing, and has yet to be applied to the DSN.

3. LINK TERMINOLOGY AND FREOUENCY SPECIFICATIONS

The following terminology and frequency specifications are used throughout this report. A forward link is defined as the link carrying data from Earth to a specified destination. A return link is defined as the link carrying data back to Earth. Table 1 shows the frequency band space that has been allocated for deep space research.

Band	Direction	Freq. Allocation
S	forwad	10MHz (2110 - 2120 MHz)
	Return	10MHz (2290 - 2300 MHz)
X	forward	45 MHz (7145 – 7190 MHz)
	Return	50 MHz (8400 – 8450 MHz)
Ka	forward	500 MHz (31.8 – 32.3 GHz)
	Return	500 MHz (34.2 – 34.7 GHz)

Table 1: Presently Available Bandspace in Frequency Bands of Interest.

4. PREDICTED TECHNOLOGY DEVELOPMENTS

When designing a communications network it is crucial that sufficient transmit power can be generated to successfully implement an RF link. Limitations will be placed on component parameters such as amplifier power and antenna size due to available technology.

To generate the power levels that are likely to be required to implement Deep Space links, travelling wave tube amplifiers (1WT As) will almost certainly be the preferred amplifier choice. It is thought that with the current rate of technology developments over 2015 to 2035, a spacecraft will be able to use 1WT As transmitting up to 400W RF power. These would have 65% efficiency at Ka band and 70% efficiency at X band. Since surface bases will have a greater supply of d.c. power and less restrictions on mass they will use TWT As able to transmit up to lkW RF power.

Launch vehicle payload envelope constraints in 2015 are likely to restrict solid reflector antenna size to about 5m. By 2035 this will have increased to about 10m. Any requirements for reflective antennas above these sizes will have to be met using deployable antennas. Constructing the antennas on board a space station and then boosting them into orbit may also be an option. Antennas of 15m and above could pose launch mass and attitude and orbit control system (AOCS) problems for the spacecraft.

Optical communication terminals would be substantially lighter and more power efficient than RF technology. It would not involve the complication of large antennas. However optical links need a very high degree of pointing accuracy and are badly degraded by the atmosphere.

For optical return links to Earth, over distances such as from Mars, it is proposed that a 10m photon bucket (non-diffraction limited telescope) is used to receive data. Ideally this should be situated in-orbit. However, a more cost effective option is to install the receiver on the ground, in a favourable environment. This would still give a predicted 10 to 15dB performance over conventional RF systems. The transmit terminal would consist of a laser transmitting through a telescope. For example, on Mars, a transmit telescope diameter of 30cm would be required for a 32Mbps return link. This would have a mass of about 50kg and power consumption of 80W. Optical forward links from Earth, over long distances, would be a lot more difficult to implement this is due to the large receiving telescope (10m) that would need to be implemented in space. Over shorter distances optical links could be implemented using smaller Optical Multiple Access (OMA) type terminals [1].

5. SUBNET COMMUNICATION ARCHITECTURE

The three deep space subnets considered are Moon, Mars and the Solar System. The users, their requirements, and how these demands would vary over the time period 2015 to 2035 were assessed for each subnet. It was decided that, where possible, the most appropriate and economical way to transmit data was to multiplex the various services on to a small number of channels of the same data rate. The size and number of these channels was calculated using Erlang-B theory. The system parameters of each subnet were obtained by producing link budgets. Trade offs between amplifier RF power per channel and antenna sizes were carried out. In all cases, meeting the return link user requirements was the driving influence in the communication architecture design, because of the higher data rates required on this link.

Keeping the technology constraints in mind the following is a summary of the proposed architectures, based on those produced by Space Engineering [2].

5.1. MOON SUB NET

In 2015 it is predicted that there will be one surface base on the side of the Moon facing Earth. The Moon base could communicate directly with Earth using ESA's currently developing 15m SIX band ground stations. One problem arising from the use of X band is that the return link from the Moon requires 96MHz of bandwidth and the current X band frequency allocation is only 50MHz. This difficulty can be circumvented if a bandwidth reduction modulation scheme, such as 16QAM, is used, but this would leave no room for further expansion of the system.

By 2035 there will be a space station orbiting the Moon. This will result in a requirement for two Lunar-DRS satellites to provide continuous communications coverage to the station (Figure 1). These satellites would be positioned at the Ll and L2 Lagrange points. They would also link any facilities on the far side of the Moon with the Moon base. All traffic to and from Earth would pass via the MCA hub. The 15m SIX band Earth ground station facilities could still be used to meet these requirements. However, it is important to note that additional X band frequency allocation would be needed.

It is also recommended that optical technology be used for the Lunar-DRS to Lunar-DRS intersatellite links, and Lunar-DRS to Moon base links. However it is not felt that the expense of implementing optical links between the Moon base and Earth is justified.

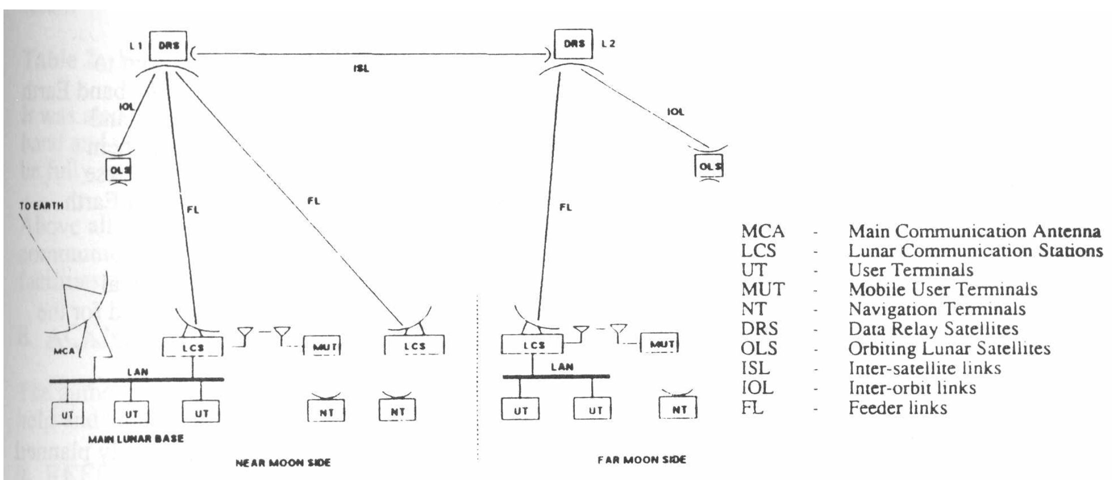


Figure 1: Communications Network Architecture for Lunar Operations.

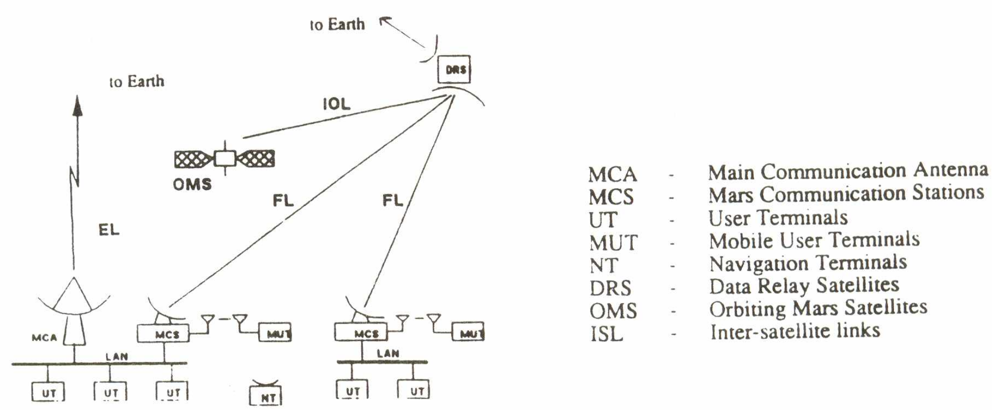
5.2. MARS SUB NET

In 2015, Mars subnet users will be interplanetary spacecraft. The predicted requirements of these I users can be met using a 34m diameter Ka band Earth station.

By 2035, when a surface base is on Mars, Ka band technology will be needed to meet the new demands. A 34m facility would be sufficient to keep the Mars main communications antenna to below 10m diameter. There is ample bandwidth to meet these requirements, as the Ka band allocation is 500MHz.

To reduce communication loss due to the rotation of Mars, a Mars-stationary DRS could be used (Figure 2).The link between this DRS and Mars surface base should ideally be optical, using an OMA type terminal. For the return link between the DRS and Earth the only practical solution available is to implement the link optically. The forward link would then be implemented at Ka band.

The conjunction and opposition of Mars and the Sun will result in a communication black-out, Between the Mars base and Earth, of up to 35 days. This loss could be avoided by using a satellite placed midway between Earth and Mars in a heliocentric orbit. However, this solution is considered impractical to implement even using projected capabilities of the considered technologies. Instead, the base should be designed to survive these periods of communication loss.



igure 2: Communications Network Architecture for Mars Operations.

5.3. SOLAR SYSTEM SUB NET

The Solar System subnet users in 2015 are interplanetary spacecraft. For distances out to Jupiter, return link communication requirements can be met using a 34m diameter Ka band Earth station. However, spacecraft antennas of 15m and above would be required at Saturn and beyond. The launch mass and AOCS system needed for these antennas could make them impractical. Optical technology would then have to be used for the return links over these distances. The forward link requirement would be met using a 34m diameter Ka band Earth ground-station, utilising a 3m spacecraft antenna at distances out to Neptune.

In 2035, an Asteroid base will be present somewhere between Mars and Jupiter. Optical technology would be required for the return link from the base. Ka band would be used for the forward link, utilising a base antenna of 4m.

6. DSN DEVELOPMENT STRATEGY

In 2015 the communication requirements of a Moon base can be met using the currently planned 15m *SIX* band facilities, as long as a bandwidth reduction modulation scheme is used to implement the return link. To meet the user requirements for Mars and Solar System interplanetary spacecraft some Ka band capability will have to be developed. If Solar System missions do not take spacecraft further than Saturn, 34m Ka band ground station facilities can be utilised. To obtain continuous coverage of deep space missions at least three ground station facilities would be required per subnet, positioned 120. longitude apart. The total number is dependent on the number of back up ground stations deemed necessary to help overcome the disruptive effects of bad weather.

By 2035 matured Ka band technology should be used to meet the increasing Moon user requirements. This would save the need for greater X band frequency allocation. The link between Lunar DRS satellite and Moon base would use optical OMA terminals. as would the Lunar-DRS to Lunar-DRS link. Solar System interplanetary spacecraft sent beyond Saturn, and the Asteroid base would require optical return links. Forward links would still be met using the 34m diameter Ka band ground station facilities.

Since the cost of developing optical technology will have been covered to carry out distant Solar System missions, it would be advantageous to implement all Mars return links optically. Again, the 34m Ka band ground stations would be used for the forward links. The link between Mars

DRS satellite and Mars base should be established using optical OMA terminals.

7. CONCLUSIONS

Having derived the above implementation strategy we have concluded that no additional frequency allocations need be applied for to service future Deep Space Communication requirements.

Table 2 illustrates frequency requirements for each link in each subnet, and the band in which it is proposed the requirements should be met.

	2000-2015		2015-2035	
	Max.Freq		Max.Freq	
Link	Requirement	Freq.Band	Requirement	Freq-Band
Moon Subnet				
Forward	4MHz	S	8MHz	Ka
Return	96MHz	X	224MHz	Ka
Mars Subnet				
Forward	16kHz	Ka	8 MHz	Ka
Return	2MHz	Ka	160MHz	Optical
Solar System subnet				
Forward	16kHz	Ka	4MHz	Ka
Return	2MHz	Ka	64MHz	Optical.

Table 2: Frequency Requirements for Moon, Mars and Solar System Subnets.

It was also concluded the ESA would need to sponsor a major development effort in both Ka band and optical communications technologies, before the activities predicted in this study could be fully supported in terms of their communication needs.

Above all we concluded that any commitment made by ESA to developing a deep space communications network would entail an extremely large investment in technology and facilities, whatever implementation route is finally chosen.

8. ACKNOWLEDGEMENTS

The author would like to thank Dr M.A. Grant of British Aerospace (Space Systems) Ltd for his help and support.

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ST4

Integrated Multi-Service Communication Networks

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SUMMARY

Recent advances in computing and communications enable voice, video and data services to be carried on a single network. This paper summarises the development of integrated service networks, examines user applications and discusses the communication protocols which enable these applications to be mounted.

1. THE DEVELOPMENT OF INTEGRATED SERVICE NETWORKS

Information of many kinds can be encoded in digital form and transmitted over telecommunication links. A variety of techniques are currently used for switching digitised information from source to destination through a network shared by many users and techniques are emerging which will enable all information services to be switched in a uniform manner.

There are two principal approaches to switching - circuit switching and packet switching. In circuit switching, which has evolved from the analogue telephony environment, a fixed amount of capacity is reserved for the duration of a call between a transmitter and a recipient. In packet switching, which has evolved from the need to interconnect computers, all information is carried in packets which consist of a variable number of bits of user data together with a header which is used for addressing and other purposes. A packet switched network interleaves packets from many sources and often from several processes within a particular source system. This provides an efficient means of sharing capacity where the information sources are “bursty", i.e. produce information at irregular intervals and have frequent silent periods. Packets must not be greater than a maximum size for the network and may be queued at intermediate exchanges in the network, whilst awaiting an opportunity to be forwarded.

For some years telephony, telex, teletex and data were all carried on different networks. The move towards carrying all services on a single network is in response to two main influences. Firstly, it is expensive for telecommunication providers to operate and maintain several complex and widespread networks in parallel. Secondly, the evolution of new services and processing techniques is blurring the formerly distinct boundaries between service types; new services may also have requirements which could not easily be met by existing networks.

These trends have led to the concept of the Integrated Services Digital Network (ISDN) [1] whose objective is to offer a network capable of carrying all digital information services. ISDN is now being introduced and services are available in several countries. It is effectively based on the circuit

Switching principal, with standard transmission rates of 64 k bit/s and multiples of this value. An important aspect of ISDN is that signalling (that is information about call set up and progress) is carried out using separate channels to those which convey information. Packet data can be carried either using the signalling channels or by operating in packet mode on circuit switched channels. Another important design feature of ISDN is that it presents a small number of standard interfaces to customers, thus encouraging the design of compatible user equipment and techniques.

ISDN as just described (called base band ISDN) is an excellent vehicle for many telecommunication services, but is not suitable for all potential future services. In particular, there are limitations on the bandwidth and pattern of the traffic carried, for example video services would be subject to severe compression at a fixed rate with no allowance for fluctuations in the information content. A faster and more flexible network is required to carry the new services. This is in the course of development and is called Broadband ISDN (B-ISDN).

2. BROADBAND ISDN

The design of an integrated services broadband network has been under study for a number of years. A variety of switching approaches have been considered. These have been developed both from packet and circuit switching and hybrids of the two techniques. After much discussion, the target transfer mode for broadband ISDN has been agreed to be Asynchronous Transfer Mode (ATM)[2]. This is a technique which uses short fixed size packets with fixed size headers in which all information is carried and switched. The decision to use a packet switching technique has not been taken lightly as it can result in complex switching equipment, but a major factor is its flexibility both for current applications and for future as yet undefined services.

Advantages of circuit switching include guaranteed availability of capacity and constant delays. These are very important for services such as telephony. The advantages of a packet approach include the facility to cope with a wide range of traffic speeds and source patterns; packet headers also enable different applications to be easily distinguished, and error detection and recovery to be carried out where necessary. Packet techniques for integrated services have developed from a number of prototype high speed Local Area Networks (LANs) which are dedicated to transmitting both voice and data traffic (e.g. [3,4]). Conventional LAN techniques such as those involving contention are ideal for data but their unpredictable delays are not suitable for voice traffic, thus techniques for guaranteeing bandwidth and limiting delays are required.

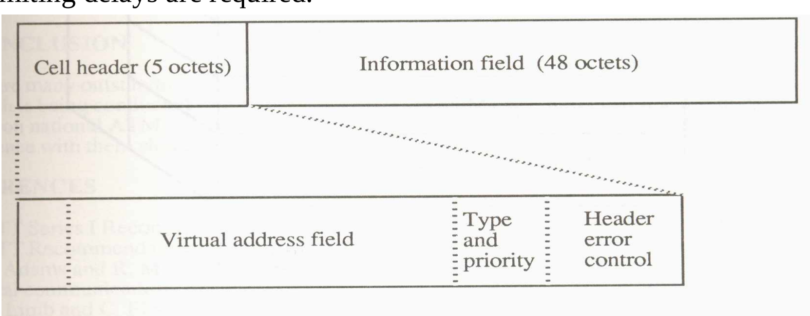

Fig 1. ATM cell format

The ATM packets are called cells and have the structure shown in Figure 1. (Note that one octet comprises 8 bits.) The addressing information is contained in the header; a correspondence between source and destination is set up when a call is opened, thus the addressing information carried with each cell is an abbreviated form of the full address (called the virtual address) which is occupies a small number of bits. Where a service requires more than one cell for an item of information, segmentation takes place and the original item is reassembled from the sequence of

Cells at the receiving end. In some cases one cell may be used for several streams of information e.g. for a number of telephone calls between two sites) in this case the cell would consist of examples (of say 8 bits each) from each of the telephone calls which would be reconstructed into the appropriate voice stream at the receiving end. Further aspects of cell content and structure are discussed in Section 4.

3. MUL TI-SERVICE APPLICATIONS

An integrated service network should be capable of carrying existing services without degradation. These include facsimile, electronic mail, file transfer, telephony and telex. It also opens up the possibility of new applications. Such applications can be broadly divided into distribution services and interactive services. Distribution services would include TV quality distribution, audio programme distribution and security surveillance and could offer some user selectivity. Interactive services can be further divided into conversational, message and retrieval services. Examples of conversational services are videophones and videoconferencing. Messages could consist of text, audio information, high resolution images or combinations of these. Information retrieval could be from audio, image or text information bases or libraries.

One of the major benefits of an integrated network is for services which make use of a variety of communications media. For example a medical retrieval service might offer information as text with supporting photographs, scanned images and spoken commentary. Multi-media conferencing involves communication using voice, moving and still images with pointing devices. Another emerging service is that of Computer Supported Cooperative Work in which people use the facilities of interconnected computer systems to collaborate to solve a common problem. This too can involve a variety of media.

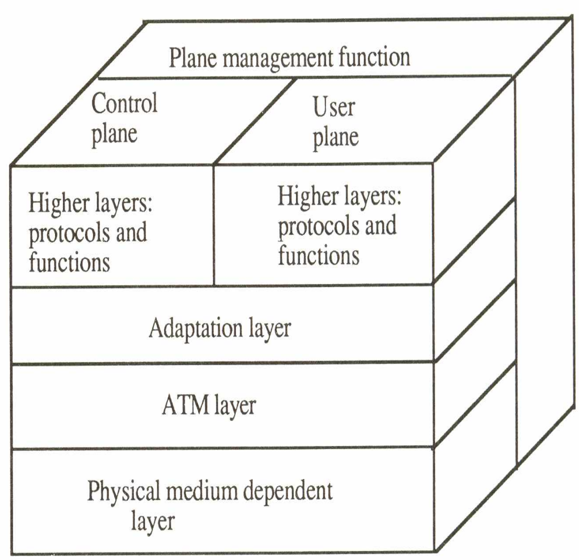

Fig 2. B-ISDN protocol model for ATM

4. PROTOCOL ISSUES

Any communication must follow procedural rules so that it can take place in an orderly manner and so that the information content can be interpreted correctly. In circuit switched networks, the end users must be capable of operating at the same speed and must agree on their own rules. For packet switched networks, the situation is more flexible and therefore inherently more complex. There are rules for defining boundaries and content of packet headers, for establishing calls and for maintaining the correct transfer patterns during these calls. These are called network protocols. Because of their complexity, it is usual to divide protocol functions into a layered structure, each layer dealing with one particular aspect of communication. For data networks, a model (the Open Systems Interconnection

OSI) Model) has been defined which has seven layers.

Layering is also used for the protocol architecture model for broadband ISDN as shown in Figure 2. The control plane is where the signalling (e.g. for call set up and closure) is defined. Management is necessary for correct operation, monitoring and accounting and may need access to all layers. In the user plane, the A TM layer defines the use of the fields in the A TM cell header. The adaptation layer provides for segmentation and reassembly or for the combination of samples from different sources into a single cell as mentioned in Section 2.

The higher layers are not yet defined. There is a conflict here between keeping protocols simple to enable high speed services to be run, and allowing for new features for an increased variety of uses. Simplicity may be attained by condensing some problems into a single layer or by relying on the end users to sort out problems which do not need to be overcome for all services. An example of the first for data networks is a protocol, XTP [5] which condenses two layers of the OSI model into a single layer called the transfer layer and is thus amenable to fast VLSI implementation. An example of a protocol aspect which can be left to end users is error control. Error recovery is not always required for speech communication as a received speech stream will usually be understood even with parts of it are missing and a corrected sample may well arrive too late to be sensibly interpreted.

Integrated service networks must be capable of responding to a wide variety of Quality of Service features. For example some services will need a certain amount of guaranteed bandwidth; others may be subject to a maximum delay or require a low rate of packet error or loss. Services which combine a variety of media may need different service qualities for the various media. Other features which may be needed are synchronisation (e.g. lip synchronisation between voice and video streams), new approaches to fast delivery of data and the facility to multicast i.e. to deliver the same information to a number of destinations.

Research is taking place into these new protocol needs and an example for a small private A TM network can be found in [6]. Here a call consists of a number of unidirectional connections each of which is from one source to one or more destinations. Each connection will be of a given quality e.g. have a certain mean and maximum bandwidth requirement or given delay constraints. Multicast is inherently available and facilities for synchronisation and group management must be built on top of these basic service. By combining different connections with different service qualities there is a slightly increased overhead in setting up the calls but greatly increased flexibility in the nature of the call and how the various connections are used.

5. CONCLUSION

There are many outstanding problems with A TM networks, but small prototypes are being built and research is being conducted into protocols, performance aspects and design techniques. It is not clear how soon national A TM networks will be available, but small scale trials should be with us soon and experience with them should lead the way to the resolution of the major issues involved.

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ST5

Recent Advances in Long Haul Optical Fibre Transmission Systems

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Recent advances in long haul optical fibre transmission systems The paper will review in general terms recent developments in long haul high capacity optical fibre transmission systems. Advances in components such as optical amplifiers, sources, modulators and receivers will be briefly presented together with a short discussion on their use in systems envisaged for future applications. The paper will conclude with an overview of global optical fibre networks.

New Satellite Receiver

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ASTRACT

This paper describes a new satellite receiver which uses the high intermediate frequency technique and integrated circuits, so at the interference of image frequency is restrained and the relative demodulation bandwidth becomes wide. The production in large scale of this type of receiver demonstrated the cost is low d the performances are stable.

In 1945,A Clark suggested the possibility of the global communications by using three geostationary satellites in a 120 degrees impacting configuration. Since then satellite communications have developed rapidly. In the part nearly 30 years satellite broadcasting has resided in international, regional and domestic satellite communications, but now turns out to be a redistribution system ,serving million of communities and individual families via broad casting satellites.

To deliver any new producing and processing techniques to thousands of families or other users in variously needs the best transmission media and receive means.

The signal received from satellite is microwave, signals (C Band r Ku Band) via LNB amplified and converted to Radio-frequency signal which input frequency is 950MHZ-1750MHZ, into the satellite receiver. The receiver changes the radio-frequency signal to the, Intermediate frequency signal, and then output the video signal. In general, the intermediate frequency is choiced to be 70MHZ, some receivers are 140MHZ.

The scheme of this new satellite receiver is shown in Fig.l. The second intermediate frequency is selected to be a High Intermediate frequency IF2=480MHZ for overcoming the image

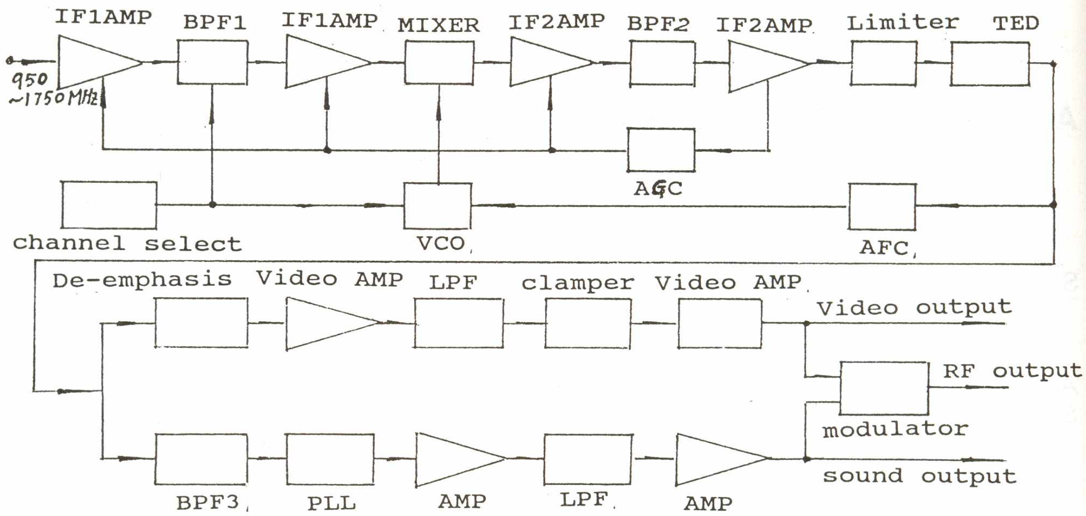

Fig.1

interaction and the interaction of the broadcast TV on ground. Fig.2 shows this spectrum. The band pass filter (BPF) does not need to tracking tune.

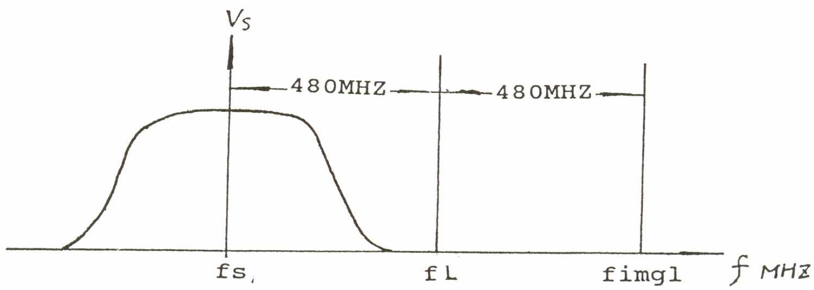

Fig.2

The third harmonic of IF2 being 1440MHZ is able to be possible into the receiving band, and then feedback to input to cause interaction. So that, it is necessary to shield exactly the limiter and demodulator.

The bandwidth of second band pass filter determines of input signal to noise (C/N) of the demodulator. In considering pre-emphasis, the based spectrum bandwidth calculated by Carson-Jingin's rule

$$B = f_{mp-p} + 2f_v + f \qquad \ldots (1)$$

Where fmp-p -- peak to peak frequency deviation of main carrier wave

fv -- highest modulate frequency of image signal the ratio general, B can be *f* -- main carrier frequency difference caused by 25HZ energy extension signal

Obviously, it is more narrow than the bandwidth calculated by Carson's formula, performing over frequency deviation receipt, so that increasing C/N as possible. However, if the bandwidth is too narrow, some side band of FM signal must be cut to cause the effection e/N is decreased and the correspond pulse noise is increased, the "cut-off" noise on the screen is presented. Also, the group delay feature worsen due to produce the distortion demodulation wave. Therefore, the bandwidth can not be too narrow.

The sound surface wave filter (SAW) used in this equipment is better than the LC filter to obtain the flat feature with good group delay feature, less intercrossing interaction modulation, less distortion, as shown in Fig. 3 .

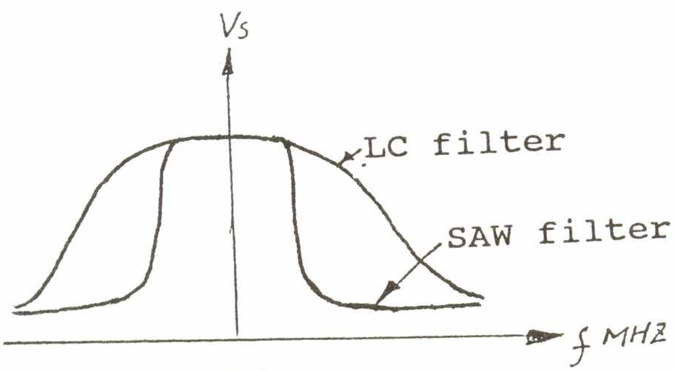

Fig.3

In low C/N, the efficient method is to design the threshold extension demodulator with low threshold level. The table 1 shows the threshold level of the demodulator decreased by threshold extension technology.

Type	FMFB	NTF	ILO	PLL	CSFF	BNF
Threshold extension region	2dB	2dB	2dB	2-3dB	4dB	>5dB

The threshold extension region of several type including the frequency modulation degenerative feedback (FMFB), the narrow band tracking filter (NTF) , the injection limited oscillator demodulation (ILO) , the phase locked loop demodulation (PLL) , the color sub carrier FM feedback (CSFF) and the base band noise eliminator (BNE) are listed. The BM-3 satellite receiver selected Hi-intermediate frequency for restraining effectively the noise of image frequency and obtaining larger threshold extension region by the phase locked loop demodulator (PLL). The scheme of BM-3 new receiver used integrated phase locked demodulator operated on 480MHZ is shown in Fig.4.

Since the phase locked loop possesses the capability tracking input signal, the output voltage of the discriminator corresponds the change of the frequency of input signal. As long as design the loop bandwidth to be enough wide for the voltage control oscillator can track the frequency defference hange of input signal, the demodulation signal with frequency modulation can be taken out

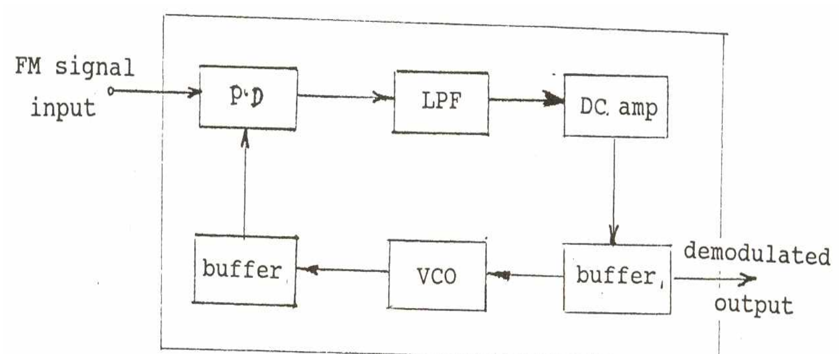

Fig.4

From the output voltage of the discriminator.

The circuit used this demodulator has large threshold extension region, simple circuit and low cost.
In BM-3 image processing circuit, the low pass filter is put behind the video amplifier for filtering off the noise outside video band

For filter off energy extension signal, the clamper has used the syn-chronous peak transistor, so the ratio of filter off vertual synchronous distortion less energy extension signal is more than 40dB.

In sound circuit, beyond the band pass filter with good feature, the demodulation circuit has used the integrated phase locked loop to demodulate FM sound signal, and has designed the low pass filter with 15KHZ bandwidth to increase the ratio of signal to noise (SIN) of output sound to enough high.

The switching regulater for a stable power supply is used for applying conveniently to large region with big change of power supply.

The new methods utilize the high intermediate frequency technique,threshold extension technique and integrated technique, etc. so that is restrained the interference of image frequency and the relative demodulation bandwidth become wide, that is good for decreasing the derivative gain DG, for decreasing the derivative phase DP and for decreasing time delay DT, etc. And it is also to decrease the quantity of components, to simplify the adjustment. Finally, the cost of receiver is decreased and the performance is increased.

Acknowledgement: This work was partially supported by the national natural science Foundation of China.

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The Metropolitan Area Network
A Powerful New Telecommunications Vehicle

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SUMMARY

The MAN is the next evolutionary step beyond the LAN. It provides voice and data communications. It operates at speeds and across distances greater than a LAN and with more versatllity than today's public switched WAN. This paper explores the design and technical requirements of a MAN, its compatibility with the networks of today and those of the future, and the standards under development.

THE METRO WIDE SOLUTION

The rapid penetration of personal computers into the office and workstations into laboratories and factories has created a booming market for local Area. Networks (LAN). A LAN is a software controlled, high bandwidth, medium-sharing, data communications network, spanning a limited geographica1 area, and usually owned by the user. In contrast to LANs, the Wide Area Network (WAN) is based on telephone industry technology and offers a unified view of the world. Data can be sent over modems for long or short distances, and the equipment cost is comparable. But the speeds normally obtainable by thus adapting telephone voice circuits to data communications are not optimal for computers.

Now consider a LAN-type technology that can provide city-wide high-speed transport for both voice and data at speeds in the 100s of Megabits and higher; serve as a highly efficient bridge between disparate LANs; provide a gateway for local and wide area networks; be compatible with FDDI, SONET, the OSI model, ISDN/BISDN, and all 802-based LAN standards; serve as a central hub between public and private networks by linking private nets to ISDN/BISDN and visa versa; run on any and all media but be designed for fiber optic transmission; and be fully compatible with the existing Public Switched Telephone Network. This is the Metropolitan Area Network (MAN) that is being defined by the IEEE 802.6 committee.

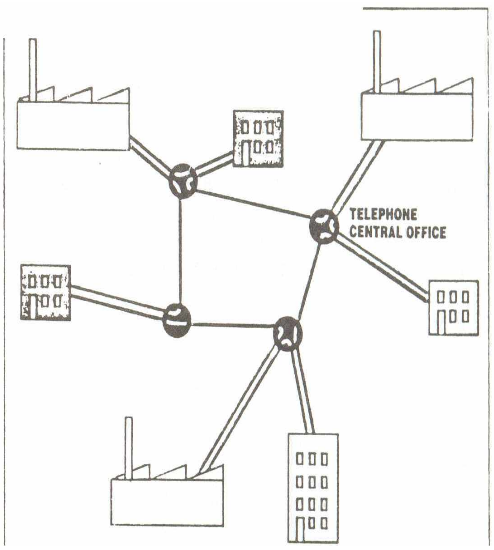
MANs represent local area network technology optimized for the longer distance. The metropolitan area network is an extension of the shared-access LAN, extended to the size of a city and its suburbs. It is designed to take advantage of the great speeds possible with fiber optics. Typical MAN traffic is expected to include LAN interconnection, graphics and digital images, medical imaging, bulk

Data transfer, compressed video, conventional terminal traffic, and digitized voice. Some technical aspects of LAN technology must be changed, though much of it remains the same. A MAN need not handle all the computer and voice traffic of a city. Rather it is an overlay on existing communications facilities, one that can interconnect networks scattered throughout a city as well as the large numbers of personal computers in businesses and homes.

THE STANDARDS: PROTOCOL AND TOPOLOGY

A significant distinction between a LAN and a MAN is in the area of privacy and security. A LAN is intended to carry only data belonging to the organization that owns it. Operating on shared media raises concern that competitors will potentially have access to a company's data or that disaffected customers and employees may damage the system. Therefore the architecture considered assumes that the full MAN will not traverse each customer's premises. The MAN is divided in effect into two networks, an access network carrying only one customer's data and the transport network carrying many people's traffic *(Figure* 1). Bridging between the two takes place off the customer's premises. It requires a central organization to install it, operate it, and bill for services.

A good standard is crucial to MAN development, since interoperability between compute rand te1ecommunications networks is a prerequisite to a successful launch of the new techno logy. Severa1 key require ments have been fashioned. These include a shared medium capable of operating over areas at least 50 kilometers in diameter, providing high speed packet data transmission and voice capability, as well as other services requiring guaranteed bandwidth and constrained delay. A dual bus MAN employing Distributed Queuing Dual Bus (DQDB) access protocol was chosen by the 802.6 committee as the ideal networking technology for a MAN operating in a public network. It performs more re1iab1y and efficient 1 y than the other protocols that were proposed. This is because its multilevel priority structure, synchronization, and signaling are unaffected by congestion.

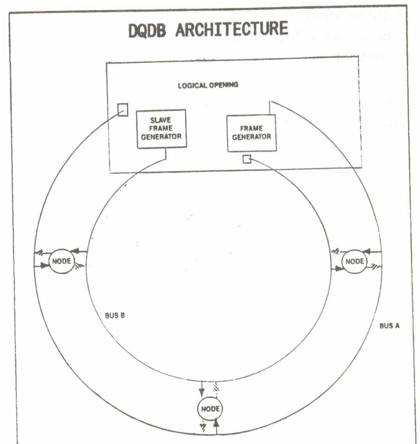


An access network carries one customer's data and
a transport network carries everyone's data.
Figure 1[4]

DQDB is a dual non-branching bus that may be looped into a ring. It is nominally fiber-based, but it can also use coaxial cable or even radio segments. The dual bus architecture shown in *Figure* 2 consists of two lines or buses which carry traffic in opposite directions. Each node which connects to both buses, has read and unidirectional write capability. Every node can communicate to every other node sending information on one bus and receiving it on the other. In contrast to ring architectures, data does not pass through each node. Nodes on the bus read the addresses of passing packets and copy data if there is an address match.

DQDB permits a mixture of slots to be used for synchronous voice and asynchronous data traffic. To accomplish this, a timing pattern is impressed on the underlying transmission protocol. The monitor station emits empty frames every 125 microseconds, corresponding to the voice digitizing rate of 8-bit samples 8,000 time per second. The synchr0nous slots are preallocated with each active

Voice station on the ring assigned a byte position within the frame. No explicit addressing is needed because once assigned, addressing is implicit in the byte position. This scheme provides synchronous transmission with fixed bandwidth and low de1ay. The even 1 y spaced transmission of bytes eliminates the need for buffering mechanisms.



Although DQDB is physically a two ring architecture, logically it is a dual bus.

Figure 2 [7]

Data, inherent1y bursty, does not require the low delay or fixed bandwidth needed for voice traffic. While the synchronous slots required for voice traffic are preallocated, the slots used for data are assigned dynamically with the distributed queueing mechanism. Thus for data loads, the network behaves more like a convention a 1 token ring. This arrangement provides a flexible allocation of the bandwidth to both circuit-oriented and packet-oriented traffic.

The DQDB protocol enables the network to operate at maximum efficiency at very high speeds over unlimited distance, and there is never any wasted capacity with distributed queueing. Each distributed queuing node keeps a current state record of the number of packet segments across the network awaiting access. When a station has a packet for transmission, it uses this count to determine its position in the queue. If no packets are waiting access is immediate, otherwise deference is given to those that are queued first. Therefore capacity is never wasted and minimum access delays at all levels of loading is guaranteed right up to 100 percent utilization of the bus.

COMPATIBILITY WITH THE FUTURE PUBLIC SWITCHED NETWORK

The large area envisioned for MANs, as well as its ability to handle voice, places the MAN squarely in the arena of public network providers. To make the MAN compatib1e with the pub1ic network environment, the committee adopted the following goals for a MAN standard. The MAN should accommodate fast and robust signalling schemes; guarantee security and privacy; permit establishment of virtual private networks; ensure high network reliability, availability, and maintainability; and promote efficient performance regardless of size. In addition, the segment size was adjusted by the 802.6 committee to correspond to the voice digitizing rate of 8-bit samples 8,000 time per second, the telephone industry standard 64 kbps voice channel, and a round trip delay of less than 1.5 millisecond. Therefore the protocol provides for segmenting the traffic into fixed time intervals so that it can accommodate fixed-bandwidth, low delay traffic such as voice. The dual bus network can operate with any synchronous transmission interface including DS3, CCITT G.703, and SONET.

ISDN (Integrated Services Digital Network) is the current wave of the future offered by the Local Exchange Carriers. Basic rate ISDN provides for two 64 kbps circuit-switched B channels and one 16 kbps packet data D channel. Primary rate ISDN is a reinvention of T1, providing (in North America) 1.5 Mbps on a circuit switched basis, or (23) 64 kbps circuit-switched B channels and one 64 kbps packet data 0 channel. Although current ISDN does not Quite meet the needs of data, the proposed MANs are compatible with it. The synchronous channels can be

Mapped into ISDN's B channels, as both are 64 kbps, full duplex digital channels. The packet slots can interface to ISDN's D channel, although there is a speed mismatch with ISDN's basic rate service.

For data communications, the next generation fiber optic based Broadband-ISDN (BISDN) appears to be a better match. It promises services that complement, rather than compete with existing telecommunications. It is packet-oriented rather than circuit-oriented. It offers the capabilities of medium sharing and burst tolerance that computers need. And it provides for the wide area transmission that LANs and MANs lack. The combination of all of the facilities provided by the proposed MAN provides a demand-based multiplexing that is ideal for BISDN. In addition, the MAC address has the same format as the addresses used in ISDN and BISDN and the same header will be used by both standards. The fact that ISDN/BISDN is intended for both voice and data has resulted in the specification of telephone numbers for both types of services.

The use of common formats in the MAN and BISDN, as well as their common potential use of ATM switches, will facilitate building gateways between them. As BISDN circuits become available on an inter-city basis, they will likely become the interconnection choice between MANs, handling the portion of corporate data and voice that requires wide area networking. The result of bridging MANs via BISDN is that the user need not be aware of the MAN at all. Data can be sent and voice calls established across town or across the ocean with the same procedures, providing seamless integration between the two network types.

CONCLUSION

The information revolution's progress is usually measured in terms of memory size and processing speed. But as these have increased so have the distances and speeds at which we can share information. We have moved from individual PCs exchanging disks or using modems at 1200 bits per second, to local area networks transmitting at up to 100 megabits per second, to dedicated wideband high speed links that transmit information allover the world. But these dedicated links are currently available only to a few, very large companies with sufficient intra-corporate demand to support an extensive and expensive worldwide network. For the information revolution to take its next step in a way that most businesses can use, a wideband, high speed, public network service that can connect business premises within a single metropolitan area and that can provide WAN connectivity via the inter exchange carriers extending beyond the metropolitan area is required. As such, Metropolitan Area Networks may one day revolutionize the information industry.

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The Role of Multispectral Imagery and of Other Relevant Techniques on Geological Mapping, Terrain Analysis and Resource Evaluation

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During the Gulf war a British journalist, speaking from the desert in Saudi Arabia, stated that we do not need maps, we have satellites -- a statement that reflected a failure in communication on a powerful technological development in communication. It seems appropriate, therefore, to outline the form and nature of data provided by imaging satellites, the manner in which this may be processed to provide information on the environment, the role of interpretation in the evaluation of this information and the roles of other techniques in the overall and coordinated assessment of the environment and its resources.

The launch of the first environmental satellite – LANDSAT 1 -- July 1972 heralded the beginning of a new technological era in the acquisitation of information on the earth's surface and its resources. The onboard multispectral scanner, designed by the distinguished American scientist, Virginia Norwood, acquired data in four discrete spectral bands, 0.5-0.6 um, 0.6-0.7 um, 0.7-0.8um and 0.8-1.0 um at a spatial resolution of 79 metres. By acquiring data in the near infrared as well as the visible parts of the electromagnetic spectrum the scanner provided additional information to that possible from conventional aerial photography which is limited to the visible part of the spectrum. As technologies have advanced it has become possible to image the earth. at longer wavelengths, to increase the number of spectral bands and the spectral resolution and to acquire data giving a greater spatial resolution. The constraint is that of data handling for the greater the spectral and spatial resolution the greater the amount of data to be handled. Currently the two most important satellites for acquiring data on the earth' s environment and resources are the LANDSAT THEMATIC MAPPER launched in July 1982 and the French SPOT satellite launched in 1986. the former acquires data in six spectral bands at a spatial resolution of 30 metres and in a thermal band at a spatial reso1ution of 120 metres. The latter acquires data in three spectral bands with a spatial resolution of 20 metras in colour mode and of 10 metres in black and white mode; it also accords the possibility of stereoscopic cover in black and white mode. Military satellites targetting or: small areas provide data with a much greater spatial resolution while the scanners mounted on aircraft provide data at desired spectral and spatial resolutions; This may be in a very large number of channels and at very high spatial resolution.

The data from the satellites and from scanners mounted on aircraft platforms comes in the form of computer compatible tapes and has to be programmed through digital image processors to yield information on the earth's surface. Because it comes in this form, however, it is possible to generate colour composites by combining the data in individual bands through red, green and blue filters, to ratio the data in the different bands and to generate colour composites of the rationed bands by displaying them through the red, green and blue filters, to subject the da0a to principal components analysis and generate colour composites of the principal components and to employ classificatory and decor relation analysis techniques followed by display as colour composites. The use of these techniques makes possible the extraction of the maximun information on the earth's surface. Neither the satellites nor the scanners mounted on aircraft provide ready made information. The data has to be processed and the processed outputs have to be interpreted for the preparation of maps of the terrain features.

Interpretation of the outputs generated from the satellite and aircraft data requires a knowledge of the relationships between the spectral responses of the individual components of the earth's surface -- notably vegetation, bare soils, exposed bedrock -- under different climatic conditions and in different types of terrain and the colours displayed on the outputs. Since most of the earth's surface is covered by some form of plant growth, vegetation is particularly important. For correct interpretation of the outputs, knowledge of the vegetation and of its relationships to soils, geomorphology and especially to bedrock geology is essential. For example in desert and semi desert areas, saline tracts in which after sporadic rains vehicles may become bogged are, according to the combination of spectral bands and filters, displayed in colours that are distinct from those revealing areas of calcrete which affords a firm substrate. (Cole 1985) On the ground each type of terrain is discriminated by the presence of distinctive plants that are unique to it. Areas underlain by the weathering product laterite, that also provides firm ground, are likewise distinguished from sandy terrain.

My Own research has focussed on the use of remotely sensei imagery and geobotany for geological mapping and of these techniques together with geochemistry and biogeochemistry and an understanding of the geomorphology in mineral exploration. The emphasis has been on the interdisciplinary approach and the integration of the several techniques at appropriate stages. This may be illustrated from work undertaken in different environments in different parts of the world.

The first example is from work carried out in the 1967-7l period before the advent of multi spectral imagery and of imaging satellites. This work was undertaken on the western fringes of the Kalahari Desert in Botswana and Namibia. The objectives were to locate, beneath cover of sand and calcrete, the continuation of the Proterozoic sedimentary sequence of rocks that in Katanga and Zambia host important copper deposits and to identify areas of copper mineralization. (Cole and le Roex 1978) The initial techniques were aerial survey and geobotany. As seen from the air the nature of the vegetation and the parallel alignment of trees and shrubs correctly suggested presumed contacts of different lithological units and the near surface presence of the sedimentary sequence whereas different forms of vegetation with random distribution of trees and shrubs correctly suggested areas of calcrete and/or deep sand cover. Subsequent traversing across the inferred orientation of the presumed near surface sedimentary sequence identified areas of anomalous plant cover correctly considered to indicate toxic ground related to copper mineralization. Trenching and drilling established the presence of copper deposits in several areas, with those in Botswana being delineated by a different plant

Species from those in Namibia. Geological mapping was undertaken by interpretation of air photos and by ground reconnaissance, in both cases based on and assisted by studies of the vegetation. Evaluation of outputs genera tad from LANDSAT and SPOT imagery when these became available showed that these effectively displayed in distinctive colours the discrete geological units where near surface, revealed faults and fold structures within the sedimentary sequence, distinguished send dunes and areaas of deep sand, discriminated areas underlain by calcrete and portrayed major drainage lines and pans. (Cole 1982, 1988, Cole et al 1986) Some of the lines cut through the vegetation during the exploration work in Botswana were also discernible. Had the multi spectral imagery been available when this work was undertaken it would have assisted greatly the programming of fieldwork and reduced the time required for geological mapping? it would no t have lessened, however, the need for the geobotanical input and the reconnaissance ground traversing which succeeds in locating the cooper deposits.

Investigations undertaken over the Thalanga zinc-lead.-copper deposit near Charters Towers, Queensland, Australia in 1980 provides an example from a different geographical environment in which the contributions from the several techniques differed from those in Namibia and Botswana. Within the savanna woodlands of this area different Eucalyptus tree species distinguished the different geological units and Eucalyptus tree species different from those of the background vegetation revealed the presence of the ore zone. (Cole 1991, press) This change could not be identified on Outputs from LANDSAT or SPOT imagery, largely because the leaves or Eucalyptus trees hang vertically downwards and hence their spectral responses are similar. The gossans or iron cap produced by weathering of the ore body where exposed at surface, however was uniquely displayed on outputs of SPOT imagery by a distinctive colour. Different geological units could be differentiated only with difficulty because of the similarity of the spectral responses of the different Eucalyptus species but drainage lines and fences were readily identified and provided useful reference features for mapping. The anomalous Eucalyptus species that distinguished the exposed ore zone continued sporadically over the inferred extension of this zone where overlain by considerable thicknesses of soil, overburden and flat lying Tertiary sedimentary rocks. Here biogeochemical techniques involving the analysis of samples of leaves and twigs of Eucalyptus trees collected along transect lines orientated across the inferred extension of the ore zone effectively located the subsurface presence of this zone whereas outputs generated from remotely sensed imagery, geochemistry and geophysics, because of the nature of the terrain, failed to do so.

The importance of the understanding of the geomorphology of the terrain in the interpretation of multi spectral imagery and of anomalous vegetation cover in the detection of mineral deposits may be illustrated from studies over the Coed-y-Brenin porphyry copper deposit in North Wales (Cole et al 1986) and the Yeelirrie uranium deposits in Western Australia. (Cole 1985) In Coed-y-Brenin forest a series of small geobotanical anomalies occupy seepage sites around the periphery of the porphyry copper deposit, their presence related to the toxic conditions emanating from ground waters that have circulated over the deposit and precipitated their copper content in peat developed over glacial deposits that are a legacy of the Quaternary Ice Ages. The largest geobotanical anomalies, notably that over Dolfrwynog bog, are detectable on outputs of the high resolution SPOT imagery and of the higher resolution airborne Multi spectral imagery. The anomalies do not occur over the copper deposit, the detection of whose presence required interpretation of their distribution, with reference to geomorphology. The formation of the Yeelirrie uranium deposits depended on the juxtaposition of drainage from granite containing uranium and potassium and

Ultra basic rocks yielding vanadium and the precipitation from these waters of these minerals in calcrete along old drainage lines transverse to the geological strike. The different geological units and the geomorphological features are readily distinguished on outputs generated from LANTDSAT imagery and the uranium deposits are uniquely displayed.

For geological mapping and mineral exploration the interdisciplinary approach and an understanding of the environmental features contributing to spectral responses, notably vegetation, soils and exposed bedrock is critical in the interpretation of multi spectral imagery. this type of imagery can be used For many other purposes such as the discrimination of geological faults likely to be the sites for earthquakes and of areas of volcanic activity, the identification and assessment of forest resources and the monitoring of the destruction of tropical forests, the identification of agricultural crops and. the estimation of crop yields, the monitoring of drought and the advances of desertification. In every use it is important to emphasize that multi spectral imagery from satellites and. aircraft platforms provides a powerful tool but does not provide a ready made picture. The data has to be processed and the outputs generated through digital image processors must be interpreted with reference to ground truth information.

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Echo Cancellation in Telecommunications

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1. INTRODUCTION

Echo is the phenomenon in which a delayed and distorted version of an original sound or signal is reflected back to the source. The echo canceller must accurately estimate the echo path characteristic and adapt to its variation. This involves the selection of an adaptive and an algorithm for the adaptation. The best selection depends on particular application and on performance requirements.

This paper examines the various situations in which echoes are generated. Then, echo path modelling techniques and adaptive algorithms for coefficient control are reviewed in particular, those used in telecommunications. Two adaptive algorithms have been investigated, namely, the least mean square stochastic update algorithm and the fast Kalman algorithm. Computer simulation results will be presented as well as discussion of factors influencing the design and implementation of their associated hardware.

2. BASIC PRINCIPLE

The telephone network generates echoes at points within and near the ends of a telephone connection. A starting point on echo terminology is given in Figure 1. Echo is generated at the hybrid transformer used for two-wire-to-four-wire conversion. At end-to-end connection of the current telephone network consists of both two-wire links, as in a subscriber loop, and four-wire links, as in a long-haul repeater link. A hybrid transformer is used at the connection point, and due to imperfect impedances matching, echoes are generated as shown. An echo canceller placed on the four-wire side combats these echoes as shown in Figure 2. The echo canceller first estimates the characteristics of the echo path, and then generates a replica of the echo. The echo is then subtracted from the received signal. Adaptive Digital Filtering (ADF) is required to obtain a good echo replica; since the echo path is usually unknown and time-varying.

3. FILTER SELECTION

The adaptive Finite Impulse Response (FIR) filter, also referred to as a tapped delay line, is by far the most widely used. The convergence property of the coefficients to optimum value is well understood. However, as the echo duration becomes longer, the number of taps increases proportionately and the convergence speed decreases. For example, the echo duration for telephone speech transmission is usually several tens of ms, and the required number of taps is of the order of several hundred. For Satellite transmission systems, which have round-trip delay of about 550 ms, a straightforward FIR implementation requires more than 5000 taps and results in a prohibitively complex hardware.

Research is currently going in several directions in an attempt to find new filter structures that reduce complexity and improve performance.

4. ADAPTATION ALGORITHM

The algorithm chosen for adaptation is largely a trade off between complexity of implementation and speed of adaptation. There are generally two measures of performance of an adaptive echo canceller: the speed of adaptation and the accuracy of the cancellation after adaptation. In most instances, the accuracy of the final cancellation of the echo is the most critical design factor.

The two basic categories of algorithms for echo cancellers are shown in Table 1. A brief description highlighting the most important features will now be given.

Table 1 Adaptation Algorithms and Characteristics

Algorithm	Characteristics
Least Squares (LS) method	• Calculation of tap coefficients, which minimize the squared error summed over time • Fast convergence speed independent of input signal • Large computation number
Least Mean Squares (LMS) method	• Gradient tap adjustment to reduce the estimate of error • Convergence speed dependent on input signal • Small computation number30 ST

The first algorithm is called the Least Squares (LS) algorithm and is closely related to the Kalman filter control theory. It is based on the minimisation of the LS cancellation error over the choice of adaptive filter parameters, with a weighting function decreasing exponentially into the past to give the algorithm finite memory. The advantage of this algorithm is fast convergence, irrespective of the correlation characteristics of the input signals. However, obtaining the optimum coefficient value involves computation of the inverse matrix and results in complex implementation. There are several algorithms proposed to simplify this computation, such as the Fast Kalman method.

The other adaptation algorithm is the Least Mean Squares (LMS) algorithm. Here, the criterion function is taken to be the expected value of the squared error, and the tapes are adapted according to the stochastic steepest descent algorithm. The LMS algorithm is widely used due to its comparatively easy implementation and its well-established stability characteristics. Its major drawback is the dependence on correlation of the reference signal; the convergence slows for highly correlated signals such as voice. In some applications with a large number of taps, the use of a whitened training signal or a pre-whitening filter such as the lattice structure, linear predictive filter becomes necessary.

5. SIMULATION RESULTS

The above mentioned two adaptation algorithms have been used in computer simulation to investigate several (EC) design considerations, such as the speed of adaptation, the effect of near and far-end signals, the impact of signal levels and spectra, and the impact of nonlinearity.

The software for the simulation was written in C programming language and compiled using a Turbo C V2. 0 compilers. All of the calculations were performed using double precision floating point numbers to reduce the effects of rounding noise. Pseudo random data was generated using the compilers internal random number routines. Figure 3 shows a comparison of convergence rates of LMS and Kalman algorithms.

Figures 3, 4, 5 and 6 sample some of the results obtained during the optimisation process.

6. ALGORITHM TEST HARDWARE

The algorithm test hardware (Figure 7) is based around an AT&T DSPl6 digital signal processor which provides data generation, control signals, and digital domain processing. The digital signal processor has an internal pseudo random data generator which is used to produce a random transmitted data sequence. This data is then used to set the gain of an amplifier at either +1 or -1; the gain can be adjusted so that the positive amplification is equal to the negative amplification, ensuring a balanced data signal. The input to the amplifier is taken from the reference voltage of the analogue to digital converter. Thus the maximum transmitted voltage is equal to the maximum analogue signal that can be converted before the analogue to digital converter saturates. The output of the amplifier is passed through a low pass filter and then sampled by a sample and hold circuit, prior to being digitised by an analogue to digital converter. This value is then strobed into the digital signal processor.

The value of the original transmitted pulse is stored, in a 16 bit wide sample, in a delay line along with the past N-l echo canceller. These samples are then multiplied with their corresponding 16 bit filter coefficients to produce the output of the echo canceller. This value is subtracted from the incoming 16 bit data sample, from the analogue to digital converter, to produce the error value. The modulus of this value is compared with a threshold to determine if the echo canceller has achieved a certain level of echo cancellation. If the error is greater than the threshold then the converge pin is set high, if the error is below the threshold then the converge pin is set low. The error value is then multiplied by alpha (the convergence constant) and this added to the filter coefficients. The next transmitted symbol is generated and the process repeated.

7. SUMMARY

This paper described the principles, applications, algorithms and technology of echo cancellation. New applications of echo cancellation, such as the elimination of acoustic reverberation, noise cancelling in hands-free mobile telephones, are currently being studied.

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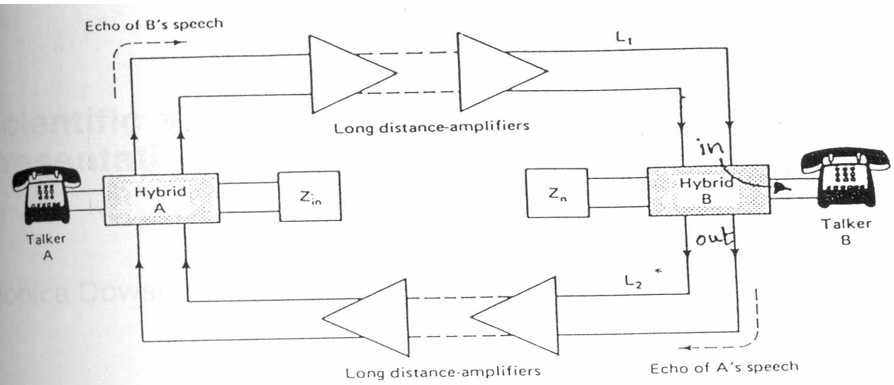


Figure 1 Sources and types of echo in telephone network

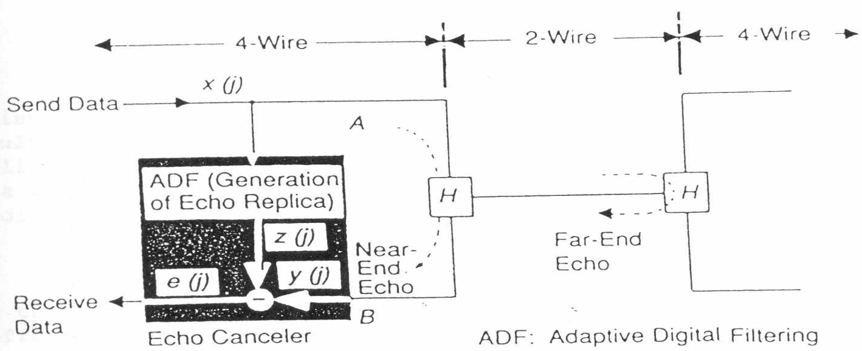


Figure 2 Principle of the echo canceller based on generating an echo replica and subtracting it from the near-end talker signal plus echo. ADF Adaptive digital filtering, x(j) ≡ reference signal at time j, y(j) ≡ received echo signal, z(j) ≅ echo replica, e(j) ≡ the estimated error, N denotes the tap length

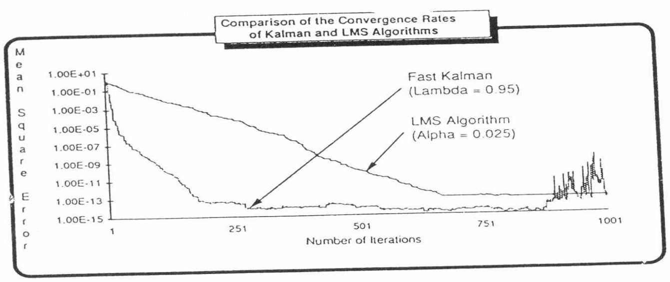


Figure 3

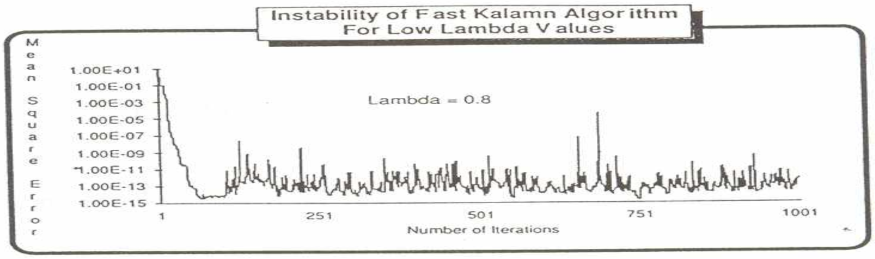


Figure 4

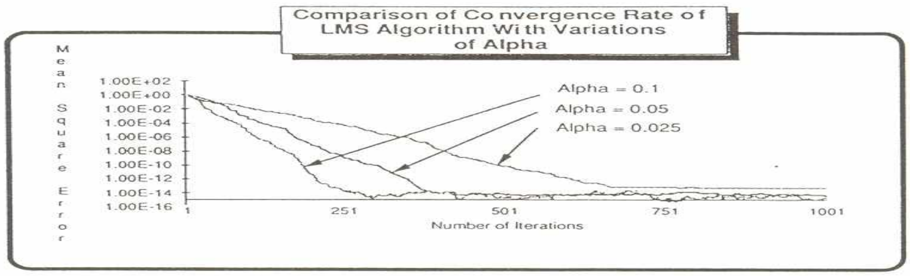


Figure 5

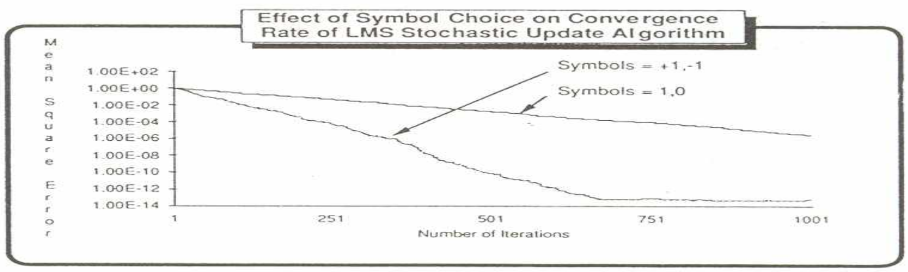
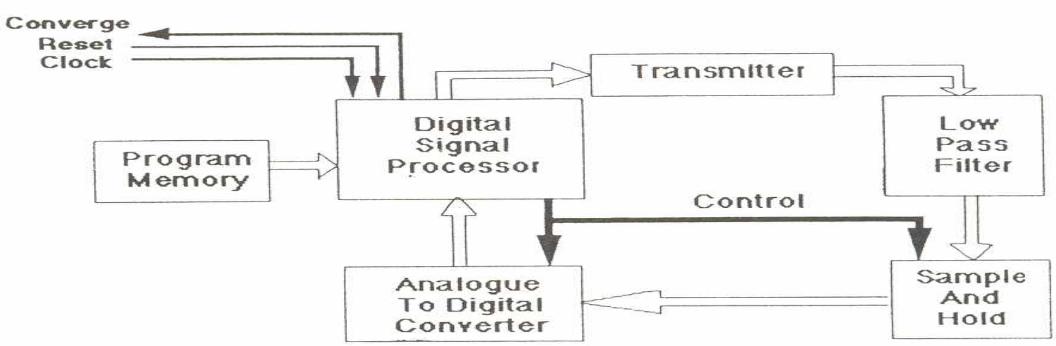


Figure 6



Algorithm Test Hardware

Figure 7

ST10

Scientific Visualisation - The Graphical Presentation of Computed Data

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SUMMARY

Scientific visualisation is a way of helping scientists to understand computed results. Representations for numerical optimisation and microwave device modelling are discussed. The major conclusion is that the data must be shown in a way that is meaningful to the scientist. A prototype interactive display for microwave device modelling is shown.

INTRODUCTION

The theme of this conference is 'Communication' and this can mean different things to different people. In the world of physics and electronic engineering it would be interpreted as telecommunication. In the advertising I world it would be considered to be the means of conveying ideas, images and, product information.

In this paper, the interpretation of communication used combines both the .electronics angle by describing the modelling of electronic devices at microwave frequencies, and the human communication angle by discussing ways in which computed results can be conveyed to the researcher to enable their understanding of the results.

SCIENTIFIC VISUALISATION

Scientific, and indeed all other, applications using computers can now produce vast amounts of data which cannot easily be assimilated. Scientific visualisation has been hailed as the breakthrough in the presentation of complex computed results. The aim is to present data in a readily understood graphical form. Examples of scientific visualisation can range from simple line graphs or histograms, such as can be produced by most spreadsheets, to three-dimensional solid models of data which are rendered making full use of colour and highlighting models and even animated to show how the data varies with a fourth dimension, usually time.

Two dimensional data can easily be visualised as a graph or histogram. If the data is three-dimensional, most people can imagine a 3-d graph or model, either in wire frame or as a solid model or as a contour map. The use of

Colour can emphasise one of the variables, such as the height in a contour representation, or colour could be used to overlay a further data variable onto the 3-d model. Alternatively, additional data can be represented by additional lines overlaid on the model. Another dimension, such as time, can be represented by using animation. However, it is easy to recognise that multidimensional data is difficult to display graphically and this paper attempts to highlight one application where multidimensional data is to be visualised.

The production of effective visualisation requires that the designer has knowledge of computer graphics techniques, human visual perception, human knowledge and information processing, human-computer interaction techniques, data analysis, interpolation and graphic design, in addition to an understanding of the science, or at least an understanding of what the scientist would like to gain from the results displayed. The scientist or engineer would also want to control and guide the data that is being visualised and so human interaction with the display is an important part of scientific visualisation.

OPTIMISATION

Numerical optimisation is a technique which can be utilised in many sciences and which produces vast amount of data. Basically optimisation is used to find the values of a set of variables at which a function or several functions are at a minimum or maximum. There are many algorithms available. Two classes of algorithms are

(i) Gradient descent methods such as the Newton Raphson method which calculates and uses gradient calculations to indicate corrections to be added I to each variable to produce a 'better' value
(ii) Random search and pattern search algorithms such as the Simplex method of Nelder and Mead [1) which home in on the maxima or minima after evaluating the function at selected variable values.

Using the supposition that use of scientific visualisation techniques might enable understanding and perhaps control of the optimisation of functions, prototypes were developed for displays using an algorithm of class (i) above.

Looking at graphs and histograms of the variables and functions, the results showed features that had not be seen before when simply looking at printouts of the results. In that sense the visualisation was successful. The main surprise was the sudden and rapid increase in the values of one of the variables and one of the functions just prior to the equally sudden and rapid decrease in all of the functions. This was an unexpected result and whilst it could be understood by using an analogy in say, geography, where a deep valley lies beyond the next rise, the possibility of predicting and controlling the progress of the optimisation technique using graphs of this type was thought to be unlikely.

A better representation of the functions, therefore, was thought to be by colour rendered contour maps. This would be of particular use in random search techniques. However, contour maps consist of height information displayed as a function of two variables. The problem being used as an example consisted of 8 functions of 8 variables, where the 8 functions were reduced to a single sum of squares function to be minimised.

In this case therefore, a 'multi-layer' view could be used. This uses several stacked contour maps showing the sum of squares function against pairs of variables. An image of the function in relation to all of the variables is then possible. But bearing in mind that the aim of visualisation is to aid understanding of the science, it was obvious that seeing

These different views of the function did not achieve this aim.

One of the reasons for this was that the data was being displayed simply as data without any reference to the science. Therefore, if the aim of visualisation is to understand the science then a more effective way to promote this is to ensure that the representation of the functions and variables is one that is more relevant to the researcher.

This is, in fact, one of the major rules in designing a human-computer interface: "Know the user", Hansen [2].

DEVICE MODELLING

The author's interest in numerical optimisation stems from research into the production of equivalent circuit models of microwave devices [3]. As described in the paper cited, equivalent circuit models are automatically developed from an initial model proposed by the user. The optimisation attempts first to optimise the element values of the original model to match as closely as possible the s parameters of the device to be modelled. Further improvements to the model are then effected by the algorithm automatically inserting and deleting elements in the model, using the optimisation algorithm to adjust the element values in the whole model as necessary. Thus, a series of new models evolves from the initial model.

The algorithm is driven by the optimisation process, always aiming for the most rapid improvement in the match between the measured s parameters of the device and the calculated s parameters of the model. Hence, the type of developments shown in figures la and lb is possible. Whilst the final result gives a good match between the model and the device, the engineer might not like or understand the model.

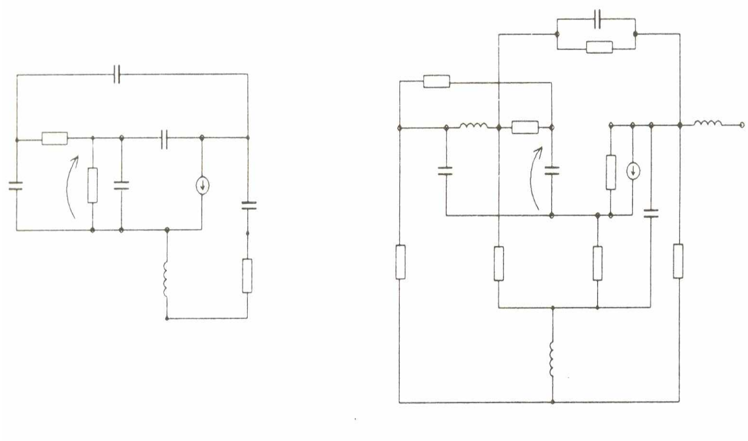

Fig 1a Model using minimum number of elements

Fig 1b Model giving best fit to s parameters

If the model is being developed to aid the engineer's understanding of the device, rather than to use in some CAD program, the stages in the development of the model should be more under the engineer's control. The engineer might wish to study the automatic stages in more detail or, more likely, the engineer would like to specify which type of component, its initial value and position in the circuit, the computer program should attempt to insert into the circuit. The ability to hold element values constant and vary the value of just one element whilst displaying the effect of this on the s parameters is also seen as part of this visualisation approach. Thus the engineer would be able to learn about and understand the development of the new models.

The prototype shown in figure 2 is presently under development to perform this visualisation.

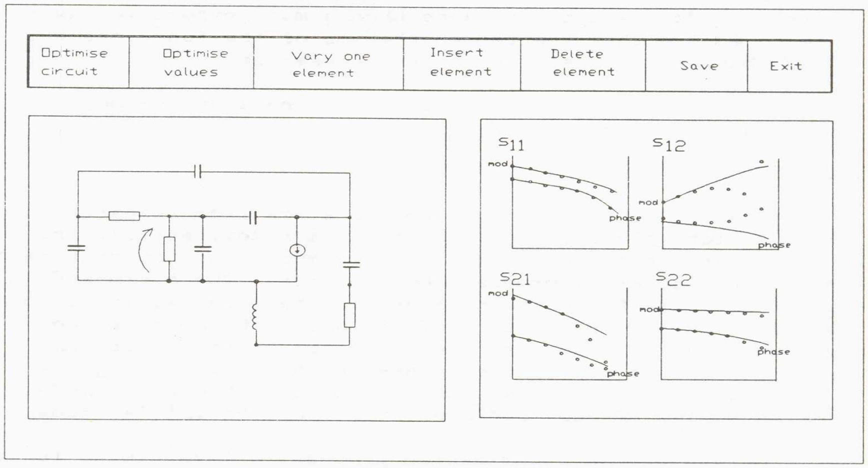

Fig 2 Prototype for visualisation of equivalent circuit models

CONCLUSION

This paper addresses some of the problems in the design and development of scientific visualisation. Some excellent work has already been done in this field enabling scientists to understand the results of computations. However I there is still much work to be done, particularly on suitable representations' of multidimensional data.

The skills of graphic designers and of experts in human-computer interaction and computer graphics are necessary to develop suitable visualisations. In accordance with the basic principles of human-computer interaction, scientific visualisation should use representations which are meaningful to the scientist, rather than simply displaying the data as numerical data.

The prototype shown for the development of equivalent circuit models of microwave devices offers the opportunity for engineers to develop and understand new models and to understand the operation and design of the devices themselves.

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Speaker Verification - Security for Remote Computer Access

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1 Summary

To avoid unauthorised access, current remote database systems rely on Personal Identification Numbers (PINs). More secure access control is provided by Speaker Verification. The system holds a template which describes the characteristics of a valid user's voice. When system access is requested, the Verifier matches the user's voice against the stored voice template. A good match results in the user being granted access to the system.

2 Technical Overview

Ensigma began work on the Verifier in January 1990 and filed a patent on the technology in October.

In the past, speaker verification systems have not been able to achieve the required levels of performance required by many applications. A recent report from Sandia Laboratories quoted figures of 5% false rejection rate and 3% false accept rate for currently available speaker verification systems. A major problem has been that of setting the decision threshold. There was a constant tradeoff between setting the threshold high enough to prevent impostors gaining access to the system but low enough to give a very low 'insult rate' i.e. rejection of valid users due to variations in the way in which they speak or variations in background noise.

Ensigma have solved the problem of Speaker Verification in an entirely different way. Instead of matching a speaker's voice against a single template and then making a decision based on thresholding, Ensigma's system compares the voice against two models. One of these models is built for the characteristics of the specific user's voice while the other is a general model for the word spoken (like a speaker independent model in speech recognition). The -decision to be made is then whether the utterance matches better to the user model or the: world model. If the best match is to the user model, then the speaker's identity is validated and access is granted. If the best match is to the world model, then the speaker is judged to be an imposter and access is denied. This method has proved to be far more robust than the traditional approach, for example it is far more tolerant of background noise.

3 Performance

The performance design aim of Ensigma's Speaker Verification system was to achieve equal false accept (ie allowing access to an imposter) and false reject (ie refusing access to a valid user) rates of less than 1%. Testing of the false reject rate shows that the aim has been achieved - in internal tests, 1 rejection was noted in 600 trials. However, it has been difficult to give a true figure for the false acceptance rate - as no one has yet been able to gain access as an imposter.

The characteristics of a speaker's voice are largely dependent on physical characteristics of the vocal tract together with information about the speaker's accent and manner of speaking. For this reason, the most difficult test to which the Verifier has yet been subjected was to differentiate between a pair of identical twin boys. The boys were 15 years old and had grown up together with the same influences on their accents. A series of tests recorded no false acceptances and no false rejections for the twins.

4 From Laboratory to Real World

The availability of a suitable verification algorithm is only the first stage in the design of a successful verification system. There are several factors which can adversely affect the perceived performance of such systems. Several of these issues have been discovered and resolved as a result of discussions with users and trials at customer sites.

- The major security threat to a high performance Speaker Verification system is that of a user being recorded speaking his password and an imposter gaining access by replaying this recording. Ensigma have tackled this problem by avoiding the use of a password. Instead, the system works by requesting the user to speak about five digits. The ordering of the digits is random in order to make it difficult for an imposter to play back a recording of a valid user gaining access to the system.

  In order for an imposter to gain access to the system, he would need to:

  1. Discover a valid user's PIN number (or other means of initial identification)
  2. Record the chosen user speaking all of the possible digits
  3. Devise a system which could play back a voice recording in the correct order within the time limits

- Although for applications which require a very high level of security, the ability to prevent impostors from gaining access is of the greatest importance, the concern expressed by many potential users of biometrics is not how good a system is at rejecting impostors but how low is the 'insult rate' - i.e. the percentage of valid users which a system rejects. It is important to recognise this fact and to discover which issue is of greatest concern to a customer when designing a system.

- Before a new user accesses the system for the first time, he must be enrolled. During this process, a series of samples of his voice are collected and templates built for each of the words to be used by the verifier. Five samples of each word are required.

In order to enrol a user for all of the digits, it is necessary to collect samples of him speaking each digit five times giving a total of fifty utterances. Although this only takes two minutes, many users find it tedious. In addition, the enrolment environment needs to be reasonably quiet. One type of background noise which has been observed to adversely affect performance is the clicking of computer or typewriter keys.

Both of these problems can be greatly reduced if enrolment is by speaking continuous strings of digits rather than isolated utterances. It's much easier to speak ten five-digit strings than to speak fifty isolated digits. If the word models are then built using embedded training techniques, the model building algorithm is forced to examine the digit string in order to find the specific words requested. Using this method ensures that any spurious noises such as clicks or lip smacks are not built into the models.

§ If a mistake is made, for example speaking the wrong digit, then the template built for that digit will be poor and, although the system is robust to this sort of error occurring once or twice, performance will be degraded. In addition, mistakes of this kind can confuse the user who is not sure how to correct his mistake. By designing the application so that recognition is run in parallel with enrolment, the utterances spoken by the user can be checked as he enrols. This ensures that the models are built using the correct utterances and can give the user a chance to correct any mistakes which he has made.

§ There are several ways in which the enrolment process can be disguised or avoided altogether. For example, samples of a user's speech could be collected through a game, competition or other question and answer session the first time they access the system.

An idea which is popular with bankers is to have no formal enrolment stage. They are willing to introduce some risk in order to increase the ease with which the system can be used by their customers. Under this system, the first few times a customer uses the service, the operations which they can access are limited to those presenting low risk. The data collected from the customer speaking their account number is used to collect samples of their voice. When sufficient samples have been collected, a model is built which is used in subsequent sessions to verify the identity of the user who is now allowed access to more sensitive operations.

5. Applications

Speaker verification is particularly applicable to remote security problems due to the widespread use of the telephone. However, there are several other application areas.

Current methods of local access control include keying in a PIN to a door lock or identifying yourself using an identification card carrying a photo and signature. These methods are open to corruption as ID cards can be forged and an imposter can find out a valid user's PIN by watching him entering the number at the access point. In addition, the PIN number can fall into the wrong hands through the valid owner writing it down or the imposter intercepting the valid user's mail.

There are now several biometric devices around, i.e. devices which identify a user by means of some personal characteristic, the most popular being voice, fingerprint, retina pattern or signature. Although some of these techniques can give a high level of performance, there are

Associations which users find unacceptable. Fingerprint identification is unpopular among some user groups due to the associations with criminal investigations. The retina pattern is an accurate method of identification, however it is an expensive system and there have been fears voiced about some safety aspects. Signature verification units may have a place in point of sale transactions as people are used to signing for goods received however, in many other situations, people find it more natural to identify themselves by speaking.

Remote access of computer databases and physical access control are standard applications of verification technology. However, potential customers are discovering that speaker verification can address their problems in slightly more unusual application areas:

- An ever increasing amount of personal and confidential information is being stored on portable and notebook computers. Speaker Verification can be used to control access to sensitive information.

- Although speech technologies are usually regarded as being applicable only in highly developed countries, one application has come from a less sophisticated market. Voice can be used to verify the identity of people who are illiterate (and are therefore unable to sign their names).

- We have been approached by a company which develops PC based training packages. They are interested in the application of Speaker Verification to the problem of ensuring that only one user is able to use a single user licence.

6. Conclusion

This paper has described Ensigma's Speaker Verification system and discussed how it differs from other commercially available systems. As a result of the approach which Ensigma has taken, the speaker verifier is more robust than other systems and achieves a higher level of performance. Common problems experienced when taking speaker verification out of the laboratory and into the real world have been explored and a range of applications of the technology discussed.

Communication in an Underwater Environment

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The "1st International Submarine Races" were held in June 1989 at Riviera Beach, Florida. This was a competition for small submersibles, propelled by human power and designed to race around a 1 kilometre course at 7 metres depth in the ocean. The event was organized by the Ocean Engineering Department at Florida Atlantic University and the H. A. Perry Foundation; through the specification of a human power source, it was intended to encourage technical advances in the hydrodynamics, propulsion and life support systems of subsea vehicles.

Each submarine carried a crew of two people, a pedaller (who produced propulsive power) and a pilot (who was responsible for navigation and safety). Since the submarine was fully flooding, the crew depended on SCUBA for their life support, which prevents normal speech communication. Visual communication between the crew was not feasible, because of the internal arrangement of the vehicles. Therefore the submarine designers were forced to invent alternative means of transmitting essential information between the crew. This paper will review the various solutions to the problem which were used by competitors and compare their effectiveness.

Engineering Applications of Colour Image Processing (043)

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Image processing has been an important science for the last decade which has many engineering applications. The paper discusses image process1ng fundamentals, image capture and display. Some important parameters, e.g. spatial resolut1on, spectral balance, are explained. Illumination is an important area in colour 1mage processing which is studies extensively [1]. Colour is represented in basic RGB systems. Converting into fraction and HLS coordinate systems provides some advantages. Shading effect due to non-uniform illumination is avoided using fraction transform. HLS transform is near to human visual systems for colour recognition systems. A comparat1ve study of these two non-linear transforms with presentation of results is given. Segmentation is a process which is used to separate an object from its background. Results of segmentation for different samples such as colour resistors, printed packages, are presented using colour image process1ng.

Colour image processing has a number of applications. Some of them are satellite 1mage processing, automatic alignment of television rece1vers, med1cal applications, print quality inspection, surface inspection of engineering mater1als and their destructive testing, classification and component identification in industrial applications. Some aspects of these are mentioned in the paper.

[1] Joshi, M.A. 1990. Colour Image Processing and Studies of Colour Transforms. MSc thesis (UMIST).

Modern Communication and Standard Time and Frequency Signal Dissemination

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The technology originally developed for communication was utilized for time and frequency dissemination. At the same time the modern communication with high traffic density and fast data rate would not have been possible had there been no development of very precise and highly stable frequency source of clock. The mutua1 co – existence of the time and frequency activities and modern communication technologies is a well rea1ised fact.

The paper describes the different methods of standard time and frequency signal (TFS) dissemination and their: apability of frequency comparison. It is of interest to note: hat the main emphasis in the design and development of radio communication art is on the improvement of retrieval of massage quality in the face of pressing traffic demand; wide coverage economic viability etc, whereas in STFS dissemination the main emphasis is on the improvement of accuracy of transfer of time and frequency information. The merits and demerits of different STFS dissemination methods have been discussed on the basis of the advantages and disadvantages of modern radio communication using similar frequency band. It has been seen that the consideration which are of primary importance of achieving better accuracy in STFS dissemination may not be of much or any relevance for quality of message retreival in radio communication and vice versa.

ST15

The Work of the Telecommunications Vocational Standards Council

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SUMMARY

This paper gives a brief historical outline of National Vocational Qualifications (NVQs) and the Telecommunications Vocational Standards Council (TVSC). Following this detail of the work of the TVSC will be covered together with an outline of the methodology used to develop an NVQ.

INTRODUCTION TO NVQs

The initials NVQ stand for National Vocational Qualification. These qualifications are a recent Government initiative which is aimed to simplify the qualification jungle which currently exists. They are designed to be qualifications that satisfy the requirements of industry. This will be achieved by industry lead bodies (ILB) for each industrial sector. The ILBs are required to involve industry in all stages of standards development and check that the final qualifications from A warding Bodies support their standards. All areas of industry and every career strata will ultimately be affected by the introduction of NVQs.

In order to progress the idea of NVQs throughout England, Wales and Northern Ireland and maintain a common high standard the Government set into being a body entitled the National Council For Vocational Qualifications (NCVQ) in 1986. This body is responsible for accreditation of standards produced by ILBs and/or qualifications produced by awarding bodies which have ILB approval. NCVQ is also responsible for auditing the implementation of qualifications into the workplace. The accreditation that NCVQ gives is for a maximum of five years.

As the education system in Scotland is historically different there is a different body responsible for vocational qualifications there and it is called SCOTVEC. At the time of going to print TVSC are awaiting SCOTVEC'S decision on the accreditation of SVQs for our current qualifications and whether TVSC can be an A warding Body north of the border. SCOTVEC, unlike NCVQ, is both an accrediting and A warding Body.

An NVQ should clearly indicate competence in employment. Competence does not just involve the possession of certain knowledge or skills, but must include the ability to apply and transfer them to new situations within the occupational area. It encompasses organisation and planning of work, innovation and coping with non-routine activities. It includes those qualities of personal effectiveness that are required in the workplace to deal with colleagues, managers and customers.

The role of determining statements of competence for each occupational area is given to experts from the appropriate sector of employment. Representatives of employers, trade unions and professional bodies work together with ILBs to decide what statements of competence are necessary and the level of performance required. This employment-led standard setting process is crucial. It not only ensures that NVQs are relevant to work but also that they are recognised by employers as an indication of an individual's competence.

The standards of competence written by industry comprise a number of units. These are further subdivided into elements of competence and performance criteria. This structure is shown diagrammatically in Figure 1.

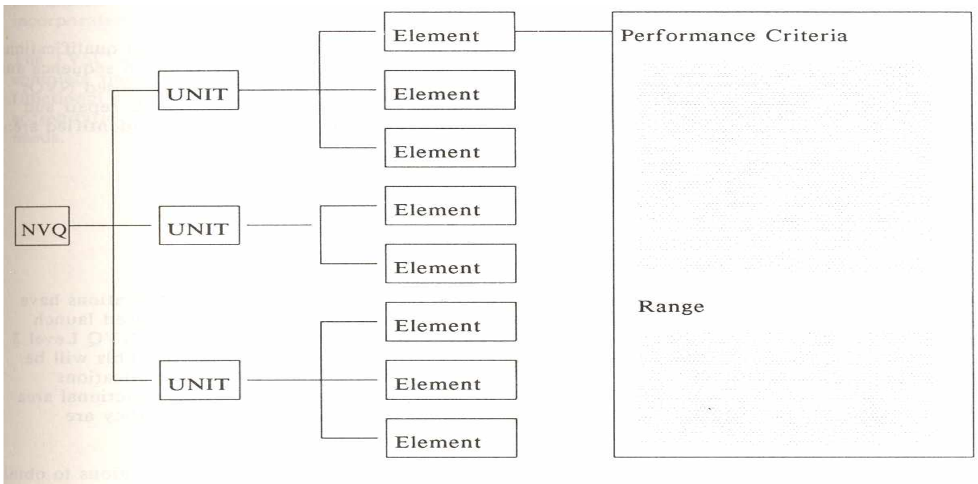

Figure 1 The Structure Of An NVQ

INTRODUCTION TO THE TVSC

The Telecommunications Vocational Standard Council (TVSC) is the approved ILB for the UK Telecommunications Industry. As such it is responsible for developing Vocational Standards for all the telecommunication specific functions within the industry and approving qualifications from various awarding bodies. The TVSC is both the focal point and catalyst for industry contributions to the work.

The TVSC was formed in August 1989 as a company limited by guarantee. The initiative came from a consortium of British Telecom, STC and Cable and Wireless group including Mercury Communications and Telephone Rentals in response to the Government's initiative.

Work as an ILB began when the company was first formed and consultants were used to assist in the derivation of a functional map of the telecommunications industry sector with the aid of industry. Once this was complete the consultants and newly appointed TVSC standards development specialists then looked at a specific area with representatives from industry and derived relevant occupational standards.

In addition to being an ILB the TVSC has also been recognised as an Awarding Body. In other words the TVSC can design NVQs using the standards written by the ILB and obtain accreditation. They can then award NVQs to those people who have been assessed as being competent when compared against the Qualification standards. To satisfy NCVQ criteria and to maintain Quality the TVSC has to have in place Quality assurance and Quality improvement systems, internal and external verification and an administration system to support these.

THE CURRENT WORK OF TVSC

As outlined in the introduction to the TVSC the work of the TVSC is in two main streams namely the work as an ILB and as an A warding Body.

Under the auspices of an ILB the TVSC are continuing to develop standards and qualifications for the remaining key functional areas initially identified. These will be done in sequence and take on average 6 months between starting the work on an area and getting proposed NVQs into NCVQ for their approval. The current area being worked on is maintain & repair and qualifications are available in install and commission. The six functional areas identified are:

- install and commission
- maintain & repair
- manufacture
- manage & operate
- design & develop
- Promote, sell & distribute.

Work as an Awarding Body has gained more prominence this year as the qualifications have come on stream. At the current time assessments are being carried out in a phased launch program which is being closely monitored. These assessments are available for NVQ Level 2 in Install & Test Telecommunications Switching and Transmission Equipment. This will be followed in Autumn 1991 with NVQ Level 2 Install & Commission Telecommunications Terminal Equipment (Radio). Level 3 NVQs for the Install and Commission functional area should be available in 1992 and qualifications in the other areas will follow as they are developed.

The TVSC's policy is to provide quality in terms of qualifications that are prestigious to obtain and of some considerable worth both to the individual and the industry. In order to maintain and control this quality effectively the phased launch of qualifications is deliberately slow. We believe that this will enable the required network of Assessors and their trainers to get on-board and up to standard in the most effective manner.

HOW TVSC DEVELOP NVQs

The standards of competence are derived from a functional analysis of a key area with the assistance of industry through a number of workshops, interviews and other techniques. These standards are then used as a starting point to derive qualifications at the various NVQ levels and disciplines throughout the industry.

An analysis of the working practices and technology within the functional area is undertaken in order to identify relevant qualifications and their appropriate titles. These are then ratified via the Telecommunications Standards And Implementation Steering Group (TS&ISG). Once the qualification title and levels have been established the standards are used as a basis and amended, with industry's aid, to reflect the appropriate width and depth of competence for each qualification.

These qualifications are then submitted to NCVQ for accreditation together with indications of the knowledge and assessment evidence that the Assessor will be seeking before awarding an NVQ. If the Qualifications are accredited then they may be launched and made ready for candidates to be assessed against. (I.e. Assessors prepared and administration arrangements made)

THE FUTURE WORK OF THE TVSC

For the immediate future the TVSC will be enabling a Quality network of Assessors and Verifiers to be put in place throughout the industry. Close monitoring of the first phase of the launch will highlight potential problems and improvement opportunities that can be incorporated into future phases.

The TVSC will also continue with standards and Qualification development work and aims to complete the main functional areas as soon as possible. Following completion of the remaining functional areas the TVSC will re-examine the existing Qualifications before their NCVQ accreditation elapses. This will enable them to be kept up to date and tailored to industry needs.

Women, Science and Technology: Shifting the Paradigm from Role Modelling to Mentorship.

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Based on a five-year major research project (UQWISTA) looking at policy factors which help or hinder women's access to and progression in "non-traditional" scientific and technological disciplines in higher education, this paper argues that a shift in paradigm is needed. Two decades of research into why women's access to certain scientific and technological disciplines, and of policy initiatives to improve female access and progression, have concentrated on "what is wrong with girls and women" instead of looking at the need to change the ecology of male-dominated institutions and disciplines in relation to new clienteles. Within this approach, policies have perpetuated the unsubstantiated myth that same-sex role modelling is an essential, even a key, policy factor. But the UQWISTA research establishes that this is not so

This paper argues for a major shift from role modelling as a policy mechanism (making pioneer women responsible for women) to improving mentoring (not necessarily same-sex) as a more influential and mainstream policy factor (making men responsible for helping women). The paper will produce new research-based evidence from a major research review and from ten major Australian institutions, to substantiate the paradigm shift.

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(Further papers are also available).

Can an Institute of Technology Improve Equality of Opportunity for Women in Technical Education?

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In Sweden women students of technology only amount to about 20%. This figure applies to both undergraduates and postgraduates. Thus, by quantitative measures the system is not egalitarian. A qualitative view on the situation of women students shows, however, that most students are satisfied with the conditions - and that they hesitate to take a feminist stand.

The question then arises: Why are we not satisfied with the low percentage of (presumably happy) women students? There are two obvious reasons. The first one focusses on the individual level: We think that more women should have possibilities to develop themselves by learning how technical measures can be used for a better life. The second one points at the common weal: Women's perspectives and experiences of the role of technology are needed in the interplay between humanity and society; they give a valuable contribution to the new leadership roles and society at large would gain if there were more women in the technical professions.

Therefore, the Royal Institute of Technology has started a programme aiming at educating more women leaders. The point of departure is to define the obstacles to equal promotion. We have found, that the main reason is, that power stuctures make women invisible. In general there is no ill will underlying the mechanisms which exclude women from the system. As long as the majority of technicians innocently believe that we have achieved gender equality one can not demand that they recognize the subtle difficulties which women face in the current system. The primary goal for the work for egalitarianism is, thus, to increase understanding for the conditions women meet. In the next phase the realization that women must come forward in their own right needs to be incorporated. This endeavour calls for a new kind of communication, both within the university world itself, and in the interface between university and industry.

Women, Higher Education and Culture Change

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SUMMARY

This research based paper considers the imp1ications for higher education of widening access to computing and information techno logy courses. It stresses toe need for organisational change and offers possible strategies which can be effective in altering staff behaviour and hence the culture of higher education to make it more responsive to women students.

INTRODUCTION

Over the last ten years concern has been expressed about the ability of Britain to compete with other nations. There is strong evidence to suggest that our workforce is lagging behind that of other countries in terms of education, training and skills. In addition, there is a need for a higher leve1 of educational achievement to cope with a society where the emphasis is increasingly moving from manual to intellectual skills [1].

Disquiet is particularly strong in the area of computing and this is reflected in targets set for the polytechnic sector of higher education. Overall, the participation rate is projected to increase from 14% to 20% by 1994- and to 30% by the year 2000 [5]. Returns from the institutions themseives show plans to increase full--time student numbers by 7.6% between 1988 and 1992. Within these targets one area where the highest growth is planned is information technology/computing [13]. If numbers are to increase, then institutions of higher education will need to consider different target populations in view of the decline in the number of 18 and 19 year aids [15].

This is has bean recognised in the national emphasis on widening access to higher education courses [3]. Demographic and economic factors are, however, not the only reasons [16] There is also acceptance that the selective, competitive and specialised nature of our education system has excluded people who could benefit and have not had the chance. Where an individual has the motivation and competence she should be offered a place [5]. The largest, possible poor of students is that of mature women [1].

To do this attention needs to be paid to methods of increasing participation and considerable change will be needed in practices find procedures [5]. So far, there has been little recognition that different students need to be taught in a different way within a different culture (1). This is reflected in the low numbers at women applying for and being accepted on to degree Courses in engineering, particularly in computing [12]. While there are many reasons for this lack of women [15], the issues relating to organisational culture change have not been tackled in a systematic way [13]

CULTURAL CONCEPTS AND CHANGE

If higher education is to be actively promoted among mature learners, then institutional changes must be wide-ranging. Previous efforts to change higher education culture from the outside have resulted in very little movement [1]. Organisational culture, like an individual's personality, tends to remain relatively stable over time. The shared values, attitudes, norms and goals are powerful shapers of behaviour and are expressed in the systems and practices that have evolved in the organisation [14,171. Existing culture has a constraining effect, inhibiting the change necessary if these organisations are to produce the different results sought for this country's continued compe1itiveness on an internationa1 basis [1].

Culture is sustained through the action of organisational members and their relationships [17]. Since culture is deeply rooted in the organisation's life, cu1ture change needs to focus on changing member' s behaviour. Once this is accomplished, attitudinal, and perceptual and cu1tural change should follow.

Systems with in higher education should be changed to make them responsive to the potential students who must be attracted. Reviews of administration, teaching methods, course design, assessment and guidance and support systems are needed [4]. A system which has been producer--led needs to become more user-- led and structures made more appropriate to a society where learning opportunities are becoming more integrated into day-to-day life.

In order to change behavior and hence the organisation culture there are strategies which can be employed [7]. Training is an important element. Recruits to an organisation learn their behaviour.Participation in training courses, listening to others' ideas or simply observing can change attitudes and behaviour. Using group discuss ions, team briefings and role mode is can be a successfu1 means of changing culture [7]. Implementation needs to be introduced on an organisation-wide basis, as badly planned training is likely to be ineffective. Of crucial importance is a. "precipitating event" to act as the impetus for change [7].

CHANGE WITH IN HIGHER EDUCATION

for higher education the impetus for change exists and an organisation development programme introduced through specific policy initiatives can give academic staff the support they need to change[3] . Po1icies need to be directed towards facilitating the entry of mature students and encouraging them in the areas where they are under--represented. While the tradition of departmental autonomy is to be maintained, some centralization is essential to establish a framework and procedures so that policies can be properly implemented [8, 9]. This is not to suggest, however, that bringing mature women students into engineering is an easy task [6].

To attract mature women students attention should focus on their needs and meeting these needs, within higher education. Mature students are often discouraged by bureaucratic procedures. The may lack confidence and this feeling can be re-formed by inadequate support and guidance, inappropriate teaching and learning strategies and irrelevant course materials [5].

ADMISSIONS PROCEDURES

Then is degree of inflexibility in laid-down entry requirements for higher education m general, but, they appearing particularly rigid in engineering areas. Coupled with the siting of computer courses with in engineering faculties this deters women from applying [9]. Students without mathematics or science at 'A' level are still capable of succeed log on computing courses [9] Entry requirement are sometimes inappropriate and do not recognize potential.

While interviewing is subjective and may not assess the applicant's ability successfully to complete the course [2],

A recognition of the value of alternative methods of learning and an examination of en try requirements to ensure that they are broad enough to include all students who could benefit from the course would help. Where applicants are asked to demonstrate their knowledge and skills, the Admissions tutor gathers more information than can be provided on a standard application form [8] structured training of personnel in interviewing techniques would help consistency in admissions, as would developing systematic comparisons between what is expected from 'A' level and non-standard entry student[9].

Admissions procedures should include pre- entry support for students to build on their enthusiasm and faster self-confidence in their ability to cope with the course. Reading lists, study skil1s workshops and contact with staff should be offered. Mature students, particularly women, need time to reorganize family life, so course details and timetables should be provided before the start of the course. This type of help can case the transition to what, for some, is a very different life [15].

Marketing should include "taster" courses, open days and should show information technology in an attractive context. Stronger links with further equation feeder colleges could help to increase numbers of mature women students.

TEACHINGE METHODS

This widening of access through admissions should be accompanied by a review of teaching methods. Within the computing area there are many techniques used in lower level courses that could be applied to degree leve1 teaching. To make the courses more attractive to women students, teaching needs to move away from traditional methods where learning is controlled and directed by the lecturer and where use is made of a limited range of techniques, particularity the lecture [10] current methods place too much dependence on the lecturer for the selection of facts and on students' ability to memorise these facts.

Students can be encouraged to understand and apply knowledge in a creative way through teamwork, experimentation and self-paced learning [1, 8, and 10]. Where students are helped to learn tram each other, self--confidence can be developed and a "women--friendly" environment created where women's commonsense approach is valued and strengthen through the use of a sharing atmosphere and lively relevant material [11]. Remedial help should be offered where required and mature students given the opportunity to practise without being watched by others [9] This move horn passive to active learning recognizes education as a joint learning experience with lecturer's willing to hand over control. For some this may involve considerable training [1].

COURSE DEVELOPMENT AND ASSESSMENT

Changes in teaching methods are connected to the design of the curriculum. Modular approaches and credit accumulation and transfer are in place in some areas and this opportunity should be used to restructure courses in information technology and computing. Stress needs to be placed on Learners needs and the development of courses that are more attractive to potential students. These changes should be mirrored in the area of assessment. Which should become more interactive and practical to prepare students to deal with the Interpersonal elements of information technology as well as the technical? Assessments could measure student’s progress against specific

Criteria, through a devetopmenta1 process of tasks for students to complete at their own pace with credits awarded a teach stage [16].

STAFF DEVELOPMENT

The areas above are linked through the need for staff development. Staff needs training to improve selection methods and interviewing techniques. A training programme would help to turn innovative curricular ideas into planned activities [8] in terms of working with students; lecturers need help in learning how to foster students' self-confidence and autonomy through a staged learner-orientated system [9]. Lastly, lecturers themselves need support in dealing with a different type of student and in offering relevant guidance to mature students [9].

CONCLUSION

Higher education is still trying to make students fit a pattern rather than giving consideration to its own responsiveness to the needs of potential students. Non-standard entry students are no longer the marginal groups they once were and efforts need to be concentrated on changing staff behaviour, so that the culture of higher education institutions; becomes more sympathetic and the needs; at the clients come first.

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E4

They Can Because They Think They Can

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SUMMARY

The focus of this paper is a short course entitled "Technology for Women", run for a small, isolated community in the Welsh Valleys in early 1989. Firstly, the aims and structure of the course will be discussed. Some responses to the course will then be given, followed by an analysis of its success but the failure to establish a similar course elsewhere.

INTRODUCTION

The all-pervading problem that industry will face in the early 1990's is the unfavourable demographic trend. Industry is just waking up to this fact, realising that women must be encouraged to make up a larger percentage of the technical workforce than they currently do. Positive initiatives are springing up everywhere to encourage re-training, provide creche facilities and convert arts to science A-levels etc. The technical revolution has swept through society like a tidal wave, but it is salutory to remember that the wave has, and will continue to pass over the "pebbles on the sea bed". These people who have been out of the education system, or employment, for more than ten years, are probably, by today's standards, technically illiterate. Without the opportunity for enlightenment, they face a downward spiral in technical confidence and competence as shopping, banking and even the home increases in technical complexity. This paper reports on a short course entitled "Technology for Women" run for a small isolated community in the Welsh Valleys in early 1989. It is a personal view of the observed attitudes of women towards technology.

THE PHILOSOPHY

For several years, I have lectured to Electrical Engineers and have observed that, given two equally capable people, a woman invariably underestimates her capability whilst her male colleague will usually overestimate his. Suspecting that this lack of self -confidence persists at all levels of technical expertise, a colleague and myself conceived the "Technology for Women" course. Ostensibly, it was a course in technical DIY but the underlying aim was to increase the self-confidence of the participants. Confidence is often a product of the environment and this can largely be controlled by the attitude of the presenters. A relaxed, informal atmosphere was created, permitting an air of professionalism and competence by implication. The normal environment and level of expertise of the participants precluded the use of jargon and, where possible, concepts were explained by analogy. Pretentious titles and our employment histories were consciously omitted. The most important aspect was to achieve an aura of enthusiasm, knowing this to be highly infectious.

Familiarity is of paramount importance to confidence. Because of the nature of the task, familiarity in this sense meant hands-on experience. This in turn required intensive supervision and an adequate provision of equipment. The aim was to gently persuade all participants to "have a go" at everything; fully realising that it is far easier to sit in the corner like a wall-flower when faced with a new and daunting challenge, hence defeating the aim of the course.

THE MATERIAL

In one sense, familiarity also dictated the contents of the course. The aim was to enhance awareness and self -confidence with the technology that the participants meet daily. It was obvious that the initial sessions would be at a fairly low level, and could include the concepts of electricity, the choice of fuses, cable and plugs. This led to basic electrical DIY - changing the flex of an iron and the element of a kettle. We got quite carried away by this DIY self -sufficiency and even included a session on changing washers and taps! Computers, word processors and programmable devices such as alarm clocks and videos formed the basis of a further two sessions. Each topic was to be self-contained and to cover no more than one two-hour session. At least half of each session was devoted to hands-on experience to build confidence.

THE RESPONSE

On the face of it, the response was disappointing - only six ladies! However, in practice the number was ideal. The ladies had various backgrounds from housewife to nurse, and all freely admitted "techno-fear". The range of ages was broad also, from young mum to happily retired. The ratio of 3:1 supervision was at times taxing, but as the aim was to increase confidence, it was important not to rush or chastise.

I had grave misgivings about the contents of the initial lecture; to spend two hours talking about fuses and wiring plugs seemed a little bit of an overkill. In reality, twice as much time could have been allocated. For someone such as myself, who deals with electricity "by trade", it was appalling to discover that some of the ladies had no idea that the colour of a fuse indicated its rating, and less idea still as to what that rating meant. It is still more frightening to realise that this may be indicative of the knowledge of the general public.

The ladies were genuinely appreciative of the attention and the manner in which the course was delivered, but actions speak louder than words. One lady, crippled with arthritis came to the following session, clutching a beautifully wired plug as if it were a trophy - she had never wired a plug before and was unable to complete the exercise at the previous session due to her disability. She admitted that it had taken her a long time but as she lives alone, the sense of achievement and independence was reward in itself.

As a parting comment following a session on programming a video recorder, one lady, previously suffering from a severe bout of "techno-fear", was heard to exclaim "I am going to baby-sit for my grandchildren tomorrow, I usually take my knitting but I think I will play with their video instead!".

Another lady danced into one of the latter sessions chanting "I have mended my hoover". She then proceeded to tell us the gory details, remembering to say that she had noted our instructions on safety and had first switched the hoover off and unplugged it. On further questioning, she admitted that she would previously have waited for her husband to return home to solve her predicament.

The above comments are a small, but representive, selection of the little gems resulting from the course, to my knowledge.

IN CONCLUSION

I make no apologies for saying that delivering this course was highly rewarding, of course, the aim was to ensure that through patience and familiarisation, the -confidence of the ladies was increased. Viewed in this light, I believe the course succeeded.

Looking at the course in a broader sense, does however lead to other conclusions. Firstly, it is inherently intensive in supervision. These ladies had effectively built a barrier between themselves and technology to the extent where one lady would not even change channels on the television. It required a lot of gentle persuation to entice them out of their shells. They must effectively want to come out of their shell for the course to succeed, and often they are oblivious to their plight. We actively encouraged the ladies to suggest gadgets or concepts on which we could offer some enlightment - silence was the reply!

Advertisements for a second course elicited a similarly silent reply. Regretfully, second course has never been run. That the first course ran at all may not be as result of the conscious effort of the ladies to dispel "techno-fear". Sadly, I suspect that it was a product of their community spirit, and a strong resolve to make their community program successful. These attitudes are not surprising coming from small, fairly isolated, mining community which has seen much economic hardship in e recent past.

Whatever the reason that the course succeeded, succeed it did and it beautifully illustrates the fact that, as Virgil said, “they can because they think they can"!

Between the Pit and the Pedestal. Career Patterns of Women Scientists and Engineers in Western and Eastern Society.

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SUMMARY

This paper reviews the contribution of women in the sciences in Antiquity and the Middle Ages, in Western and Eastern cultures. A college level course designed by the presenter will also be discussed

While participation of women in the scientific profession is a recognized fact in our century, the commonly held belief remains that this is a recent phenomenon. However, historical evidence shows the continuity of participation of women in the physical and biological sciences as well as in some areas of engineering well over the past 3,000 years. Over the centuries many women overcame economic and social obstacles to acquire education and contribute to scientific endeavors of their choice.

The prevailing view in current literature on this subject is that women of the aristocracy and those aided by the so called craft tradition were most often able to make their mark in the sciences in 17th and 18th century Europe. My thesis is that these two structures allowed women to become scientists for a considerable longer time period and in a geographical area that also far exceeds Western Europe [I]. In a practical sense not only societal pressures and attitudes determine career choices for women but also the responsibility they take in raising the next generation and caring for aged family members. Throughout recorded history these practical considerations may explain the prevalence of women scientists among the nobility. It is assumed that these women were relatively free of household cares and had access to learned tutors and libraries. A good example would be the queen-physician Hatshepsut of the XVIIIth Dynasty in Egypt, who, in addition to her practice of medicine also organized a botanical expedition to search for hitherto unknown medicinal plants [2]. Another representative from the Chinese culture would be the legendary Se Ling She, wife of the Emperor Huang Te (3000 BC) who is said to have invented the process for weaving of silk.

Beside the nobility we find numerous female scientists among unmarried women particularly nuns, both Christian and Taoists, a group presumably free of the traditional family responsibilities. Medical knowledge of the middle Ages owes much to such practitioners as Heloise, Elizabeth of Schonau, Herrad of Landsberg and the most outstanding of these, Hildegrad of Bingen. Among the Taoist nuns a good example is the alchemist Li Shao Yun, whose work represents the first attempt at quantitative chemistry in the early 1100's in China.

The so called craft tradition as a possible route for women scientists in the 17th and 18th century Europe also far extends geographical space and time. Many accomplished women scientists in the ancient and medieval period in the Near East and China were mothers, daughters, sisters and wives of scientists. Such relationship must have provided the necessary ingredients for their pursuit of scientific endeavor, such as education, motivation, encouragement, access to laboratory equipment and economic resources. These women were not merely helpers, many achieved distinction in their own right. I wish to cite a few scientists to illustrate the universal role of societal status and craft tradition in the development of women practitioners.

During the 1st century AD, Alexandria was one of the great centers of learning of the ancient world. This city was the home of one of the most accomplished women scientist of Antiquity, Maria or Miriam the Jewess. Miriam was the first scientist whose writing survived in any form. While her original works were lost, significant extracts were preserved by Zosimos of Panopolis, a 3rd century Egyptian alchemist who cited Miriam's work extensively in his 28 volume encyclopedia. Miriam's contribution to science included design of chemical equipment such as the water-bath, the three-armed still and the reflux oven. The double boiler still bears her name as Balneum Mariae. The three-armed still was used for distillation of complex mixtures. Its description including quantitative measurements distinguished it from the obscurity and imprecision of most alchemists. Miriam's recognition of the advantage of glass equipment in the laboratory was quite advanced for that time. As an experimental chemist, her contribution includes the preparation of a lead-copper sulfide, still called Mary's Black and used as a pigment by artists. Miriam's writing reflects the prevailing attitudes among alchemists of her time period as well as illustrates her Jewish heritage. Little is known about her as a person. She was a student of the alchemist Ostanes and had many followers. She had the reputation of a good teacher who encouraged her students [2].

In one of the earliest science books in China (975 Ad), the author Wu Shu gives an account of the work of a famous woman alchemist, Teacher Keng or Keng Hsien Seng. The daughter of an eminent scholar, Teacher Keng was described as intelligent, beautiful and eloquent in speech. She is credited with designing a distillation process of vegetable oils. Other achievement attributed to Teacher Keng was her ability to transform mercury and snow into silver. Her reputed authority and relationship with the Emperor suggest that Teacher Keng was a charismatic personality and skilled scientist.

Both Miriam and Teacher Keng share common attributes as recognized authorities in their endeavor and are descendants of scholarly families though not of the nobility.

The medieval period represented an era of extreme attitudes toward women, for to use a scientific analogy, women found themselves oscillating between the pit and pedestal. At one extreme women were regarded as the instruments of sin and evil, while at the other regarded saintly and even godlike. Despite these notions the theoretical subjugation of women was only imperfectly maintained allowing a quasi-state of equality to exist and for some women to take advantage of. The edict forbidding the employment of Jewish

Physicians in 1267 might exemplify this ambivalent attitude toward this ethnic group. In all likelihood this edict was observed loosely for it was renewed every few decades, thus allowing many Jewish women to pursue the study and practice of medicine, the majority of whom in the speciality of ophthalmology. To cite another example, while in France women were not allowed to enter medical school until 1897, the edict issued in Paris in 1311 allowed women to practice surgery after passing an examination.

Surviving documents provide a fascinating picture of how the possession of necessary and valuable medical skills allowed women to surmount the dual liabilities of being female and Jewish in a male governed and Christian society. Legal records such as payments, exemptions from taxation, licences and title deeds constitute the largest body of evidence of the life and works of these women physicians [3]. A good representative of this group is Sarah de Saint Gilles, wife of a doctor, herself a practicing physician, who had apprentices and headed a private medical school in Montpellier in the 13th century. As a case in point I wish to cite the famous trial of the physician Jacobina Felicie, who maintained a successful practice in Paris in the 1320's. Jacobina was accused of practicing medicine without a licence. During the trial seven patients testified on her behalf, testifying for her success in alleviating fevers, kidney problems and arthritis previously treated unsuccessfully by licenced male physicians. Jacobina skillfully argued her case and entered a passioned plea for the training and licencing of female physicians in order to preserve women's modesty and honor. At the conclusion of the trial the charges were withdrawn against Jacobina, however, an injunction was issued to prevent her and other men and women without university training to practice medicine in the Paris area.

It is of interest to note the mother-daughter alchemist team in 15th century China, Shen Wan and her daughter Shen Yu Shiu. They were both interested in the chemical reactions of lead and mercury, however, they owe their fame to their success for allegedly transforming copper and iron into gold and silver. For the lack of a major representative in late Medieval China, I would like to include the 18th century astronomer, Wang Zheny, in the group of outstanding women scientists. Wang Zheny was the daughter of an enlightened physician who recognized her intellectual gifts. Wang Zheny was educated in a manner usually reserved for the son of the family. Wang Zheny accompanied her father on his travels and these trips enhanced her interest in geology. Her primary interest was in mathematics and astronomy. Wang Zheny published her experiments and calculations regarding the motion of stars, clouds and the eclipse of the Moon in 12 volumes, all of which were subsequently lost. Only essays on astronomy and some poetry collections survived into the 20th century. Wang Zheny died at a regrettably young age. Her attitude to learning is poignantly encapsulated in the following citation:

> Knowledge is infinite but life is short.
> That's why I treasure every second of my time.

These women scientists of Western European and Chinese culture came from middle class families and their intellectual and scientific development was shaped by their heritage of the craft tradition.

Time constraints of this presentation does not permit an in depth survey of women in science let alone a more detailed exposition of their contribution. I have attempted to do greater justice to this subject in a one semester college level course that was offered at the Roosevelt University in Chicago. The course was cross-listed in the Physical Sciences and the Women's Studies program. The course reviewed the participation of women in the sciences spanning the time from Antiquity to the present focusing on their scientific

Contribution as well as their efforts in achieving recognition. The course makes extensive use of audiovisual materials and encourages students to give oral presentations on their research of a woman scientist of their choice.

The main objective of this course is to educate college level students of both sexes to the long standing and illustrious contribution of women in the sciences and in so doing fill a void in traditional textbooks. Another objective is to demonstrate that women of many social strata and ethnic background contributed to scientific culture. Therefore, my outline includes lectures on Chinese, Jewish and Black woman scientists. In many institutions of secondary and higher education the erroneous view that women shy away from mathematics and the so called "hard sciences" still prevails. I believe that by illustrating the continuity of the contribution of women in such varied disciplines as mathematics, crystallography and astronomy we may successfully counter such misconceptions. Discussion of the achievements of women scientists may provide a more accurate dimension to view these fields as a human endeavor equally appropriate to pursue for students of both sexes.

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Mathematics, Minerals and Molecules - Contributions of Women to Engineering and Science

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SUMMARY

The work of women in the sciences seems to be a relatively "new" phenomenon, limited to the 20th century. A closer look shows that women have been making scientific contributions throughout recorded history. Sometimes this work has been obscured by that of a more famous man. Some women worked independently and used a pseudonym to submit work. Most were unrecognized and discriminated against by institutions that did not admit women as students or faculty. Now, recognition is growing of women's contributions to the progress of science.

MATHEMATICS

Mathematics is the study of number, form, arrangement, and associated relationships, using rigorously defined literal, numerical, and operational symbols. Physical scientists require the language of mathematics in order to communicate their ideas with each other. Modem mathematics got its start as early as 300 BC when Euclid organized geometry. His book, "Elements", is still the basis for all modem textbooks on geometry. Archimedes developed some of the basic principles of what evolved into integral calculus as early as 225 BC. The foundations of algebra were laid approximately 275 AD.

One of the earliest women noted by scientific and historical writers is Hypatia, (c370-415). The daughter of Theon, a Greek mathematician and astronomer and director of the University of Alexandria, Hypatia studied mathematics under Plutarch the Younger in Athens and his daughter, Asclepegeneia. Hypatia later became a mathematics instructor herself at the University where she taught algebra, geometry, and astronomy.

It is believed that Hypatia assisted Theon in writing his eleven-part treatise on Ptolomey's "Almagest" and wrote her own commentary. She also co-authored at least one treatise on Euclid's "Elements" with Theon. Hypatia was also credited with inventing two astronomical instruments, the astrolabe, an instrument used to measure the altitude of the sun or other celestial bodies, and the plan sphere, a representation of a sphere or part of a sphere on a plane surface. While none of her writings have survived, they are referenced in other writings of that period.

The Italian mathematician Maria Gaetana Agnesi (1718-1799) was encouraged by her father, a professor of mathematics at the University of Bologna, to study mathematics at an early age. Her primary contribution was her book "Analytical Institutions" written as a text for a younger brother and published in 1748. Her objective was a complete truculent of algebra and analysis with emphasis on concepts that were relatively new in the mid-eighteenth century. Maria withdrew from scientific study after her father's death in 1752.

In France Sophie Germain (1776-1831) decided at the age of thirteen to become a mathematician after reading about the life of Archimedes. Her families used various means to discourage her studies, but were unsuccessful. She was virtually self taught until her eighteenth year when she began collecting lecture notes from classes at the new Ecole Poly technique. Sophie submitted a paper under the pseudonym LeBlanc to Joseph Lagrange, the mathematics professor, who was impressed by its originality and encouraged her continued study. On her own she began to study Karl Gauss' dissertation on number theory and began a correspondence with him also under the name LeBlanc.

In 1811 the Acadamie des Sciences offered a prize for the best answer to the challenge of formulating a mathematical theory of elastic surfaces and its comparison to empirical evidence. Sophie submitted three papers from 1811 to 1816, the first anonymously. Her 1813 revised paper received an honorable mention. Finally, in 1816, she won the grand prize for a paper submitted in her own name for treating vibrations of general curved as well as plane elastic surfaces. She also published other work on the theory of elasticity and proved the solution of Fermat's Last Theorem for all prime numbers less than 100.

The Englishwoman Mary Somerville (1780-1872) was virtually uneducated until after the death of her first husband. After winning a prize for solving a problem on diophantine equations that appeared in a popular ladies journal, she purchased a small library of mathematical texts and began her study in earnest. With her second marriage to William Somerville, a surgeon, other doors were opened to her. The leading scientists of the day and their wives became her friends and attended frequent salons held in her home.

Mary's writing became her most significant contribution to science. In 1830 her translation from the French and commentary on LaPlace's "Mechanism of the Heavens" was published. Her later book "The Connexion of the Physical Sciences" went through ten editions in forty years. Other writings covered astronomy, geography and mathematics. In 1835 Mary Somerville was elected an honorary member of the Royal Astronomical Society.

One of Mary Somerville's acquaintances was the young Ada Byron Lovelace (1815-1852) daughter of the poet Lord Byron. Ada was fascinated by mathematics and studied with private tutors. With Mary Somerville she attended scientific demonstrations and lectures, saw new devices and inventions. One of these inventions was Charles Babbage's Analytical Engine, a general purpose calculating machine and forerunner of the modem computer. In 1843 Ada translated from French to English a paper by the Italian Menabrea which described Babbage's engine. Her "Notes" to the paper describe certain "software" - what the machine could be made to do - rather than how it would be constructed. In recognition of this anticipation of modern computing software, when the U.S. Department of Defense commissioned a general purpose computer language, it was named ADA.

The Russian Sophia Kovalevsky (1850-1891) is called "the greatest woman mathematician prior to the 20th century". She became interested in mathematics when, at age the age of fourteen, the walls in her home were temporarily papered with sheets showing differential and integral calculus. At eighteen she married in order to go to Heidelberg to study mathematics and physics and later went to Berlin where she studied with Weierstrass, the "father of mathematical analysis". By 1875 she had completed three research papers, any of which would have qualified her for her doctorate. The University of Gottingen agreed to grant her a doctorate "in absentia" in 1875 based on her dissertation "The Theory of Partial Differential Equations" which included the Cauchy-Kovalevsky theorem on the existence and uniqueness of solutions to partial differential equations.

Unable to gain an academic post anywhere in Europe, Sophia returned to Russia. By 1884 through the efforts of Weierstrass, she was appointed to a lectureship in mathematics at the University of Stockholm. Here she did her most important research. In 1888 she was awarded the Prix Bordin by the French Academy for her paper "On the Rotation of a Rigid Body About a Fixed Point", the solution being so general that no new cases have been researched since.

The German mathematician Amalie Noether (1882-1935), daughter of Max Noether, one of the "guiding spirits of 19th century algebraic geometry", had planned to be a teacher of French and English. She began studying mathematics and foreign languages at the University of Erlangen and later specialized in mathematics at the University of Gottingen where she audited courses because women could not be admitted as regular students. She was granted her doctorate, "summa cum laude", by Erlangen for her dissertation on algebraic invariants. At Gottingen she taught courses listed under Hilbert's name from 1922 to 1933. Here her research provided the mathematical formulation for several concepts of Einstein's general theory of relativity. She emigrated to the United States in 1933 after all Jewish faculty were dismissed from the university. Amalie Noether was considered "the greatest of all female mathematicians".

Astronomy is the most ancient of the sciences. From the earliest times, eyes turned heavenward tried to discern the messages in the stars. Its study is intricately interwoven with mathematics. Copernicus (1473-1543), the "founder of modern astronomy", revolutionized the science with the publication in 1543 of his book "The Revolutions of the Celestial Spheres". He upset the Ptolemaic system by, representing the sun to be at rest in the center of the solar system and the earth and planets to move around it in elliptical orbits. His work became the foundation for modem astronomical science.

One of the earliest "new" astronomers was the Dane, Tycho Brahe (1546-1601). His better instruments and accurate measurements of the positions of stars and planets paved the way for later discoveries. He was closely associated with the German Johann Kepler (1571-1630) who developed the three fundamental laws of planetary motion. Not at all well known was Sophia Brahe, (1556-1643) who assisted her brother with his observations that led to the computation of the lunar eclipse of 1573.

One of Brahe and Kepler's other contributions were the "Rudolphine Tables" of planetary motion. Maria Cunitz (1610-1664) attempted corrections and simplifications to these tables. She was limited to manual calculations and introduced further errors. Her book, "Urania Propitia", was finally published in 1650.

In 1772 Caroline Herschel (1750-1849) set off from Germany for England to be with her brothers William and Alexander, and for a career as a singer. William, however, found his interest turning from music to astronomy and since Caroline would not perform except under his direction, she gave up her career and began training as an assistant astronomer. William Herschel (1738-1822) threw himself into the science, building larger and larger telescopes, observing all night, making calculations, writing papers. In 1781 he discovered the planet Uranus.

William gave Caroline her first refracting telescope in 1782. It was adapted for sweeping the sky for comets. Her earliest discoveries included three nebulae for which William credited her in his "Catalogue of One Thousand New Nebulae". By the end of 1783 Caroline had discovered several star clusters and fourteen new nebulae. In 1786 she was given her own observatory and in August of that year she discovered her first comet, the first woman to be so recognized. Between 1783 and 1802 the Herschels discovered 2500 new nebulae and star clusters - the visible evidence of distant galaxies. Together they founded sidereal astronomy, the study of stars.

William was appointed King's Astronomer in 1781 and given an annual salary. In 1787 Caroline was appointed assistant to the Court Astronomer and awarded an annual salary, her first money of her own. Their work continued for fifty years until William's death. At the age of 75 she completed her work on the positions of some 2500 nebulae for which she received the Gold Medal of the Royal Astronomical Society in 1828. In 1835 honorary membership in the Royal Astronomical Society was bestowed on Caroline concurrently with Mary Somerville.

In the United States the astronomer Maria Mitchell (1818-1889) was educated by her father. At age eighteen she started astronomical observations on clear evenings. In October 1847 Maria discovered a new telescopic comet. Public recognition came quickly and she was awarded a gold medal by the king of Denmark. From 1849 to 1868 she was employed by the U.S. Nautical Almanac Office to compute the ephemerides of the planet Venus. Vassar Female College was founded in 1865 and Maria became its first Professor of Astronomy and the Director of the College Observatory, a post she held until her death. Maria Mitchell was the first woman elected to the American Academy of Arts and Sciences.

MINERALS

Minerals are naturally occurring, homogeneous, inorganic substances which have definite chemical composition and characteristic structure, color, and hardness. They are the materials of which the earth is made. Mining is the process of extracting the minerals and other substances from the earth while metallurgy is the science of extracting metals from their ores, of purifying metals, and creating useful objects from the metals.

The Baroness de Beausoliel Martine de Bertereau du Chatalet (1602-1642), a French woman, was perhaps the first woman geologist. Her writings, published in 1632 and 1640, reported on the mines and ore deposits of France and discussed general metallurgy, types of mines, smelting, the assaying of ores and methods for locating deposits. She was imprisoned for witchcraft and died there.

The American geologist Florence Bascom (1862-1945) was educated at Johns Hopkins University. She earned her doctorate in 1893, the first awarded to a woman. In 1896 she became the first woman scientist employed by the United States Geological Survey eventually rising to the level of vice president. She also taught at Bryn Mawr College for thirty-three years where she founded the department of geology. She was the second woman elected to the Geological Society of America.

Georgius Agricola (1494-1555) wrote a comprehensive series of works on physical geology, mineralogy, metals and mineralogical and metallurgical terms. Of these "De Re Metallica", published in 1555, has become the most famous for its contributions to the sciences of mining and metallurgy. For over two hundred years it was the only authoritative work in this area. In 1906 Lou Henry Hoover (1875-1944) and Herbert Hoover (1874-1964), both graduates of Stanford University in Geology, embarked on the massive task of translating Agricola's work from Latin to English. It was finally published in 1913 at their own expense. The Hoovers were awarded a gold medal by the Mining and Metallurgical Society of America in 1914 for their "distinguished contributions to the literature of mining".

The study of mineralogy includes both the external features of the substance and its internal structure. Crystallography was developed as a branch of mineralogy to assist in determining the internal structure of the mineral but has grown to include not only minerals but all crystalline matter, inorganic and organic.

The British physicist Dame Kathleen Lonsdale (1903-1971) began working on the crystal structure of organic compounds by x-ray analysis in 1922. Among her contributions were the methods for the determination of space groups and demonstration for the first time that the benzene ring was hexagonal and planar. Later she developed a method of making x-ray photographs of single crystals. In 1936 she developed structure factor tables which became the basis for the "International Tables for X-ray Crystallography" and was published from 1952 onward. She served as principal editor. Her intensive study of the magnetic anisotropy of crystals resulted in the establishment of the reality of the concept of molecular orbitals. Dame Lonsdale also had a special interest in the structure of diamonds and made important contributions to their study.

Crystals also fascinated Dorothy Crowfoot Hodgkin (1910-) from the time she was fourteen and learned to grow them in a chemistry experiment. She received her doctorate in chemistry from Cambridge University in 1937. During World War II she began efforts to crystallize penicillin so that it could be examined by x-ray diffraction methods. By determining the arrangement of atoms, it became possible to produce large quantities of a variety of antibiotics. Further work included the analysis of vitamin B-12 and the structure of insulin. She was one of the first to enlist the assistance of the computer for her calculations. In 1964 Dorothy was awarded the Nobel Prize for Chemistry for her work in determining the structure of substances by x-ray methods.

MOLECULES

The basic building blocks of matter are the atoms and the molecules, composed of atoms, which combine to form the simplest structural unit that displays the characteristic physical and chemical properties of a compound. Women have long been involved in the elementary research identifying these fundamentals and in learning how to use them effectively.

Perhaps the most famous woman scientist of all is Marie Curie (1867-1934) who was the first woman to win the Nobel Prize for Physics in 1903 in cooperation with her husband Pierre Curie (1859-1906) and Antoine Henri Becquerel (1852-1908) for identification of the element polonium. Her continued research also led to the identification of a second element, radium, and a second Nobel Prize for Chemistry in 1911. She remains the only woman to have won two Nobel prizes.

Marie's daughter Irene Joliot-Curie (1897-1956) and son-in-law Frederic Joliot-Curie (1900-1958) also became Nobel Prize winning scientists (Chemistry 1935) for their identification of artificial radioactivity. These discoveries helped forward research into the medical applications of radioactivity. Irene's later work showed that bombarding uranium with neutrons resulted in radioactive isotopes.

A former research associate of Marie Curie's, Marguerite Perry (1905-1975), identified the naturally radioactive element francium in 1939. From 1949 she held the position of Honorary Professor of Nuclear Chemistry at Strasbourg, and from 1958 was the Director of the Nuclear Research Centre. Marguerite became the first woman member of the French Academie des Sciences in 1962, a position denied Marie Curie because she was a woman.

Lise Meitner (1878-1968) studied physics at the University of Vienna graduating in 1906 with her doctorate. From 1908 she was an assistant professor at the Institute for Theoretical Physics in Berlin where she met Otto Hahn (1879-1968) and began a lifelong professional association. Their joint efforts yielded the discovery of the element protactinium in 1922. By 1935 Meitner and Hahn were studying the neutron-induced activity of uranium with experiments similar to those of Irene Joliot-Curie. In 1938, after Lise obtained a position at the Nobel Institute of Theoretical Physics in Stockholm, Hahn and Strassman showed that barium was one of the by-products of the bombardment. Based on this information, she and her nephew Otto Frisch theorized about splitting the uranium atom into barium and krypton gas and calculated the resultant energy that "fission" would yield. Their paper was published in "Nature" in early 1939 and helped lay the groundwork for the development of the atomic bomb.

Another important investigator into the internal structure of the atom was the German physicist Maria Goeppert-Mayer (1906-1972). Educated at Gottingen she received her doctorate in 1930. That same year she and her husband Joseph Mayer, an American chemist, moved to the United States. During World War II Maria joined the SAM Research Project, a part of the Manhattan Project, which worked to separate Uranium 235 from Uranium 238. After the war she worked with Enrico Fermi (1901-1954) at the University of Chicago and Argonne National Laboratory. While there Maria developed the shell model of the nucleus of atoms in which the protons and neutrons in the nucleus are arranged in concentric stable shells which move like dancers waltzing around a room, both spinning and orbiting. The idea is called spin-orbit coupling. Her discoveries on the structure of the atomic nuclei won her the 1963 Nobel Prize in Physics which was shared with Eugene P. Wigner and J. Hans D. Jensen. She was the first American woman to win this award and the first woman since Marie Curie.

THE LEGACY

What do we owe these women? When we recognize their achievements and contributions to the development of science we recognize a heritage for ourselves and we take pride in these accomplishments. Mathematical research and progress have led to the rapid and far reaching development of the computer in today's society. Grace Murray Hopper symbolizes the modem women of science. She worked with Howard Aiken, "the father of the computer" and her work led to the development of the first English based language compiler which was a major input to COBOL.

We reach to the stars, continuing to unravel the mysteries of the formation of the universe through the study of astronomy. Sally Ride, the first of several American woman astronauts who have journeyed into the heavens aboard the space shuttle, demonstrates that women will continue to play an important role in this work.

Women continue to make contributions to the sciences and are actively employed as researchers, technicians and educators. These historical women of science overcame many obstacles to contribute to our knowledge. We remember and honor their contributions as we make further progress in the advancement of science.

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NASA and SWE Expanding Opportunities for Girls Through Partnership and Communications

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In its final report, The Task Force on Women, Minorities, and the Handicapped in Science and Technology, reported to the President of the United States and to Congress on a looming crisis in the technology workforce. We face as shortfall of scientists and engineers by the year 2000 which can only be met b¥ utilizing those traditionally under-represented in Science and engineering, women, minorities and people with disabilities. Without world class science and technical excellence the US's competitive prospects will dim. Fast action, long term commitment and new partnerships are needed now to avoid this crisis.

As a federal agency with a historical commitment to increasing the number of minority engineers and scientists, NASA is well positioned to assist the nation in achieving its educational goals. Through partnerships with such organisations such as SWE, NASA has increased the numbers of women and minorities in its own workforce. Now it must help increase the number of women and minorities who are available to fill the new positions by becoming scientists and engineers. For this to happen, a shift must occur early in the educational pipeline, before career goals are set and before the necessary math and science are not taken. To meet the challenge of developing workers by the year 2000 NASA is strengthening its partnerships.

The society of Women Engineer's commitment for 40 years has been to increase and strengthens the role of women in engineering. It has developed a strong career guidance program its 69 local Sections of professional engineers. Over 250 student Sections on university campuses support women students aspiring to become engineers. SWE's strength is its ability to bring together the resources of corporations and universities through its corps of committed volunteers.

NASA and SWE developed a program three years ago to increase the future number of under-represented minority women in engineering by working with girls aged 13 to 18 at critical points 1n the educational pipeline. Four different programs encourage these girls to consider engineering as a viable career opportunity. A research project compares the four interventions. The overall goal is that each girl who participates will enter a bachelor's level engineering program.

Each program depends on volunteers to provide role models for the girls and 0 conduct programs at a local level. The national office coordinates, supports, and networks between Sections. Local SWE members bring considerable resources from the business and academic communities to the programs with a base of financial support from NASA. SWE brings volunteer time and expertise without which the programs could not occur, and the support of employers, direct and direct. NASA's funding provides cred1bility and continuity for a long-term project. Neither of us could do it alone.

Education of Girls in Physics

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SUMMARY

This paper reports the results of an extracurricular activity designed to stretch the ability of pupils in the application of their scientific knowledge. The conclusions are that, when presented with a scientific challenge, girls can show capabilities beyond expectations.

INTRODUCTION

The stereotype of girls' attitudes towards science is well known. The traditional roles have, within them, the assumption that certain occupations as well as areas of education are inherently masculine or feminine. The extent to which the home promotes or challenges sex role stereotypes and the effects of such experiences upon girls' choices in relation to a scientific career have been recently reported by Curry [1]. The 'Wendy house' syndrome of sex role stereotyping in early childhood was reported by Whyte [2]. The acclaimed benefits from 'Wendy house' play have to be balanced against the dangers of establishing, at a very early age, future roles for boys and girls. Kelly [3] argues that the 'lived reality' of sex roles is deeply ingrained and probably has more influence on children than abstract and rarely expressed ideas about equality.

The association between gender and the response to science education has been widely reported in recent years [4, 5, 6]. There are numerous publications showing how the performance of boys in certain scientific areas is higher than that achieved by girls [7, 8, 9]. However it is evident that this observation is strongly linked to the culture of the country.

In contrast with the line of thought that accepts that girls are constrained to under-perform in physics, Klainin et at. [10] reported on the successful achievements by girls in learning physics. They showed that girls performed at least as well as boys in problem-solving and

Theoretical tests of physics knowledge. But in practical tests involving manipulative skills the girls in single-sex schools out-performed both girls and boys in co-educational schools and boys in single-sex schools. Klainin et al. concluded that their results negated suggestions of biological bases for the widespread under-achievement of girls in the physical sciences reported elsewhere. They attributed the girls' remarkable achievements in physics education to organizational aspects of the secondary curriculum that encouraged both girls and boys to continue studying science and that required all three sciences to be studied. The existence of choice in the curricular Organization of schooling enabled existing societal attitudes to invade the process of learning and allowed girls to opt out of physics.

CASE EXPERIENCE

For several years now I have taught physics to both boys and girls at secondary level. In parallel with teaching I have run a research project in school supported by the Royal Society. Separate groups of sixth formers, boys or girls, have at different times been involved in the research project which provides a platform from which pupils can apply and further their scientific knowledge. This long-term research project allows pupils to investigate a concrete problem of genuine scientific interest where the answers are as yet unknown. It is the fact that there is still uncertainty and therefore room for wonder that attracts the interest of my young researchers. They also feel that they are contributing to a larger effort that their colleagues will build on their work so that their findings will continue to be relevant beyond the time of their involvement.

The project which I describe was initiated under the Royal Society Research in Schools Scheme. It has received funding from the Royal society, the Institute of Physics and ICL. The project is an investigation in cloud physics, with the aim of understanding thunderstorms. Since the weather is experienced and observed every day, it forms an excellent basis for illustrating the relevance of many physical principles. I now report on the way sixteen and seventeen year old girls approach this demanding activity and I show that their capability goes beyond expectations.

THE PROJECT

The purpose of the experiment is to study the microphysics of clouds and their relation to hunderstorm electrification. By simulating a super-cooled cloud in the laboratory it is possible to observe the different particles present in it. Specifically, the ice crystals (which are known to play an important role in the process of cloud electrification) are studied in relation to the environmental conditions in which they are formed.

The experimental work is done by the pupils themselves and involves producing, collecting and observing ice crystals in clouds. The temperature and the liquid water content of he cloud are varied and different types of pollutant are also introduced to either the water forming the cloud or the chamber in which the cloud is formed. The effect of these changing parameters on the crystals is studied. The project touches on many physical concepts, such as temperature gradients, super-cooling, surface tension, convection currents, latent heat, crystal growth, static electricity, microscopy and microphotography.

The experimental set-up is relatively simple and robust to cope with repetitive running. The main body of the apparatus is a large deep freezer where clouds at different temperatures are treated, thereby simulating clouds at various altitudes. Temperature is monitored by lowering a probe into the cloud. A flow of W3ter droplets at room temperature is produced outside the

Freezer by an ultrasonic nebulizer and forced, by a jet of air, into the freezer where its temperature is lowered. Although water solidifies at OOC, droplets can be maintained in liquid form at lower temperatures if their sizes are small enough. The smaller the droplets' sizes the lower the temperature can be before they solidify. However at -400C all droplets will solidify spontaneously. In our experiments the temperature ranges from -5°C to -25°C. The resulting super-saturated atmosphere inside the freezer is seeded with solid carbon dioxide. The crystals formed fall out of the cloud and are collected on microscope slides that have been coated with 'formvar' glue and then placed at the bottom of the freezer. The slides are allowed to dry and later removed from the freezer for analysis. One experimental run, which takes about is minuet produces an enormous amount of these data. The observation and measurement of the crystals a meticulously made from a video monitor display of the microscope image. The data are then classified for statistical analysis.

ACHIEVEMENTS

The project was initiated in 1984 by a team of ten sixth-form boys in a boys' grammar school. Their contribution, which was at the stage of setting up and developing apparatus, was inevitably concerned with overcoming the frustrations which are typical of the initial stages of any experiment and they had ample opportunity for applying their inventiveness. The boys provided the foundation for the more recent work.

The research is carried out during free times by a team of volunteers who maintain a detailed log of their work. Each research team, which changes from year to year, decides collectively on the line of investigation to be taken, building on the work that was done before. The Royal Society Research in Schools Scheme appoints a Scientific Adviser to each project. Adviser to our project is Dr CPR Saunders from the Atmospheric Physics Group at UMIST visits the school regularly and presents his own state of the art research. He also encourages t pupils to visit and work in his laboratory during vacations.

The research carried out by the girls in the last three years at Washington Girls' School been commendable. In the summer of 1989 their findings were submitted and accepted for presentation at the Second International Conference of School and Popular Meteorological Education in Washington, USA [11]. Two sixth form girls attended the conference by themselves where they presented the achievements of the research team. The results presented showed the dependence of crystal shape with environmental temperature. Following on from these finding during the next academic year the research team focused on the effect that sodium chloride we have on the crystal shapes. This would indicate any differences found in clouds over the ocean comparison with clouds formed over the continents. Their results, which were quite conclusive, were presented in London by two girls at the Royal Society Scientific Soiree in June 1990. Interestingly, rather than their being overwhelmed by this experience, these girls rose to the occasion sufficiently to be able to give a coherent interview about their research. This interview was broadcast on the popular BBC Radio 'Science Now' programme.

The present research team continues the study of airborne pollutants. As a result of their concern for the consequences of the recent Gulf War on the environment, the girls are looking into the effects that smoke, from the burning of crude oil, has on clouds. The early indications from these experiments are that the ice crystals grow to comparatively larger sizes and appear to cluster around soot particles. It is possible to conclude from these laboratory simulations that the microstructure of clouds is significantly altered by the direct burning of oil into the atmosphere

CONCLUSION

The pupils feel this is an opportunity to take part in an interesting and demanding activity that allows them to discover phenomena for which answers are not yet known. They enjoy wondering why things happen the way they do and the challenge of trying to explain what they observe. They see that scientific research requires perseverance and hard work but it is rewarded with the feeling of excitement and achievement. Their involvement in the research has given them the opportunity to meet and talk with scientists as fellow researchers. My conclusion from observing these pupils' involvement in this challenging extracurricular activity is that the confidence the teacher places in a pupil produces results which go beyond the stereotypical boundaries of gender.

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Operation Smart: A Hands-on Program that Encourages Girls to Enjoy Mastering Math and Science [1]

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SUMMARY

Operation SMART (Science, Math, and Relevant Technology) was developed by Girls Incorporated in 1985 and continues to employ techniques that encourage young women to enjoy learning about scientific principles. Self esteem, confidence and problem solving skills are enhanced through participation in the program. These qualities may encourage girls to choose careers that involve math or science.

INTRODUCTION

Women have historically made significant contributions to science, math and engineering. Hypatia, a mathematician in 370 A.D., developed instruments for studying stars; Eleanor Burbidge, an astronomer born in 1919, became the first woman Royal Astronomer at the Royal Greenwich Observatory in England, and Marie Curie was the first person to receive two Nobel Prizes--one in Physics, the other in Chemistry [2]. Natural curiosity, self reliance and innovation moved these women to persist in their desire to ask probing questions and ultimately make important scientific discoveries.

Despite this rich history, young women have traditionally been led to believe that science is a mysterious, foreboding field rather than one of marvelous discoveries that help us to understand how things fit together to make an interesting, exciting world.

Girls Incorporated, a national organization with more than 200 informal learning centers across the United States, developed Operation SMART because of a desire to "give girls a coherent message that math and science are for them." Early researchers [3] focused on the qualities attributed to successful scientists: persistence, the ability to question and the courage to try new things. They reasoned that these qualities could build self esteem and, in fact, convince girls that scientific principles could not only be understood, but mastered. Above all, the process could be fun. Perhaps our most vivid memories about learning experiences are reflected in things we've done rather than things we've seen or read.

The premise that self esteem and science mastery are related has been further corroborated. A nationwide poll designed to assess self esteem, interest in math and science and career aspirations of girls and boys in the United States showed circular relationship between enjoyment of math and science and high self esteem. Students who liked math and science possessed significantly greater self esteem--students with high self esteem liked math and science more [4].

Operation SMART builds self esteem and stimulates learning through simple hands techniques that demonstrate scientific principles. These techniques will be reviewed and discussed in detail.

METHODS

Since it' s incept ion in 1987, the Operation SMART program has been expanded. , valuable information on its implementation is being gathered in formal and

In the Fall of 1990, surveys were sent to approximately 120 local affiliates to determine the extent of their implementation of the program. Participants were asked to describe activities performed and to identify staff responsible for program implementation.

In January, 1991, a team of eleven women participated in a national training event to review essential elements of the program, participate in hands-on activities, and ultimately insure delivery of a high quality, consistent program to affiliates and other youth-serving organizations (Young Women's Christian Association, public schools, etc.). A communications network was formed among is training group. Information about program implementation was obtained rough dialogue with this group.

Limited time and distance prevented on-site visits and evaluation of all programs. However, several affiliates with strong, functioning programs were served and evaluated in March-April 1991.

DISCUSSION

A girl involved in Operation SMART might:

“Go on a worm hunt, dismantle a computer, make a cloud, measure the wind, design circuit, shadow a plumber, help an architect draft a blueprint, dig in the dirt with a construction worker, or test the water with an environmental engineer. "

In informal settings at local youth centers girls gather in small groups of 8-10 perform these hands-on tasks after school or on weekends. The activities are not rigidly structured with formal lectures, but involve self-initiated, self paced observation and experimentation with materials that have been placed in an en space, on a table or in a room. One or two facilitators guide the activity providing brief opening questions or statements. The rest of the activity focuses on the girls as they determine their own quest ions about the activity and Irk on ways to obtain answers.

Facilitators are always present to answer questions and provide encouragement and support. At the end of the activity, the girl sand facilitators process the activity. Questioning and inquiry continues ... "What did you observe? How did is work? What do you think would happen if ...?"

The activities that make up Operation SMART are varied and may involve special projects, weekly sessions, field trips or special events. There are, however, several key elements that are common to all Operation SMART programs. These can be summarized by the letters, alphabets, "3 E's and an F"-- Exploration, Equity, Empowerment and Fun.

Exploration is a key element because it is fundamental to scientific inquiry. Equity is reinforced through program activities shared in a setting where girls feel free to challenge themselves and their peers. Empowerment is a vital part of the mastery of tasks that are perceived at first to be too difficult, puzzling, or "not for girls." Finally, fun is essential to a girl's desire to see the science-based activity as something to be remembered, tried again and perhaps influential in a career choice.

All of the programs reviewed, evaluated and observed had these key elements:

For example, in San Leandro, California, girls conduct hands-on experiments that give them basic engineering skills and familiarity with physical principles. In small groups, girls build simulated houses, towers, bridges and experiment with various building materials - clay, bricks, wood, etc. The program, Hard Hats and High Heels - An Architectural and Engineering Program for Teen Women, is supported by local practicing engineers, architects and construction workers who ensure delivery of accurate information and serve as role models.

In Schenectady, New York girls use power tools such as jigsaws and drill presses to construct useful items (stools, benches, etc.) in a woodworking shop. The knowledge of practical scientific principles related to force, leverage, and material strength results in mastery of woodworking techniques and increases self esteem through the use of tools traditionally used by men and boys.

Program activities summarized from surveys and communication with the training team network revealed additional interesting techniques:

- In an activity called Sink or Float, girls learn about mass, density and related properties as various fruits and vegetables are placed in tubs of water and predictions about the buoyancy of each object are made. Information about the nutritional value of the food is shared and provides added incentive towards healthy lifestyles. (Girls Incorporated of West Contra Costa County - Richmond, California)

- At a two week summer day camp called Girls Build the Future, young women become familiar with design drawing, hands on use of tools and wiring for electricity. (Girls Incorporated of Lynn, Massachusetts)

- In a program, Weather Watchers, girls learn specifics about meteorology; observe weather patterns and record data. The program includes a visit by a meteorologist from a local television station. (Girls Incorporated of Cobb County, Atlanta, Georgia)

- A special event, Vascular Valentine Day, features games with girls participating as body parts, healthy snacks, aerobics with observation of pulse and heart rate and dissection of a sheep's heart to describe anatomical structures. A female medical student serves as a role model. (Girls Incorporated of Minneapolis, Minnesota)

Girls Incorporated has developed resource materials that are helpful in the implementation of these programs. These include activity guides, planning

Guides, a videotape, selected papers and reports, and a research tool kit for evaluation purposes [5, 6, 7, 8]. These materials are free to local affiliates and are available at moderate cost to non-members. Organizations desirous of implementing Operation SMART are encouraged to receive formal training about the program. As Girl s Incorporated works to serve more girl s through Operation SMART, dissemination of these training materials, networking with the core training team, and committed staff and volunteers will be vital to the program's continued success. This success,in turn, will insure that interesting, purposeful, carefully researched programs will continue to be delivered to young women scientists of the future.

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Girls and Technology - Some Issues

E10

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SUMMARY.

The paper aims to show that the small number of girls studying technology in schools is likely to be the result of an ineffi~i0nt system of communication. Reference will be made to two curriculum development projects and the influence of gender on teachers' assessment of students' performance. A woman into Science and Engineering Year was the catalyst for the development of an equal opportunities policy at an infant's school where I was the local authority educational adviser. The first task was to investigate whether stereotyping was influencing children's work in school. Creative activity periods are regarded as an essential feature of best educational practice in the primary phase of education in the United Kingdom. Normally some teacher direction takes place in order to ensure that each child has a wide range of experience. In this instance a free choice was allowed and the teachers noted the activities chosen by the children.

Table 1.

	Boys Dominated	Girls Dominated
Nursery	Bricks & blocks	Role Play, Climbing Frame
Main School	Bricks & Blocks, Lego Giant Lego, Motorway, Boxcraft,plasticine,Railway, big Builder computer	Role play, collage, painting ,Drawing, Music Making

The teachers were particularly concerned as to how they had communicated the notion that use of the computer was a male activity because they felt that girls and boys had received equal encouragement and instruction. Since the teachers had elicited the fact that none of the children had access to a computer at home the most likely explanation was thought, be the software which included subjects such as: boats, towers, trains, letter bombs and dinosaurs.

In a study ('f the library cards over a period of two terms (12 weeks) it was found that: girl's chose 80% fiction and 20% nonfiction: boys chose 60% fiction and 40% non-fiction. Although there had been some exceptions the teachers had found that

In general girls became fluent readers at an earlier age than boys. Therefore it appears that somewhat paradoxically girls' higher attainment in reading may have encouraged them to select more fiction which is of course frequently sex stereotyped. Their limited interest in non--fiction will have retarded the development of new interests.

Following the analysis of the results of this investigation a strategy for change was formulated. Two key features were the careful selection of reading materials and the provision of a classroom where children could use a computer and construction kits in addition to making models using a variety of materials, tools and equipment. A new reading scheme was chosen after the teachers had consulted widely and taken expert advice. Although this new scheme may be deemed a success in that there was an improvement in the general standard of reading, the overall evolution showed that the publisher's professed attention to stereotyping was inadequate.

This project highlights the difficulties that teachers have when they try to ensure that girls have access to those educational experiences which are likely to influence their knowledge and understanding of science and technology. Teachers have the power to ensure that girls and boys work together and that no activity is perceived as a purely male or female preserve. Their control over reading material is limited by the choice available and in this instance no other scheme came so close to fulfilling the teachers' requirements.

Teachers have no control whatsoever over the messages which are communicated to children outside school, particularly in the crucial early years prior to t he start of compulsory education. Parents too can only choose from the resources available. Each year new more sophisticated electronic and mechanical toys are produced and manufacturers spend large sums of money communicating the fact that these toys are intended for boys. I would now like to turn to a project where I was privileged to be able to gather data over a period of several months when I was a Research Fellow with the St.William's Foundation Technology Education Project, [1]. A third year (13.14 year old) class at a co educational comprehensive school was charged with the task of designing and constructing a raft. The specification agreed by the teacher and students included that the raft should: carry two people; be powered by paddles or some other simple means; potentially open to commercial exploitation and easily assembled and dismantled. The budget was £l0, but additional materials were allowed if obtained free of charge.
The students worked in teams of five: there being three groups of girls and two of boys. The teacher provided materials for the modeling phase gave an exposition of Archimedes' Principle and general advice regarding the organisation of the work. The students had already done some work on density earlier in their Physical Science course and were instructed to undertake their own library research prior to the commencement of the practical phase of the project. Most of the work was done during what would normally have been Physical Science lesson time and some mathematics time was used during the modelling phase. The project made considerable intellectual and social demands upon the students: not only was the raft the largest and most complex artifact which they had made they had the additional formidable, challenge of being responsible for the entire project. In this radically change learning environment teachers would be there purely as consultants rather than fulfilling their traditional

Role of director of operations.

The level of application of scientific knowledge varied considerably between the five groups; the highest being in a group where one girl had done all the calculations. It is a sad reflection on the efficiency of our communication system that this girl (who was regarded as one of the cleverest students in the year group) had asked the teacher if he considered her clever enough to study Physics in the subsequent two year examination course.

The three teams of girls were very resourceful; much material was obtained free of charge from a variety of sources. They were creative and inventive; there being a strong desire to produce an original design rather than a copy. All three groups of girls had voluntarily spent substantial amounts of extra time working on their rafts after normal school hours: there were no instances of boys; doing this. The construction purse was successfully completed in time to meet the deadline for testing the rafts in the school swimming pool and the girls' rafts were the first three to be successfully launched. Following final modifications the rafts were tested on a small lake a few miles from the school. The testing was frequently described as the most enjoyable part of the project and the formulation of ideas for the design was perceived as the most difficult.

An outstanding feature of students' comments was the long term value which they attached to the experience of working in a group over a lengthy period and taking responsibility for the organisation and completion of the work. One group of girls had found that they were working as individuals rather than as a team; consequently they had signed an agreement that: there would be no more arguments; all ideas, would be thoroughly discussed; everyone would be kept fully informed and there, would not be a boss!

The picture of teams of girls working enthusiastically and imaginatively on a technological task provides a stark contrast to the findings of my former colleague, E. Cawthorne, [2] who investigated the factors influencing the poor representation of girls in Craft Design and Technology (C.D.T.) groups in secondary schools. C.D.T. may perhaps be regarded as the epitome of gender differentiation since it is by far the least popular subject choice for girls in the last two years of compulsory education. The system of class organisation and management observed by Cawthorne was very different from that of the raft project. It was teacher-centred: the students were heavily reliant upon the teacher for access to knowledge, materials and equipment and the checking of each stage of the work. The students' own knowledge and willingness to work co-operatively were rarely used. In this learning environment girl: experienced difficulty in gaining the attention of the teacher; were less well known by their teachers and were more likely to be left to their own devices. When teachers did assist students boys were more likely to be given additional technical information.

The influence of teacher expectation on students' performance is well known to educationists. Perhaps the most disturbing feature of Cawthorne's work was the notably different expectations the C.D.T. teachers had for girl's compared with boys. Girls tended to be commended for good behaviour. Conscientiousness and neatness, but: were described as uninventive and having inabilities which impeded their progress. Whereas boys were more likely to be described as inventive and showing initiative but were more frequently described in negative behavioural terms. Rays appeared

To be seen as more deserving of success and only boys were specifically referred to as under-achieving.

Most of the current research on gender differentiation is related to causes and affects whereas teachers' priorities tend to focus on practical strategies for change. A significant feature of the two projects I have mentioned was the high level of parental interest and support. The head teacher of the infants school kept the governors and parents fully informed of the equal opportunities policy and its practical implications. Such careful attention Ito communications is essential if a high level of parental support is to be achieved. In this context the most glaring example of a communications failure is that the educational and psychological research appertaining to the vital importance of a child's early learning experiences is still largely the property of the professionals; whilst parents remain relatively uninformed.

Cawthorne's work forces us to address the delicate communications problem as to how we can help teachers to appreciate the subtlety of discriminatory practices. All teachers take pride in their professionalism and the suggestion that they may lack objectivity and allow gender to influence their assessment of students' performance is likely to be strongly resisted. The fact that Cawthorne was able to find such a disturbing situation at a time when every local education authority has an equal opportunities policy and vast amounts of research data have been accumulated is in itself a sign of poor communication somewhere in the system.

Although it would be foolish to draw general conclusions from the raft project it does suggest that a team approach is worthy of further scrutiny. However, I cannot overlook the fact that the project did not cause any girls to consider the possibility of further study in technology. Perhaps there is another information gap: teachers alone cannot communicate the idea that technology is a creative, interesting and vital area of human endeavour which offers opportunities to both women and men; students need to have some idea what technologists do and girls require information, preferably at first hand, about the experiences of women who have embarked on technological careers.
Research has hitherto focused on causes and effects; more attention should now be given to communication.

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Programs Designed to Encourage Young Women to Study Engineering

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SUMMARY: The United States Society of Women Engineers (SWE) have had great success with the Educational Programs that introduce much and sciences to the youth of our Nation. The Professional and Student Section Members are well received by Students, Teachers, and Parents when these successful programs are presented in our community.

We have all heard the dire government predictions 01 the engineer shortage by the turn the century and at the 560,000 engineering positions that will not be filled in the United States by the year 2020. These predictions are published in the "NEW FACE OF SCIENCE & ENGINEERING" [l]. A report by a United States Government Task Force.

How do we, the schools and engineering community, fill this need and reach students that have the potential of being engineers. Many of these Future potential candidates do not personally know anyone that works in the fields of science or engineering. They have no role medals. After all, 95% of the students in engineering at college have an uncle, a brother. Father, mother or close friend that earns their living working in engineering related jobs.

I will comment an Some of the programs the 69 Professional Sections and the 249 Student Sections of. SWE have developed and are successfully using. These Award Winning Progress encourage young people to study math / science and influence them to consider engineering as a lifetime career opportunity. These programs were written and submitted through the section Career Guidance Reports in the spring of each year. Reports are judged by a Committee of SWE Volunteers as to the most innovative or the most improved programs that introduce engineering to young people. The annual Awards for the "Best Programs are presented at the SWE National Convention each gear.

A FEW OF THE AWARD WINNING PROGRAMS BY THE SWE STUDENTS SECTIONS ARE:
"A PROGRAM TO EDUCATE SCHOOL COUNSELORS" [2] - Who better to reach the young students than a counselor 7 A person who can encourage or discourage a student just by a word. One year, The University of California Berkeley Student section invited 115 counselors to an all day seminar. The counselors represented 40 schools from the surrounding area. They heard from College Educators on how to encourage young students to study math and science. Professors from seven engineering disciplines presented programs on "STATE OF THE ART ENGINEERING" from their chosen field at Berkeley. Speakers from Admissions, Financial Aid, and the CO-OP Programs spoke of monetary help available through the college. The Director of Graduate Women and Minorities Programs offered advice to counselors on monitoring the atmosphere in classrooms toward girls and minorities. Industry Representatives presented the opportunities and rewards of working as engineers. The Students told of their engineering studies and expressed the excitement of being in a University environment.

- "CONSIDER THE ALTERNATIVES" 1:2,3J - is a University Student Program designed to work with Junior High and High School Students. The University students produced an Award Winning 18 minute slide show on what it is like to go 10 colleges and study engineering. A team of two Students and one Professional Women Engineer will visit schools in the area. When visiting a minority school two of the team are to be of minority origin. They relate their engineering experiences, present their slide show and distribute their "CONSIDER THE ALTERNATIVES" Brochure indicating the math & science courses necessary for college engineering entrance.

- "GIRL SCOUT ENGINEERING BADGE" [4] - Local Brownie, Girl Scouts and their Troop Leaders were invited by the SWE Purdue Students to a "Sleep Over" at the ~iver5itg. The Scouts had an opportunity to visit Dorms; go to classes; visit ~oratories; talk to professors, students and persons from industry. They earn heir Computer or other Engineering Badges at. Workshops prepared by SWE College students.

- "A PROGRAM TO ENCOURAGE MATH" - State University of New York (SUNY) at buffalo published a Math Book for 6th through 8th grade students. This MATH-A-THON" [2] Program. Encouraged the young participants to collect pledges per correct answers in the Math Book. An Awards Reception was held at which students Gift Certificates were from the local McDonald's and Burger King.

- "ENGINEERING ENLIGHTMENT DAY" [2] - Forty local High Schools were asked to register students for a special Event at SUNY Buffalo campus. Their "ENGINEERING IS IT FOR YOU" Brochure was distributed along with National SWE Scholarship information. Films depicting all engineering disciplines were shown and a local professional-Engineer spoke on “WHAT IT IS LIKE TO BE AN ENGINERR” guests were taken on a tour of the school's engineering and science laboratories.

- "A WEEK AT THE UNIVERSITY" [4] - The Student Section at The University of Michigan at Ann Arbor sponsored a week long program for 60 -fifteen to seventeen , old High School Students to visit the University. There were day lectures professors, Graduate Students and Industry Representatives. The Guests lived in the Dorm with Counselors and University Students, who led evening discussions financial Aid, Career Options and life at the University, The program concluded with a Seminar for the Parents. This program was funded through the Student Section's own Fund Raising Activities.

II. AWARD WINNING PROGRAMS BY SWE PROFFESIONAL SECTIONS: These programs are up and above the SWE Basic Career Guidance Programs such as the High School Certificate Awards, Job Fairs, Science Fairs, Job Shadowing, and Section Scholarship Drives.

- "COMPUTER LITERACY *I* ADOPT A SCHOOL PROGRAM" [3, 5] is an Educational Program started at an economically disadvantaged Middle School which was plagued far lore than a decade by a high drop out rate, and administrative turnover. The test Scores were some of the lowest in Calif. The Computer Literacy Project was established to direct some of the near by community's abundant resources into a school district which desperately needed outside involvement and Professional expert. The long term objectives of the project were to encourage children to continue their education through High School and College; to reduce the 70% Drop Out prior to High School Graduation; to raise the level of Technology used by training Students, Teachers and Administrators to use computers; to inform Students of Career opportunities and lifestyles which might not be evident in their community; and to build a Partnership between School Staff, Students and Volunteer Professionals from Industry and the Universities.

  The projects major program was a Series of Mini-Courses on Computer Literacy, taught during the school day as part of the Language Arts Curriculum. The program teaches the fundamentals of computer use and Word processing, using a Public Domain Software Package called FrEdWriter. It is easy to learn and students are free to make copies of the software for use at home. The classes are taught by volunteers from Industries and Universities. Engineers, Computer Scientists, & Administrative Assistance comprise the teams of volunteers. The only prerequisite for volunteers is that they be computer literate, interested in children, & committed to contributing their time and effort to an under serviced Commuting. In addition to the ward processing classes, The project has sponsored several workshops for Teachers at the school. SWE purchased a MODEM for the Lab in order that students could communicate with other schools in the area. A Computer Club was started as well as a School Newspaper.
- A special relationship has been established between the Community, Industry the School and SWE. This volunteer program was so successful it was taken over by the High School District. Additional programs are being introduced by Volunteers by bringing in Speakers on various Careers and helping to automate the School office.
- "A DAY IN THE LIFE OF AN ENGINEER" [3, 6] - is a popular New Orleans Section Program that can be presented each year. This Saturday project is designed for Junior and Senior High School Students who are capable in Math and Sciences. IT shows the practical aspects of engineering such as Cost Estimating, Stress Analysis, Multiple Solutions and Competition. The project chosen was a structural engineering problem to demonstrate to students the Engineering Concepts of Bending, Compression, and Tension. The Fun Challenge presented to the students was to design an Elephant Bridge at the local Zoo. Volunteer jobs were classified as to the amount of time required. The SWE program called for a General Lecturer to introduce Engineering and Structural Concepts; an Architect to present the problem; Group Leaders, one for five students; Three to five Contractors to give prices for the cast estimate; and one consultant for General Engineering Purposes and Information. This project is well received by the schools and has Funding by the Community.
- "SPEAKERS BUREAU": A Training Session for Professional SWE Members is held each year at the section level. Instructions are given on how to communicate with an audience of School Children. Do not use big words, Do not talk down to Students, Be Pleasant, and answer all questions honestly. If you do not know

The answer then say you will get back to them or use it as a challenge for a school project. Hand-Outs given introduce engineering and yet appeal to the school grade being visited. Most presentations are for one hour in the classroom. and could be on a variety of engineering topics.

- "EXPANDING YOUR HORIZONS" [7J -Is a Mill's College "Math Science Network" Program. These yearly Conferences introduce 6th through 12th Graders to female Role Models in Science, Math, and Engineering Careers. The Goal is for these Girls to go h08e understanding the prerequisites, especially the High School Hath and Sciences, that they need to pursue these Careers. This program is an all day Saturday Presentation at a local University. OUR local program last year had 65 different workshops, frail which the Girls and their Parents were to choose three. One workshop entitled "ENGINEERING THE WORLD AROUND US" was organized by the Student Outreach committee of SWE. There were 893 young women & 148 adults registered. The post conference evaluations indicated participants were very enthusiastic about what. they learned.
- "HIGHER EDUCATION OUTREACH PROGRAM (HEOP)" [8] - Is a National SWE Program supported by a NASA GRANT each year for five years. Four Major SWE Sections with large groups of volunteers have a one week SUlll1ler Camp introducing Engineering to 8th through 12th grade minority girls. The program starts with the 8th grade and follows the students through the 12th. The Program Structure includes an "APPRENTICESHIP DAY" at a Ideal University and Hands On experience of Engineering principles far the week. This program. Provides in-Formation to let students know Engineering is a viable option for a lifetime Career for them. Minority for this program is defined as the ethnic groups under represented in Engineering per United States Population. They are Spanish, Negro, Native American Indians and South Sea Islanders.
- "4-H SERIES" [9]: This New Program is inspiring & a very innovative program. SWE is just beginning to be involved. This 4-H Program is "SCIENCE EXPERIENCES & RESOURCES FOR INFORMAL EDUCATIONAL SETTINGS" (SERIES I. When we hear of 4-H we think of Cooking -Farming- Raising cattle & Going to fairs. This is "SCIENCE EDUCATION FOR YOUTH AND THE COMMUNITY". SERIES is a science training for Teenagers with hands-on activities which build on Science Concepts and Processes. It is designed for an adult to recruit and train their Teenage Teams. The Teen Teams will present the Science Program to youth of the 4th to 6th grades. The Teen Teams present "SCIENCING" not with the Absent Minded Professor image with a white Lab coat and thick glasses wandering around in a maze. Instead it is every day ordinary Observing -Comparing -Organizing -Relating Experimenting -Inferring -and Applying. This is what all children do all day long, they are natural scientist's. Parents will attest to this, when they answer their children's constant Why? Why? Why?

AT PRESENT THERE ARE 6 UNITS IN THIS SERIES:

l."SNAILING "introduces animal science through experimentation with one Common anima1.

2."BEYOND DUCK & COVER" is understanding why and how earthquakes occur, what it is like to experience one, and how to prepare your community for earthquakes.

3 "CHEMICALS ARE US" explores chemicals that are around us, observe chemical change, provides community action for identifying hazardous chemicals and how to safely dispose of the.

4."Recycle/Reuse" provides an opportunity for participants to identify the

Naturally accruing environmental cycles and to develop an understanding of the importance of recycling in the community.

"Pests" - The curriculum. Provides activities in developing, understanding, and appreciating what pests are and what they do.

"Agriculture" - Investigates plants life and experiments with growing corn in a bucket a' water.

In order to show you the scientific depth of this program. I will give a brief overview of the Module "Sailing".

Define the Snail's Speed: Put Snail an wax paper. Measure distance traveled and time. Plat distance vs. time. "That's Sciencing"

Snail food preference: Determine food Snails like. IE. Veggies, Fruit, Honey, etc Graph results. Type food Snail likes best & least. "That's Sciencing".

Snail Race: Need Snail racetrack sheet & timepiece. Can you predict which Snail will win? Can you alter Snail's speed? is their relationship between size & were found ? When they ate last; or where they Graph size vs. time "That's Sciencing"

Snail Statistics: Need balance scale. Use paper clips as balance. Record weight length circumference. Collect and record these vital statistics! "That's Sciencing"

Snails and the lightness of being: Place Snails near light of different intensity Does different color light make a difference. Plot Snail's reaction to light." That' s Sciencing" -Use flashlight for cool light.

Snails and Chemica1s: Surround the Snail with 3 strips of towel soaked in water and: Plain Water or Vinegar or Salt OR: Lemon or Sugar or Detergent. Record Snail's response. "That's Sciencing"

Record Snail reaction: To Touch, Sound, Puff of air from a straw and Reaction when placed on: Cotton, Clay, Charcoal, Rubber Bands, Sponge wet, Reaction to Sponge dry, Sand paper wet, Dry, Mirror, Masking tape sticky side.

A-Mazing Snail: Hake maze of salt water soaked paper towel~. Can you train a Snail,?

Circus Comes to Town:

1. Death Defying Razor Blade Leap: Snail crawls aver sharp objects without being hurt.
2. Tightrope: Snails crawl along a taut string hanging upside dawn!
3. Strong Snail: Harness a Snail and tie to a toy car. Compare weight the Snail pulls to weight of cars. That is a "Sciencing" proportion.
4. Jailbreak: Place Snail inside nail jail- Predict whether Snail can escape! this is a science survival tactic.
5. Think up and design other amazing feats (feets) far Snails

The overall goal of SERIES is to increase bath the quantity and quality of science experiences available to youth in a way that children develop a clearer

Undersigning of science relates to their everyday life. The activities are designed for youth to learn and do science in a -no traditional educational Sluing. You'll have to admit. a middle school student learning from teenagers would be a lot more fun than reading frail a book.

SWE volunteer are Mentors and Teachers. The time dedicated will depend an the module or the section of module and the audience. The complete module will take a full day with the Hands-On involvements of the 4th to 6th grade students.

The "SERIES" Program was designed with the collaboration of, the staff from. California's Cooperative Extension Program. The Lawrence Hall of Science, and UC Berkeley's School of Education. They are responsible for the implementation of the 4-H SERIES Program. The Program is currently funded -through a Grant frail The National Science Foundation and A Kellog Grant.

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Introduction of a Record of Achievement for Students in a University Engineering Department

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The value of a broader based education, which encompasses more than pure academic learning, is well recognised. Recording achievement and planning individual development are essential to the successful completion of academic studies and to the identification of suitable career choices. A Record of Achievement (RoA) can be used as an effective means of maximizing the development of individuals; it is now widely implemented in Schools and in Further Education, but has so far had a limited introduction in Higher Education.

The University of Birmingham, as part of the Enterprise Initiative, is intending to implement, from January 1991, an RoA scheme for students. The RoA scheme will assist the student in developing a profile relating to their personal qualities and transferable skills. The scheme will be introduced first into the School of Manufacturing and Mechanical Engineering as it is considered that the curriculum delivered within the School is already capable of providing the student with the opportunity to develop some of these skills.

The RoA scheme is designed to operate within the existing structure of Personal Tutoring. However, the RoA is student-led and involves the student in keeping a Working Diary to record how skills and personal qualities have been addressed and developed within a given period. The Personal Tutor discusses the Diary with the student, and assists the student in defining aims and objectives for the next period. The Careers Service will also provide guidance and counselling for the student. The RoA is not intended to be a formal assessment of these skills and qualities, but is aimed at raising the awareness of the student to them in order that they are more successful in their studies and potentially more employable when they graduate. A summative record of achievements will be prepared annually and will be a document negotiated between the Tutor and the student.

E13

Women in Engineering: A Fresh Approach

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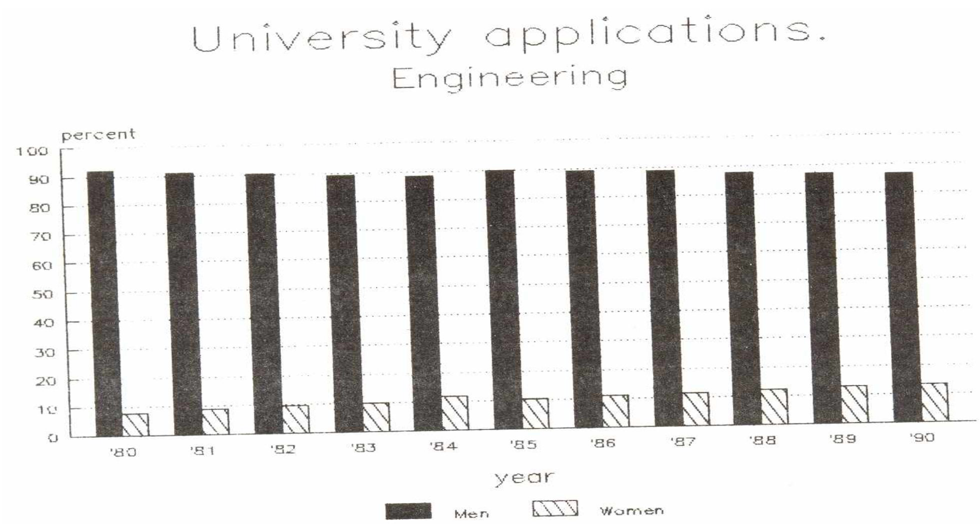
SUMMA RY:

This paper reports on an 'open day' held in the Department of Electronic and Electrical Engineering of the University of Sheffield for fourteen and fifteen-year-old girls from local schools. The aim of the day is to introduce the girls to the engineering discipline through a series of experiments, demonstrations and talks.

BACKGROUND:

Following the WISE and Insight initiatives of the 1980's the number of women applying for places on university engineering courses has steadily increased, reaching 13.3% of the total in 1990 [1], (Fig. 1). However, the percentage of girls gaining' A' level mathematics and physics has remained constant at around 31% and 22% of the total number of passes respectively [2], (Fig. 2) .



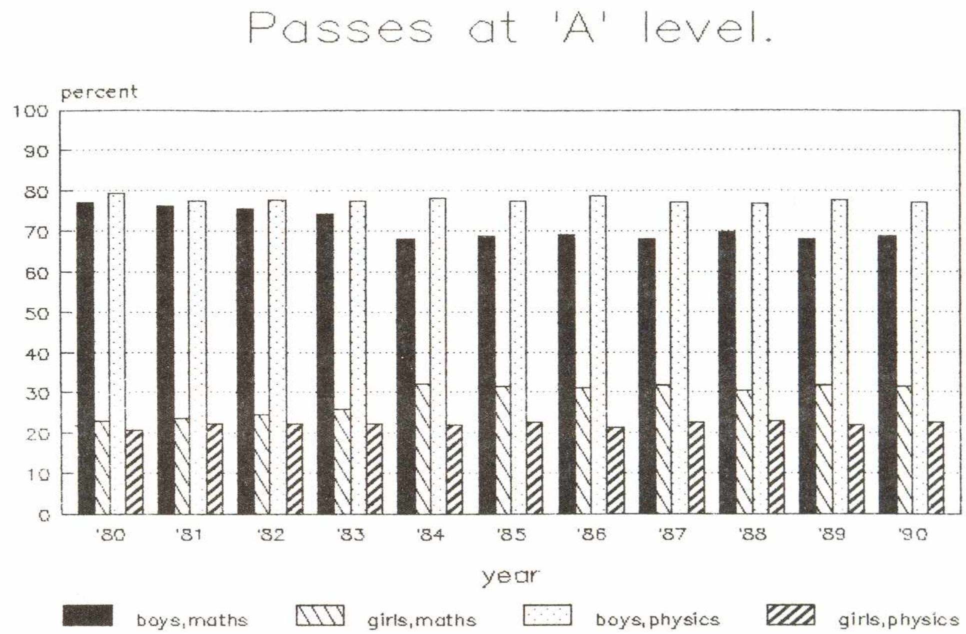


Fig. 2.

Previous and current initiatives, such as Insight, have tended to concentrate on girls who are already committed to 'A' level mathematics and physics courses. We felt that a younger age group should be encouraged if the success of the previous initiatives were to be maintained and reinforced. The aim is to provide information for girls in the first year of their GCSE courses, well before any decision has been made about' A' level choice. In this way it is hoped to encourage more girls to take 'A' level mathematics and physics. We also hope to compliment an annual event organised by Sheffield City polytechnic which takes place over three and a half days for thirteen-year-old girls [3]

The organisers of the event are female postgraduate and undergraduate students in the department who have the support of the academic and technical staff.

THE SHEFFIELD INITIATIVE:

The Sheffield Initiative aims to introduce 3rd and 4th year girls to the engineering discipline through a series of experiments and demonstrations carried out during an ' Open Day' in the Department of Electronic and Electrical Engineering at the University of Sheffield. We aim to introduce concepts, rather than detail, by using principles from many scientific disciplines to solve a particular problem. We will also introduce the ideas of working together and communicating with each other to emphasise the 'human' side of engineering as well, as the technical. We aim to show the broad range of problems in engineering through demonstrations of the current research in the department. The girls will also be given ample opportunity to talk to people involved in engineering at the university and in industry by involving both current students and female graduates who are employed in industry.

We hope to test the effectiveness of the day in the short term by asking the girls their perceptions of an engineer at the beginning and end of the day, and by sending a questionnaire to the school after the event. We intend to assess the value of the event to determine whether we should hold the event annually and whether we should involve more departments within the Engineering Faculty.

In the long term we hope that events such as this will become more popular and raise the awareness of the girls to the benefits of a career in technology.

THE OPEN DAY:

The response from local schools has been such that two separate open days have been arranged for June 18th and 19th, 1991. The timetable will include the following events.

1. A simple experiment, with instructions, lasting half-an hour. The aim is to 'break the ice' and to get the girls used to basic equipment.

2. A paper engineering exercise, also lasting half-an-hour. For this session the girls will work in small groups. Our aim is to introduce the girls to the importance of communication in engineering. We hope that primarily the exercise will be fun and we intend that there will be a competitive element with the results being discussed during the closing session.
3. A simple project lasting one and a half hours. Our aim is to give the girls the chance to develop ideas for themselves and solve a simple problem. We hope that they will develop the processes involved in producing a working solution to a problem.

4. Demonstrations and Departmental tour, interspersed throughout the day. The aim is to introduce the girls to applications of engineering which they may not have considered. By involving undergraduate and postgraduate students, academic staff and graduates of the department the girls will have the opportunity to talk about engineering and ask questions.

5. A guest lecture, lasting half-an-hour. We intend, quite literally, to end the day with a bang. A member of the academic staff will give a short lecture which, although demonstrating some serious scientific principles, is essentially fun.

6. Group discussions. We intend to give opportunities for discussion during tea, coffee and lunch breaks and in the final group meeting at the end of the day.

CONCLUDING COMMENTS:

We are unable to comment on the success of the Open Days at present as they are scheduled to take place in June 1991. This will be reported in a future communication and at the ICWES'91 conference. However, we are able to comment on local interest in the event.

We originally contacted every state secondary school within the Sheffield Local Education Authority (38 in total). Of these, 10 have replied (26%). All those replying wished to send girls to the Open Day, and the numbers are such that two days are needed to accommodate all those wishing to attend.

It is significant that the schools which replied are in parts of Sheffield with catchments areas which include many traditional, middle-class homes. We have, initially, been unable to attract girls from other areas of the city. The reasons for this are unknown as we have no way of knowing whether the information is filtering through to the pupils themselves. This is an area in which more effort needs to be concentrated in the future.

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WISEST - An Initiative at the University of Alberta

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SUMMARY

WISEST, Women in Scholarship, Engineering, Science and Technology is a University of Alberta committee which has instituted programs to encourage young women to consider careers in the sciences and engineering. The on-going summer research program, annual conferences and undergraduate, graduate and staff support group have developed as initiatives which are judged to have been successful from follow-up studies.

BACKGROUND

Early in 1982, the late Dr. J. Gordin Kaplan, then Vice-President, Research, at the University of Alberta attended a seminar on microprocessors. The room was packed; there was one woman in the audience. Already concerned by the low participation of women in careers in the sciences and engineering, Dr. Kaplan took action. WISEST, Women in Scholarship, Engineering, Science and Technology was established. The committee has about twenty members including academic staff, students, professional engineers, representatives from Alberta Education and the Alberta Women's Secretariat (both Alberta Government departments) and educators. The mandate of the committee is to initiate action to increase the percentage of women in decision-making roles in all fields of scholarship. Since women are markedly under-represented in the sciences and engineering, many of the studies and actions of WISEST have concentrated on these fields.

Much has been written about why young women do not choose careers in the sciences and engineering and many answers have been given as to why this is so [1]. It has been argued that there is something intrinsic to the nature of science as we practise it in the late twentieth century which excludes women from the field [2]; some have suggested that women are not as good at science as are men [3]; yet others cite social, cultural, educational and occupational barriers to women entering these fields [4]. Believing that women have a great deal to offer to the scientific and engineering disciplines, WISEST has initiated several programs to try to build bridges across some of these barriers. Being based within a university, much of our effort has been directed to university and senior high school students. We recognize that many young women have made choices by this time and that we are having an influence on a very small group. However, we are convinced that it is important to build bridges wherever the expertise and the opportunity exist. Some of the programs of WISEST are described in the following paragraphs [5].

SUMMER RESEARCH PROGRAM FOR HIGH SCHOOL STUDENTS. [6]

One of the barriers which has been identified as keeping girls from considering the sciences and particularly engineering as possible careers, is their lack of knowledge of what a scientist or an engineer does in their everyday work. One of the on-going programs of WISEST is intended to help to break this barrier. In the program, students who have completed their second to last year in high school spend six weeks during July and August working in research groups at the University of Alberta. The girls work in the Faculties of Science, Engineering and Agriculture and the boys in

The Faculties of Home Economics and Nursing. The program has been in operation for seven summers and has increased from ten students in 1984 to forty in 1990. It is unique in that the students join research groups and work on on-going projects, rather than taking specially developed courses. In this way we are making use of existing resources.

A pool of academic staff at the University who are willing to take students has been developed. Students are recruited for the program through the science supervisors of the local school boards and directly through the WISEST office. Students are chosen using several criteria: in fairness to their University supervisors, they must show strong academic achievement in the sciences; they should be at least somewhat open-minded about their career plans and they should have extra-curricular interests. Choosing the students has been described by a member of the selection committee as both an exhilarating and a depressing experience; exhilarating because of the genuine interest and quality of the students, and depressing because so many excellent students cannot be accepted into the program. Each student is paid the minimum wage for the six week's work, a total of about $1,000 (£500). Funding for the program comes from Federal and Provincial summer employment programs, from Provincial Government departments, from a local philanthropic foundation and from the University of Alberta. The program is managed by a paid! Co-ordinator who works full-time from May to September. In addition to soliciting the research projects from supervisors and helping in the choice and assignment of students, the co-ordinator visits the students regularly in their laboratories and maintains close contact with supervisors. The co-ordinator also arranges weekly gatherings of all of the students at which time they tour the university, learn about the library system, hear about job trends, listen to men and women in nontraditional careers talk about their experiences, and share with the group a description of the work each has done during their stay at the University. The students have worked in the department of zoology collecting and analysing water samples from lakes in Nonhern Alberta, in the department environmental engineering studying the effects of various disinfectants on drinking water quality, in the department of physics analysing the distensions to the earth's magnetic force field which result from the burst of solar energy which produces the Northern Lights, in the department of I. mechanical engineering gathering data leading to the determination of the surface tension of various I hydrocarbons and in the department of microbiology studying the effect on fish of different strains of bacteria.

When asked to evaluate the program, the majority of the supervisors have been very positive. Most faculty who have supervised students have done so for more than one summer and have indicated their willingness to continue to do so. All of the students have responded that they enjoyed the experience and have benefited from it. In a follow-up of students who were in the program in 1987, 1988 and 1990, 100% of the respondents were attending or planning to attend university. A big majority (86%) indicated that the WISEST program had influenced their choice of field. Moreover, 80% expressed their intention of continuing on to graduate studies or of entering a professional school on completion of their first degree. Not only does the program provide information about what scientists and engineers do, it also introduces the students to university life and many of them who have come up to university a year later have commented on how much more comfortable they feel than their classmates who were not part of the program. They also know a staff member to whom they can go and talk over any problems they may have.

Perhaps the most rewarding aspect for the supervisors and coordinators of the program has been the surprise and delight expressed by the female students when they realise that "This is engineering (or science); it is imponant; I can do it!". Our experience with the program leads us to believe that it is successful both in encouraging young women into the sciences and engineering and also in increasing the likelihood of their being successful at university and continuing on to post-graduate studies.

ANNUAL CONFERENCE.

When asked to visualize a famous scientist, school children still most often describe an elderly man in a white coat who is an extremely hard-working and intelligent person and who has worked most of his life alone in a laboratory with little time for family life or other interests [7]. Seldom is the first image that of a woman, especially of a woman with a so-called 'balanced' life. To try to counter this perception and to help to answer questions about how a career and a family can fit together, a day-long meeting is held at the University each May for high school and undergraduate students. The meeting provides the students with both the opportunity to meet and talk informally with women in a variety of non-traditional careers and to have hands-on experiences in the sciences and engineering. Titles such as 'Invest in Your Future with RSPs: Rewarding Science Programs', 'Science, Engineering and Technology: They are for Women Too' and 'Choosing Your Career the

WISEST Way' have been used. The format of the conference is a plenary session with a keynote speaker or speakers followed by small group sessions in which the students can question three or four women in non-traditional careers about the requirements of their work, the qualifications they needed, how they manage their career and their family and why they chose their career. The small group discussions are facilitated by a teacher. Discussion continues over lunch and then there are a variety of hands-on activities for groups of about ten students. Each student participates in two of these activities. They have included working in the water resources laboratory of the civil engineering department, using a computer program to test the viability of a new product and how many need to be sold to make a profit, doing one of several experiments in the chemistry laboratories, making models of strands of DNA, exploring superconductivity, learning about the Hubble telescope and examining plant cells. The day closes with a plenary discussion and wind up. About one hundred students and forty women scientists and engineers have participated in each meeting.

One of the teachers who acted as a small group facilitator in 1990 was the principal of an elementary school. She felt that much younger children could benefit from a similar experience and so in February of 1991, a day-long conference was held at the University of Alberta for one hundred and twenty female elementary school students aged 9 to 12. The length of the small group discussions was shortened and group model building competitions were included but otherwise the format was very similar to that for the older students. Log books were prepared for each child so that they could record their experiences and reactions during the day. The enthusiasm and. eagerness to try new things of the younger children made it an exciting and exhausting day. The success of this first venture in 1991 has encouraged the planning of such a meeting annually.

UNIVERSITY OF ALBERTA WOMEN IN SCIENCE AND ENGINEERING (UAYS)

It has been shown that many young women who very successfully complete a degree in the sciences and engineering choose to move into a more traditional career rather than continuing on to graduate school [8]. These are the young women who are needed to fill academic positions in these fields and to help to increase the proportion of faculty women. In what way can WISEST provide encouragement for female students in the sciences and engineering? The UAYs, an acronym for University of Alberta Women in Science and Engineering, is a mutual support group for all women in these fields at the University, including undergraduates, graduate students, post-doctoral fellows, and academic and technical staff. The group meets about once a month during the academic year and produces a newsletter, the UAYs News, also on a monthly basis. A mailing list of just over five hundred names has been developed. The names of students who have participated in the WISEST High School Student Summer Research Program are added to the mailing list each year. Each September the newsletter of the group and a letter of invitation to the first meeting are sent to female graduate students and third and fourth year undergraduates in the Faculties of Science, Engineering, and Agriculture and Forestry, and distributed to as many first and second year female science and engineering students as possible. Meeting notices are posted around campus. Meetings have included panel discussions on topics such as 'Choosing a Graduate School and a Research Director', 'Gender Role Development' and 'Managing a Career and a Family', talks by visiting women scientists and engineers, including Dr. Rose Sheinin, a Molecular Biologist who is Vice Rector, Academic, at Concordia University in Montreal, Dr. Ursula Franklin, Professor of Engineering, University of Toronto, and Dr. Marie Morisawa, Professor of Geology, State University of New York at Binghampton, and informal pot luck suppers followed by discussion. A buddy system has developed within this group. Students who have questions about a specific course they are taking are paired with someone who has already completed the course. The effect this group may be having is hard to measure, but it has the potential to provide the role models and the informal networking which may help to persuade some young women of the viability of continuing their studies and of considering an academic career.

In addition, thirty-five graduate student members of the UAYs volunteered to be role models for the pilot project of the Stepping Stones Program organized by the Alberta Government. The students visited schools in Edmonton to talk with grade eight classes (13- to 14-year olds) about their choice of career. In this way, young women who still have choices to make about their careers have an opportunity to talk with those who have already made these choices.

CONCLUSION

The members WIWISE' think it is important to encourage young women to consider careers in the sciences and engineering and give much time and effort to try to make it happen? e several reasons. Firstly, we believe in equal choice and opportunity for all members of

Our society. Secondly, it is projected that there will be a shortage of trained personnel in these I areas in the next five to ten years, so that jobs will be available. These jobs will be replacing many' of the traditional women's jobs such as switchboard operators and stenographers. Thirdly, men have traditionally been expected to provide a good standard of living for their family; when it becomes wholly accepted that women can have careers which allow them to share this role, pressure will be lifted from men. Finally, it is our expectation that increasing the number of women practising in the sciences, engineering and technology will bring to these disciplines a broader spectrum of human values.

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The Integrated Engineering Degree Programme Opening Doors for Women into Engineering

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SUMMARY

In recent years, industry has begun to identify a need for a new type of graduate engineer, one with a broad based knowledge of engineering principles rather than specialist knowledge in narrow areas. This paper discusses the Integrated Engineering Degree Programme at the University Of Wales College Of Cardiff, which was set up under a joint D.T.I./Engineering Council initiative.

INTRODUCTION

The Integrated Engineering Degree Programme was initiated in 1988 with the publication of a consultative document (Engineering Council (1]) which presented a scheme for an honours degree in Engineering which offered a broad-based curriculum suited to industrial needs. This degree is intended to be as intellectually demanding as a single-honours degree course and to fulfill the SARTOR (Engineering Council [2]) requirement for the B.Eng qualification. A joint initiative between the Engineering Council and the Department of Trade and Industry awarded financial support to six institutions to set up pilot schemes in integrated engineering. These six institutions are; University of Durham, University of Wales College of Cardiff, University of Southampton, Nottingham Polytechnic, Portsmouth Polytechnic and Sheffield City Polytechnic. In October 1990, the School of Engineering at the University of Wales College of Cardiff enro1ed its first Integrated Engineering Undergraduates, having also secured additional funding from local industry. In a year when applications for general engineering degree courses are down by 4% (source; UCCA), applications to study integrated engineering in Cardiff are up by 25%.

WHAT IS "INTEGRATED ENGINEERING"?

For those of us who are involved in the integrated engineering degree programme this is a question often asked. Integrated engineering is not a multi-discipline course, it is not a modular course and it is not a joint honours course. Integrated engineering is an honours degree course which emphasises both the full integration of traditional engineering subjects and also the linking of academic studies with industrial engineering practice. The curriculum embraces the disciplines of civil, electrical, electronic, manufacturing, mechanical and structural engineering supported by computing, mathematics and science. Business and management studies together with a European language are all taught in an engineering context.

Conventional, single discipline engineering courses give the student an initial specialisation upon which the breadth of training is supposed to be added during future employment. In comparison, the integrated engineering degree gives the

Student the necessary breadth initially, allowing and developed at a later stage. This formation opportunity employment and the aspirations markedly during the degree course.

The integrated engineering course is based upon guide- line syllabuses (Engineering Council [3]) drawn up by a steering committee comprising of representatives from the professional institutions and from industry. The detailed syllabus is designed to reflect the teaching and research interests ~ the School of Engineering at Cardiff. The course is a demanding one, which requires a student-centered approach. Students are encouraged to develop self learning skills in order to cope with a broad course.

A feature of the course is a subject group entitled "Integrating Studies" which is timetabled for approximately one-third of the total hours. Integrating studies is the vehicle for the integration of the engineering subjects, with the objective of integrating the learning from formal studies and applying these techniques and skills to real industrial problems. This is achieved through laboratory projects, industrial case studies, computing workshops (including the use of computer-based learning packages), seminar presentation, small group discussion and design projects. The interaction between integrating studies and the engineering subjects is shown in Figure 1.

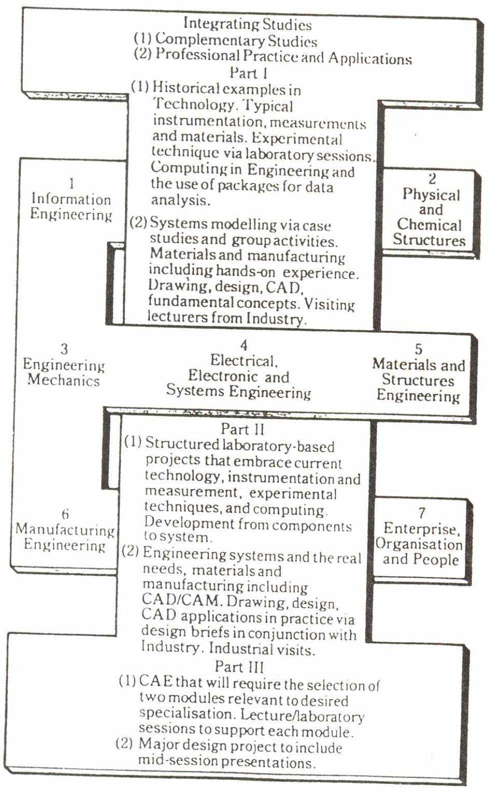

Figure 1. *The interaction between integrating studies and the engineering subjects. (Watton and Jones [4])*

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Briefly, the main aims of the integrated engineering degree programme are:

a) To instil a knowledge of fundamental sand applications, not to produce specialists, and to emphasise group study and interaction.

b) To develop an attitude towards scholarship that will allow any necessary specia1isat ion to be gained during employment.

c) To provide a sound introduction to the basic tools of engineering ana1ys is, design, manufacture and management and to bring the students into contact with practical situations.

d) To respond to the demand from modern industry for engineers with technica1 capabi1ity who are not constrained by traditional disciplinary boundaries.

e) To widen the access to engineering without lowering standards, by accepting students without A- 1eve1 physics and compensating by teaching the basic physica1 concepts with in an engineering context.

THE INDUSTRIAL PERSPECTIVE.

Industry has recognised the need for a broad-based engineering course for some time. In 1979, during the committee of inquiry into the engineering profession, which led to the "Finniston Report" [5], employers frequently described deficiencies of their engineering staff in terms of personal qualities rather I than specific engineering skills and mentioned the need for flair, enthusiasm, , innovative or problem solving skills, flexibility and communication skills. There was a general consensus amongst those employers consulted, in favour of a change in emphasis in an engineer's academic education, with greater stress being put on the exploitation of knowledge rather than its pursuit. links between industry and academic institutes are vital for the continuing development of engineering education. The IEDP in Cardiff has been set up with an industrial advisory board as part of the management structure in order to ensure that the course is designed to meet those industrial requirements. In the 1990's, technological advances dominate the industrial climate and it has become clear that the tools and responsibi1ities of Chartered Engineers have changed and will continue to change to reflect the changes in the industrial climate. The integrated engineering degree programme aim is to educate the engineer for a working life rather than just for a first job. If support from industry is a reflection of the need for this type of course, then in Cardiff we have found that need to be great. The type of support we are current1y receiving inc1udes: (a) involvement in the planning and monitoring of the course by appointment to the industrial advisory board, (b) sponsorship of students and/or provision of industrial training, (c) participation in project and design work, (d) provision of equipment, (e) secondment of staff for industrial seminars and case studies and (f) direct cash support' s. Companies already supporting the course in one of the above forms include;

Alpha Engineering Services Ltd (Bristol), Allied Steel and Wire (Cardiff), British Aerospace Commercial Aircraft Ltd (Bristol), British Gas plc Wales (Cardiff), British Steel Strip Products (Newport), BP Chemicals ltd (Sully), Ford Motor Company (Bridgend), Hoover plc (Merthyr Tydfil) and South Wales Electricity. Direct cash support from some of the companies above has amounted to over £75500 for the first three years, which is in addition to the funding of £70000 from the Department of Trade and Industry. This clearly demonstrates that industry is firmly behind the course.

WIDENING ACCESS TO ENGINEERING - IS PHYSICS A-LEVEL NECESSARY?

Practicing engineers need to utilise physical phenomena for practical purposes. The question is, how do we best equip our students for this? Engineering courses can often be deficient in developing the teaching of physical effects as they rely upon A-level physics to provide the necessary knowledge. This approach does not take into account students entering degree courses without A-levels, neither does it allow for the fact that the content of various A-level physics courses varies considerably and that they are rarely taught in the context of engineering applications. A significant factor in the low numbers, in particular of women, entering undergraduate engineering degree courses may be the requirement for physics at level. Many girls opt out of studying physics at A-level for various reasons. Despite increased awareness of opportunities for women in engineering, particularly since WISE year in 1984, there is still evidence that at the age when A-level choices are made, many girls see physics as a male subject (Gold [6]). Peer pressure, parental pressure, lack of effective advice and perhaps the shortage of good physics teachers in Schools are all factors which may contribute to girls choosing not to study physics after- the age of sixteen, whilst continuing to study mathematics and other scientific or numerate courses. There is evidence which shows that since 1981, the numbers of candidates taking both mathematics and physics at A-level has been declining, whilst the number of

Candidates taking mathematics without physics is rising. Therefore, by insisting on both mathematics and physics as entry qualifications, engineering degree courses are reducing their pool of applicants quite considerably. In fact, in the school of engineering in Cardiff, whilst physics is seen as desirable for entry to engineering courses, it is not compulsory for any.

STUDENT ENTRY

All candidates are interviewed and assessed on their individual merits. Obviously the course is a demanding one, and in general terms, selection is made on the basis that the students should have the abi1ity to gain second class honours had they opted for a single-discipline engineering degree. However, enthusiasm and commitment to engineering and to the spirit of the IEDP are regarded as the overriding factors in selection of students. The Engineering Council [1] has stressed the particular importance of the need for more women to enter engineering degree courses. They regard the IEDP as M important initiative in encouraging women to enter engineering, for two main reasons. Firstly, many girls opt out of Physics at A-level, so the design of the course to enable students without Physics to enter will be attractive to women. Secondly, the IEDP doesn't involve an initial commitment to a specific branch of engineering - the Engineering Council also believes that women undergraduates prefer to keep their options open until a later stage.

EXPECTATIONS OF THE IEDP

For students, the course must be up-to-date in its content and approach. It must be organised in a straightforward way and be relevant, enjoyable and exciting. The students must fee 1 that they" be1ong" to a department even though they may be taught by staff from several departments. The teaching must promote collaborative effort as well as individual initiative. The course must be firmly related to industrial practice, promoting relevant training and enabling the student to gain industrial experience to be integrated with academic studies. the course must finally promote wider access to engineering without lowering standards.

Staff must be dedicated to the concept of IEDP, must feel that they are leading a worthwhile effort and that the students are gaining maximum educational value. It must be recognised that time is better spent in supervising lively aspects of engineering such as design and project work and in continuous assessment to ensure progress, rather than spending time on repetitive lectures and single - subject tutoria1s. Motivated students can 1 earn fundamental theory, with guidance, from texts, video and computer-based packages in support of lectures. In conclusion, the IEDP is an exciting new development in the education of engineers. It will not replace conventional single-discipline courses, rather to provide an alternative course which will create interest and achieve depth in relation to the whole of engineering.

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Developments in Engineering Course Design and Delivery -Is There a Gender Issue?

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In the post-Finniston era Engineering Education in the UK has gone through many changes and there has been a great deal of innovation both in terms of course structure and course delivery. This has been an effort to solve a national problem, namely that of a shortage of good quality graduates and technicians in engineering and technology, but also an effort to respond to other external factors such as the ‘ needs ‘ of industry.

This paper is a summary of some of the main changes which have taken place along with the rationale behind them. Instead of looking at the overall picture, however, the specific question of whether anything has been done to try to target courses at that highly valuable half of the population normally 'missed' by engineering courses, i.e. women is raised. Whilst it must be the case that everyone involved in the field is aware of the problem it is the author's perception that little account of this has been made in terms of course design and delivery. Consideration is given as to whether this would be either practical or desirable and whether changes at this level would be a suitable approach to the problem.

Secrets of Success for the 21st Century "Recruitment & Retention of Women in Non-Traditional Professions"

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SUMMARY - This paper presents a process for business and institutions to improve productivity and quality through diversity, creating a world-class generation of engineers for the future through recruitment and retention of women. The process identifies the critical need for both social and technical applications necessary to achieve permanent results.

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The U.S. is in heavy competition with Asian and European technology markets. We have been and continue to experience a technical explosion that has set many professions scrambling to be more creative and gain the competitive edge. The Harvard Business Review states that "the real problem is not technical change but the human changes that often accompany technical innovations." [1] By the year 2000 only 32% of the net new workers entering the work force will be white men and 68% will be women and minorities. How then can businesses function profitably in the current technical revolution with the predicted demographic changes and in the shrinking global economy as we enter the 21st century? Currently, less than 7% of engineers in the U.S. are women, yet statistics clearly show that the future engineering and science work force w ill include more women. Therefore, women will playa strategic role in the future of engineering. The liberal integration of women into engineering and all nontraditional professions provides the opportunity to build on the strengths of both women and men as we manuever through the technical revolution.

The successful recruitment and retention of women is a two dimensional process, both technical and social. The social applications are the epistemology and foundation for the technical applications. For equitable integration of women into the professional world, we must attend to both the social and technical applications. The businesses that come to understand this now -- acting to bring about change and balance in the current decade -- will gain the competitive edge and be the success stories of the next century.

SOCIAL APPLICATIONS

Historically, women have not chosen traditional male professions. Aggressive feminists would have us believe men are at fault. The men's club would have us believe the women are at fault. The fault does not lie exclusively with either men or women. Rather, it is a combination of barriers, stereotypes and messages that, over time, have created imbalance in society.

BARRIERS

Barriers that have kept women out of nontraditional professions in the past did not simply spring up overnight. These barriers evolved over time and developed in all. Stages of life. Barriers from socialization tend to surface during childhood, education and career. Each phase has new barriers that interrelate and affect the following phase. A progression of barriers evolves that tend to come to fruition at different stages of a woman's careers.

When Dr. Doris Kuhlman-Wilsdorf was presented the Society of Women Engineers' highest award at the 1989 National Convention, she spoke insightfully about the status and barriers of women in engineering and science:

"The problem of lingering anti-woman bias in science and engineering lies as much with women as with men. It is grounded in what, for the moment, I should like to dub the "Yoda syndrome" in the film Star Wars the hero Luke looks for the wise Yoda who shall give him supernatural powers. In the course of his search he runs into this queer dwarfish creature with-pancaked features, deeply creased dark leathery skin, hunched back and large peaked ears projecting above his head, whom Luke asks for directions to Yoda. Well, that was Yoda The Yoda syndrome is based on the simple fact that before knowing better, we judge, indeed cannot do anything but judge, on the basis of appearance -- and most of us even now do not expect a successful scientist or engineer to wear lipstick!" [2]

Wilsdorf identifies a cultural barrier that is the result of shared perceptions. She is describing how visual perceptions affect us, those predetermined images in our mind that are the socially-induced personal standards by which each of us functions and relates to others. The barriers and resulting discouragement are not always blatant; on the contrary they are usually subtle, a low voice constantly haunting a person. These micro-inequities send messages that evolve from stereotypes.

STEREOTYPES & MESSAGES

Stereotypes resulting from socialization surface in the career environment in many forms. Consider a common example of one typical stereotype affecting women and the implied message the stereotype sends. "Let me introduce you to the pretty engineer." This sounds like a man's generic view of women. The focus is immediately directed towards physical appearance and away from the job. What message does it send? A woman is different, being pretty is somehow a value for an engineer, or she is evaluated on appearance rather than professional competence. What does being pretty have to do with the job qualifications? I chuckle every time I think of flipping this statement around for men. What message would it send to a man if a woman said, "Let me introduce you to this gorgeous hunk of an engineer?" Imagine relating to peers in such an unprofessional manner.

Other common stereotypes women experience include being addressed as Mr. Engineer and even the token woman engineer or being seen as fragile and not wanting to get dirty.

Perceptions and messages affect all the people involved. These subtle and not so subtle messages can and do ruin the work environment for women in nontraditional fields and destroy the professional atmosphere. Stereotypes lose all

Merit judged by the standards of professionalism alone, not to mention those of human rights. Stereotypical assumptions and behavior have no place in professional environments. Consider the first line of the preamble to the Code of Ethics for Engineers: "Engineering is an important and learned profession." [3] Ethically, how can gender-based stereotypes be condoned in the important and learned profession of engineering?

WORK ENVIRONMENT

Barriers from socialization set the stage for mixed perceptions and expectations that can develop into a tense, hostile atmosphere and work environment. The interactions result from opposing perceptions between women and men which can surface in manifestations that create more complex problems. An unbalanced work environment cannot help communications or productivity, and will disrupt both until there is balance and mutually understood expectations from both women and men.

An inequitable environment also leaves the employer open for litigation and negative public exposure. In today's world of prolific litigation, how can any manager or company afford to risk such legal action, loss of time, productivity and money? And in today's changing and competitive business world, how can any company risk not developing a progressive, diversified and equitable work environment that supports all employees and ultimately benefits the company? Walt Disney understood the importance of a diversified staff to the work environment over 50 years ago. The results of his success are well known. We must gain from his wisdom.

The social understanding and applications of recruitment and retention that yield positive results do not happen overnight. They can, however, evolve over time with additional assistance from continuing education programs, books such as <u>The Female Advantage</u> by Sally Helgesen, and the work of professional consultants. Top executives must show by example to help employees learn how to balance the social aspect of the work environment. This will lead the way and set the tone to implement the technical dimension of a recruitment and retention plan.

<u>TECHNICAL APPLICATIONS</u>

Actively supporting women in nontraditional professions means that companies must make a long term commitment to recruit, develop, advance and retain women. Employee development and advancement are subjects of many management seminars and books and are a product of individual company philosophy and policy. Therefore, we will not address these issues here. We will simply look at some basic philosophy to seek out and maintain qualified women employees. The good news is that there are qualified women engineers to be recruited. One must simply become part of the network.

RECRUITMENT

1. Develop, foster and maintain contact with local, national and international women's support organizations and societies, e.g., the Society of Women Engineers (SWE), American Association of University Women (AAUW) and the National Association of Women in Construction (NAWIC). Get to know the women.
2. Make a commitment to accelerate affirmative action and increase the number of women engineers and CEO's in your office.
3. Enhance your public relations with women engineers, faculty, professionals, students, high school and college career counselors to develop a dialogue that will pave the way for future professionals, students and the public to know about your business.

RETENTION

Retention is the tough part of a recruitment retention plan. This is where we separate the progressive companies from the unprogressive and mediocre companies. To successfully retain women, the minority must learn and understand the majority <u>and</u> the majority must learn and understand the minority. A stable retention plan paves the way for mutual understanding and adaptation. Consult with or seek assistance from professionals and other organizations that are developing progressive action plans for recruitment and retention.

1. Provide support and active involvement from <u>all</u> chief executive officers.

2. Actively research, monitor and take action on the overall company work environment for women with a commitment to upholding positive role models, equitable salaries, nonsexist work conditions, eliminate discrimination and maintain career advancement opportunities.

3. Educate all employees about equitable work environments for women, company liability and human and civil rights.

Be realistic about the work environment in your company. If your evaluations signal problems in the work environment, don't ignore them or give a sunshine report of success. The first step to success is acknowledging that there are issues and problems that require action and an ongoing commitment to change.

A commitment to integrate women in nontraditional professions, to balance the work environment, takes time and will lead to change in the workplace -- changes that will challenge old standards, cause conflict and uneasiness in an adjustment period, yet will ultimately provide an organization with greater diversity, an equitable work environment and a greater pool of skilled and diversified employees. It is not easy, it will take great perseverance and time. However, the positive results clearly provide greater quality, productivity and success.

In a speech for the National Women's History Month in 1987, Commander Sue Lyon spoke about A Blueprint for the Future and expressed her hope for women by quoting from Margaret Truman's book <u>WOMEN OF COURAGE:</u>

> "First, courage is an individual quality of mind and heart which is more dependent on character and conscience than sex. Second, by focusing on women's accomplishments, inspiration and example are provided for all women. Equal rights and equal responsibilities will follow. Third, the sooner men realize that women deserve a place of honor in our past, the easier it will be for them to accept us as full-fledged partners in our future. Finally, a sharing of courage is the heart of equality. This is the direction American men and women must take if our nation is to survive." [4]

Margaret Truman's vision arises from the basics of professional and personal ethics, which are the foundation of a diverse and equitable work environment where women can simply be accepted for all their ordinary and extraordinary talents, skills, and contributions. The successful employees and businesses of tomorrow will understand diversity and practice equity to integrate both social and technical changes that will create a world-class generation of engineers. Will you be one of them?

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Developing Distance Education for Women in Engineering

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SUMMARY. This paper argues that two recent trends in engineering: the increasing numbers of women entering engineering, and the need for new forms of flexible training and updating for Europe (and the world!) 1992 onwards, can both be assisted through open learning and distance education. However, the particular social context and the preferred learning styles of women must be taken into account in order to develop appropriate professional education.

Conferences like ICWES reinforce what employment statistics for Europe and other developed countries have been showing for some time: that more women are studying for and practising as professional engineers. During the 1970s and 1980s increasing numbers of women have entered employment at all levels. As more women have graduated in engineering fields and entered the profession, and employers have implemented supportive work practices such as maternity leave and career break schemes, the engineering industry has begun to be a more attractive option for women. In the 1990s the effect of the European Social Charter and the Single European Market should be to offer even more support to working women, through parental leave schemes for example. Opportunities for professional women will be expanded by the possibility of free movement between Member States in order to take advantage of the best conditions of employment on offer. But women will also have to invest in education for professional development and - especially in the case of those taking a career break - updating, in order to take advantage of these widening opportunities.

PROFESSIONAL PARITY AND EDUCATION

The Single European Market applies, but with limitations, with respect to employment and education. There are obvious advantages to be gained from having a professional qualification recognised in all member States, as well as more widely. Although there are also other important criteria required for professional membership, achieving educational parity would be a great step forward. However, the UK. Department of Trade and Industry reminds us that for the immediate future:

> *"Existing Treaty and case law does not require member States to accept qualifications gained in other member States: it merely prevents them from rejecting such qualifications without good reason "[1.p13]*

And although it recognises that educational providers must respond to new demands, its promotion of change is rather timid:

> *"Educational institutions and professional bodies in the UK might also consider building into their mainstream training elements which will make it easier for UK professionals to*

gain access to professions in other Member Statesand ...with their EC counterparts extend areas of study they have in common in order to assist professionals across the Community" [1p 16]

Educational institutions and students already show enthusiasm for international work. For example in 1987/8 3,225 full-time undergraduate students in Europe received ERASMUS grants to enable them to study for some time at a university in another member State. However, only 15% (488 students) were studying engineering! natural science, and of these only one third (196) were women [2]. It is in the area of professional training and updating, rather than undergraduate education, where most expansion is likely to happen, as professionals cope not only with new technical and managerial skills, but also with the need to be familiar with other languages, cultures and legal systems. Unlike undergraduates, professionals cannot move to the appropriate educational institution to study, the study has to be taken to them, and in some situations follow them around as they move from country to country.

DISTANCE EDUCATION AND OPEN LEARNING

In the 1980s distance education began to be seen to offer unrivalled flexibility for people in employment who wanted updating and further training. The image of the low status 'correspondence college' has been replaced by one of accredited institutions producing high quality self-study materials using various forms of media and new technology. For anyone unfamiliar with the terms 'distance education' and 'open learning' the following are two authoritative definitions - not unproblematic definitions with respect to educational debate - but clear and straightforward ones:

"For education to occur there must be someone who needs educating and someone to do the educating. This implies that there is both a learner and a teacher, and some form of two-way communication. In the context of education, distance means that the learner and the teacher are not face-tojace. Thus two-way communication must take place despite the fact that they are not in the same room together. Two-way communication can be established using any medium that is available." [3]

"Open learning: arrangements to enable people to learn at the time, place and pace which satisfy their circumstances and requirements. The emphasis is on opening up opportunities by overcoming barriers that result from geographical isolation, personal or work commitments or conventional course structures which have often prevented people from gaining access to the training they need." [4]

Distance education usually incorporates aspects of open learning.

DISTANCE EDUCATION IN ENGINEERING AND TECHNOLOGY

Because of the practical requirements of education in engineering and applied science, running distance education courses in these subjects has been problematic, unless a student is with an employer who can guarantee supervised practical experience. In some less developed countries, and those with State control over industry, technical education has been done - in part through distance education, for example in the USSR, Poland and Venezuela [5]. However, European distance teaching universities such as the Open University (UK.), the Fern Universitat (Germany) and the Open Universiteit (Netherlands) have had only limited programmes in undergraduate technology education. In the Open University, although in any year about 18% of undergraduate students are studying courses in the technology area (about 14,000 students) a much smaller number than this are specialising in technology; most are taking some technology courses as part of a modular degree programme. Students in these institutions have, in the past, had only a very limited choice within the area: in the Fern Universitat for example only computer science, electrical engineering and mathematics were available.

In the 1970s these institutions concentrated on establishing their status as providers of recognised first degree qualifications. During the 1980s they expanded into the area of

Professional training and updating, in both management education and science and technology. In pen University (UK) the Open Business School has been the fastest growing sector of course provision, with a variety of autonomous short courses as well as a Masters Degree in Business Administration (MBA) and a Professional Diploma in Management. There are also, at the time of 19, almost 40 courses and self-study packs in aspects of scientific and technological updating, from robotics and knowledge engineering, to polymer engineering and conservation for management.

European distance education providers are planning programmes for the 1990s in a more co operative fashion, under an umbrella organisation: the European Association of Distance Teaching Organisations (EADTU). That along with new legislation which will enable EC nationals to register as students in institutions anywhere in the Community, will provide a more extensive choice for students. Some new developments are in subject areas such a foreign age teaching for professionals, others explore new interactive media such as computer mediated communication for teaching and student support. All are more specifically directed at the training needs of industry, than were the original 1970s liberal education models.

DIFFICULTIES AND ADV ANT AGES FOR WOMEN OF DISTANCE EDUCATION

Adult women have in the past been more involved in non-vocational education than professional development. This was not due simply to the fact that women professionals were a small group, but because employers seemed more willing to invest in the training of male employees, and unfortunately for the UK in particular, not in very many of them. The authors' research on women engineers in the UK and USA in the 1980s suggested that these engineers it harder to convince their employers to provide training for them than did their male colleagues, especially in the management techniques that they needed for promotion. New technology training was almost non-existent, and engineers were expected to absorb new technologies into their work by trial and error, and studying the manual. The situation in other countries, for example France, where employers are required to invest in training, may be better all, but we would expect the gender bias to remain.

It is usually presumed that by its very nature distance education will provide the flexibility adult women, with family responsibilities need from an education system, because for these women their personal schedules are set by the needs of other members of the family. As far as the is concerned the Open University developed an unwarranted reputation of being a 'housewives' university. In the first year of operation: 1971, women were only 27% of new undergraduate students, but by 1981 44% and by 198846%. In the FernUniversitat in the 1980s women were less than 25% of the student body compared with traditional West German ersities where they were 40% [7]. At the Open Universiteit in the same period approximately third of undergraduates were women compared with 35% in traditional Dutch universities[8].

In all these institutions women are even smaller proportions in science and technology subjects. In the Open University women are less than 20% of students on undergraduate technology courses, compared with nearly 70% on humanities courses and nearly 40% on science courses. These figures compare well with the proportion of women on similar courses in traditional UK universities. However, the picture is not so optimistic with respect to professional updating; the proportion of women on management courses rose from 17% in 1984 to 33% in 8, while in the same period it dropped from 20% to 7% on scientific and technological updating courses [9]. This seems to be another situation where the necessary involvement of employers - these courses are more expensive than courses in the undergraduate programme - is so forthcoming for women as it is for men.

But distance education does have advantages for women, when courses are designed to advantage of their particular circumstances. One of the most successful initiatives in distance education in technology and engineering for women has been the Open University's special men Into Technology Bursary Scheme [10]. In this initiative a group of women with a first degree in science or technology who have been out of paid employment, in order to look after members of the family are funded to study an OU course as to update their skills in order to return

To employment. After the first couple of years the scheme expanded to include a group of women who had similarly been out of paid employment, but who were beginning technology education, they were retraining to enter a new field of employment. During the 1980s almost 500 women have taken up a bursary, most have completed their course of study and gone into paid employment or further study. Apart from the financial help provided by the bursaries the other special facet of the scheme is the attempt to provide extra support through a special weekend school and developing networking amongst the students. Distance education is an ideal way of providing updating and retraining for women who take a career break for family reasons, however during this time when the family income is low, there needs to be some way of subsidising student fees.

Research on gender differences with respect to student needs in distance education has begun rather later than similar research in other areas of education. The work of Carol Gilligan [11] has provided inspiration for many researchers (including the authors). She demonstrated that women had different ways of thinking about problems and a different set of intellectual and moral values than had been recognised by previous researchers when they studied men. Gilligan provides a theoretical base for the teaching methods developed in the last twenty years in women's studies and women's education, including the technology education done in women-only groups and workshops across the world. Research carried out by one of the present authors, in conjunction with a German colleague [12] shows that women studying by distance education find the flexibility offered by it very attractive, but at the same time they dislike the isolation much more than do male students. They exhibit a strong desire to have contact with other students when they study because they find the social contact intellectually and socially supportive, more so than do their fellow male students. This does not need need to be a contradiction, distance from the institution and the teacher does not necessarily mean distance from other students.

During the 1990s we hope to see European initiatives in particular which which address the particular needs and preferences of women students. Work done by women in the International Council for Distance Education (ICDE) and the Gender and Science and Technology (GASAT) network is coming together as plans to produce specially designed international distance teaching material. We look forward to a closer association with professional women engineers and with employers in the process of this work.

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Review of Engineering Education of Women in India

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SUMMARY

Women need the benefit of Technical Training & the engineering profession needs women. Engineering is the most rewarding profession in India. Women must try to have equal share of participation, contribution and above all, advancement in all branches of engineering including the male dominated ones.

EDUCATION

The fifth All India Educational Survey, NCER T 1989 reports "There has been tremendous growth in educational facilities at all a level of education defrag the last 40 years of Independence. The growth in enrolment and schooling facilities at the primary and post primary stages of education was the result of the concerted Government effort to implement the directive principles of the Constitution to provide free and compulsory education to all children up to the age of 14". Unfortunately, so far education system has not been able to make sufficient contribution towards women's equality. Theoretically women have the right to equal education but in reality it is different. Only 22% of rural women and 55% of their urban counterparts qualify as literates. A survey carried out by the Committee on the "Status of Women in India" revealed that higher education for girls is seen to be most favoured by middle classes for their liberal attitude and for economic reasons, whereas the affluent follow traditional customs. The following is the educational development gap between boys &. girls shown in Survey 1980-81.

Enrolment	Total No. of boys & girls	% of girls enrolment
1. All India Institutes	110 million	30%
2. Primary Education	75 million	39%
3. Secondary Education	20 million	34%
4. Higher Secondary Education	10 million	30%
5. College & Universities	3 million	29%
6. Vocations, Polytechnics etc.	3 million	17%

Women constitute nearly half of India's population. (Actually during birth the number of women's ratio is more than parity, i.e. 105:100 but later the ratio declines to 93: 100 due to increased female deaths in early childhood - obviously due to discrimination).

ENGINEERING

Women's participation in every sphere of education is a critical parameter in the economic growth & technical advancement of a country. The post-Independence period in India has, however witnessed increasing participation of women in every sphere of activities. India has made considerable progress in the field of Engineering during the last two decades. She has started making inroads to Hi-tech Engineering. Her engineering exports are picking up but the contribution of women engineers in India leaves much to be desired. The participation of women to join engineering profession has remained very low. This is a matter of concern on several counts. It means their missing out on an important component of education. Pressing economic and social needs call for correction of such a situation. For those employers who are concerned about availability of able recruits to the engineering profession, a young woman is the largest untapped source.

VARIOUS DISCIPLINES

The development of a profile of women students in Engineering education, the level of their participation and branch wise distribution is to be studied for the development of career profile of women engineering professionals. In certain branches women's participation is slightly better, e.g. Architecture, Electronics Engineering, Computer Engineering and Nuclear Engineering. But certain disciplines like Mechanical Engineering, Metallurgy, Aeronautical Engineering etc., the disciplines are still considered to be men's domain. A survey in some Indian Universities conducted by the author has shown the following admission pattern in the year 1990-91.

% of girls (approx.)	Branches
50%	Architecture
20%	Electronics
18%	Computer Engineering
15%	Computer Engineering
15%	Electrical Engineering
5%	Chemical Engineering
4%	Civil Engineering
0%	Mech. Engg., Prod.Engg.
0%	Marine Engg., Naval Arch.Engg
0%	Agri.Engg. & Aero. Engg.
0%	Mining Engg.
0%	Petroleum Engg.

The reason for such admission pattern is due to the fact that parents and the Institution authorities believe that studying courses like Architecture, Electronics, Computer science etc. involve less physical strain. Also after graduation they may get employment in Arch firms, research, TV Stations, Drawing & Design offices, teaching Institutions and in Government jobs. The college authorities also encourage women to join these courses. They are biased against women joining courses like Mechanical, Metallurgy, and Aeronautical Engineering etc. The parents and often college authorities dissuade women to join these courses and even sometimes just debar women's admission on flimsy ground. There is also an employment problem after graduation in these courses. Men after graduation normally join corporate sectors, the jobs being highly remunerative. The corporate sectors are not woman friendly and developed male dominated corporate culture through ages. Thus women are always kept away from these highly remunerative jobs.

SURVEY

A study has been undertaken in the Department of Mechanical Engineering, Indian Institute of Technology, Powai, Bombay - 400076 by Prof.(Mrs.) P.P.Parikh and by Prof. S.P.Sukhatme. The objective of the study is to quantify the participation of Indian women in engineering courses to study their contribution in the field of Engineering and to analyse the factors which influence their careers. A suitable questionnaire is being prepared for engineering students and working women engineers to quantify the current status of women engineers and also understand the factors & mechanisms which result in such low participation of women in Engineering courses and professions. The results of this study when completed will enable to make some effective suggestions for improving the situation.

TECHNICIAN EDUCATION

The establishment of women's polytechnics worked very well to popularise technician education amongst girls. But here again the same ideas persisted. The courses conducted in different women's Polytechnics were Electronics Engineering, Computer Engineering, Architecture and other vocational non-engineering courses like Commercial Art, Interior Decoration, Secretarial practice, Library Science etc. and not Mechanical Engineering, Metallurgy etc.

CONCLUSION & REMEDY

To improve upon participation of women, it would require collective reflection and decision making. The parameters may be spelt as

i. Improving self image and self confidence of women in general.
ii. Educational counselling and career guidance at the primary and secondary level
iii. Encouraging girls to take Maths & Science subjects in Higher Secondary education.
iv. Providing better information to girls regarding employment opportunities in Engineering.

v. Providing exposure to various science and technical activities through formal and non-formal courses.

vi. Providing massive programme of in-service Teacher Training of the girls schools (Secondary & Higher Secondary) in modern method of teaching to make subjects interesting for proper implementation of science & technical education.

The fact remains that Engineering is the most rewarding profession in India & Women should be aware of it. Every effort should be made to make the corporate culture gender-blind to make the Engineering Companies more women-friendly. A male-dominated corporate culture is an obstacle to women's success.

Women should not be cut out from the path of climbing to success just because family responsibilities fall much more heavily on them whether by choice, nature or forced.

For most women, both the burden of family and career sometimes becomes too heavy and that puts off often their will to success of career. The Government will have to give special attention to the admission of girls to the so called non-traditional courses along with all other courses that have much more employment possibilities and create an environment by changing attitudes and practices to overcome the obstacles.

Women in Engineering in Zimbabwe

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SUMMARY

Very few women are engaged in engineering in Zimbabwe due to educational restraints, traditional and cultural pressures, and absence of role models and lack of career information. Future action to educate more women in the profession includes organised career guidance, affirmative action and promotion of women in engineering.

BACKGROUND

Zimbabwe has a well developed industry and there is a great need for skilled people in the engineering trades including engineers, technicians and craftspeople. This paper is primarily concerned with engineers. At present there is a shortage of experienced engineers and expatriates are filling the gap as well as training Zimbabwean engineers. Those people employed in the engineering sector as technical staff are almost exclusively male. There are probably no more than 25 women engineers in Zimbabwe, including expatriates. Using the membership records for Zimbabwe Institution of Engineers (ZIE) as representative for the country, women comprise 1.5% of the total number of engineers and 0.6% of the total number of technicians [6]. These percentages (especially for technicians) may be slightly lower than the real situation since it appears that women engineers and technicians - working double shifts, one at work and one at home - avoid becoming involved in Institution work and this is reflected in the registration numbers.

Looking at the University Engineering Faculty and the technical/ scientific departments of the technical colleges, the percentages of women students enrolled are 1.4% (1989) [7] and 1.1% (1985) [5] respectively.

FACTORS AFFECTING RECRUITMENT OF WOMEN INTO ENGINEERING

The ratio of women to men at the University of Zimbabwe engineering faculty has not changed significantly in the last 7 years [7]. It is also interesting to note that although the number of girls attending high school (Form VI) has gone up since independence the percentage of girls has in fact decreased from 35.5% in 1979 to 24.2% in 1986

[3]. This does not bode well for the future involvement of women in engineering. The overall pass rate for 2 or more 'A' levels in 1987 was 49.4% for girls and 44.9% for boys [3]. However, considering

(a) The overall 3:1 ratio of boys to girls

(b) The fact that maths and science subjects are favoured by boys more than by girls and

(c) The fact that entry to an engineering department requires 3 'A' levels

Few girls will attempt an engineering degree course.

The massive expansion of the education system since independence and the vastly increased enrolment (of both boys and girls) has caused a drastic shortage of teachers and lack of basic equipment, books, stationery, library facilities and so on [4].

This especially affects the rural areas. Few rural children, particularly girls, attend university. There are several reasons for this. For a rural family with little spending capacity it is a major financial undertaking to send a child through an expensive secondary education. The family would most certainly favour the son. (Form VI fees for the cheapest high density area school in Harare are Z$75 per term and Z$315 for the examinations [8]. In comparison the minimum wage is Z$150 per month for waged workers; a peasant family's monthly income may be far less.) Furthermore many men have migrated to the cities leaving the women in the rural areas with an even greater work load. Traditionally women are responsible for all domestic work, child care, tending of gardens, taking maize for grinding, fetching water, cultivation of "women's crops" (for domestic consumption and bartering), obtaining wood for fuel, grinding by hand peanuts and cereal crops other than maize, keeping chickens, weeding and shelling of "men's crops" (cash crops) and - in the absence of men - herding cattle, taking cattle to weekly dips, guarding crops against baboons and undertaking all agricultural tasks and marketing. Rural women rely heavily on their children and especially their daughters for help, so even if a girl managed to stay on at school she would be severely hampered in her studies by the number of domestic duties expected of her [1].

Urban girls in the lower income families face much the same problem as rural girls. The family will always favour the sons with regard to secondary school. Those girls who do study at secondary level have to undertake domestic chores which the boys would never be asked to do. This again favours the boys' studies.

As the educational level and occupational status of the parents increase so too does the proportion of their daughters entering higher education [3J. Generally, female students have better educated parents with higher status occupations than male students, showing that parents with higher incomes can afford to educate their daughters as well as their sons.

Engineering is a "hidden" profession in that the general public is not often exposed to engineers either in daily life or in the media. The popular idea of an engineer is a man in a boiler suit brandishing a spanner. This is the perception of most school children. When they do come into contact with the engineering profession it is almost inevitably through male engineers, role models with whom the girls do not identify.

Career guidance is sporadic and in many schools completely absent

With regard to the engineering professions. Often the information about tertiary education entry requirements is given too late for the pupils to choose the right combination of subjects. In addition non-availability of teachers can deny children access to the necessary subjects. One example is a Harare high school which had no physics teachers for a year (and some of the Form VI pupils were taught English Literature instead) [8].

Most engineering students are sponsored through the university. Sponsorship! Can be a problem for women students. Women are expected to marry, have children and drop out of the job market. Therefore they are often seen as a bad investment. As one woman experienced: III needed a bursary to help finance my studies. This proved a major problem. I was invited to very few interviews and in retrospect I do not think I was taken seriously at the ones I attended. The interviewer's main worry seemed to be that I would not complete the course and if I did complete it I would immediately get married and stop working. Meanwhile the men in my class who received lower marks for' A' level and 1st year already had bursaries" [12].

Having embarked on an engineering education female students face different problems to those of their male counterparts. They generally have to prove themselves, while the men are expected to be "natural engineers". They often have family pressures that the male students do not experience. If they are single and living at home they are usually faced with domestic duties and if they are married they are expected to be responsible for the home [3].

This trend continues after graduation. At a "Women in Management" Seminar in Harare in 1989 [11] it was almost universally reported that the women - no matter what their job - were responsible for organising the home and bringing up the children. Even women, who felt that their husbands were very supportive of their career, told the same story. This was largely attributed to public attitudes. There is a strong feeling of what a "woman's job" is and men, however supportive, are not willing to assist for fear of ridicule – and presumably also because of the inconvenience. There is a great deal of pressure from the extended family for a couple to conform to traditional roles - home keeper and bread winner and it takes a strong man to withstand that pressure. One woman who studied in England together with her husband told her story: "We shared the housework. When I was away all day I'd come home in the evening to a cooked meal and clean children. We lived like equals for four years but within three months of returning home (to Zimbabwe) my husband's family had convinced him that he was degrading himself doing "women's work" - so children, home and all that goes with it was suddenly my responsibility, even though we were both working full time" [11].

Another problem experienced by married women at the conference was that of promotion which involves travelling. Many men are not prepared to allow their wives to travel without them in what could be construed as a morally compromising situation. As one woman put it: "My husband will not let me go away for conferences. He says that I cannot be with all those men there and that everybody will think that I am promiscuous. Heaven knows what he is up to when he goes away" [11].

FUTURE ACTION

Positive steps have to be taken to encourage women to take their place in the engineering world. Printed material and other visual

Aids for career guidance should portray women as well as men. Too often half hearted attempts to include women in the target group serve only to appease the conscience of the publishers while the publications are in fact giving out conflicting messages. An example is the existing ZIE Careers Guidance booklet [9] which states that "(Engineering) is a career which is equally suited to both men and women although in the past it was considered as a man's job" but nevertheless features men only in all the accompanying illustrations. An effort must be made to ensure that the engineering career advisory teams include women members whenever possible. Female role models need to be included in the public image of the engineer if there is to be a change in the present ratio of women to men in the profession.

The Zimbabwe Government has pledged its commitment to the promotion and advancement of women. This commitment partly manifests itself through the application of "Affirmative Action" within the Public Service. The Public Service Commission has agreed on a policy which is outlined in a Ministerial Statement [10]. In summary, the aim is for women to hold 30 percent of management positions in the Public Service. This goal is to be achieved through training and further education of women employees and - in the case of an equally qualified male and female candidate - by giving preference to the woman. While this goal of 30% women in management may be a long way off as far as the engineering sector is concerned it should serve to encourage women in this as well as other professions. Affirmative action can play an important role in the process of changing public opinion. As government policy, and thus applied in the public sector [13], it could be very effective. Also, with government being the main sponsor of students there is hope that more women will obtain sponsorship for engineering studies.

Traditions die hard and it is a slow process to introduce women into traditionally male professions. Eventually it is hoped that higher living standards will be attained which will enable women to be educated on an equal footing with men.

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Engineering Education and Job Opportunities for Women: Kenyan Experience and Views

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Kenya which now spends 34% of her GNP on education has in the past 27 years seen a steady increase in number of primary and high schools, colleges and universities. Girls constitute almost 50% of the enrolment in schools. Inspire of this noticeable trend an insignificant number opts for the engineering faculties. For example in 1980 the faculty in Nairobi had 3 names in the nominal roll of 235; in 1988 the number had increased to 22. By 1990 the engineering faculties will have 11 departments in mechanical, civil, electrical and electronics, surveying and photogrammetry agricultural engineering, and production and electrical technology.

The choice to enrol in the faculty starts with the selection of mathematics, physics and chemistry or mathematics and physical science at A’ level and normally at A’ level reading mathematics, physics and chemistry. From a sample of schools between 1980 and 1985 it was noted that compared to boys schools a relatively smaller number of girls schools offered the combination leading to entry requirements. For schools with facilities for teaching physics majority of the girls joined such faculties as medicine, agriculture, veterinary and science general.

Presented in the paper is the enrolment of women in the engineering faculties from 1980 to 1987 and subsequent relative performance. The professional training and experience in employment is based on a representative sample of women graduates: demands for graduates in industry is still high; only two women are members of the teaching staff; civil engineering tops in the list of women graduates who are registered; and agricultural engineering has no fully registered engineer.

Presented in generalized form are comments from teachers, career masters, education directors, parents, faculty members and industrialists. Generally, engineering and subsequent practices, are least understood. Metalworking generally "taken" to form the bulk of the engineering practice traditionally was confined to the blacksmith clan. Besides being a guarded secret from all other intruders, it was taboo for women to approach the workplace. The paper enumerates methods to popularize the subject among the girl students, career masters and parents.

Science Education for Women in Ghana

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SUMMARY

Science, technology and mathematics education is a common heritage of men and women alike, If science is to be a medium of change and development for all, special efforts must be made to encourage girls, who are sometimes left on the periphery, to study science.

The Ghana Education service and the Association of Women in Science and Technology in Ghana are reaching out to secondary school girls through In.'og1'ammes of Science Clinics and career guidance.

INTRODUCTION

Science has been described as “a shared heritage" of humanity [1], Most governments now accept that education plays the most important role for the rapid economic, social and intellectual development of a country. In the light of current trends in development, science education holds pride of place in the general framework of education. The 1965 Pug-wash Conference of Venice declared that “science education as an integral element in general education, like the skeleton within the human body, supports and gives form and power of movement to all else" [2]. for effective development, no country can afford to leave 50% of the population, the half that consists of women, out of the process of scientific, technological and mathematics education (STME) and application.

THE ROLE OF SCIENCE EDUCATION

If science is to fulfil the expectation that it is a medium of change and development, then a country's Science education programme must be planned to achieve the following broad aims.

1. To make learners appreciate, through its presentation, that science is a living and ever-changing subject of study.

2. To portray the beauty of science by showing the inter-play between experiment and theory, and to demonstrate the logical development of ideas and the link between facts and ideas.

3. To teach learners the basic principles and the laws of science through indoor laboratory experiments as well as outdoor nature activities. To encourage learners to observe and explain natural phenomena by systematic laws.

4. To inculcate an attitude of independent penetrating enquiry into learners' way of thinking.

5. To make learners aware of their social responsibility in the practical application of their knowledge to solve problems of the society.

6. To infuse into learners a sympathy with measurement methods, a careful approach to experimental accuracy, and the ability to communicate clearly.

If Women are to participate fully as agents and beneficiaries of development in a world which is constantly and increasingly changing in technology, then strategies must be developed to encourage more girls into science, technology and mathematics education (SMTE). The scenario in Ghana, according to available statistics shows a low participation of women in Science and Technology. (see Table :1)

PAST SCENARIO

Available records indicate that in most of the early schools in Ghana, girls were taught the basic home crafts cookery and housekeeping in preparation for the expected role they would play in society as keepers of happy homes, wives and mothers of contented husbands and children. It was believed that the pursuit of scientific studies in school would only lead to outside jobs that might encourage women to abandon -their traditional roles.

PRESENT SCENARIO

In recent years, special efforts have been made by the educational authorities in Ghana, to address the imbalance of girls to boys ratio in science [4, 5]. School and University intakes still show very small proportions of female to male in the pure and applied sciences. There is a myth that boys perform better Mathematics and Science than girls. Unsupported by any

TABLE 1A: GIRLS' REPRESSENTATION IN SCIENCE IN GHANAIAN SECONDARY SCHOOLS
REF: WEST AFERICAN EXAMINATIONS COUNCIL DATA, 1986/87

FEMALE PARTICIPTION IN SCIENCE IN GHANA UNING 1987 MAY / JUNE W.A.E.C.

G.C.E. 'O' LEVEL RESULTS

TOTAL SAT		ENG. LANG.	MATHS	ADD MATHS	PHYSICS	CHEMISTRY	BIOLOGY	GENERAL SCIENCE	ADD GEN SCIENCE	HEALTH SCIENCE	AGRIC SCIENCE
30116	TOTAL	28936	27394	5922	5569	5380	8371	4801	378	4512	1185
	BOYS (%)	70.9	78.6	88.1	89.1	87.2	74.3	54.7	82.8	53.2	77.7
	GIRLS (%)	29.1	21.4	11.9	10.9	12.8	25.7	45.3	17.2	46.8	22.3

NOTE: ADD MATHS Comprise Add Modern Maths and Add Traditional Maths

TABLE 1B: FEAMLE PARTICIPATION IN SCIENCE AND MATHEMATICS USING 1986 AND 1987 MAY / JUNE W.A.E.C. G.C.E. 'A' LEVEL **FIGURES**

SUBJECT	1986 NO.OF STUDENTS	BOYS (%)	GIRLS (%)	1987 NO.OF STUDENTS	BOYS (%)	GIRLS (%)
MATHEMATICS	2476	95.2	4.8	2180	95.2	4.8
PHYSICS	3133	89.9	10.1	3241	88.8	11.2
CHEMISTRY	3201	89.4	10.6	3301	88.6	11.4
BIOLOGY	1280	81.2	18.8	1627	82.6	17.4

Facts arid figures, this myth has been accepted by many people, including women and girls. However, our studies on the examination results of three categories of schools

A Single-sex girls' schools
B Single-sex boys' schools
C Mixed schools
Seem to indicate that girls' performance in Mathematics is at par with that of buy:", [6] .

Through the institution of Science Clinics for girls, the Ghana Education Service has started a process of motivating more girls into science by exposing them to women in science, lectures and practical demonstrations and on-hand activities. The Association, of Women in Science and Technology in Ghana (WIST) has a programme of career guidance to schools on regional, district and local levels in order to reach as many school girls as possible.

FUTURE SCENARIO

With the introduction of a new educational structure in Ghana, whi8h alms at exposing all students to science, several girls have started secondary school courses pursuing subjects like Technical Drawing which were male preserves for a long time. These changes, and the efforts of WIST and the Ghana Education Service Clinics, should usher in a new era in which gender stereotyping in science education will be a thing of the past.

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Gender Differences in Communication in Engineering Classes in Nigeria

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The presentation is the outcome of investigations into the processes and styles of communication that exist in engineering classes in selected engineering schools in Nigeria, with the main purpose of identifying any gender differences and relating the same to observed differences in achievement.

The paper has the following outline. A brief report on women in engineering in Nigeria. A short review of literature on classroom interactions and the participation of girls in science and technology. A summary report of an investigation into the problems of communication in engineering classes. Discussion of results of an investigation in relation to the participation and achievement of girls in engineering in Nigeria. Suggestions for improving the communication skills of teachers of engineering to minimise gender inequalities in the profession.

Educating Modern Engineers: CAD Tools and Communication

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SUMMARY

Modern engineering education makes extensive use of Computer Aided Engineering (CAE) tools. The problems of graphical communication for visually handicapped students are discussed using two case studies. Alternative communication options are stressed. New opportunities are outlined for CAE graphical interfaces.

INTRODUCTION

Engineering design, manufacture and testing are central areas of engineering education and training for undergraduate students. Computer aided engineering software has since the early 1980's played a major role in assisting the design process. The benefits of using networked computers for information storage and analysis has been enhanced by recent advances in computer hardware, which has allowed the graphical entry and display of data.

At Exeter University students of the School of Engineering participate in wide range of engineering design activities. These cover the broad techniques for mechanical, electronic, civil and chemical engineering. A concurrent approach has formed the basis for many of the design tasks. The students work in groups when undertaking mini-projects, which are formulated to develop professional engineering skills.

The developing CAE programme has been adapted to the recently introduced modular course structure [1]. The students initially use entry level software for sketching activities. This leads to more complex CAD software for numerical analysis, 3D modelling and finite element analysis. An extensive range of electronic design software is introduced from schematic capture and circuit simulation leading through to printed circuit board and VLSI device layout.

The students are taught how to use the software and develop an understanding of the underlying features and limitations in its use. Wherever possible the latest. Professional software and computer systems are made available. However, even I with advanced engineering workstations or powerful PC platforms and software, there are still many areas for improvement when humans interact with machines in the design process, particularly for those engineers with any form of visual handicap.

COMMUNICATION WITH COMPUTERS

The development of engineering workstations has enabled CAE software to provide a more graphical communication environment. Particular features of these machines include the opportunity to use multiple windows to run several engineering operations at one time. In general the displays of workstations have offered a higher resolution than PC based computers. This level of resolution together with zooms and pan facilities enables the display of detailed circuit schematics and mechanical 2D drawings. The common feature of engineering design software is the use of a menu system, which although initially keyboard driven has evolved into the selection of menus and submenus (Figure 1), by moving a cursor via a mouse or graphics tablet. This combination of features with faster and more powerful machines has helped to improve the productivity of the modern engineer.

<table>
<tr><td colspan="2">Status Line</td><td></td></tr>
<tr><td>Pull
Down
Menu</td><td>Drawing Area
(Graphics)</td><td>Screen
Menu</td></tr>
<tr><td colspan="3">Command Prompt Area</td></tr>
</table>

Figure 1. Typical CAD Menu System

However problems remain with these versatile graphical interfaces for partially sighted students, particularly the:

- Small text size for menus and help information
- Small cursor size for object selection
- Thinness of lines for objects and route layouts

To overcome some of these problems, software requires to be customised for visually handicapped students. A less graphical form of inputting data would prove efficient for those students with limited vision. Recent experience with students of the School of Engineering provides examples of how visually impaired students can cope with the current CAE tools. The two case studies provide details of changes that were made to assist them in their engineering education.

The first engineering student, who graduated in 1988, had slight tunnel vision. To assist him in the general study process, normal A4 typed hand-outs in lectures were enlarged to A3 size for ease of reading.

During the CAD course he attended, where a range of interactive work with computers was necessary, the input of data files was possible by the selection of a larger character set on the engineering workstation. During the course the students worked in pairs on CAD projects. Hence for the 3D modelhng and Computer Aided Manufacture assignments he was assisted by his partner on some of the more visually demanding aspects.

This student successfully completed a final year electrical project using the engineering workstations to analyse the design of specialised transformer circuits. The analysis software SPICE could be manipulated by text file input and the simulation data displayed, plotted and enlarged. This facility to provide enlarged text on screen is thus invaluable for a student with a slight vision impairment and demonstrates the need to provide a range of options for controlling professional software.

The second engineering student, who graduated in 1990, had a more severe visual handicap having previously attended a special school. Her vision was limited but she was able to distinguish 1 inch size characters on paper or screen if they were in black and white. Hence difficulties were encountered with menus and help information display. However, prior to arriving at Exeter University, she had gained considerable skills in the use of braille. Sponsorship from GEC Marconi enabled the purchase of an electronic braille punch and an embossed paper copier for her use. In normal engineering studies she was able to produce reports using a standard keyboard and provide sketches using plastic film. Practical experiments were augmented by the use of a video camera system and monitor to assist the viewing of meters, oscilloscopes and printed circuit boards. Normal size text book print was enlarged using a microfiche reader.

The individual assignments of the CAE programme were modified to allow the use of text input to the graphical systems. The PC based computer aided drafting project, meant that co-ordinates of points could be typed and sketches enlarged on screen by a zoom facility. The main problem was the inability to change the size of the cursor for selection of entities on the screen. In the final year the student enrolled on the VLSI Design course, which used the engineering workstations. This required the creation of a special font set that she could view [2]. The schematic entry system for designs could be textural or graphical. Similarly the simulation output could be viewed in tabular form. There would have been problems in implementing manual layout routes for this student had that proved necessary, however the automatic chip layout tools of the system were successful in routing.

The final year project undertaken was the writing of PC based software for a teletext system. The student was sponsored for a new vision system by a special fund of the IEE upon advice from the RNIB. This provided enlarged text from text files and control of the text display on the screen. All the visual aids assisted the student to successfully complete the course. However, a link between scanned text to enlarged screen text and braille output would have made the transition smoother.

FUTURE COMMUNICATION TOOLS

The options for communication between humans and computers have improved over recent years. However as the two case studies have indicated, much can be done to increase facilities for inputting data and its display. New developments fall broadly into categories of software advances and hardware interface improvements.

CAE software is continually being modified to enable the modern engineer to become more productive. Developments of the interface towards a video user interface [3] will increase the ability to record and retrieve graphical data. However in the case of visually handicapped students, special facilities will be required. These include better control over the menu system to modify text size and the number of submenus. The graphical interface could be improved with the use of a modified cursor and thicker lines on-screen. Typed text could be scanned in to a system, recognised as a text file, with the resulting file translated into braille [4].

There are advances occurring in the hardware interface field. The use of adequate voice recognition [5] and adequate speech synthesis would make the data input and retrieval process more efficient for all engineers. The more recent developments of cyberspace systems [6], which use a stereoscopic display helmet with control from head movement or a special glove, may open up further opportunities to assist visually handicapped students in their careers as engineers.

CONCLUSIONS

The computer aided engineering programme at Exeter University has been recently modified to reflect new course structures and adapted to meet the needs of particular students. This environment requires the assessment of new software and hardware advances as they become commercially available. The needs of two visually handicapped students were accommodated and their engineering experience widened by the use of modified CAE software and special hardware.

However the experience of these students indicates areas that need further attention. These include better control of text size, cursors and size of lines in the graphical interface. Alternative options provided by newer advances in software and hardware interfaces, including less visual input control, may pave the way for the communication of engineering ideas and the training of students for the world of modern engineering.

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Biomedical Engineering Education

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Biomedical engineering progress has over the past 100 years provided the technology required for successful diagnosis and treatment of diseases, surgery, and treatment for physical disabilities - in short, providing a better life for many who otherwise may not have even survived. It seems that only recently, however, have engineers been specifically trained for the biomedical discipline of engineering.

In this paper, an exploration of biomedical advances of the past, present, and future will be synopsed with the technological ramifications of future generations of biomedical engineers. A brief synopsis of biomedical education available in the united states, but emphasizing the state of Texas at a graduate level and possible programs stressing the importance of science education at pre-collegiate levels.

A survey of biomedical engineering majors at SMU will be reviewed in relation to these other topics discussed above.

Tracking the Gender Barrier Through Declining Interest in Technology

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SUMMARY

Female enrolments of under 20% are typical of many undergraduate programmes in Canadian engineering schools. This limit has been attributed to a gender barrier. The subject choices of over 13000 children in enrichment mini-university courses and summer camps are examined. The participation rate of girls in technological subjects such as engineering shows the gender barrier becomes a significant factor as early as age nine.

INTRODUCTION

There is general agreement that efforts should be made to attract more women into engineering[l]. Unfortunately, female enrolments of only 10 to 20% are typical of Canadian engineering schools although in some programmes the numbers are higher. The 10 to 20% limit has been attributed to a gender barrier. Certainly, an examination of children's perceptions of their future found that gender was the most significant variable in determining their responses [2].

The objective of this research was to identify the age at which the gender barrier seriously affects young women.

METHOD

The principal source of data was the Enrichment Mini-Courses Programme for bright and highly-motivated students from ages 13 to 18[3]. During the 1982 to 1990 period, 163 mini-courses involving 6250 students were offered at Carleton University. The gender and age of the students in each course were obtained. The courses were categorized into 4 content areas: arts, social sciences, science and engineering. The engineering category included technologically-based disciplines such as architecture, industrial design and computer programming. In all cases the participants had a free choice of subject area.

Additional data for 6967 children between 9 and 15 years of age were obtained from 4 university sites, each in a different province. Carleton University, University of Calgary, University of Manitoba and Simon Fraser University run children's summer camps which combine athletic and academic modules. Data were obtained for the period covering 1987 to 1990. Some sites provided data for only a portion of this period. Gender and age, where available, were obtained for each of the sites. The children chose academic modules with 4 or 5 components. The engineering content ranged from 0 to 50%.

SPSSX[4], was used to analyse the age, course content and gender data for the mini-courses and children's camps.

RESULTS

In the mini-courses, a chi-squared test showed a significant effect of content area on gender ratio. The ratios of enrolment differed across content areas with engineering having the lowest female enrolment. The overall percentage of female students enrolled in all mini-courses was 50.5%. Arts had a female enrolment of 62.9% and social sciences had a female enrolment of 60.2%. Science and engineering had significantly lower female enrolments of 38.5% and 20.2% respectively. Although this study is directed at engineering, the low female enrolment in science should also be a concern. Figure 1 shows the gender ratio by content area for age 13. The same pattern was found at every age level examined.

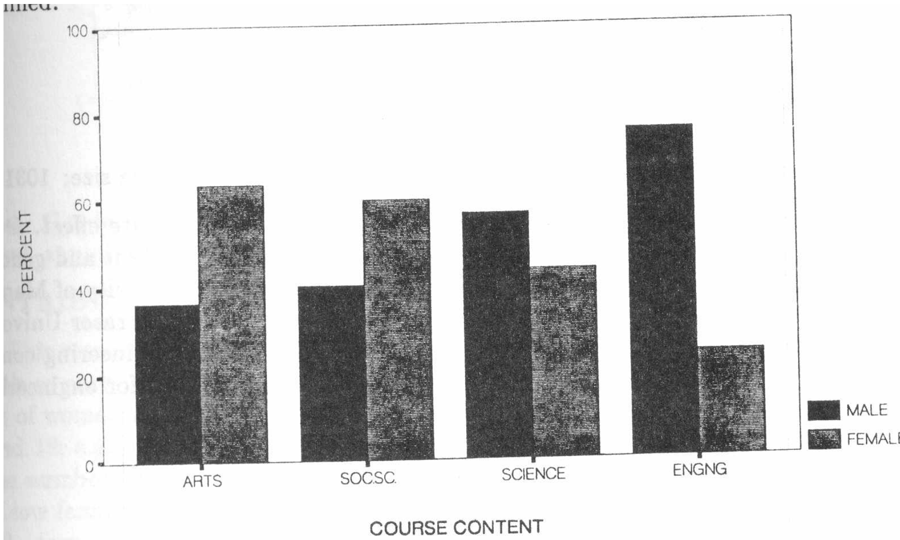

Fig. 1 Gender ratio for mini-course enrolment for age 13, sample size: 2087.

Surprisingly, age had no significant effect on gender ratio in any of the content areas. This is of particular importance in engineering where female enrolment was as low as 24.3% at age 13. Figure 2 shows the gender ratios for engineering. Although there is a slight downward trend with increasing age, there is no significant change. The gender barrier, in terms of the enrichment mini-courses, is in existence by age 13.

The data from the children's camps were less easily analysed due to their diverse nature. For example, ages were available only from Carleton and Manitoba. There was a marked variability among the sites and the low student numbers in some modules made interpretation more difficult. It should also be noted that the students' selection of courses was more limited than in the mini-courses. Parental guidance, which can contribute to a gender barrier, may playa larger role in the students' choices, especially for the younger children.

Fig. 2 Gender ratio for mini-courses enrolment in engineering, sample size: 1031.

A chi-squared test on the overall gender ratio showed a significant site effect. Over the entire age range of 9 to 15 the relationship between engineering content and gender ratio, as shown in Figure 3, was significant at Carleton University, University of Manitoba and University of Calgary but, for unknown reasons, not at Simon Fraser University. Carleton and Calgary show a monotonic decline with increasing engineering content. At Manitoba, where the sample size is larger, the decline occurred for engineering contents between 20 and 40%.

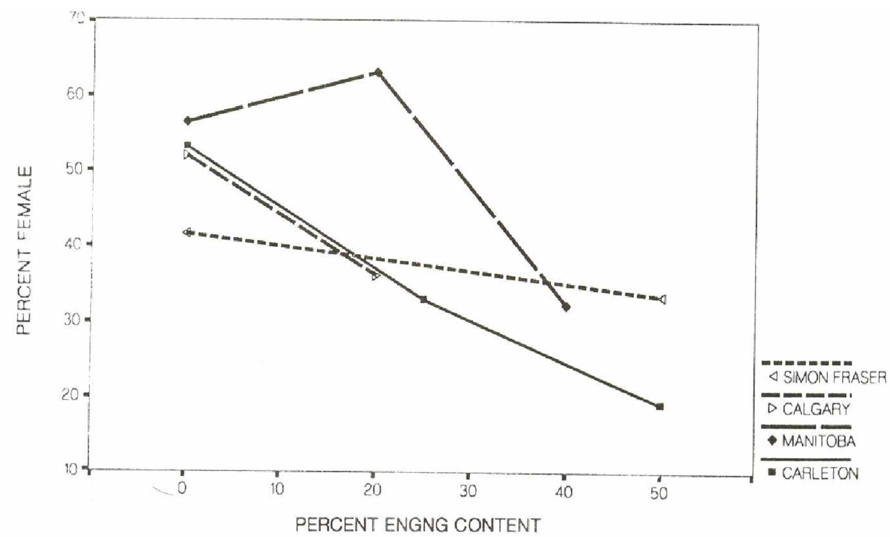

Fig. 3 Female enrolment at children's camps, sample size: 6967.

Although low number of students, only 387, may make the data inconclusive, Carleton's camps show a significant engineering content effect at ages 11 and 12. The larger sample size at University of Manitoba made it possible to examine the age effect at that site. The effect of engineering content was significant at every age level. In Figure 5 the percentage female enrolment for an engineering content of 40% is shown. Although there is a slight increase at ages 13 and 14, female enrolment is as low as 30% as early as age 9.

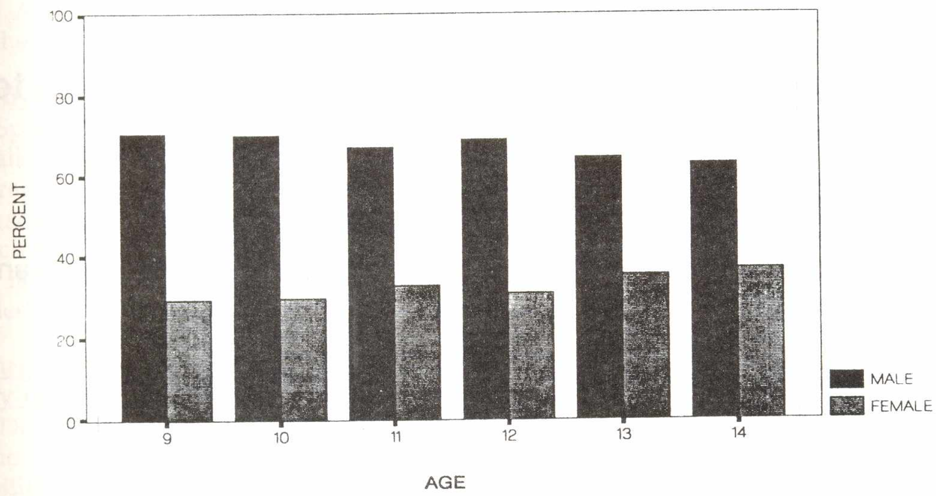

Fig. 4 Gender ratio for University of Manitoba children's camp for 40% engineering content, sample size: 758.

CONTRIBUTIONS AND CONCLUSIONS

This research shows that the gender barrier becomes a significant factor in the lives of girls as early as age 9 and is firmly in place by age 13. Efforts to address low enrolment of women in subjects such as engineering often target women between the ages of 16 and 18;e.g., [5]. The authors feel that programmes aimed at these women may add to the numbers in engineering at the expense of the science subjects, which also suffer from low female enrollment. Clearly, to increase the number of women in technologically based programmes, society must remove a gender barrier that affects girls in their early school years. It is the authors' opinion that programmes to alleviate this gender barrier should be geared to the needs of children younger than age nine.

ACKNOWLEDGEMENTS

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The Marie Curie Society - Encouraging Women to Enter Scientific Careers.

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SUMMARY

The Marie Curie Society has been set up by graduate women in the Department of Chemistry at Cambridge University. Its aim is to provide a communication link between our members and professional women scientists. A description of the work of the society and its meetings is followed by the results of a survey carried out to ascertain the information which women post-graduates would like on careers in science.

INTRODUCTION

The recent report by the Hansard Society [1] entitled "Women at the Top" has shown that women are under-represented at the higher levels of Science and Engineering. One reason is that women are trained as scientists but then fail to choose scientific careers. A departmental society can playa role in reversing this trend by encouraging links between women scientists and women graduates.

The Marie Curie Society was founded in September 1989 in response to the perceived wishes of the female post-graduate students in the Chemistry Department at Cambridge University. Its aims are two-fold; the encouragement of greater social links within the department and the dissemination of information of particular relevance to women chemists; it is not designed to be a pressure-group.

Membership is open to all women graduate members of the Chemistry Department. This includes PhD students, post-doctoral workers and members of the academic staff. In addition, women graduates working in professional chemistry or related fields are also eligible to become members. There are approximately ten meetings a year, alternating speaker and social meetings as appropriate. Although relatively informal, the society has a well-defined structure. It has a written constitution and there are three executive positions (President, Treasurer and Secretary) and others (Publicity, Social Secretary etc.) which have a twelve-month tenure. However the Committee encourages all members to participate in the running of the society, more formally at the AGM at which a quorum of 20 % of the members is required. FundiI1g via subscriptions from members is considered inappropriate. The department, which pays for all speakers' travelling costs, allocated £100 as a start-up

Grant. Additional funding has come from industrial sponsorship and donations from the Cambridge University Chemical Society.

MEETINGS

Speaker meetings have a mostly informative function. People are invited to give talks on issues which affect a member as future professional chemists- the encouragement of more women to enter the profession is implicit within the aims of the society. Moreover eminent women scientists are invited to speak on their research interests in recognition of the effect of role models on junior scientists. Below is a summary of some of the speaker meetings organised by the society. It is included to demonstrate the variety of information that is communicated.

Dr Margaret Farago "The Work of the Women Chemists Committee of the Royal Society of Chemistry"

Dr Farago explained that the crucial time for professional women chemists and their career prospects seemed to be if or when they choose to have a family. Flexibility at the workplace in terms of creches, job sharing schemes, flexitime and maternity leave were often found to be woefully inadequate. She also described the role of the Women Chemists Committee of the RSC. One of their objectives is to pressurise employers on the issue of career breaks for women having families and to disseminate information about the employers who can provide the best facilities.

Professor Dorothy Hodgkin "Beginnings"

Over a hundred people came to hear the Nobel Laureate, Professor Hodgkin's talk. She described work that she carried out in Cambridge in 1932-34 in collaboration with J. D. Bernal. The research involved x-ray crystallography on a number of interesting compounds, which included penicillin and vitamin B12, work which culminated in her receiving the Nobel Prize for Chemistry in 1964. It was particularly interesting to glimpse what it was like to be a chemist, and indeed a woman, working under conditions very different from those today.

Dr Mary Archer "Life After Chemistry"

Dr Archer described her transition from academic chemist to businesswoman. She gave a fascinating insight into the worlds of television, radio and city insurance. Of particular interest was her assessment of the benefits and indeed disadvantages that had accrued from her experiences as a chemist. However Dr Archer explained that a major regret of her current work in finance and entertainment was that there was rarely enough time to study the topic of the moment in depth.

Ms Yvonne Brill "A Woman Chemist makes it to Outer Space"

Ms. Brill gave an entertaining description of her career. She had some fascinating insights to give into the world of space technology, and the role that chemistry can and does way there. Ms. Brill was involved in the space program during its infancy including the introduction of hydrazine as a rocket fuel. She has worked for NASA, RCA and has been a Space Consultant, also finding time to a bring up a family.

Dr. Joan Mason "The Thin End of the Wedge: Women in Science

Dr Mason related some of the more entertaining stories arising from her research into the history of women in science. She discussed both the difficulties of women to be accepted in the Royal Society, Royal Society of Chemistry and also the University of Cambridge, the last university in Britain to admit women to degrees.

Professor Daphne Jackson "The Retaining and Retraining of Women Scientists"

The late Professor Jackson gave an invaluable talk on her successful fellowship scheme for the retaining and retraining of women scientists. She described the difficulties encountered by women when they want to take time off to have a family and explained how the scheme encourages universities and industry to take on women who have been retrained.

Ms Nina Hall "From Chemistry to Journalism"

Ms Hall gave a brief introduction to her career, from a degree in Chemistry, to being an editor for New Scientist. This was followed by an outline of an average week in the life of a science journalist, the deadlines that have to be met and the people involved. She also provided information for those interested in taking up scientific journalism as a career.

THE SURVEY

A survey of eligible members was carried out in the department in order to ascertain whether the society was meeting the needs of its members and in order to generate new ideas. Of a total of 75 to whom questionnaires were send, 20 replies were received. Whether this relatively small number is due to a lack of interest in the society, apathy or work commitment is unknown. All those who replied felt that the society was beneficial. Some of the comments included:

"Keeping women in science, and attracting more women to science are going to become more important not less, given the increasing lack of suitably qualified people. The Marie Curie Society at least plays a small part in smoothing the way forward. "

"I think it benefits all scientists to learn more about our role in society; the sensitizing of men to women' s' issues in science."

Many women enjoyed having a forum where issues relating to women in science could be discussed. It was also felt that the society had provided an outlet for speakers who would otherwise not be given an opportunity to speak on these issues. Most respondents liked the format of the meetings. It was felt that they were constructive and at the same time friendly and relaxed. Since all speaker meetings are open to women and men, this helps to keep the talks at a level where they were informative but not exclusive. Many of the men attending felt that they benefited too.

The survey also asked respondents to comment on the aims of the society. Most agreed that the general ethos was essentially correct. The majority felt that the providing of information and role-models were the most important aspects of the society. Some of the comments which arose were:

"The aims of the society should be to give talks related to the role of women in science, and to bring the female community together."

"To encourage and promote the continuation of women in a scientific career: Discovering reasons for the current fall-off and communicating the information obtained where a successful career has been maintained."

The final question asked, was for ideas for future events or information that could be obtained and distributed. It was suggested that future speaker meetings could examine the role of women scientists in other countries. Other contributions included inviting personnel officers of major chemical companies to speak about how they recruit and retain women scientists. Also scientists from other disciplines could be invited; to date mainly women chemists have been invited to speak. There was also a request for panel-led discussions, debates, and "how-to" meetings on a variety of topics including making presentations, interview technique and finding child care. More information on career breaks, child care, maternity leave and job-sharing in various companies was requested

THE FUTURE

It seems clear from the result of the survey that the prime role of the society is to provide career-related information of relevance its members. Another committee post, that of Information Officer, whose main role will be to collect material to be stored in the Departmental Library, will therefore be created. The society is gradually acquiring a library of relevant literature for the general use of all members. These have taken the form of information packs from industry, the Women's Committee of the Royal Society of Chemistry, newspaper articles and books. Links have already been established with Cambridge University Careers Service and national societies such as WHEN (Women in Higher Education Network.) It is hoped that further contacts can be made with other scientific departments within the university and with industry.

The structure of some speaker meetings will also be adapted to involve more skills-based seminars, in liaison with the Cambridge University Careers Service. Personnel officers from major chemical companies will be invited to talk about returner schemes and child-care provision, subjects which the survey showed to be most important to the members. It is considered that there should be fewer social meetings arranged, since they tend to be less successful than speaker meetings. They will, moreover, be geared towards specific events such as the Christmas party or the introductory cheese-and-wine

CONCLUSION

It is both vague and difficult to define the success of the general aims of the society let alone measure them, but we feel that it is well on the way to achieving them. The society has provided a chance for women graduates to have some idea of what faces them during a scientific career and have been shown that it is possible to achieve success at all levels and-often in conjunction with bring up children. Equipped with this kind of information, it is hoped that women will take up the challenge of a career in science.

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Women into Engineering Recruitment to the Profession

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SUMMARY

This paper describes initiatives supported by the School of Engineering Information Technology at Sheffield City Polytechnic to stimulate women's' interest in the engineering profession. It highlights work done on engineering taster courses with examples of practical sessions. Feedback from a recent survey of course participants is also presented.

INTRODUCTION

Efforts to encourage young women to consider an engineering career start early at Sheffield City Polytechnic. The School of Engineering Information Technology attracts interest first by means of technology appreciation courses for local 12-13 year old girls, then fosters their interest and enthusiasm by a weekly Young Engineers Club.

For 16-19 year olds and mature returners, a residential engineering taster course is run each summer. These attract young women from all over the country. Run in partnership with local industry they give an insight into the variety of challenges offered by an engineering career. Practising women engineers and current students provide role models and can advise on alternative career routes. Response to a recent survey of past course participants has been overwhelmingly positive. Many commented that the course had been the "deciding factor" in their choice of Higher Education course. This has encouraged the continuing development of work in this field.

RANGE OF INITIATIVES

- **"What is Technology Anyway?"** a 3-day non-residential course for local 12-13 year old girls has been run for the last 4 years. It is designed to help girls find out more about computing, engineering and information technology. It challenges the myth that technology is not for girls and introduces them to possible careers in technology before they choose their GCSE subjects. The most recent course took thirty girls from eight Sheffield Schools. They worked on projects using computers and engineering equipment, visited the local Science Park, and talked with women studying technology and working in science, engineering and computing.
- **Young Engineers Club**, a weekly club for girls started in January 1990, and is based in the SCEPTRE (Sheffield Centre for Product Development and Technology Resources) workshop in the local Science Park. This makes use of Polytechnic engineering facilities to concentrate on longer term practical project work. The girls' projects are wide ranging, they include stripping down and re-building a mini-tractor, building electronic kits (such as sound-effect and

Flashing tri-colour LED circuits) and constructing model bridges and wind powered vehicles. Three members of the club took one of their projects to exhibit at a national celebration of Britains Young Engineers at Gatwick Airport in July 1990.

- **Access conversion courses** have operated since 1987 for both male and female students without suitable maths/physics qualifications. These now form a full-time foundation year for nine of the Polytechnics' degree courses.
- **Recruitment of women technology lecturers:** still a very small, but increasing, proportion of our technology lecturers are female.
- **Engineering taster courses** Sheffield t s week long residential courses for women only have operated since 1984. These have targeted both 16-19 year olds and mature returners, informing and influencing their career choices. They are run in partnership with the EITB (Engineering Industry Training Board) and have the active support of local industry. These courses have proved singularly successful, and a more detailed outline is given below.

ENGINEERING TASTER COURSES

Work first started on WISE (Women Into Science and Engineering) courses in 1984, with the addition of EITB supported HILIGHT and INSIGHT courses in 1989 and 1990 respectively. Since these were over-subscribed, several one-day events were added for unsuccessful applicants. The basic format includes:

(a) Introductory sessions giving a broad overview of the different branches of engineering, and range of work done by professional engineers.

(b) Practical work tackling a variety of engineering projects to give hands-on experience. Examples include build and test of electronic circuit kits, circuit simulation on Apollo workstations, 3D logo design and manufacture using CAD/CAM equipment, fibre optic splice and test and set up of a variety of communications links. The fields explored embrace electronic, communications, control, production, metals and materials, civil and mechanical engineering, with the more recent addition of engineering physics.

(c) A day spent in local industry giving a taste of life as a practising engineer. A range of engineering functions have been experienced in, amongst others, the local steel, chemical, manufacturing, electronics, instrumentation and control industries. This shows day to day application of engineering principles and the different roles of engineers. Several local firms sponsor course participants, and offer further work shadow opportunities as well as sponsorships of Higher Education courses.

(d) Advice and discussion sessions with practising engineers and female engineering students, covering career opportunities, qualifications required, courses and sponsorship/scholarships available.

Further details of the electronic and communications hands-on sessions are given below as examples of the introductory engineering project work used.

ELECTRONIC PROJECT CONSTRUCTION AND TEST

The time allocated to this activity is approximately two and a half hours. Each person is given a project pack, containing a circuit diagram, electronic components, and a printed circuit board (PCB). The circuit is first built on breadboard to ensure it works correctly, and when this has been satisfactorily completed, the circuit is soldered onto the PCB.

The aim of the session is to give an insight into how circuits are traditionally designed and tested, before being manufactured into a PCB.

In the early years of the course, the circuits were soldered onto sripboard, a time consuming and error prone process. With the availability of a low cost PCB service within the School, it became much easier to build a circuit that worked first time. It was also possible to give a demonstration of a PCB manufacturing process, to show how circuits are produced in an industrial environment.

TEST AND SIMULATION OF ELECTRONIC CIRUITS

This activity also *takes* approximately two and a half hours, and is split into three distinct parts:

(i) The student spends approximately one hour building an amplifier circuit on a breadboard. A power supply, signal generator and oscilloscope are attached, and the participants monitor the input and the corresponding output, then calculate the amplifier gain. They are encouraged to produce a graph of gain versus frequency, and the term frequency response is explained.
(ii) A demonstration is then given of an IEEE-488 test system. This system essentially does the same tests as the student, but instead of a dozen dots on the graph, it produces 200 readings. A computer controls the power supply, signal generator, and multi meter, with an oscilloscope displaying the input and output signals. The computer then takes the readings and produces a graph on screen, with the option of sending the results to a plotter, also connected to the IEEE-488 interface.
(iii) Finally, the participants are introduced to the Apollo workstation and the concept of analogue circuit simulation using SPICE. They use a schematic capture package, CASS, to enter their circuit and its component attributes, and SPICE to run the simulation. The results can be shown graphically. The simulation output is compared to that of the actual circuit, and it can be seen that the correlation is very close. There is time for a discussion session afterwards, to explain the benefits of computer simulation.

COMMUNICATIONS

This session is also given approximately two and a half hours. Demonstrations are set up which can be experimented with showing:
(i) An audio and video fibre optic link from a microphone and video camera to a TV monitor. This uses SWFM (square wave frequency modulation) to transmit a signal along 1 kilometre of fibre. Additional inputs and displays are available for investigation.
(ii) A similar link (with the same end points) but using FM microwave transmitter and receiver dish antennae. This system demonstrates microwave transmission with a potential 10 mile range. The same receiver is shown to pick up signals from satellite television stations; another is used for geostationary weather satellites.
(iii) Computer communications and interfacing are demonstrated using a pulse code modulated (PCM) transmitter and receiver to send data along coaxial cable. A 20 mA current loop is used to demonstrate a common industry standard interface.

COURSE APPRAISAL

Using feedback gained informally and from questionnaire responses at the end of each course, the activities have been modified to meet the perceived needs of participants. For example, a choice of type of engineering firm they visit (instead of a random selection) was introduced, and a presentation session was added for participants to share their own industrial experience with the others - an opportunity to input to the course. The presentation session also allowed better assessment of the success of the industrial visits. In addition, to reflect the increasing use of computer workstations in engineering, more time has-been allocated to computing, since this is a style of work that engineers of all disciplines will have to become more familiar with.

Further feedback has been gleaned from a recent survey of 1984-1989 course participants. The courses were originally designed to stimulate women's interest in an engineering career - feedback from the survey revealed some additional benefits. As a bonus the courses have given participants the confidence that the full range of options is 'open to them, and given a preview of Higher Education life. Quoting from some responses to the recent survey:

"When I was on the course I was doing a YTS in Fabrication and Welding. The course made me realise I could do better and go further. I am now doing a full time apprenticeship at Pilkington's p1c, with the chance of sponsorship at University if I wanted! "

And another:

"I thought the format of the course I attended was excellent and helped me make a positive decision to study engineering."

The courses did not over-glamorise the engineering profession, seeking rather to give a realistic taster and allow participants to make informed choices - quoting again:

"The course was very interesting, informative and enjoyable, but I decided that engineering was not for me!"

From the survey results, there seems to have been a good take-up rate. Of 88 replies, 43 have embarked on a career in engineering, and a further 20 have chosen pure or applied science or maths courses. However, it is difficult to determine if the participants would have entered engineering in any case.

Although our courses focused on particular branches of engineering, the participants' choices span the full spectrum of options. Several said that they had gone on to engineering summer jobs or work shadow schemes to find out more. Nine mentioned that they had gained sponsorships for their Higher Education courses.

CONCLUSIONS

As outlined above, a range of activities have been developed over the past seven years. The developments' increasing momentum is due, in part, to the enthusiastic response of participants. Feedback has been overwhelmingly positive. Although it is difficult to measure a positive outcome for Sheffield City Polytechnic in particular, it is believed to be beneficial to the professions' recruitment of women engineers. This has encouraged our continuing development of work in this field.

Facilitating Girls and Women's Access to Engineering: A Case Study in Higher Education

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There has been considerable interest in the UK in attracting women into and and back into the workforce generally and into engineering and computing in particular. Unlike the earlier WISE 84 initiative, there appears to be a government strategy to encourage women into HE (and FE), through widening access and for women returners to update their skills. Reasons for this are suggested and responses by government, industry, professional bodies, educational institutions and voluntary bodies which can be traced from the end of the 1970s, are outlined and their responses (and, in some cases, inconsistencies) highlighted.

A case study of the Faculty of Design and Technology, Lancashire Polytechnic, is then described. The Faculty has developed a strategy that has grown out of and now reinforces the Polytechnic's institution-wide policies (its Mission Statement, which is dedicated to widening access, equal opportunities in employment, the use of language and equal opportunities in academic affairs, eg curriculum development, delivery and assessment). The strategy also draws on the experience of earlier research and initiatives and incorporates action research including a project investigating Asian women and girls' access to technology. The experience gained from the various initiatives is, described and ways forward are suggested.

BS1

Inter-Species Communication

Dervilla M. X. Donnelly and Fionnuala M. Walsh

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The use of pesticides has proved a major failure in the control of insect pests. The problems include the inducement of secondary pest species, pesticide addition and, not least, the severe harm to non-target insect species and the environment. Various aspects of insect behaviour are exploited for control purposes, for example, feeding behaviour which is exemplified in the complex relationship between the pine shoot moth (Rhyacionia buoliana) and the host plant, the lodgepole pine (Pinus contorta), an understanding of which should provide the long term solution to the problem. Preliminary host preference research has indicated a variation in susceptibility to R. buoliana between the coastal and inland provenances of P.contorta. The role of the photochemical in the host plant to the pine shoot moth will be described.

Inter - species Communication

Dervilla M.X. Donnelly, Mary T. Dunne and Fionnuala M. Walsh

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SUMMARY

Preferential attack by Rhyacionia buoliana on the Coastal rather than the Inland provenance of Pinus contorta was observed. Two larva attractants, 19-succinyl-epitorulosol and its methyl ether, were found in the Coastal buds as well as a notablely low concentration of 3-carene and neoabietic acid. The aggregation pheromone was identified as (E)-9-dodecenyl acetate and was synthesised from (Z)-9-octadecanoic acid.

INTRODUCTION

Man has a rich and varied ecosystem of informal scientific communication. It has developed through Universities, Research Institutes, Academies, learned Societies, besides personal patronage and Networking through various channels - data links, electronic mail etc. - linking scientists working on similar problems in related fields. This informal communication system is complimentary to the formal system of papers published in refereed journals.

The importance of person-to-person communication in the scholarly community is without question. Scientists however communicate by a formal language which often divides them from those persons responsible for national and international policy, and this result on occasions in generating a mistrust. The media of communication try hard to educate the public and depend on the scientists to act as advisors. Therefore one must give thought to the nature of the ideas communicated; the means of communicating ideas and the modes of communication.

The common mode of communication for scientists is audio-visual whilst the communication system of plants and insects is based mainly on chemical signals - the chemical language of nature. Chemical agents are of major significance in the adoption of species and organisation of communities. Chemical ecology, has in recent years expanded and the study of allelochememic interactions have shown how chemical compounds from one species affect the growth, behaviour or population biology of organisms of another species [plant-plant interactions, plant-insect interactions, plant-animal interactions].

Volatile chemicals that act as messangers between members of a species are termed pheromones. The pheromones are secreted outside the body and act to regulate the external environment by influencing other individuals. The behavioural responses are varied and categories of pheromones are recognised

E.g. stimulatory, signalling a pathway or presence of an individual (aggregation, reproduction); inhibitory pheromones which are concerned with defence and protection

Flowers on the other hand offer colour, perfume, pollen and sometimes they seem to offer sex itself. For example orchids of the genus Ophrys are almost exclusively pollinated by bees and wasps: It is the males which are attracted and excited by a combination of olfactory, tactile and visual stimuli from the flower. These signals release sexual behaviour in the males so they try to copulate with the flower labellum. Floral sex is a proxy affair.

The potential use of chemicals in communication is for exploitation as biological control agents. The use of repellant secondary metabolites as antifeedants might be especially advantageous. In principle, the pest could be controlled by starvation. Secondary metabolites of the terpenoid group have been demonstrated to act as allelochemics.

The interaction between phytophagus insects and their host plants is well documented. In terms of evolutionary history this interaction is relatively recent. Fossil evidence for herbivory was first recorded from the early Permian. Plant evolution therefore preceeded this major interaction by about 70M years. The complexity of the relationship of insect and host is well demonstrated in the pine aphid Cinara pinea (Mordr.). and its host plant Pinus sylvestris. Seasonal changes within the tree influenced growth, development, reproduction and mortality of the aphid. Host induced changes were the dominant factor (other than predation) in limiting population growth in the C. pinea. **It** was Fraenkel (1959) who formally attributed host selection by insects to the presence or absence of repellants and attractants in plants which were otherwise of uniform food value.

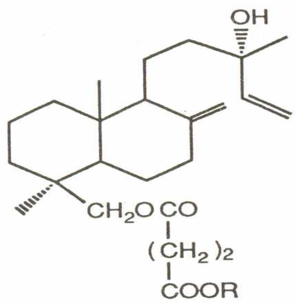
HOST INSECT INTERACTIONS - PINE SHOOT MOTH/LODGEPOLE PINE

The European Pine Shoot Moth (Rhyacionia buoliana) is a major pest of pine in Ireland, the most severe injury occurring to Pinus contorta (Lodgepole pine).

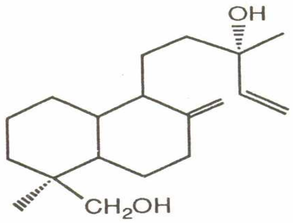
Preliminary host preference studies indicated a variation in susceptibility to R. buoliana between the Coastal and Inland provenances of pine. The moth showed a preference for the Coastal provenance, laying her eggs on the bark of the tree. Previous researchers [1] subjected the leaf oil terpene composition of P. contorta to chemosystematic studies in order to distinguish between Coastal and Inland provenances. The Coastal provenence was characterised by more than 50% β -phellandrene, 2-3% β -phenandrene, <10% β -pinene and < 1 % camphene. In contrast the Inland contained 15-45% β -pinene and <50% p-phellandrene. We report comparable results but observed 20% β-pinene in the coastal sample. The most notable difference in the bud analyses was the absence of 3-carene from the Coastal provenance. The lack of attraction of the pine shoot moth to the Inland provenance need not necessarily be attributed to the presence of 3-carene in the Inland provenance, as attraction or repulsion could equally be due to the synergistic effect of the volatile constituents [2].

LARVA ATTRACTANTS/ANTIFEEDANTS

The major damage to the Lodgepole pine is caused by the larvae feeding on the leader buds. A study was aimed at the communication system on a molecular basis i.e. the secondary metabolites as attractants in the Coastal and the potential antifeedants in the Inland provenance of the pine. Isolated from the Coastal buds were five known diterpenes, seven bicyclic diterpenes of which two were new natural products, 19-succinyl epitorulosol (1) and 19-succinyl epitorulosol methyl ester (2). Both new metabolites behaved as attractants to the pine shoot larvae. The hydrolysis product of both new natural products was 13-epitorulosol (3) which elicited a trend of negative responses that increased with increasing concentration. 13-Epitorulosol is considered an antifeedant.



1 R = H
2 R = CH_3



3

DEFENCE MECHANISM

The pine shoot moth has a defence mechanism i.e. the laying down of a tent to protect the larvae from predators. Less than an hour after the egg hatches the larva starts spinning a web. It is a process that is continued throughout each instar period. When the third-instar larva bores into the bud from the shelter of the web, the first bites are incorporated into the web. The larva coats the web with resin which is carried as droplets from inside the bud. An analysis of the "tent" showed the presence of resin acids obtained by the larva from the host tree. Interestingly, a high concentration of 13-epitorulosol resulting from ingestion of the succinate esters 1 and 2 was observed. The "tent" contained also neoabietic acid, a resin acid which had not been found in the buds (see Table). In addition to the resin acids, six of the corresponding aldehydes were present in the resin tent. The aldehydes were identified as pimaral, sandaracopimaral, isopimaral, dehydroabietal, abietal and neoabietal. Aldehydes have been reported to occur in the twigs of other pine species, P. palustris, P. densiflora and P. sylvestris.

Compound	Resin Webs	% Yield	
		Coastal	Inland
Pimaric metyl ester	+	18	Tr
Sandaracopimaric methyl ester	+	12	4.3
Isopimaric methyl ester	+	33	34.8
Dehydroabietic methyl ester	+	28	16.7
Abietic methyl ester	+	9	19.2
Neoabietic acid	-	0	24.4

Table: Methyl esters of the diterpene resin acids from P. contorta (Inland and Coastal provenances).

The web "tents" differed from the bud constituents - in the bicyclic diterpene content. In the labdane series, acetyl cupressic acid and isocupressic acid were absent as were the manool series 19-succinyl-epitorulosol (1) and its methyl ester (2).

BS1

Inter-Species Communication

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The use of pesticides has proved a major failure in the control of insect pests. The problems include the inducement of secondary pest species, pesticide addition and, not least, the severe harm to non-target insect species and the environment. Various aspects of insect behaviour are exploited for control purposes, for example, feeding behaviour which is exemplified in the complex relationship between the pine shoot moth (Rhyacionia buoliana) and the host plant, the lodgepole pine (Pinus contorta), an understanding of which should provide the long term solution to the problem. Preliminary host preference research has indicated a variation in susceptibility to R. buoliana between the coastal and inland provenances of P.contorta. The role of the photochemical in the host plant to the pine shoot moth will be described.

BS2

Recent Progress on All-Optical Communication in China

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SUMMARY

This paper introduces a novel liquid density sensor which involves the optical fiber sensing head, data processing, digital display and temperature correction. It is convenient to use for automatic testing of density and refrigence of any liquid and be able to measure in-line and real time.

1. INTRODUCTION

Liquid is one of the four basic states in that substance existes, and the density of liquid is frequently measured in industry, sentific research and even in everyday life. The densitymeter presented in this paper can be used both in Lab and in industry; it will be find very useful in every field where the accurate measurement of density of solution is necessary.

2. BASIC PRINCIPLE AND STRUCTURE OF THE PROBE

(1) PRINCIPLE

In the interface between two media that one with refractive index n1 and another with refractive "index n2, a beam of parallel lights takes place refraction and reflection. According to Fresnell's formula, the reflective factor of it is a function of, n1 and n2. In the case of n1 and are fixed and medium with refrective index n2 is the liquid to be tested, measure the changes of intensity of the reflected light, the changes of I refractive index n2,hence the correspond density of it can be find.

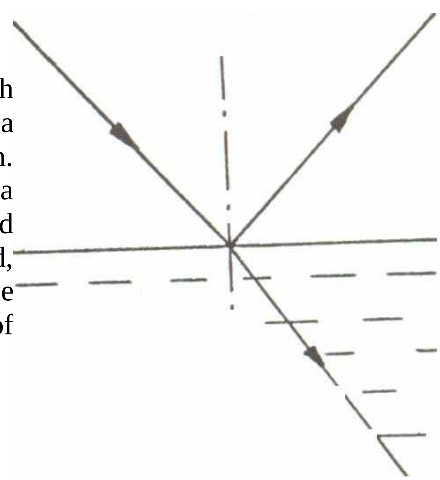

Fig.1

(2) THE PROBE

The probe consists of several parts of optical components including fiber/lens/prism. The light with wavelength O.85!am is illuminated by LED. The photo-electric transformer is a PIN diode. The multi reflection technology is applied to ensure high accuracy for measureing.

3. SENSITIVITY AND DYNAMIC RANGE

Research shows that the sensitivity and dynamic range of the probe are either related to angle, or refractive index n1 and n2. When get more and more further to c (total reflection angle c=arcsinn1/n2),the sensitivity get more and more approximate to For single reflection, more sensitive means smaller dynamic range, but select a suitable material for the prizm,may make both sensitivity and dynamic range satisfactory. To increase the number N of reflections taken place in the interface between the liquid and the prism, the sensitivity becomes N times of that of single reflection and the dynamic range keeps the same. But the intensity of light received by PIN becomes 1/N of that of single reflection in the same situation.

In fact, the lights from collimating lens are not only unparallel, but also no monochromatic. And different input angles correspond to different sensitivities and dynamic ranges, different wavelengths with different refractive index/also corresponds to different sensitivities and dynamic ranges. So the sensitivity and dynamic range of the probe, effected by all these factors.

4. BLOCK DIAGRAM OF THE CIRCUIT

The block diagram of the circuit is showed in Fig2:

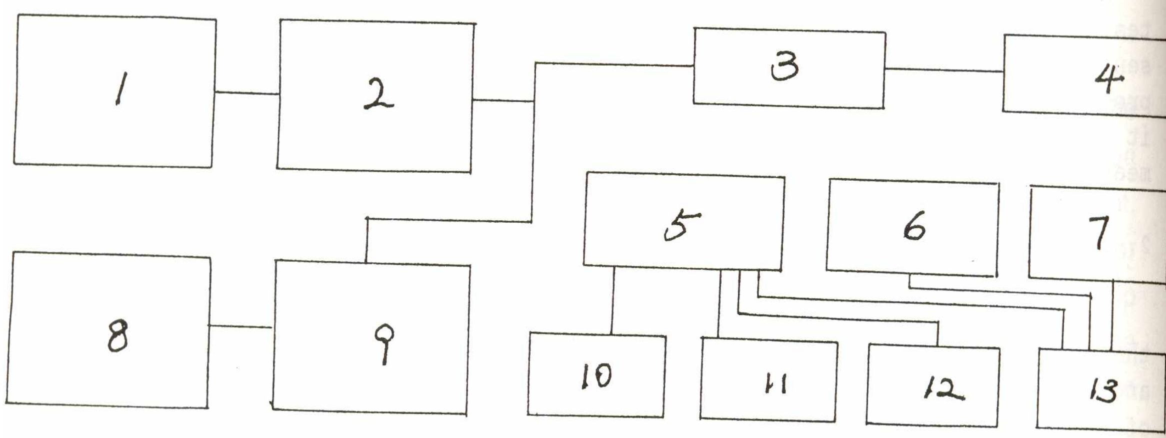

Fig.2 block diagram of circuit

1. Amplify circuit for signle
2. V/F transform
3. transform swich
4. F/V frequency measurement
5. Microcomputer and control circuit
6. Standard circuit
7. Circuit for LED
8. Amplify circuit for reference
9. V/F transform
10. Keys
11. Display
12. Printer
13. D/A convert

With the consideration of the accuracy and dynamic range of the instrument, the circuits of the instrument perform the following main functions:

a. A high stable source for the LED. A high stable constant current source is used to drive the LED, and the temperature of LED is detected in order to control the light output at a constant value.
b. A high accurate detecting circuit. Some high accurate amplifier and AD filter with amplification are used to amplify and select the modulated signal from PINS, so the optical background disturbing and other influences are reduced to a least level.
c. Measurement circuit. V/F converter and FIT method for frequency measurement, make the AID interface not only high accurate but also economic.
d. Microprocessor

A MCS-51 microcomputer is used to process the date and perform the following functions:
a) Temperature correcting to density
b) Automatic zero adjustment
c) Nonlinear scalling
d) Indicate the density in different ways
e) Store and recall the results of measurement
f) Print the results of measurement in different ways
g) Output the control signal
h) Select the test channel for 4 different solutions

The ratio of performance to price of the density meter obviously goes up, since the use of the microprocessor.

5. SOFT WARE

Most of the functions of the instrument are realized by soft ware in combination with hard ware. All of the programes of the instrument are related in the forms of blocks, it is convinent for the adjustment, transfer, service and expendision of it. Another works about soft ware will be mentioned in section 6.

6. EXPERIMENT RESULTS

The curve shown as Fig.3 is about the relation of density to the reading of the instrument before scalling and temperature correcting. A series of solution with different densities of pure sucrose are used n the experiment.

The scalling of the instrument is performed by software. The dynamic range of the instrument is expanded to the non liner section of the curve as showed in Fig. 3 due to the use of microcomputer and a program about correction of non liner. As a result, the accuracy of the density meter is better

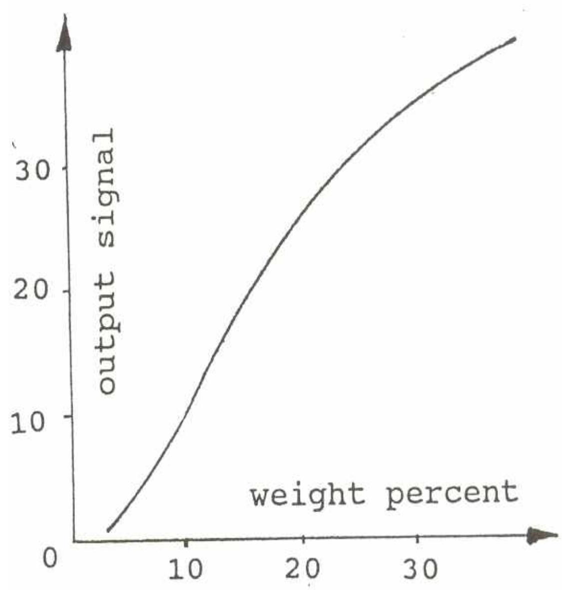

Fig.3

Them 0.1% in the range from a to bit is about 20% weight percent-for pure sucrose solution. The sensitivity of it is also better than 0.1% in the meant range. The repeatability is good enough for the accuracy and the repeatability error in the meant range is smaller than 0.1% for a time period of months.

Acknowledgement: this work was partially supported by the National Natural Science Foundation of China.

BS3

Molecular Sensors

Gillian M. Greenway

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SUMMARY

The design of molecular sensors is discussed. For these sensors to operate with any reliability they must be capable of selectively identifying a particular chemical species in a mixture of other species. This type of selectivity can only be achieved by combining developments in chemistry, biology, electronics and signal processing

INTRODUCTION

Chemical and biochemical measurements are traditionally carried out in centralised laboratories, by trained people, with specialised, expensive equipment. In recent years it has been realised that in many cases, rather than collecting discrete samples and sending them for analysis, it would be better to make the chemical measurements on the spot and to achieve this molecular sensors have been designed.

Molecular sensors are devices that combine developments in chemistry and biology with electronics technology to provide low cost, easy to use instrumentation for measurement. The development of such sensors allows real time control for a wide range of situations including the control of pollution and industrial processes. The type of sensor that will be discussed here consists of a molecular recognition element and a transducing or signal generating element (the other main type is usually used for clinical measurements and is in the form of strips or dip sticks that are coated with a reagent that changes colour when it comes into contact with the species to be detected).

At present industrial processes are usually continuously monitored in terms of temperature pressure and flow rate (for non batch processes). This is sufficient for bulk chemical production, but for biotechnology processes and expensive fine chemical and pharmaceutical processes it is important to be able to monitor the concentration of chemicals in the feedstock, intermediates, product and effluent so that action can be taken immediately a problem occurs. Continuous monitoring is also vital for environmental measurements if a complete model is to be developed, otherwise an industrial effluent may be washed downstream between sampling periods. The same considerations are needed for both these applications but environmental monitoring is usually much more difficult as lower concentrations of chemical must be detected and the mixture of chemicals present is often unknown.

SENSOR DESIGN

The most important part of the sensor is the molecular sensor recognition element. Unlike physical sensors for measuring temperature pressure etc. the molecular sensor must be capable of identifying and measuring the concentration of a particular substance in a mixture of many other substances. If the sensor can uniquely identify a particular substance it is said to be specific, but this is rarely achieved, otherwise the sensor is said to be selective. The molecular sensing element consists of either an immobilised chemical or biochemical reagent or a section of biological tissue such as a sensing antennule from a crab. Biologically based senors are often the most specific because they contain complex chemicals that have been specially developed by nature to be specific. The chemical reagents used react with the species to be detected causing some sort of measurable change. If the sensor is to be used again the reaction must be reversible or else once the chemical reagent is used up the sensor is useless, unless it can be reconditioned. Some of the best known selective chemical reagents are macro cyclic compounds such as crown ethers and these are the molecular recognition elements that will be discussed in more detail.

These molecules are circular with a cavity in the centre into which specific metal ions or molecules can selectively bind (see figure 1). New sensors can be developed by designing a crown ether with a cavity that differs in shape or size so that it specifically binds with a particular ion or molecule [1].

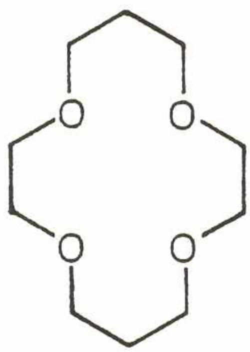

Figure 1
A 14-Crown-4 type crown ether

This particular type of reagent is very versatile and can be used to make measurements using a variety of different transducing elements. The macro cyclic compounds have mainly been used in ion-selective electrodes. To make such an ion-selective electrode the crown ether is immobilised in a PVC membrane to form the ion-selective membrane. The crown ether operates as neutral carrier, which is capable of transporting ions in the membrane and is known as an ionophore. This is incorporated into the body of the sensor as in figure 2.

The membrane has two interfaces, one with the internal filling solution and one with the external solution of the species to be measured. Electrical potentials are set up at the liquid/membrane interfaces, the internal interface being fixed and acting as a reference, but the external one altering with the concentration of the species present. To make measurements a digital voltmeter is used with a high impedance input and the measurement is made versus a reference electrode which is not affected by changes of concentration in the sample to be analysed. The relationship between potential and concentration is logarithmic and follows the Nernst equation.

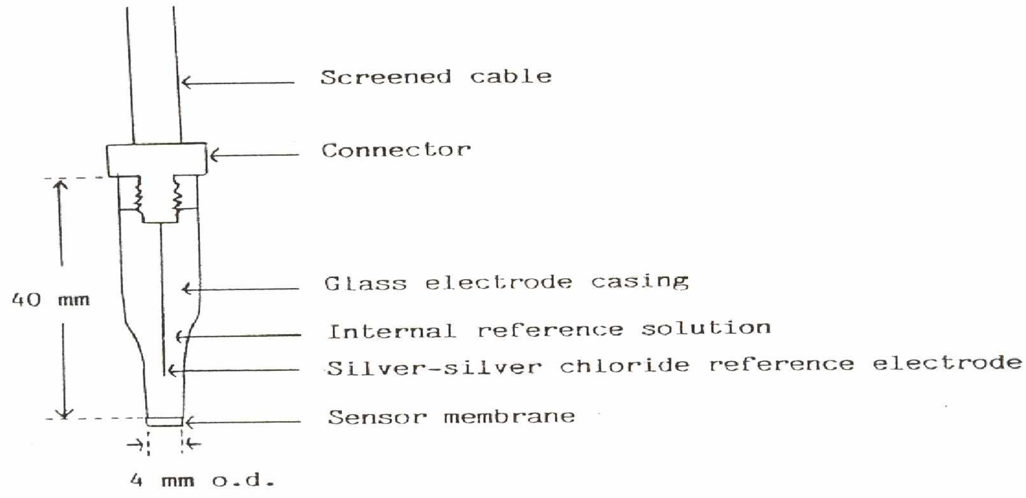

Figure 2 An ion selective electrode

Further use can be made of crown ethers as molecular recognition elements if they change colour when they form the complex with the metal ion [2]. The reagent is then called a chromoionophore, an example of such being (S-(4'-nitrophenylazo)-2-hydroxy-1, 3-xyl-18-crown-S). In that case they can be used as optical sensors where optical absorbance, reflection or fluorescence measurements are made. Several designs of such sensors have been described, but the simplest are based on optic fibres and are called optrodes. The chromoionophore is immobilised on polymer beads or in a polymer film and fixed over the end of a jacketed bifurcated fibre optic with a teflon membrane Figure 3.

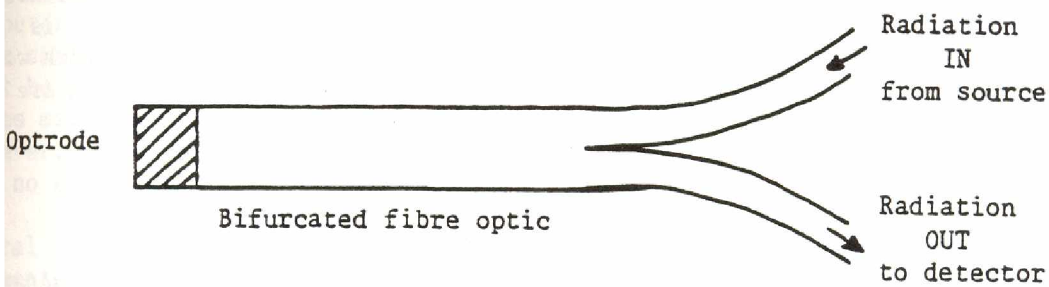

Figure 3 An Optrode

Radiation comes in from the source with an intensity 10 but once absorbed by the reagent it returns to the detector with an intensity I. The change in intensity of the radiation when the species to be identified interacts with the chromoionophore can be directly related to the concentration of the species present according to Beer Lamberts' Law.

This type of system can be made more sophisticated by using electrochemical switching to improve selectivity [3}. Electrodes are

Used to oxidise or reduce the molecule and this can alter the ion mobility or optical properties. A type of chemical modulation can then be used. Ionophores that are not chromoionophores can be used with spectroscopic systems by incorporating a potential sensitive dye such as Rhodamine B into the sensor membrane, so that when the membrane potential changes the indicator changes colour also [4].

To extend this type of system to biochemical systems and to improve selectivity more complex membranes can be prepared that also includes enzymes. A simple example that has been developed is an ionselective type biosensor for the analysis of urea [5]. The macro cyclic compound used was nonactin, a natural product, selective to ammonium ions (NH3).Also incorporated in the PVC membrane was urease an enzyme that specifically reacts with urea. The urease breaks down the urea to form ammonium ions that can then selectively bind with the nonactin and thus be detected. The change in electrode potential could then be related to the urea concentration.

CONCLUSIONS

So far this paper has given an overview of the types sensor that can be designed using one particular class of molecular recognition molecules. The sensors that have been produced have been reasonably successful but they still have a long way to go before they are as reliable as physical sensors. As mentioned previously selectivity is the key to success, otherwise the sensors are prone to interferences from other chemical species present. To improve the selectivity new more selective reagents must be designed and this requires the input of synthetic chemists. The use of several sensors together can also provide improved results if the data collected are processed using neural networks and statistical techniques. This approach requires close collaboration between engineers and chemists and has been especially developed in the field of gas sensing where specific sensors are more difficult to design.

The other major problem with molecular sensors is robustness. They cannot be hermetically sealed and are affected by light, temperature, pressure, corrosion and mechanical wear as well as other chemicals. The lifetime of some sensors, especially biosensors, is still limited to a few days of continual use. There is still much work to be done in overcoming these problems before molecular sensors are fully accepted.

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Optical Neural Networks for Pattern Recognition

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SUMMARY

The electro-optic implementation of a modified Hopfield neural network model, using both free space and Computer Generated Holographic (CGH) interconnects, is reported. The 16 neuron net stores 4 memories with 74% convergence for free space implementation, and 86% convergence for the CGH implementation.

AN INTRODUCTION TO NEURAL NETVORKS.

The performance of the human brain, which consists of millions of highly connected yet simplistic processing elements (neurons), is fairly limited when computing large data set mathematical functions, but far exceeds that of present supercomputers when implementing speech recognition and image processing functions. The reason for these processing differences is the computer architecture. Conventional digital Von Neuman computers, which consist of a small number of highly complex and sparsely connected processing elements, must be programmed with an algorithm to provide a solution to a given problem. Since mathematical functions are precisely defined, this is easily achieved. However, speech and handwritten character patterns vary from person to personed no exact definition is possible.

Neural networks consist of many highly connected, simplistic processing elements which don't require a predefined algorithm to compute a solution. Data is store in the net as connection weights between processing elements. Retrieval is achieved by propagating a input vector through the net, the positive connection weights strengthening attributes of the input which are similar to, and the negative connection weights weakening attributes which do not correspond to those of prestored memories. A solution is obtained by association rather than exact correspondence.

The optical implementation of neural networks is considered to be a favourable technology because of the inherent characteristics of optics and electronics. A neural network does not require high speed processing elements (human neuron switching time is of the order of milliseconds); it is the dense

Interconnection matrix providing fast signal propagation between processing elements which produces high speed parallel processing. In electronic systems high density, high speed (nanosecond) processing elements are easily achieved but interconnection density is low and propagation slow (the RC time constant problem). Optics offers the potential for a high density, high speed, parallel inetconnection matrix but currently lacks suitable all- optical switching arrays. Thus, a hybrid system which employs optical interconnects and electronic processing elements is presented. It is anticipated that electro-optic nerural networks will offer improved performance parameters over wholly electronic system for >104neurons and >106 interconnects.

THE HOPFIELD MODEL

The Hopfield model [1,2], illustrated in figure 1, describes a simple binary net (bipolar or unipolar) incorporating hard thresholding and feedback. The net stores memories of bit length N, the number of memories M being <0.15N. A weight interconnection matrix between the input and output neurons is obtained for each memory by calculating the outer product of the memory with itself

$$T_{ij}^{m} = V_i^{m}.V_j^{m} \qquad i,j = 1..N,\ m = \text{memory } 1..M$$

The weight matrix for the net when M memories are store is

$$T_{ij}^{S} = \sum_{m=1}^{M} T_{ij}^{m}$$

The output V_i is obtained for a given detector neuron D_i in accordance with

$$V_i = \sum_{j=1}^{N} T_{ij}^{S}.V_j^{in}$$

This undergoes thresholding such that the output of each neuron N_i is

$$N_i \rightarrow +1 \quad \text{if} \quad \sum_{j=1}^{N} T_{ij}^{S}.V_j^{in} > 0$$

$$N_i \rightarrow -1 \text{ or } 0 \text{ if} \quad \sum_{j=1}^{N} T_{ij}^{S}.V_j^{in} < 0$$

This result is fed back to the input neurons and the cycle repeats until the net converges to a stable state. This allows error correction on inputs with up to 25% noise.

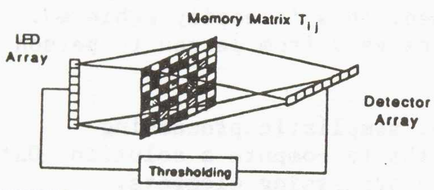

Figure 1 THE HOPFIELD MODEL

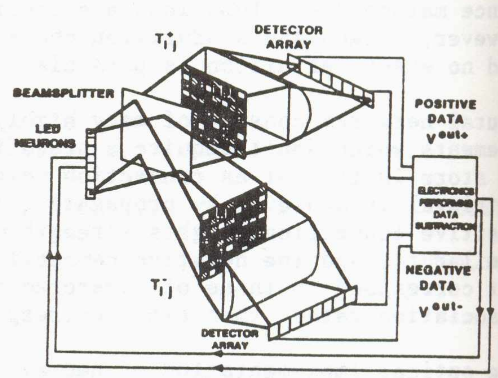

FIGURE 2 ELECTRO-OPTIC IMPLEMENTATION OF THE HOPFIELD MODEL

Memory	Bit 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0	1
N	1	0	0	1	1	1	0	1	1	0	1	1	1	0	0	1
X	1	0	0	1	0	1	1	0	0	1	0	0	1	0	0	1
Z	1	1	1	1	0	0	1	0	0	1	0	0	1	1	1	1

FIGURE 3 THE STORED MEMORY DATA

ELECTRO-OPTIC IMPLEMENTATION.

Unless interferometric techniques are employed, light cannot represent both positive and negative quantities across a single weight matrix. For this reason, the electro-optic net required two weight matrices, implemented as grey scale on photographic film, one containing the positive weights, the other the negative weights, as shown in figure 2. The natural divergence of the LED source neurons was used for connection to each row of the weight matrix, and a cylindrical lens was used to sum the columns to the detector neurons. However, in order that crosstalk from input signals propagating through adjacent weight elements could be avoided, a path length of 1.5 meters was required.

The net was used to store alphanumeric characters but initial tests proved that only two characters could be retrieved (H<O.15N, N-16 H-2). Analysis of the weight matrix produced when more memories were introduced indicated that there was insufficient weighting (positive or negative) on certain bits to allow convergence to that additional memory. For example, for the memories A,N,X and Z given in figure 3, the Hopfield net produced only negative weights for output neuron 6 preventing a positive response on this bit and thereby excluding memories X and N.

The weight generating algori thm was modified to ensure that all bits had positive and negative weights to allow convergence to all four memories. It was also found that this modification increased the error correcting capability of the net.

The results obtained for the free space implementation are illustrated in figure 4, along with those from a corresponding computer simulation. The graphs represent the convergence to each memory for varying levels of noise on the input, Overall the results represent 74% correct convergence for the implementation compared to 81% for the simulation.

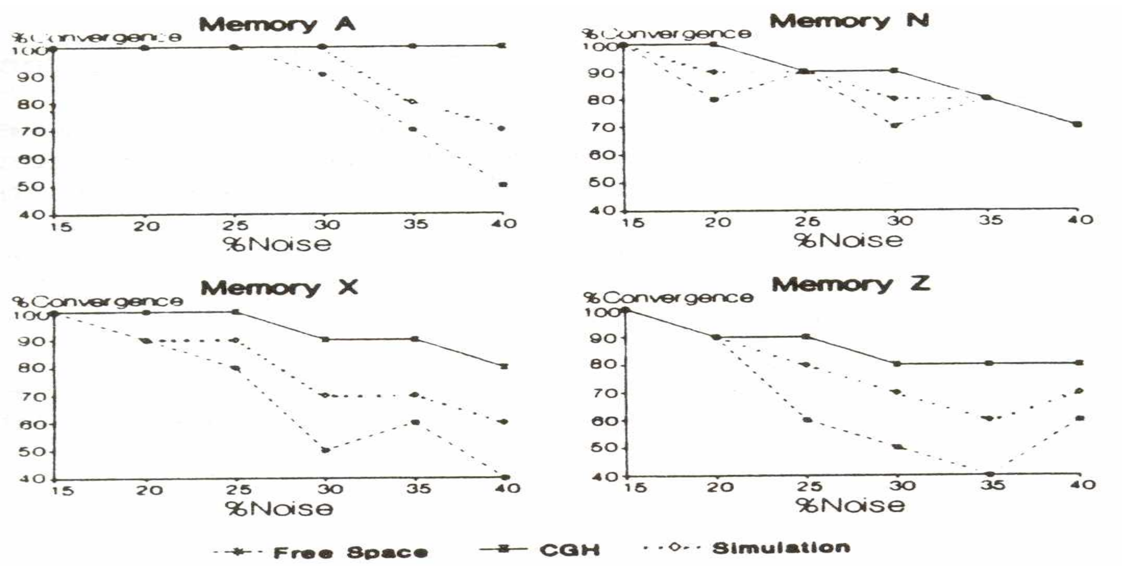

FIGURE 4

In order that the path length may be reduced, a computer generated hologram was placed Smm from the LED source neurons, and focused a single beam from each LED across the corresponding row of the weight matrix. This removed the problem of

Crosstalk reduced the path length and thereby increased the signal to noise ratio improving performance. The path length from source to detector is now 17cm. The results obtained from this implementation are also given in figure 3. Overall this represents 86% correct convergence. It is thought that improved performance over the simulation is achieved since, in practice, the implementation is analogue. There is always added noise due to path length differences which promotes convergence when the net is undecided about the result. This was evident with inputs for which the simulation oscillated between 2 memories while the implementation converged to one of these memories.

The modifications to the Hopfield model have thus increased memory capacity from <0.15N to 0.25N, and error correcting capability from less than 25% noise on the input to greater than 40%.

THE POTENTIAL AND LIMITATIONS OF OPTICAL NEURAL NETVORKS

Free space optics is not a realistic possibility for large (>10^4 neuron, >10^6 interconnects) neural networks due to path length and signal to noise requirements. CGB optical interconnects offer$_2$ the possibility of dense interconnection planes (100 interconnects/cm currently achievable) without severe crosstalk constraints. Since it is also possible to code a CGH with a weighted interconnect, the hardware requirement may be further reduced.

There are several limitations on CGH design for interconnection matrices [3], principly (a) acceptance angle, determined by the numerical aperture of the system (b) facet size (c) grey scale, i.e. number of weight levels, (d) crosstalk and (e) coherence effects. Unfortunately these parameters are interdependent and optimisation of one parameter will be at the cost of another e.g. reducing facet size can lead to increased crosstalk and coherence effects. Although dependent upon wavelength, typical values for these parameters are (a) maximum acceptance angle 30° (b) facet size 1mm (c) 10 grey levels (d) 2% crosstalk (e) 1% noise due to coherence effects.

The Hopfield neural network is a fairly simplistic model and greater complexity is required if real time classification of complex images is to be achieved. This will necessitate neural network models for which weights are updated during training (e.g. Back Propagation and Kohonen nets), and nonlinear sigmoidal thresholding functions. The former may be achieved with re-writable (updateable) holographic materials, while the latter requires a Spatial Light Modulator (SLM) capable of pixellated thresholding. That these devices will be produced is not in doubt; the question is when and at what cost? Only then will the true potential of optics be realised.

Acknowledgement: The author would like to thank S.R. Cherry for producing the CGH interconnection elements for the Neural network implementation.

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Photoelectric Methods in Study of Electron Processes at the Real (111) Silicon Surface

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SUMMARY

The results of measurements of the surface photo voltage and photoconductivity for the real (111) surface of p and n-type Si are discussed. An amphoteric character of the real surface structure, independent on the type of the bulk doping, and determined only by the technology involved in the surface preparation has been found.

INTRODUCTION

The real Si surface is still being an interesting object for investigation because of the complexity of its electronic structure as well as a large application of silicon to production of the microelectronic devices, as gas sensors, photo detectors and solar cells, which are a part of the standard equipment of the satellites.

In this work the surface photo voltage (consisting of a change of the surface potential Vs during illumination) and photoconductivity (σ) methods have been used to study of the real p and n-type Si surface. The surface parameters as the surface potential Vs, the surface position of the Fermi level Φs as well as the surface recombination velocity S and the excess carrier density n* have been obtained on the basis of measurements of .Vs and σ versus the light intensity and photon energy at different temperatures. The experimental and theoretical dependences of the small-signal surface photo voltage versus ~s have been compared.

EXPERIMENTAL

The measurements of the surface photo voltage Vs and photoconductivity σ were performed in a vacuum of 10^{-3} Pa, for the samples of p - type (p=15Ωm) and n-type (p=11Ωm) silicon, submitted to the chemical etching in HF solution as well as baking in a vacuum of 10^{-3} Pa at 700, 920 and 970K during 2h (so called "low temperature baking", causing the changes only in the surface region). The photo effects were generated by means of light emitted by the He-Ne laser, as well as the halogen lamp and the prismatic monochromator (in a range of wave length from 600 to 900 nm).

The Vs signal was detected in the static capacitor system by means of the semitransparent gold electrode and modulated light with a frequency of 40 Hz. The details of the experimental set-up are described in ref. [2].

RESULTS AND DISCUSSION

The measurements of Vs versus the light intensity have allowed the determination of the "dark" surface potential barrier Vs at different temperatures (from the saturation of Vs [3]), and then the surface position of the Fermi level Φs, from the relation: $\Phi s = \Phi b + Vs$ (where Φb is the Fermi potential in the bulk). The dependences of Vs as a function of Φs are presented in fig.1. The values of Vs show that the used technology has generated a depletion layer near the surface, regardless of the type of the bulk doping. Moreover, the complementary character of the Vs (Φs) curves for p and n-type Si suggests that the surface structure is mainly determined by the technology of the surface treatment and does not depend on the type of the bulk conductivity.

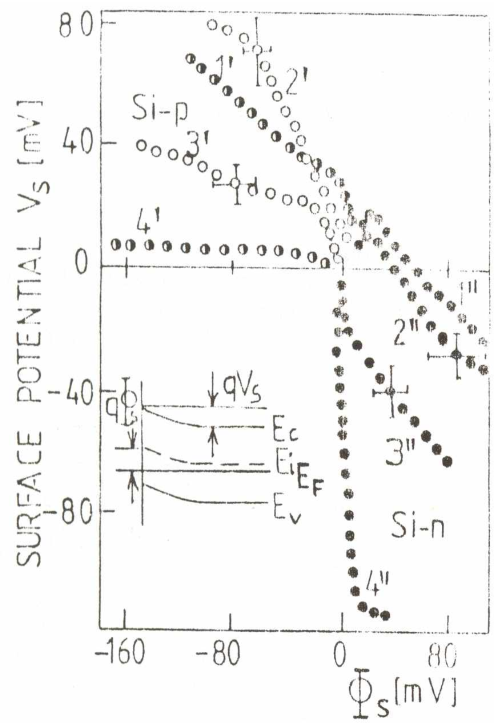
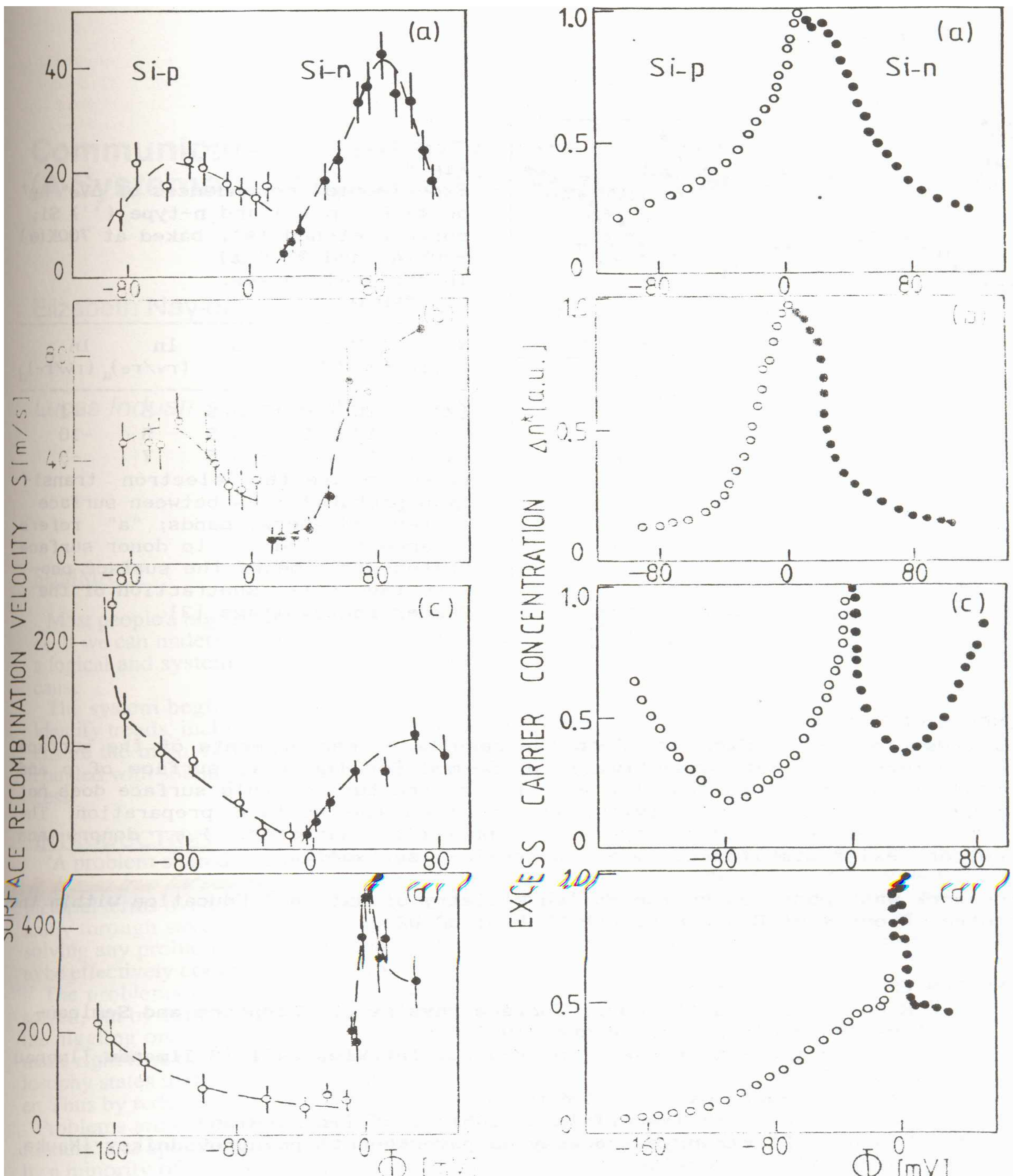


Fig. 1.
Experimental dependences of the surface potential Vs on Φs for p (‘) and n-type (‘‘) Si; surface etched (1), baked at 700 K (2), 920 K (3) and 970 K (4)

A similar conclusion can be drawn on the basis of figs. 2 and 3, where the dependences of the surface recombination velocity S (obtained from the spectral σ dependences by means of the method described in ref. [4]) and the excess carrier concentration n*. (calculated on the basis of the measured values of σ and S as in ref. [3]), versus Φs, are collected for p and n-type Sin The characteristic shape of the S(Φs) curves supports a point of view of some authors that the system of two groups of the continuous surface states (donors and acceptors) exists at the real Si surface [5]. Their densities may be expressed by the following relations: Na = A exp (aE/kT) and Nd = B exp (-bE/kT), where A, B, a, b - constants, E - electron energy and k - Boltzmann constant.

Using this theoretical model we have obtained a good qualitative description of the experimental dependences of the small - signal surface photo voltage divided by n* on Φs (fig.4).



igs.2 and 3. Experimental dependences of the surface recombination velocity S nd the excess carrier concentration Δn* for p (∘) and n-type (•) Si; surface tched (a), baked at 700K (b), 920K (c) and 970K (d).

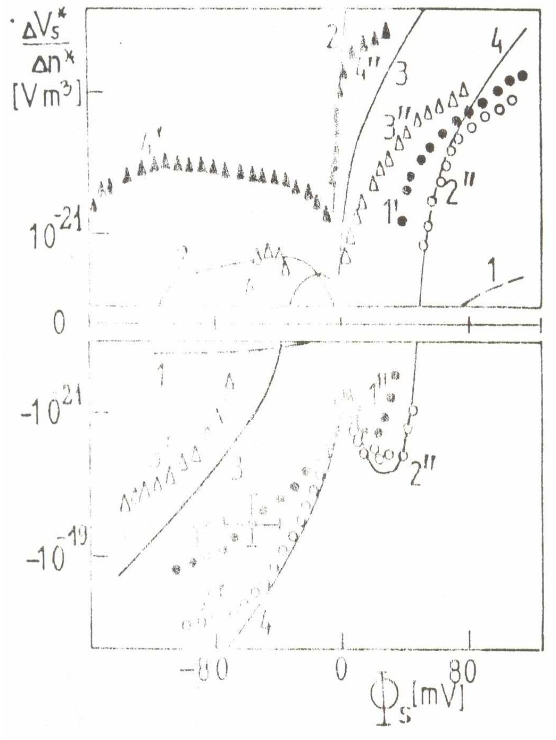


Fig. 4.
Experimental dependences of ΔVs*/Δn* on Φs for p (') and n-type (' ') Si; surface etched (•), baked at 700K(•) 920K(Δ) and 970K(Δ).

Theoretical curves:
(1) A=B=O

No	A $*10^{14}$ m^{-2}	B eV^{-1}	A	B	In (rv/rc)$_a$	In (rv/rc)$_d$
2)	1	10^{-4}	0.15	0.5	5	-1
3)	1	10^{-2}	0.15	0.5	5	-10
4)	1	10	0.15	0.5	7	-3

rv and rc are the electron transition probabilities between surface states and energy bands; "a" refers to acceptor and "d" to donor surface states; ΔVs*. means the surface photo voltage after subtraction of the Dember photo voltage [3].

CONCLUSIONS

The presented discussion, based on the results of measurements of the surface photo voltage and photoconductivity, performed for the real surface of p and n-type Si, has provided that the electronic structure of this surface does not depend on the bulk conductivity, but only on the surface preparation. The electronic surface states have the amphoteric character, i.e. donors and acceptors exist simultaneously at the real Si surface.

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Communicate by Numbers
(A Systematic Approach to Problem Solving)

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COMMUNICATE BY NUMBERS
(A Systematic Approach to Problem Solving)

SUMMARY

Most people's biggest problems arise because of unpredictable variations in products or processes. If we can understand the nature of the variation we can begin to control it. This paper is about a logical and systematic approach to problem solving which is a progressive search for the root cause.

The system begins by assessing the adequacy of the measuring system, using techniques to identify trends, including Statistical Design of Experiments. This is followed by techniques which ensure the main variables are monitored and controlled. Knowledge of this approach must be coupled with sound product and process knowledge and management commitment, to ensure success.

INTRODUCTION

'A problem shared is a problem halved', this is the advice normally given to us by counsellors. It is also true for our engineering problems. Sharing a problem by expressing it in numerical or pictorial tenns overcomes the first major hurdle in solving a problem. A component's route is typically through several departments and involves more than one person. It is important prior to solving any problem, that everyone has the same perception of the situation. The problem needs to be effectively communicated to everyone. The solution may then be obvious.

The problems that need solving are never easy, if they were they would already have been solved, but by expressing it in a meaningful way can lead to an easy solution. These problems are the niggling ones which slowly eat away at a company's profit. Those components that are not made right first time, but may involve rework, scrap or several retests. Taguchi's quality loss philosophy states that any product which deviates from its target value will incur a loss sooner or later. Thus by reducing the variation companies can save money being wasted.

Problems are solved by people. It is therefore imperative to have a system which is both 'user friendly' and appealing. A rigorous but unappealing system may only have limited success if used by a minority of people for very few problems. This is particularly important in today's environment of increased responsibility and problem ownership. Managers can no longer pass the problem over a departmental wall; instead they have to find a system they are happy with. This is not to sacrifice any of the statistical rigorousness but to package and train people in a system so it can be used by the majority of people and by those who benefit directly. It is also imperative to have a defined system or procedure. That is, a set of rules or guide-lines to be followed. It does not have to be prescriptive, but must offer a systematic approach. This is to ensure the most efficient use of problem solving resource.

TIIE PROBLEM SOLVING SYSTEM.

The system is split into three distinct stages, as shown in Figure 1. Previous problem solving systems generally only recognize one of these stages. The long lasting benefits come from the preened post-experimental stages as opposed to concentrating on just experiments. The first stage (1) Pre-Experimental. The purpose of this stage is to clearly define the problem to be solved and the aim. It is the preparation prior to carrying out experiments and involves examining existing evidence of the problem and its severity. This could be compared with a civil engineer surveying the land before starting to build. The importance of proper planning cannot be over stated .It is at this stage that the management need to show their commitment by supponing projects and approving the resource levels and plans. Experiments can take considerable time and resource and not only is full commitment required but also good preparation before hand in order to maximize effective use of time.

Once the problem area is identified, an effective measuring system needs to be established. Rather than just stating that a system needs to be established, specific techniques need to be part of the system. Many quality improvement systems offer words, targets or goals. An effective system must offer more: a means to achieve these goals. Variations in output could as equally be due to variations in the measuring system as in the product or process. Problem solvers firstly need to ascenain which of these is causing the variation as an unreliable measuring system cannot be trusted to give an accurate picture of the nature and severity of the problem.

Having established that the data observed can be believed and truly reflects what is happening, the brainstorming can begin. This stage is to highlight potential areas for investigation and not to jump in at a solution. Failed attempts at solving problems are often due to looking at too much de tail too soon. The purpose of this pre-experimental section is to stand back from any likely causes and look for potential areas of investigation. The imponance of planning needs to be realised.

The second stage in the Quality Improvement System is (2) Experimental Design and Data Collection. The causes of the variation will not all equally affect the output but will display a pareto of effects. This means that the most benefits will come from identifying the biggest cause and eliminating it. Brainstorming will help to identify the main areas but should not be used for potential solutions. Guessing at likely causes at this early stage may improve the final output but it will not necessarily have been the largest cause of variation and therefore will not reap maximum reward. The techniques to be used here identify the trends or patterns of the variation, for example, Defect Concentration Diagrams and Multi- Vari charts. A useful and successful problem solving system needs to have techniques to enable the problem solver to look for these patterns and trends before any statistical experimental designs begin. If this stage is carried out thoroughly then there should only be a few factors which need further investigation. Experiments permit a rigorous investigation of all the effects tested. They are usually carried out off-line specifically for problem solving and always involve extra resource, usually proportional to the number of factors. Experiments are what most approaches focus on, whereas in fact, many problems have been solved before this stage is ever reached.

There are many options for experimental design and the selection is fairly mechanistic. The most imponant part of carrying out experiments is to ensure the product or process is not 'interfered' with, which can anificially reduce the variation. It is also important to repeat the experiment several times to assess its performance under a variety of conditions. Experimental designs are well do cumented and if problem solvers do reach this stage then information is freely available. It is at this stage where the benefits of a user friendly system can be recognised. Experimentation needs to be brought within easy reach of practising engineers. Analysis and interpretation of the data is crucial to solving the problem. Interpretation of the results requires thorough understanding of the product or process to avoid erroneous conclusions. There then needs to be a confirmation that the problem is solved. This must be more than a one off test, it should be a continual monitoring of the product or process.

The third stage in the system is (3) Post-Experimental where the improvements are implemented. Where possible this should be a permanent solution, for instance, welding the adjustment button to the machine. Where this is not possible, there must be a permanent system for measuring and monitoring the output. This may include re-addressing the tolerances and may only apply to the critical variables rather than implementing controls on all of them. The measurement system must be capable of detecting any future deterioration in the quality in order to avoid problems being temporarily solved.

PROBLEM SOLVING IN THE RIGHT ENVIRONMENT

Problem solving is one of the methodologies which can be employed to help companies achieve goal of total quality. It alone does not achieve total quality. It must be integrated into a total approach, which must be adapted and adopted by individual companies. A key factor to the success of approaches is the environment within the company. The ground must be fertile, and people be receptive. Most solutions are a surprise and therefore, everyone must remain open minded. The route towards the solution must be a collaborative venture within the company. Problems are d working in a team environment, with individuals all contributing their skills and knowledge. Companies with simple structures and procedures and a supportive management have much more change of success. Ownership and responsibility for problem solving are also key success factors.

In summary, there are three key elements which must be in place before effective problem solving happen,

1. Management commitment
2. A systematic approach to problem solving
3. Thorough Understanding of the product or process to be investigated, individual Lucas companies have used this problem solving approach. The following case is one example of how the approach was used.

CASE EXAMPLE OF THE PROBLEM SOLVING TECHNIOUE

The Activities at Lucas Duralith Ltd., Cornwall, U.K. concerned the production of a circuit film designed for the reception of microwave signals transmitted via satellite. The production process involved silk screen printing the required dipole array design onto a 3 thousandth-of-an-inch thick polyester sheet followed by silver plating the ink and leaving it to dry. It was after this stage that they problems appeared. The most regular failure was the lifting of silver plate from the micro receiving dipoles on the circuit. The approach taken was based around the problem solving n used within Lucas.

The initial stage focussed on validating the in-house measuring systems using the isochart tech. The pre-experimental stage helped identify factors causing the greatest variations. A multi-vari experiment on dipole lifting was carried out. This attempted to pin-point where the largest frequency of quality rejects occurred, e.g. areas (zones) of all circuit films, films plated in one particular, or all films plated at a particular time of day. The results showed that zone to zone (position to position) lifting was one of the largest families of variation.

A Defect Concentration study to identify the local areas of greatest lifting was then carried out. ~ 2 present the results in three dimensions. The height in each zone (of a circuit film) represent the concentration of lifted dipoles, (the results reflect an image of a "High Back chair"). In general, the top middle zones of a circuit film experienced the maximum dipole peeling and the up to zones of the films suffered significantly more lifting than the central and lower zones. Agnation of these 'Clues' followed...It was suspected that the film handling mechanisms used and after silver plating contributed to the dipole lifting. Figure 3 shows both the unloading, using a rod and also the flexing of films caused by the jig screws. Experiment was designed to explore the effect of handling during and after Silver plating.

1. 50 films were plated in the standard way and removed from the jigs immediately.
2. 50 films were plated in the standard way and left on the plating jigs overnight.
3. 50 films were plated upside down on the plating jigs and removed from the jigs immediately.
4. 50 films were plated upside down and left on the plating jigs overnight.

Figure 4 shows the number of lifted dipoles, over 16 zones on the circuit films, with respect to the conditions above.

The results showed that the majority of failures in each case occurred along the top quarter section (in the plating jig) of the films. It was this area that the operators used to hold each film as it was re from the jig. Thus, the handling method employed was initiating dipole lifting. It was hat an alternative unloading style increased the yield by 11 % and the rejects due to lifting l by 50%. The increase in dipole lifting experienced by films left on the plating jigs over highlighted the problems caused by the jig design itself. Further designed experiments confirmed requirement for a re-designed jig, not only to improve material handling but also to provide even current distribution during the plating process.

This approach, although not yet complete and still with work to be done, demonstrated that problems easily solved when a systematic approach is used. It has also shown that the greatest me by picturing and communicating the problem, when the "High Back Chair" image appeared project gave us the confidence and enthusiasm to apply the system to other problems.

Quality Improvement Methodology.

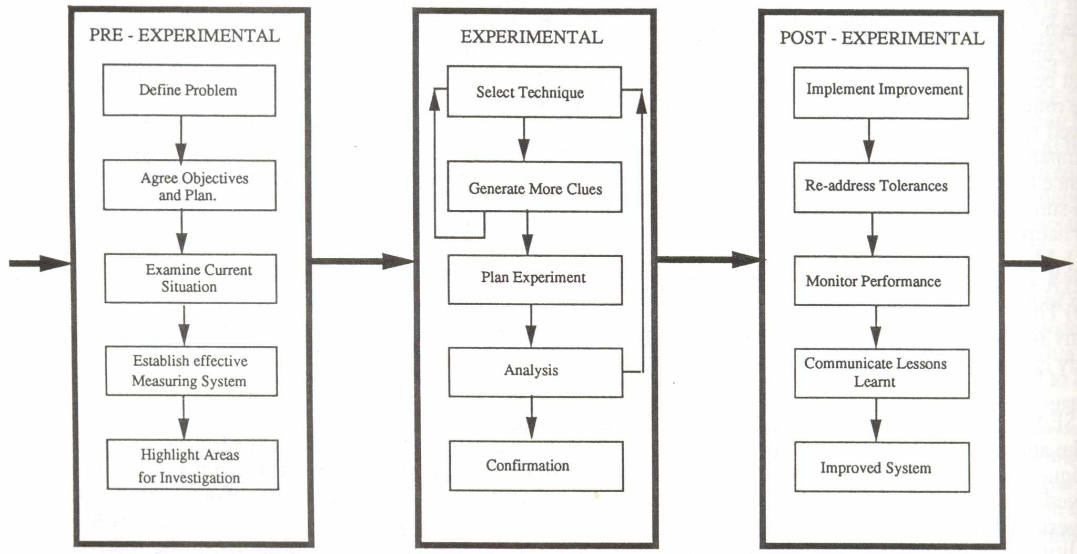

Figure 1

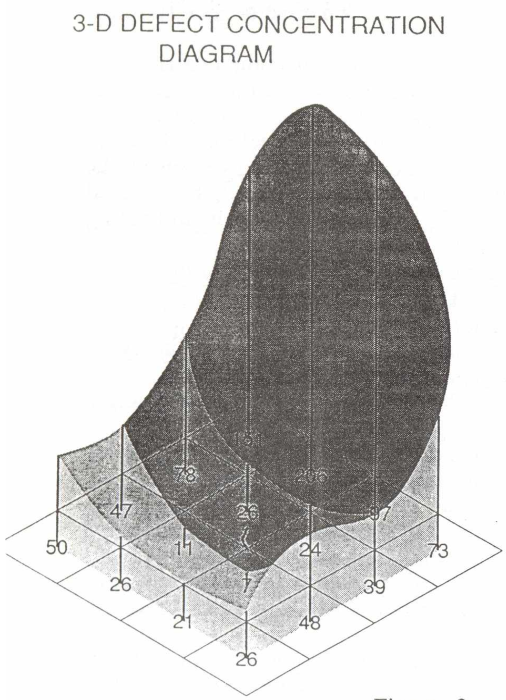

Figure 2

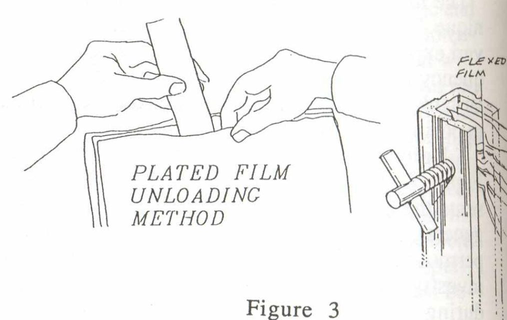

Figure 3

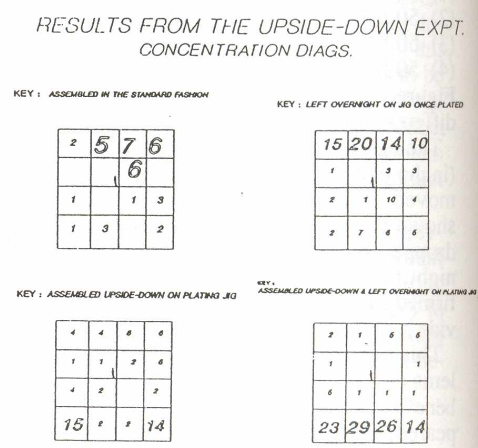

Figure 4

BS7

The Gap in EC Directives on Noise

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SUMMARY

Despite the apparent blanket coverage of EC directives on noise, none exist on high speed trains, hovercraft or helicopters. This gap is analysed by the author in a review paper.

TRANSPORT

The programme of action of the European Community on the environment [1] shows clearly the need to combat noise, where a particular activity predominates from air, road and rail traffic.

AIR TRAFFIC

The Council have adopted a directive limiting noise emission from civil subsonic jet airplanes [2]. From 1 November 1990, member states do not permit the operation in their territory of aero planes which are not registered in a member state, and which have not been granted a noise certificate. Certification is based on the 1988 ICAO [3] standards of noise emission.

HELICOPTERS

The European Commission, on 6 October 1981, proposed a directive [4] to make the introduction of noise certification standards mandatory into the laws of the member states of the EC. However, a number of countries with major helicopter manufacturing industries felt that the standards were too stringent. Therefore, the Council has not adopted a directive setting noise limits for helicopters.

ROAD TRAFFIC

The EC directives on four-wheeled motor vehicles, motor cycles and tractors are all concerned with products [5]. The objective is that these products should be so designed and constructed, so as to meet the noise limits set down in the directives. The practical effect of the directive is to prevent Member States from insisting on more stringent limits than those of the directive, and thus erecting a barrier to trade. The EC directives have two broad aims. Firstly, to lay down limits for the maximum permissible sound pressure level L_{pA} dB(A) relative to a reference sound pressure of 20 micro pascals. Secondly, to define the

Method of measuring the noise emitted during EC-type approval tests. Over the 20 year period from 1970 to 1990, the EC noise limit for the highest powered lorries has come down by 7dB (A), from 91dB(A) to 84 dB(A) [5].

RAIL TRAFFIC

On 25 July 1979, the Federal German Government informed the Commission of its intention of adopting administrative measures for reducing the noise from railguided vehicles. That notification was given with a view to possible harmonisation throughout the Community. The Commission asked the Federal Government to suspend the implementation of this purely national legislation, as the Commission was preparing appropriate Community measures. However, it was not until 7 December 1983 that the Commission presented to the Council a proposal for a directive on the noise emission of rail-mounted vehicles [8], and for the issue of certificates of conformity. At 25m from the train, the values of the maximum permissible sound pressure levels for noise from rail-mounted vehicles in movement vary linearly between:
80 dB (A) and 96 dB (A) for coaches and traction units,
83 dB (A) and 96 dB (A) for wagons.

The proposed directive only envisaged speeds in the range:
V = 50 to 111 km/h for coaches and traction unit' s
V = 50 to 136 km/h for wagons

On 17 January 1986, the Commission submitted to the Council a proposal for amendments to the original draft directive [9]. The first amendment requires that, prior to being put into operation or use, each type of rail-mounted vehicle be examined for conformity by an approved body of the Member State. The second amendment requires that the operating permit must be withdrawn if deficiencies are discovered with the noise requirements, and they are not rectified within 6 months. The third amendment requires the Member States directly concerned with a challenge to non-conformity to try to settle the dispute. Where necessary, the Commission shall hold consultations with a view to resolving the matter. The fourth amendment proposed an implementation date of 1 January 1988. However, no action has been taken by the Council to adopt a directive relating to the noise emission of rail mounted vehicles. Thus there appears to be a gap in the portfolio of EC directives on transport noise. However, it is interesting to note that the noise specification [10], for the proposed Three Capitals high speed trains between London and Paris, is a maximum of 96 dB(A) at 300 km/h, measured 25m from the train. Thus the specification is working to the 1983 proposed EC maximum of 96 dB (A), even though the speed has risen by a factor of 1.8.

CONSTRUCTION PLANT

In 1984, the Council adopted a "framework directive" [4] laying down procedures for EC type-approval. Here approved products may have their sound power level L_{WA} in dB (A) stamped on their label, together with the EC mark. The sound power level is measured relative to a reference sound power of 10-12 Watts, in strictly controlled conditions. This labelling system will help purchasers in their search for the least noisy plant. Six separative directives, [6] for particular classes of construction equipment lay down maximum sound power levels. For example, the largest concrete breaker has a permissible sound power level L_{WA} of 114 dB (A). This may be calculated [7] to be approximately equivalent to a sound pressure level L_{PA} of 89dB (A) heard by a bystander at a distance of 7.5 metres from the source. This is 5dB (A) higher than that from the highest powered lorry, mentioned earlier.

ENVIRONMENTAL IMPACT ASSESSMENT

All major projects in the EC became subject to an Environmental Impact Assessment (EIA), with effect from 2 July 1988 [11]. The developer must present information to the competent authority on the effects upon the environment, including noise and vibration, and on measures to prevent and reduce any adverse effects. For example, the Channel Tunnel Group have presented an EIA to the local authorities on the areas likely to be impacted by noise from the tunnel terminal area, during both the construction and the operation stages. The response of the local authorities [12] affected by the proposed Channel Tunnel Rail Link has been to establish their own criteria and to develop a noise standard. This standard defines the equivalent continuous sound pressure levels over the stated time periods, at which a purchase offer of property should be made and additionally sound insulation should be provided for any residential property so exposed.

TABLE 1	TIME PERIOD	dB(A) L_{Aeq} 1m from façade
Daytime	0700-1900	65
Evening	1900-2300	60
Night time	2300-0700	55
Maximum noise level	2300-0700	80L_{Amax}

By contrast, the 1991 recommendation [19] for a UK national noise insulation standard for new railway lines uses a level of 66dBA L_{Aeq} over 24 hours and 61 dBA for night-time.

NOISE AT WORK

The directive on the protection of workers from risks related to exposure to noise at work [13] came into force on 1 January 1990. This requires the employer to use technical preventive measures to reduce the daily personal noise exposure of workers to below 90 dB (A) for an 8 hour base clay. A second directive, called the machinery safety directive [14] does not have to be implemented until 31 December 1992. It requires the manufacturer to declare the noise emission from a machine at workstations if the A-weighted equivalent continuous sound pressure level exceeds 70 dB (A). If the level is lower than 70 dB (A) this must be stated.

NOISE IN AND AROUND THE HOME

Amazingly, there is a directive in force limiting the noise emissions from motorized lawn mowers [15]. The maximum sound power level is limited to 96dB (A) for mowers with a cutting width less than 500mm, for example. In 1986, the EC turned their attention to airborne noise emitted by household appliances, such as food mixers, washing machines, and free-standing heating appliances. The directive [16] does not lay down maximum noise limits, but rather states that Member States may require the manufacturer to label his product with the A-weighted sound power level. Thus the EC appear to be relying on a discerning customer to trade off noise against price and product features. The only problem with this strategy is that a customer is not normally able to turn on a machine in the shop to hear it, to compare it with other machines. Furthermore, they cannot make an informed choice, because they do not know what the maximum level should be. It is therefore suggested that this position should be rectified, with a directive stating maximum noise limits for different classes of appliance.

PROTECTION AGAINST NOISE

The directive on construction products [17] must be implemented by 27 June 1991 by the Member States. It lays down six essential requirements, which must be satisfied for an economically reasonably working like. One of these is the requirement that the construction works (e.g. a building) must be designed and built in such a way that the noise perceived by the occupants, or people nearby, is kept down to a level that will not threaten their health. It should also allow them to sleep rest and work in satisfactory conditions. This requirement of protection against noise has been given concrete form in an interpretative document [18]. The European Commission will then give a mandate to the European Committee for Standardization to produce harmonized European technical specifications. For example, a specification is needed to quantify the direct airborne sound reduction of an element of known surface area. In this way the requirement for the protection against airborne noise between enclosed spaces will be satisfied. Products which satisfy the technical specifications may bear the EC conformity mark.

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The Importance of Good Acoustics for Communication

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SUMMARY

This paper describes some ways In which the acoustics of a room or space are assessed, and indicates how good acoustics can aid communication. Some examples of different acoustic environments are given.

INTRODUCTION

It often seems to me that acoustics are only mentioned or considered when large, important and probably expensive buildings are being considered, such as concert halls or auditoria, and although it is extremely important to get the acoustics right in these places, good acoustics are also vitally important in more mundane spaces especially those we use every day. If the acoustic environment of a space is wrong for a particular use, then it will not be able to function properly. The acoustics of a space can affect behaviour within it, can spoil good communication, and can add significantly to stress to those who work in it..

THEORY

The acoustics of a space defines that way sound is heard by a listener. Sound will come from a source somewhere within the space and will be conveyed to the listener both directly (taking the shortest route) and also by being reflected by surrounding surfaces before reaching the listener. The reflected sound will have had a longer path than the direct sound and will thus reach the listener after the direct sound. If the difference between these two paths is small, the reflected sound will contribute to the reverberation in the room, if the difference is great it will be heard as a echo - an acoustic fault.

The amount of reflection which will occur within a space will be a product of the surface finishes within it. Some finishes will reflect most of the sound which is incident upon them. such as glass, plaster and concrete, and some will absorb the sound rather that reflect it. These highly absorbing materials are usually those with 50ft porous surfaces or those which can vibrate. The efficiency of an absorbing surface is rated by its absorption coefficient, which is the fraction of the sound incident on the surface which is absorbed, so if no sound is absorbed but all reflected, the absorption coefficient would be 0, and if it were all to be absorbed it would be 1.If half of it were to be absorbed it would be 0.5.

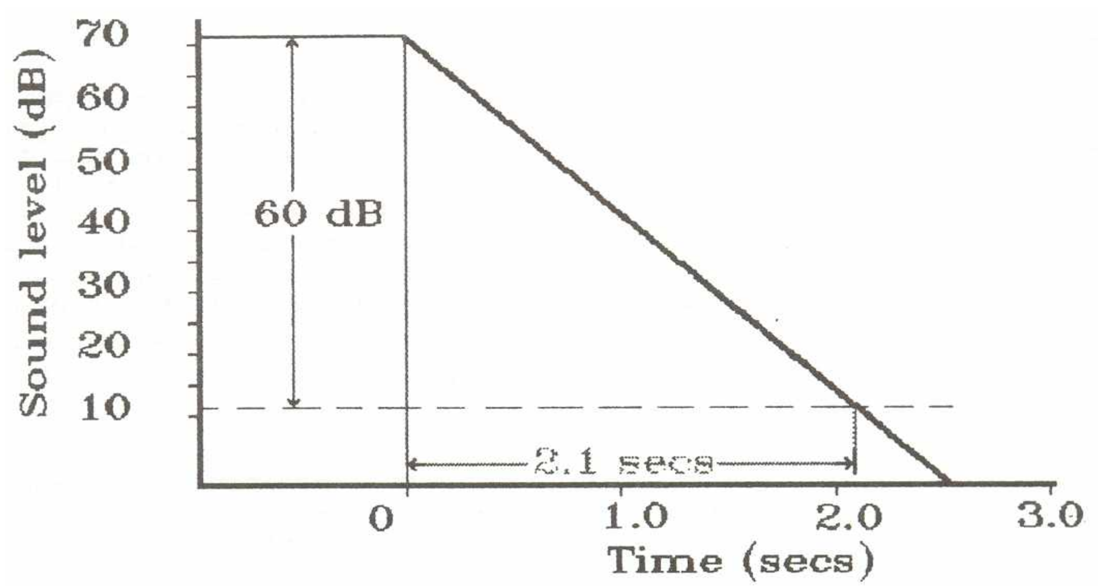
From the surface coverings and the position of reflecting surfaces, the listener will hear a sound which will die away at a specific rate, which is caused by the multiple reflections. The rate of decay of sound within a space is called the Reverberation Time (RT) and is defined as the length of time taken for a sound to decay by 60 dB, and this parameter is simply define by the relationship

RT = 0.16V/A

where V = volume of room (m:3)
A = total absorption (sabins)

(The total absorption is the sum of the absorption of each surface, Area x absorption coefficient.)

Thus the length of the reverberation time defines how 'live' or 'dead' a room sounds, and it can be controlled by the amount of absorption and the position of reflecting surfaces in a room. If a steady sound in a room is switches off instantaneously, the decay curve of the sound will look like this.



In practise, it is not normally so smooth and there may be irregularities showing echoes or double slope decays. Decay rates also changes with the frequency of the sound.

USE OF THE THEORY

So much for the theory but how can it be used? If you are talking to someone face to face then the direct sound is normally so strong that there are few problems with the acoustics which will affect the intelligibility of what you say. If the speaker and the listener are far enough away that the reflected sound becomes an important factor, then the acoustics will affect the intelligibility.

The type of communication to be used in a room or space must be considered. Do you wish to talk to someone in private, or do you want to be heard by a whole audience? Will many people be talking at the same time? Do you only need intelligibility, or do you want acoustics which will enhance music and what type of music? Do you want a quiet or a noisy environment? Different acoustic environments are listed below.

1. A teaching room such as a lecture room or classroom. In this case the sound needs to be projected to all the room, so the ceiling should be partially reflecting in order to help the sound waves to carry to the back. The reverberation time should not be too long especially at high frequencies which define the consonant in speech.

2. A small hall where music is to be performed. Similar treatment as in number 1 above, except that the reverberation time should be longer to enhance the musical sound. Also care must be taken to get the spectrum of RTs at different frequencies balanced

3. An open plan office. This has very specialised acoustic needs. The aim is to allow speech between individuals but to prevent the sound from travelling for any distance. This is brought about by covering a low ceiling with an efficient acoustic absorbent, usually acoustic tile to produce a low RT, and using absorbing screens to break up direct sound. The ideal is that although there is a background sound made up of all the noise wishing the office that no one sounds is distinguishable, and privacy is maintained where necessary. The background sound is known as masking noise and sometimes this is added artificially for example by allowing the heating and ventilating system to make more noise than would be allowed In modular offices.

This method of using as much absorption as possible to prevent sounds from travelling is often used to improve what are generally noisy environments. Two more examples of this are dining rooms and corridor-so Both of these tend to be reflecting, and both of them are sound sources, so by preventing as far as possible any transference of sound by reflection the general noise level with thin can be kept to a minimum.

4. Multi-Purpose Halls. These are the bane of acoustic consultants everywhere. It is understandable that a client should want to get the maximum use out of a hall, but it is impossible to design to give a good environment for say symphony concerts and dining rooms, and the only method of dealing with this IS to design for the median and explain to the customer that the environment will not be ideal for much at all. There are methods by which the acoustics of rooms can be changeable, but so far I do not think that these are practical possibilities for most spaces.

OTHER ASPECTS

So far this paper has concentrated on the sound within rooms and its behaviour; however, sound from other sources will also have to be taken into account when considering the acoustic environment of a room or space. Intrusive noise from any unwanted source causes problems acoustically but this is especially true when the room or space in question is devoted to listening. Noise from outside can be prevented by good sound insulation and attention to detail.

Some faults in acoustics can be changed by the use of electronics. This is especially true when the RT of a room is too short and hence the sound does not carry to all parts of the room. In this case a sound reinforcement system can relay the sound to the further parts of the room. Care must be taken with this to provide a delay line to the speakers so that the sound appears to be coming from the speaker and not from the loudspeaker which is nearest to the listener.

Electronic corrective measures have also been used in much larger endeavours. The Festival Hall in London has an "Assisted Resonance" system to lengthen the rather short RT in the hall. By feeding back frequencies which are produced by the music, the system is natural and unobtrusive. Other similar systems

CONCLUSION

In order to communicate with others in any situation, the acoustic environment must suit the use for the space. In many situations the right sort of environment has just evolved over the years, but now it is becoming more obvious that for a relatively small outlay at the start of a design, acoustics can be defined which will almost guarantee the success of the design in use. Very few people notice the acoustics of a room or space until they have had experience of a bad design (and even then people may know something is wrong but not know what>, but those who have experienced poor acoustics will tell how it limits their work and makes it difficult.

One of our primary communication methods with each other is through speech, and this should be reflected in the care with which we design our buildings.

Update for Engineers on Elementary Particle Physics

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Every engineer should be scientifically literate in this burgeoning field of modern physics that affects many engineering disciplines. In this tutorial, the author will lead participants through cosmology (the history of the universe), the "Standard Model" which depicts relationships between elementary particles (quark and lepton families), the four forces (E/M, gravity, weak and strong), and their carriers; parts of operations of proton/ anti-proton and electron/anti-electron particle accelerators, especially the ones at Fermi National Laboratory and Stanford Accelerator Center; and some basic information about the proposed superconducting supercollider. Audio visuals will illustrate the tutorial and a list of reading and reference materials will be available.

BS10

Statistical Design of Experiments in Scientific Communication

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SUMMARY

Statistical Design of Experiments (SDE) is an excellent tool for enhancing communication across scientific disciplines. It reduces the total number of experiments required, minimizing costs, resource allocations, and data analysis efforts.

IDENTIFYING THE COMMUNICATION GAP

Communication is defined as, "The imparting or interchange of thoughts, opinions, or information by speech and writing."[l] Communication must come often in the development of a new product or design. Teamwork between manufacturing, research and development, and marketing personnel is crucial, and thinking skills must be at their peak. However, everyone wants something different The scientist wants accuracy, the engineer wants convenience, the statistician wants repeatability and the manager wants it all: more quality product for less cost (and more profit). Above all, the customer must be satisfied.

Due to lack of know ledge, many engineers do not even recognize the needs of the customer. The input-output format of SDE is a tool that provides a common framework for communication across such department boundaries. Differing views of the world contribute to the tension between statisticians, engineers, and scientists. Each group uses its own jargon and, hence, cannot begin to communicate. For example, engineers and scientists see operational problems and are good at putting solutions together, but they lack a stochastic view of the world. [2] Engineers need help in implementing and managing the complete problem and solving the process. Engineers generally know little of statistical methods, and statisticians know little of engineering.

The statisticians often view their role only as helping plan for the data collection and its analysis. Typically, this role does not include offering advice and helping with the plan and management of the entire project. This is a serious gap between the service available and the need. Most statisticians have little experience in this role and may decline it, saying it has nothing to do with statistics. Partnerships must develop. All participants must spend time learning from each other. While they are learning, SDE helps design quality into the product or process. Once the process is understood, evaluations of alternative configurations and optimal material choices early on rapidly satisfy customer needs.

In Experiments in Industry, Design. Analysis and Interpretation of Results, it is stated, "Statistical design, analysis and interpretation of experiments also provides a framework for thinking about a given problem and a vocabulary to use when discussing the problem with others. This results in a unified approach to experimentation which, when adopted by an entire organization, improves communication within the organization and speeds up the problem solving process."[3]

This reference indicates that for those who have implemented SDE, SDE does indeed provide a format in which everyone is communicating on the same level. Since many factors may be evaluated simultaneously, SDE meshes well with other communication tools, such as brainstorming. It provides the framework for resolving our divergent opinions, reduces the emotion, and causes us to focus on the facts. It takes out the peripheral "causes" that people

Throw out in meetings and deals just with the facts and the events. The improved communication between departments and the involvement of the people in solving problems are extremely beneficial. [4]

With today's ever increasing data collection and data needs, we need to search out new ways for continual communication of ideas, quickly and simply. SDE is one of those basic tools. It puts all of the disciplines together and bridges the communication gap between these disciplines.

DEFINING STATISTICAL DESIGN OF EXPERIMENTS

Experimentation of any type usually involves relating the effects of some input factors, or variables we can control (or measure), to some output factors, or performance characteristics, we want to optimize. Typical examples of input factors in a manufacturing or development project might include process temperatures and pressures, materials, operators, and dimensions. Output factors might be process yield, product performance, and characteristics. In a marketing situation, input factors may be product selling price, geographical location of vendor, and quality of product The optimal output factors may be unit sales, profit per unit, total profit, and customer satisfaction.

SDE is the purposeful changing of inputs to a process in order to evaluate their effects on the response(s) [output(s)]. The process may be a combination of many things (i.e., machines, materials, methods, people, environment, and measurements), which, when used together, provide a service, produce a product, or complete a task. SDE design uses the scientific approach, which provides a better understanding of a process and how the inputs affect the process. [5]

The traditional approach is to change one factor at a time. All the other factors are held at a constant value. The effect on the output factors is measured. After the first input factor is optimized, it is held constant while a second input factor is optimized. Unfortunately, the value of the first factor may now no longer be optimal and may need to be reevaluated. Now the second factor needs reoptimization. After much iteration, the two factors may be approximately optimized; but if more factors are to be evaluated, the first two may again be deoptimized. As the number of factors increases, the experimentation becomes more difficult. The one-at-a-time approach is time consuming and costly, and the results are difficult to interpret. [5]

Another traditional alternative would be to run all combinations of all levels of all factors. This is sometimes called a full matrix approach or full factorial design. However, a matrix design with seven variables at two levels each would require 2 x 2 x 2 x 2 x 2 x 2 x 2 = 128 experiments. [7]

So what would SDE offer? If only main effects need be addressed and no interactions are expected, then as few as eight experiments may be adequate-quite a cost savings in materials, labor, and analysis dollars. This is called a 1/16 fractional factorial design.

SDE is not new. It was developed by R. A. Fisher in the mid 1920's. More recently, it has been popularized by Genichi Taguchi of Japan. The basic concepts of SDE, developed by statisticians, enhance precise statistical analysis. SDE is a tool that is applicable to virtually all experimental studies, from the simple to the complex. Literally hundreds of SDEs are available to cover any eventuality. They involve varying many input factors simultaneously in a carefully planned manner so their individual and combined effects can be separated. They offer maximum information for a given expenditure on experimentation. [7]

SIMPLIFYING THE PROCESS/GAINING MORE INFORMATION

Statistically designed experiments provide the most crucial data and use it more extensively to answer well thought-out questions. Time and thought spent in formulating the objectives will reduce waste of resources throughout the experimentation.

The right response measurements must be chosen. The selection of the right response to meet the objectives requires solid engineering insight by including critical discussion of the proper response issues. Attention must be focused on the most important factors for investigation. Success in experimentation requires a careful blending of technical engineering knowledge, practical experience of the on-line worker, statistical prowess, and common sense by all the contributors. [6]

Thomas Edison once said, "I've tried everything. I have not failed; I've just found 10,000 ways that won't work."[8] Historically, the one-factor-at-a-time experimentation used by Edison does not allow for full understanding of the process and how factors interact. The engineer benefits from experimental design by understanding the relationships between the input factors and the responses. Prediction equations (mathematical models) are established that relate responses to input factors, and responses are established. Edison's approach is slow and costly by comparison. Can you imagine what he could have done had he been more efficient in his quest for information by using SDE?

As stated in *Experiments in Industry, Design, Analysis and Interpretation of Results*, "The statistical approach to experimentation provides an orderly way to collect, analyze, and interpret data to satisfy the objectives of the study.

By using statistics in the design of the experiment, one obtains the maximum amount of information for the amount of experimentation extended. This is accomplished by the efficient allocation of the experimental runs to the combination of variables studied. A good experimental design also provides a plan for analysis and interpretation thereby enabling scientists to know what they are going to with the data even before it is collected. This encourages experimenters to carefully plan their experimental programs before they begin to conduct the tests."[3]

The most crucial stage impacting communication throughout experimentation is in the planning stage. Up to 50% of the overall effort should go into this phase. All key players (managers, engineers, experts in the particularly related disciplines, statisticians, and analysts) should be involved. The customer's needs and the applicability, and practicality of the experiment in the real world must be communicated. The resulting analysis will provide more thorough and usable conclusions. The apparent objective should be modified, rejected, and replaced until a clear meaningful objective is settled upon. To test for a meaningful objective, ask what action will be taken based on meeting that objective. What action will be taken if it is not met? If the action will be the same in either case, a serious questioning of the value of the experiment is in order. Abandoning a meaningless experiment before you start can be a most valuable end in itself. Timely communication between all those involved during the experiment will provide the most valuable and meaningful feedback.[5]

The major steps in SDE are listed below.

1. Statement of the problem
2. Objectives of the experiment
3. Establish schedule and budget
4. Identify and refine the required response to reflect the objectives
5. Determine the major factors (controllable, measurable noise) and the levels of each factor that could influence the desired response
6. Determine the desired number of runs and the allowable number of runs given time and budget
7. Compromise information with the budget, schedule, resources available, and the choice of design
8. Determine the best analysis techniques (Regression Analysis, Analysis of Variance, Signal to Noise Ratio, Response Surface Methodology)
9. Run the experiment and analyze the results
10. Make conclusions and predictions
11. Confirm results with prediction runs
12. Refine process with further experimentation.

These steps guide the communication needs. They focus the participants on the problem to be solved. This problem may be in research and development, manufacturing, advertising, or process or product development, whether it be in finding a robust or refined product or process.

COMMUNICATING MANAGER NEEDS

SDE provides the manager with the following costs and resource improvements: (a) improved performance characteristics of the product, (b) reduced cost in materials and personnel labor, and (c) shortened product development and production time. Identifying critical factor levels that optimize the response will lead to reduction of scrap and rework. Understanding the factor levels may help to relax tolerances on benign factors and permit the selection of less expensive materials. Shortened lead times are accomplished by relating testing procedures directly to what the customer really requires. [6]

CLOSING THE COMMUNICATION GAP

Learning by discovery and the communication of ideas are the foundation in the pursuit of scientific knowledge. SDE is an engineering tool that provides the "make it happen" attitude. Ways to overcome problems and work with natural phenomenons become simpler to investigate. SDE promotes the pursuit of knowledge by creative, scientific, and critical thinking in a disciplined structure. SDE can resolve interactions between variables that would not normally be discovered in using the one-factor-at-a-time approach. SDE, provides a visual tool to communicate ideas. It encourages search and discovery. Development and refinement of designs provide for better quality products and processes.

Experiments often involve people in many different disciplines. SDE facilitates the interdisciplinary communication and encourages "ownership". Demonstrations of these ideas are provided in the references given at !he end of the article. Workshops providing further structured study on SDE are given in Reference 7.

In our quest for knowledge we study the laws of nature, both theoretically and empirically. SDE provides a communications link between the theoreticians and the empiricists. SDE has become an excellent communication tool between scientists, engineers, statisticians, and managers.

Communication is vital to good experimentation. It helps to convey thoughts and ideas from many sources in order to comprehend our universe. In working toward a common goal, trying to put many disciplines together in optimizing our expertise, the famous Nobel Prize physicist Richard P. Feynman once put learning about the wonders of the Universe into perspective:

If our small minds, for some convenience, divide this glass of wine, this universe, into parts-physics, biology, geology, astronomy, psychology, and so on-remember that nature does not know it! So let us put it all back together, not forgetting ultimately what it is for. Let it give us one more final pleasure: drink it and forget it all! (Feynman, Leighton and Sands 1963, pp. 3-10)[2]

We all have special talents to contribute to the body of knowledge. Our expertise and our craftsmanship can help everyone. SDE is a tool that each expert and craftsman can use, together as teams, to build a stronger foundation. The foundation may not be mathematically or theoretically understood, but at least an empirical comprehension of the laws of nature will be available. SDE will help us to better work with Nature and to communicate better with each other.

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BS11

Automatic Finite Element Analysis: Understanding the Technology

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SUMMARY

Researchers are developing automatic finite element analysis (AFEA) so that complex problems can be more easily analysed. As with all technologies it is important to understand its underlying principles. The basic concepts of AFEA are presented. The authors approach is used to illustrate several aspects of AFEA.

INTRODUCTION

Finite element analysis (FEA) is a technique for solving partial differential equations e.g., the three-dimensional heat equation. In traditional FEA, the file containing topology, nodal co-ordinates, boundary and loading conditions defines the FEA approximation. The FEA program is unable to improve this approximation and provides little indication of the error in the results. AFEA, which addresses these concerns, has two principal advantages. The initial mesh, which need not be precisely specified by the user, is adapted to suit the geometry, boundary conditions and loading conditions. Also, error estimates are used to describe the accuracy of the results and guide the adaptive changes in the mesh.

In current FEA practice, a user must have sufficient theoretical knowledge to decompose a problem into an FEA model. Many processes are nonlinear and time-dependent. Regions requiring a fine mesh may move through the volume. It is frequently impossible to use a uniform mesh which is fine enough to resolve the local phenomena. In such problems the optimal mesh may be different for every time step. An essential component of AFEA is an adaptive mesh-management algorithm which alters the mesh to suit conditions of this kind.

Finally, something must guide the adaptive changes in the mesh. Error estimates measure the error in the solution and provide the feedback needed to steer the analysis towards a more accurate solution. The adaptive procedures alter the mesh in response to the error estimates.

MODIFYING THE SPATIAL MESH

There are three well-understood approaches to adaptively altering a finite element mesh [1] [2] [3] [4]. The first approach enlarges the function space. H-refinement i.e., increasing the number of elements, and/or p-refinement i.e., increasing the polynomial order of the elements, can be used. The second, classified as moving finite element methods or r-methods, involves deforming the function space by moving the nodes. Finally, An entirely new mesh can be created.

The authors use h-refinement and h-coarsening. H-refinement is more efficient than p-refinement if the solution is rough; e.g., the gradient is discontinuous. This often occurs at elasto-plastic boundaries and in the vicinity of local effects. In a dynamic situation, maintaining a fully refined mesh is expensive. H-coarsening; i.e., amalgamating elements, is included to reduce the computational costs.

Research in adaptive mesh management; e.g., [5] [6], indicates there are three principal requirements for adaptive h-refinement. First, bisection-type refinement should be used to maintain shape regularity. Second, binary grading, in which 2 elements join 1 element, should be used to avoid abrupt transitions from coarse to fine regions. Third, refinement may need to propagate to neighbouring elements. The authors have developed explicit rules [7] to formalize these concepts for refinement and coarsening of an 8- to 26-node mesh-grading element [8]. This element is well suited to adaptive modification of the function space since sub elements occur naturally in its formulation.

DATA STRUCTURES

Typical FEA problems may involve meshes with 105 nodes and elements. The selection of appropriate data structures is a key concern for managing dynamic and adaptive 3-D meshes.

In h-adaptive meshes nodes are inserted in and deleted from the mesh; refinement propagates to neighbours; siblings must know one another; and different generations of parents and children may be present. The selected data structures maintain: the topology and co-ordinates of a valid mesh; adjacency relationships between an element and its neighbours; and a relationship between children and their parent.

The authors use FORTRAN arrays for all three since data retrieval of a single item from a FORTRAN array can occur in constant time, 0(1), if the indices are known. This must be balanced against the cost of updating the arrays during adaptive procedures. Spatially addressable tree structures such as quad-trees, oct-trees and k-D trees are often used for the parent-child relationships. The authors prefer to use an arbitrary a parent-child relationship [7]. This has several advantages: coarsening is not restricted to the immediate family tree; the initial or root mesh can be coarsened; and keys into the tree are not required.

A MESH-MANAGEMENT ALGORITHM

The authors' algorithm uses a number of procedures to support adaptive h-refinement and h-coarsening. Boolean error indicators are used to direct the changes. To preserve accuracy, refinement takes precedence over coarsening. In coarsening, arbitrary groups of 8, 4 and 2 elements are joined. Figures 1 and 2 show this algorithm adaptively managing the mesh to follow a point source around the end of a pipe.

Algorithm: Adaptive_Mesh_Management
 Start Adaptive_Mesh_Management
Do Label 2 over elements
   For elements to be refined Refine Element
      Propagate Refinement
      Match_Edges_and_Surfaces
      Add_Required_Nodes_to_Neighbours
      Create- Children
  End for

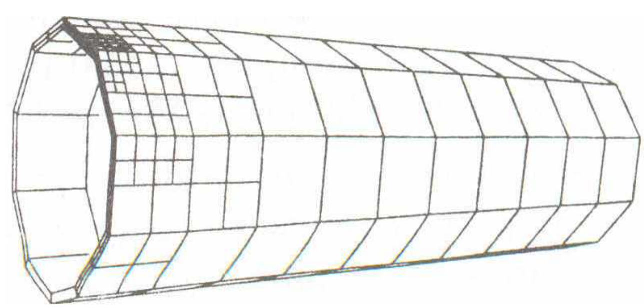

Fig. 1Mesh after 3 steps

For elements to be coarsened Coarsen Element
Do Label over groups of 8, then 4, then 2
 Find Siblings
Adopt Parent
 Remove_Redundant_Nodes3rom_Parent
 Label Continue
 Endfor
Label 2 Continue End Adaptive_Mesh_Management

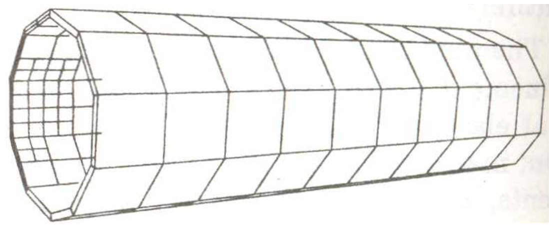

Fig. 2 Mesh after 7 steps

A POSTERIORI ERROR ESTIMATES

A priori error estimates are rarely available for practical problems[9]. Robust a posteriori error estimates which use the information obtained during the solution process I are needed. The role of error estimates is to systematically reduce the error in the solution and the computational cost of the solution by guiding adaptive changes in the I mesh. It is necessary to judge the error in the numerical solution and to understand the distribution of the error over the problem domain.

Errors are calculated in local and global senses. Local error measures are used to guide local alterations in the mesh. The global error describes the overall solution. The common forms of a posteriori error estimates are [10]:

1. Duality methods in which upper and lower bounds of the element error are derived;
2. Element residual methods in which the residual; i.e., the difference between the AFE solution and governing differential equation is computed over each element;
3. Sub domain-residual methods in which the error for a given element is determined using a patch of surrounding elements;
4. Interpolation methods which use the super convergence properties of standard FEA to produce rapid and often crude estimates of the local error;
5. Post processing methods in which the FEA solution is compared to a post processed version of the solution.

The authors consider duality methods in which the problem is split into 2 function spaces. For example, in a stress analysis, one function space contains the kinematically admissible stress (KAS) field and the other, the statically admissible stress (SAS) field [11]. The KAS satisfies the constitutive and compatibility equations exactly. The equilibrium equation is only satisfied in an average sense. The SAS satisfies the equilibrium and the constitutive equations exactly but the compatibility equation is satisfied only approximately. The KAS and SAS allow upper and lower bounds on the error to be obtained. From these, element and global error measures can be calculated to guide the adaptive changes in the mesh.

DATA TRANSFER

After adaptive changes have been made the topology and co-ordinates of the new mesh are available. Data describing the initial conditions and state must be transferred from the old to the new mesh; e.g., nodal temperatures and Gauss point stresses. Each new mesh must completely specify the initial conditions for that step.

The most common approach to this problem appears to be simple interpolation of the fields from the nodal data. This approach is used by Jiang. [12] Although this strategy is accurate for bisection-type refinement it may not conserve mass, energy and momentum when elements are coarsened. In coarsening, some form of projection must be used particularly when the fields of interest contain sharp discontinuities. A least squares approach to data transfer can be used for both refinement and coarsening. It

Is formulated by finding the new field which minimizes the error between the two fields.

SOLVERS

Direct solvers based on the bandwidth or front width of the problem are commonly used in FEA. These solvers use Gaussian elimination and back substitution. The authors use a frontal solver. The front width can be minimized for the root mesh. However, as nodes and elements are are added and removed the initial front width is degraded. Hence the front width needs to be optimized regularly. This adds a degree of complexity to AFEA and increases the computational costs. In direct solvers, memory is consumed by the need for keeping portions of the stiffness matrix and right-hand side.

Indirect solvers such as an element-by-element conjugate gradient solution [12] will become standard. Nodal and element numbering cease to be a contributing factor in the analysis. In addition, since the elements are handled individually, less memory is required and the solution of large matrices is accomplished more rapidly.

REMARKS

The principal components of AFEA are an adaptive mesh-management algorithm and a posteriori error estimates. The data structures used by the algorithm are a key concern. Data transfer between meshes and the use of appropriate solvers must also be considered.

ACKNOWLEDGEMENTS

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The Design and Development of Molecular Sensors based on selective macro cyclic systems.

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SUMMARY

The design and development of molecular sensors is discussed. The construction of a solvent polymeric membrane ion-selective electrode for the determination of iodide, using Aliquat 336 as the electro active species, is described. The electrodes showed linear response in the range 10^{-1}-10^{-4} M iodide with near Nernstian slopes.

INTRODUCTION

Molecular sensors are discrete devices which combine developments in chemistry and biology with electronics technology to provide instrumentation for measurement in a range of areas.

The molecular sensor to be discussed consists of two principle components: a molecular recognition element (chemical or biological component) and a transducing element (the instrumental component).

The molecular recognition element is very important as it must be capable of identifying and measuring the concentration of a particular substance in a mixture of other substances. The type of molecular recognition elements of interest here are macro cyclic compounds, including crown ethers, which have been widely studied in their role as ionophores. These molecules form complexes with metal ions (especially alkali and alkaline earth cations, also transition metal ions) and can show high selectivity to a particular ion. By designing specific molecules this high selectivity has been exploited for preconcentration either by solvent extraction [l] or attached to chemically modified electrodes [2]. The crown ethers have also been used as neutral carriers for ion-selective membranes for potentiometric measurements [3].

Further use of the molecules can be made if they change colour on complexation (chromoionophores). In that case they can be used for optical sensors where absorbance, reflectance or fluorescence measurements are made [4J.

The sensor developed here is an ion-selective electrode and the transducing element involves measuring the electrical potential set up at the liquid/membrane interfaces in the test electrode with a reference electrode which is unaffected by changes of concentration in the sample being analysed.

This work reports some investigations into the use of macro cyclic compounds in solvent polymeric membrane ion-selective electrodes.

EXPERIMENTAL

The sensor that was constructed is shown in figure 1.

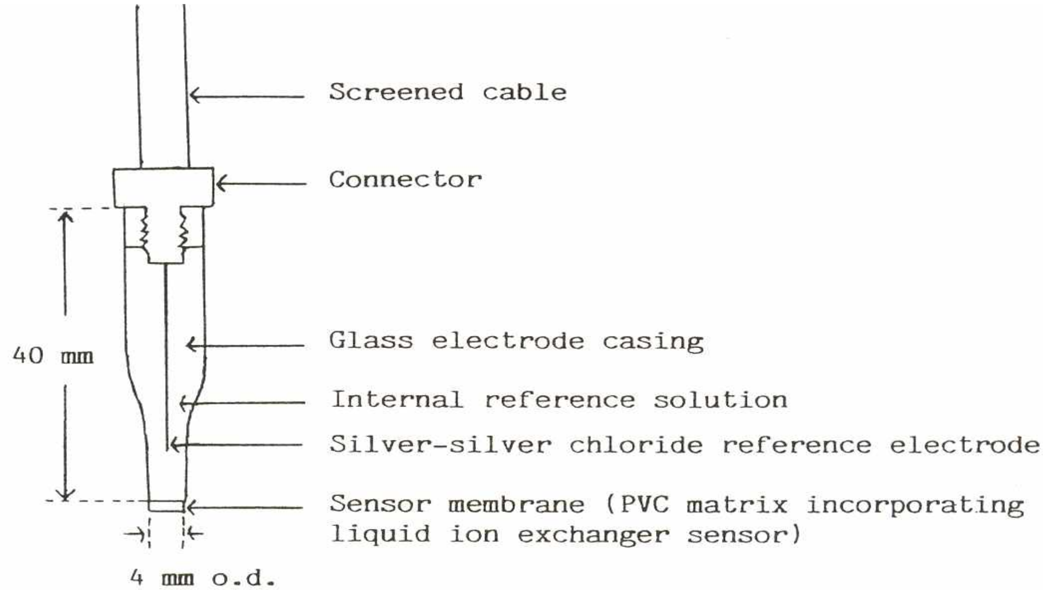

FIGURE 1. Longitudinal section of the sensor constructed

The basic electrode consisted of coaxial cable soldered to a silver wire, with the soldered joint being held in a plastic fitting. Membrane was attached to the bottom of a glass casing. The casing had a small hole in which to introduce the internal filling solution and this was sealed into the plastic fitting. The most al part of the work was the preparation of the electro active membranes. These were prepared in a similar method to that used by Thomas and co-workers [5]. Glass casting rings were cut from glass ling and placed onto a glass slide. The membrane solution was red *into* the mould and a wad of filter paper was placed over the g and weighted down. The solution was allowed to undergo trolled evaporation for 2-3 days.

The electro active species utilised was an ion exchanger, Aliquat 330 (tricaprylylmethylammonium chloride). This was physically trapped in the PVC membrane. A plasticiser, dioctylnylphosphonate, was introduced to improve the physical properties the membrane. Different quantities of the reagent were dissolved tetrahydrofuran to provide the membrane solution for casting.

Table 1 show the different compositions used.

Membrane	Aliquat 336/mg	PVC/mg	Plasticizer/mg
1	100	100	40
2	200	100	40
3	200	100	20

A punch was used to cut the membrane to the correct size and s was then sealed to the bottom of the glass casing. The electrodes were tested on iodide. This meant filling the electrode h 0.1 M KI solution. The electrode was then conditioned in 0.1 M for 1 hour.

The operation of the sensor was then tested with a Radiometer high impedance input ion meter and a reference electrode. Measurements were made at 18°C.

RESULTS AND DISCUSSION

The performance of the membranes was assessed by preparing calibration graphs for a range of iodide solutions (10^{-1} - 10^{-7} M), see figures 2-4.

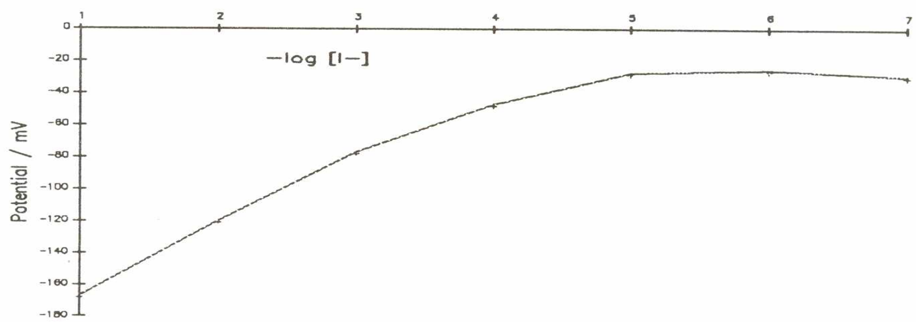

FIGURE 2. Calibration graph for electrode A, membrane 1

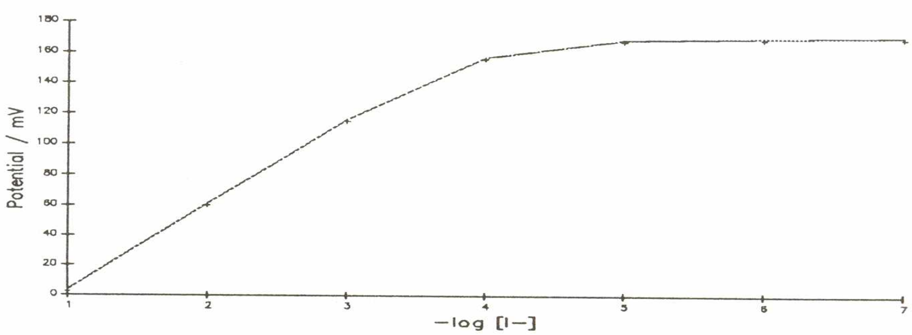

FIGURE 3. Calibration graph for electrode B, membrane 2

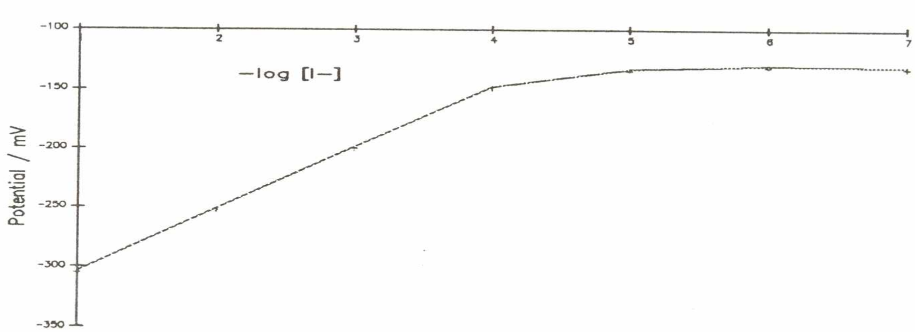

FIGURE 4. Calibration graph for electrode C, membrane 3

Linear calibrations were obtained from 10^{-1} - 10^{-4} M, below this concentration the graphs flattened out. This was because the ion exchanger lacked selectivity and interferences from chloride were being detected. The gradient of these graphs was then calculated for the linear range and compared with the theoretical Nernstian value of 59mV decade^{-1}. The results can be seen in table 2.

TABLE 2

ELECTRODE	MEMBRANE	TIME AFTER PREPARATION/hr	GRADIENT/mV decade-1
A	1	½	40±3
B	2	0	51±3
B	2	24	55±3
B	2	56	54±2
B	2	168	53±2
C	3	24-35	52±0
C	3	120	52±3

As can be seen in table 2 the composition of the membrane affects the sensors sensitivity. From a practical point of view the composition is also important, for example, if too much plasticiser is present the membrane becomes difficult to handle. The performance of the sensor also changes with time, with sensor B improving after 24 hours and then degrading after 56 hours. This is probably due to leaching of the electro active reagent.

CONCLUSIONS

This work has demonstrated the operation of a solvent polymeric membrane ion-selective electrode sensor. More trials need to be carried out using other compounds, testing membrane composition changes and interference problems from other chemical species. To improve the selectivity novel, more selective, reagents must be designed and this requires the input of synthetic chemists, this is an area of great potential to be investigated.

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A Study on Modelling Insulating Films with Two Blocking Electrodes for the Case of Two Mobile Charges.

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The transport equations in the case of thin insulating films between two blocking electrodes are solved considering two mobile charges. The mobilities are considered field dependent [1] Transit current results at high applied voltages are compared with experimental ones [2].

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The Synthesis and Characterisation of Liquid-Crystalline Crowns

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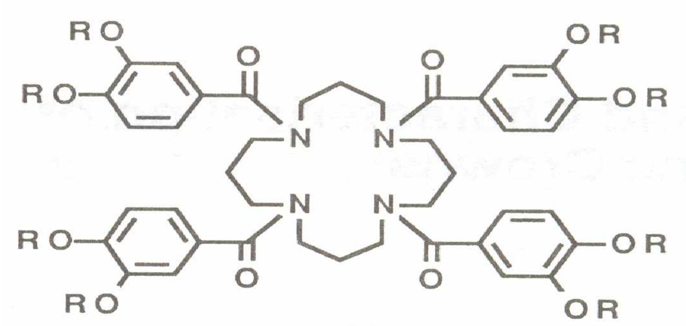
SUMMARY

The preparation and characterization of a new class of liquid-crystalline materials that incorporate crown ethers and aza crowns into their molecular structures is reported. Crowns can either be attached to the peripheral regions of the molecular structures of calamitic or discotic liquid crystals, or incorporated as an integral part of the central core structure.

INTRODUCTION

Very little work has been reported on crown ether liquid crystal systems in the literature, but respected researchers, for example Lehn [1], have recently turned their attention to the investigation of such liquid crystal crowns for applications in sensors and as ion gates [2]. Similarly, Japanese workers have also succeeded in preparing liquid-crystalline crown ether derivatives of cholesterol that selectively reflect light in their helically ordered chiral nematic phases [3]. Remarkably the pitch of the helix of the in this phase was found to be sensitive to the nature of guest molecules or atoms introduced into the crown. Thus, the average wavelength of the selective reflection band is "guest dependent". For example, when various chiral amino acids were introduced into the crown ether, it was found that the recorded change in pitch of the helix was dependent on the structure of amino acid guest. Moreover, it was shown that the spatial configuration of the amino acid could be determined by this method - one enantiomer unwinds the helix whereas the other tightens the helix.

Discotic mesophases have been shown, by Lattermann[4,5], to be exhibited by amide derivatives of aza crowns, see structure 1. In discotic phases the disc-shaped molecules stack one on top of another to form columnar structures. The molecules can be ordered or disordered within the columns and the columns are free to slide past one another, thereby imparting fluidity to the phase.



(1)

The clearing point transition temperatures for the discotic to liquid phase changes for these materials were found to be below 1000C. Moreover, the compounds readily formed glasses on cooling, thereby retaining the structures of the discophase into the glassy state. A photomicrograph of the texture of the discophase of the di-n-decyloxy homologue of compound (1) taken between crossed polars is shown in plate 1.

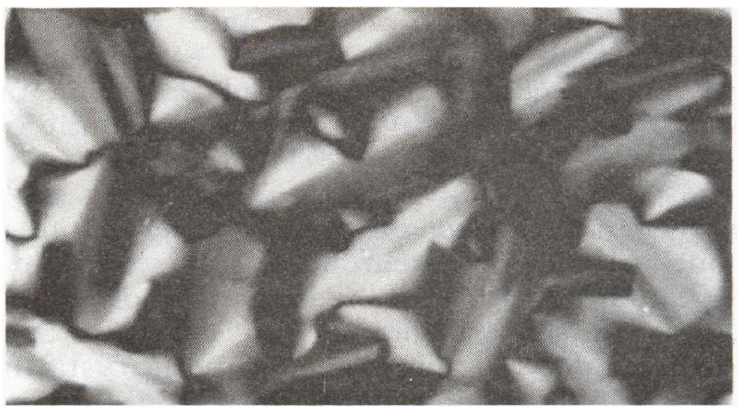
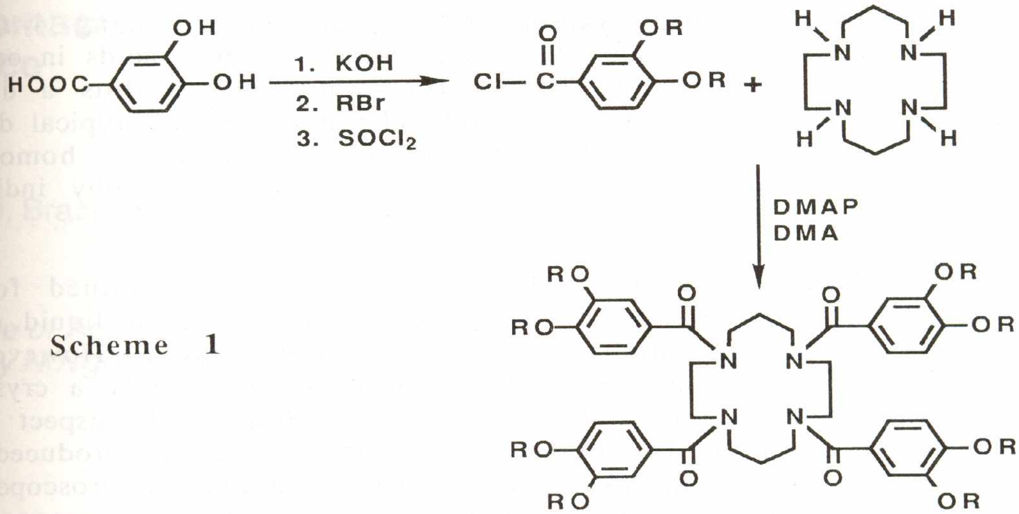


Plate 1 - The fan-like texture of the discotic phase of 1, 4, 8, II-tetraazacyclotetradecany I tetra-3, 4-di -*n* -decyloxybenzamide (x 100).

Lattermann's work on discotic aza-compounds strongly suggests that the aromatic side groups, which are required to be attached to the aza crown *via* the formation of amide bonds, need at least two aliphatic chains per aromatic substituent in order for the material to exhibit liquid crystal I phases. A single chain per side group was found to be not enough, whereas three chains is excessive. Thus, the structural architecture required for phase formation is personified by structure 1.

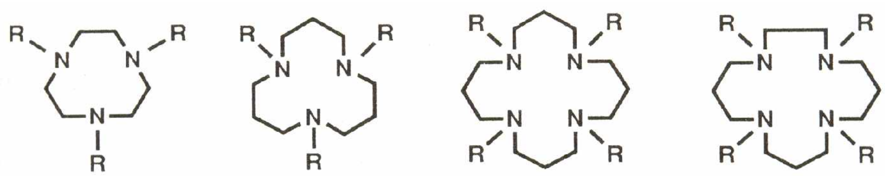
RESULTS AND DISCUSSION

The first objective of our research into these fascinating systems was to prepare some of these materials. Scheme I shows a typical synthesis of an aza crown liquid crystal. Although. The method shown appears relatively straightforward, the alkylation of 3,4-dihydroxybenzoic acid with long chain n-alkyl halides can prove very difficult and yields are often poor. Purification to the necessary standards required for liquid crystals is also troublesome and time consuming.

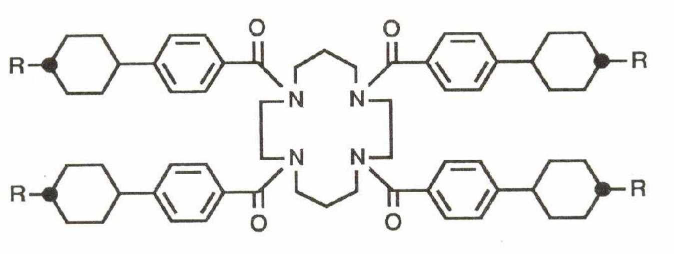


Scheme 1

A number of new and known amides of the aza crowns (2 to 5) shown below were also prepared by similar methods to the one outlined in scheme 1. Variously substituted benzoic and biphenyl acids were used in these preparations to give symmetrically substituted products with one, two or aliphatic three chains per side group. It was found that not only was the number of chains critical to liquid crystal phase formation, but their length was also very important (see later).



(2) (3) (4) (5)



(6)

For R = C_4H_9 Crystal - 35.1°C - Discotic Phase- 97.8°C - Isotropic Liquid

Combined aliphatic-aromatic systems were prepared by using 4-n-alkyl cyclohexylbenzoic acids in place of the substituted benzoic acids in order to produce structures of type (6). The n-butyl compound exhibits a discotic phase on cooling from the isotropic liquid. The phase shows typical discotic dendritic growth when it forms from the liquid. The n-heptyl homologue, however, does not show any liquid crystal properties, thereby indicating the critical nature of the alkyl chain length.

In the systems studied odd results were sometimes obtained for the melting behaviour. Heating sometimes produced a crystal to liquid crystal transition and subsequent melting to the isotropic liquid. However, on cooling the mesophase disappears and reheating produces only a crystal to liquid transition, but this time at a higher temperature with respect to the original melting point. It is not clear why this effect is produced, one suggestion is that the crown takes up ions from the glass microscope slide to produce a guest-host system that does not exhibit mesophases. Alternatively, these disc-like systems can have a variety of conformational structures where one or more of the side group substituents is not in the plane of the disc. These conformers are not conducive to forming mesophases, and therefore their presence will suppress the formation of phases. Molecular modelling in the gas phase shows that conformers with one side group out of the plane of the disc are relatively stable. However, whether these structures are present in ordered mesophases is open to question.

Thus our initial studies show that there is great potential for the synthesis of a wide range of crown ether and aza crown liquid crystals. However, we find that the inclusion of crowns into conventional liquid crystal structures generally has the effect of lowering relative phase transition temperatures.

ACKNOWLEDGEMENT

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A Biomacromolecule as an Acoustic Emission source

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SUMMARY: The paper is a theoretical investigation of the acoustic components of a human biofield. The natural oscillations, of large, biomacromolecules are shown to make a noticeable contribution to the emission in the acoustic range.

A human biofield consist of many components. There are an electric component, a thermal, an acoustic and other ones. All processes in a living Organism are reflected in changing of the emission spectrum. Both for biological research and for medical diagnostics it is important to understand how emission spectra change in various biochemical and physical processes.

"A registration and an analysis of "metabolic acoustic field", .decomposition of the" symphony" into characteristic components are the most important tasks of a biophysical research" [1]. Organs, cells, inter polymer complexes, macromolecules can be the source of acoustic emission (AE). The paper is a theoretical investigation of the acoustic characteristics of a polymer molecule. In a paper [2] an attempt to study of an elastic oscillation of a protein-enzyme molecule was made. However the molecule was considered as l mechanical system. In the present paper an investigation is made on the basis of a modern polymer theory. Now let us consider a possibility of a polymer molecule acoustic emission observation.

1. In good solvents macromolecules are in a swollen coil state due to repulsive force between polymer chain segments having their own volume [3]. An

Equilibrium size of a polymer coil is $R \sim aN^{v}$, where N is number of links with size a, v=1/2 for ideal coils and v=3/S for coil with volume interaction. A coil is an extraordinarily loose system and fluctuations of R have an order of average meaning of this value. To estimate the eigen frequency range of a macromolecule it is enough to consider two limiting cases: a hydrodynamically impenetrable coil (i.e. keeping the solvent inside during intention-compression processes) and an absolutely percolatably polymer one. Let us calculate an overall compression module K of the macromolecule:

$$1 / k = - 1 / v \{1 / ðp / ðv \} \quad (1)$$

A polymer coil pressure on spherical hole walls of diameter D is calculated by formula [3]:

$$p = Ta^{-3}. (a^3N/D^3)^{3v/(3V-l)} \quad (2)$$

And taking $D \tilde{} aN^{3/5}$ into account we get

$$K = 9T/ (4a^3N^{9/5}). \quad (3)$$

In the hydrodynamically inpenetratable coil model a polymer molecule can be considered as an elastic sphere with compression module defined by solvent characteristics, since in accordance with (3) compression module of macromolecule is negligibly small $K \tilde{} N^{-9/5}(N \tilde{} 10^3\text{-}10^6 » 1)$. Then the first frequency of natural oscillation is determined by the relation [4]:

$$w = \pi c_1/R, \quad (4)$$

where c $=(K/p)^{1/2}$, p is media density. This leads to the following estimation of w: for poly-(methyl-met-acrylat) (PMMA) (a ~ 10^{-9} m., $N \sim 10^4$, M ~ 10^5 awu): w - 10^{11} s^{-1}. ; two-stranded DNA (a ~ 10^{-7} m., $N \sim 10^6$, M ~ 10^9 *awu):* w - 10^7 s^{-1}. .Taking (3) into account the first eigen frequency of an absolutely percolatable coil with weight M is determined by the relation:

$$w = (aN^{3/5})^{-1}(T/M)^{1/2} \quad (5)$$

Characteristic values of w are: for PMMA - $w \sim 10^8$s.$^{-1}$; for DNA – w ~$10^2 s^{-1}$ .Thus the natural oscillation of big biomacromolecules can contribute to the acoustic range of the emission spectrum of a living organism. Certainly, in equilibrium state a registration of any single resonance component is impossible due to uniform energy distribution in degree of freedom, but it is necessary to take into account that most of processes occurring in a living organism are essentially non-equilibrium.

2. With solvent quality changing for the worse (transition across S-point) an attraction begin to dominate in pair-interaction, and parts of a polymer chain adhere to one another. A collapse characteristic time is [5]:

$$t \sim \eta a^3 N^2DT/\Theta^2 , \quad (6)$$

where η is solvent viscosity, t is temperature deviation from Θ-point. Substituting characteristic values meaning a range of t is obtained: from 10^{12}s. to a few hours. With globulization energy being known [3]:

$$\Delta F = - N\Theta/4\ (T\text{-}\Theta/\Theta)^2\ (1\text{-}((1^{3/2}\ N^{-1}) / ((T - \Theta) /\Theta)) \quad (7)$$

the simple estimation of considered phase transition power can be made (for a single macromolecule).For PMMA: *10-18W*. Taking into account that one drop of a dilute polymer solution (where individual polymer coils do not interact which each other) has about 10^{12} macromolecules, possibility of small polymer molecule collapse processes observation by AE registration can be assumed.

In the paper AE of individual macromolecule was considered. In reality a basis of each living organism is a high concentrated polymer systems in which all macromolecules strong interact with each other. Hence acoustic effects can be more significant in that system. A study of AE of concentrated polymer systems and interpolymer complexes is an object of further investigation.

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51 BS

Simultaneous Optical and Acoustic Measurement of Bubble Cloud Evolution in Tap and Saline Water

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SUMMARY

Simultaneous optical and acoustic measurements were per-formed on bubble clouds in tap water and over a range of salinities. Sound attenuation levels in excess of 100 dB/m were observed. Correlation between optical and acoustic data was good except <20 KHz drive frequency when damping values depart from theoretical prediction.

INTRODUCTION

This paper summarizes the major part of an investigation into bubble properties conducted at the University of Bath between 1986 & 1989. Optical and acoustic measurement of bubble properties at sea have afforded background information on typica1 size spectra and dynamic of bubble produced by breaking waves, or air entrainment in ships wakes. The objectives of the experiments outlined in this paper were fourfold:

(a) To generate bubbles in the laboratory with similar size spectra and void fraction to those expected at sea.
(b) To compare measured and theoretical attenuation values.
(c)To compare attenuation values and size spectra over a range of salinities
(d) To validate the laboratory arrangement as a suitable model for comparison with full scale tests at sea.

THEORY

In the linear regime the motion of a pulsating bubble in a liquid is that of a monopole radiator. The equation of motion for a bubble is analogous to that of a mass on a spring:

$$mV + bV + kV = P \qquad (1)$$

The resonance frequency of a bubble is expressed thus:

$$fr = 1/2\pi ro\ (3\gamma po\beta/\rho w\alpha)1/2 \qquad (2)$$

Where α & β correction terms for the polytrophic index and surface tension respectively: the basic equation is that derived by Minnaert[1].

When a bubble is insonified close to its natural resonance frequency, the vibration amp1itude is maximised and were the bubb1e perfect the frequency response would be a delta function. Energy h, lost howt-3ver", in heating the surroundings; radiating incident sound and viscous absorption at the bubble/fluid interface. Bubble vibrations ale thus damped and the total damping "constant" (the degree of damping is not constant but a function of frequency) has 3 components.

(i)Thermal radiation due to heat conduction between gas and fluid

(ii)Radiation damping due to sound scatter

(iii) Viscous damping due to shear stresses.

$$\delta TOT = \delta r + \delta t + \delta v \qquad (3)$$

Values and expressions for the above are given by Clay & Medwin [2]. A sound wave incident upon a bubble results in forced vibration of the gas and the emission of a spherically symmetrical sound wave from the bubble. The scattering process redistributes energy and is accompanied by absorption and dissipation.

The energy extinction cross section for a bubble is given by:

$$\boldsymbol{\sigma e = 4\pi r^2 (\delta TOT / \delta r) / [(fr^2/f^2-1)^2 \ \delta TOT^2]} \qquad \mathbf{(4)}$$

The signal attenuation in dB/m due to a cloud of different sized bubble may be expressed:

$$A = 4.343 \ N \ \Sigma \ P_n \ (\mathbf{d}) \ \boldsymbol{\sigma e_n} \qquad \mathbf{(5)}$$

Where N is the number of bubbles per $m^3$and p (d) is the probability.

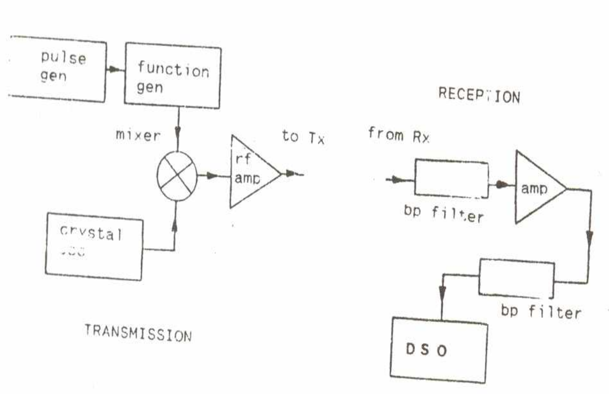
EXPERIMENTAL ARRANGEMENT

Most previous measurements of bubble spectra, both laboratory based and at sea, have been acquired using either optical or acoustic techniques thus our goal was contemporaneous optical and acoustic measurements. The most apposite acoustic method was a parametric array which operates as a virtual endfire art-ay with wide bandwidth; narrow beam width and minimal side Jobs. The transducer comprised a thin PZT disk imbedded in an araldite/glass bead mix [3] and parametric beam generation was as outlined by Berktay[4].The acoustic electronics are shown in Figure 1. Tile final choice of optical technique rested on laser shadowgraph as developed by Cooke [5] using a collimated beam from a HeNe laser'.

A plethora of bubble generating mechanisms

Exist but after exhaustive tests a filter pump was selected. Air and water were passed through 2 separate inlets and a porous mesh, with valve flitting located centrally, facilitated bubble action. It was possible to control the bubble spectrum by fine tuning the input flow rate bubble size was a strong function of air flow while water flow rate affected bubble density. The final experimental configuration adopted is shown in Figure 2.

FIGURE 1. ACOUSTICS ELECTRONICS.



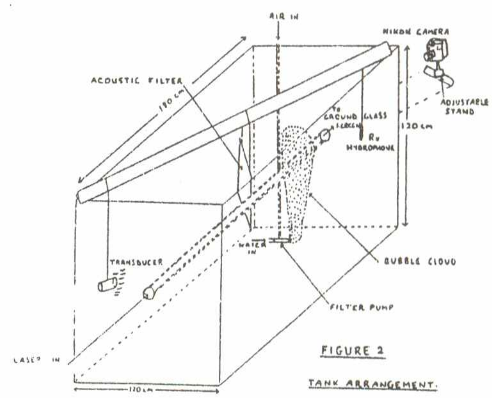


FIGURE 2

TANK ARRANGEMENT.

RESULTS & DISCUSSION

Figures 3 to 6 show the attenuation in dB/m resulting from the presence of bubble clouds. Each figure has 3 components showing (a) mean values with filter pump on and (b) 8. (c) Bubble persistence after switch off. The 2 data sets are measured acoustic levels, and those calculated from bubble theory (section 2) with the raw data obtained from optical measurements. (Each optical datum is an average of 9 to 12 shadowgraphs). Figures 7 to 10 show bubble size spectra, the optical data being measured direct from images whilst acoustic data were calculated from theory using attenuation values

Figures 3 to 6 show good agreement between optica1 and acoustic data except at low drive frequency. Optically derived attenuation values are less prone to fluctuation and show a definite trend with frequency. This is expected due to direct proportionality between acoustic cross section and area at or below resonance. Fluctuations in the acoustic data probably emanate from phase effects at the hydrophone. Figures 6 to 10 show good agreement in the 50 to 150 micron region. Optical measurements indicated that bubble coalescence was less frequent at increased salinity and ordinary tap water had a higher parentage of bubb1es > 600 um than saline solutions. By contrast however, the spectral peaks for saline solutions tend to be broader than for tap water possibly indicating some stabilisation mechanism, a factor reinforced by the increased bubble persistence after switching the pump off for the 22g/1 and 35g/1 salinities.

The bubble probability density functions appeal~ to follow a power law:

$$P\ (d)\ \alpha\ d^{-m}$$

Where m= 3.0   0.5 for diameters < mode (60 to 90 micron)
=2.3   0.3 ..   ..   > ..

the above results are averaged over optical and acoustic data

Previous measurement, of bubble spectral densities both at sea and in the laboratory fall into? Exclusive categories namely those which indicate a peaked distribution and those where a low cut off is absent. Table I summarises the findings .and includes the Bath data, while Figure 11 shows the temporal variation of total void fractions.

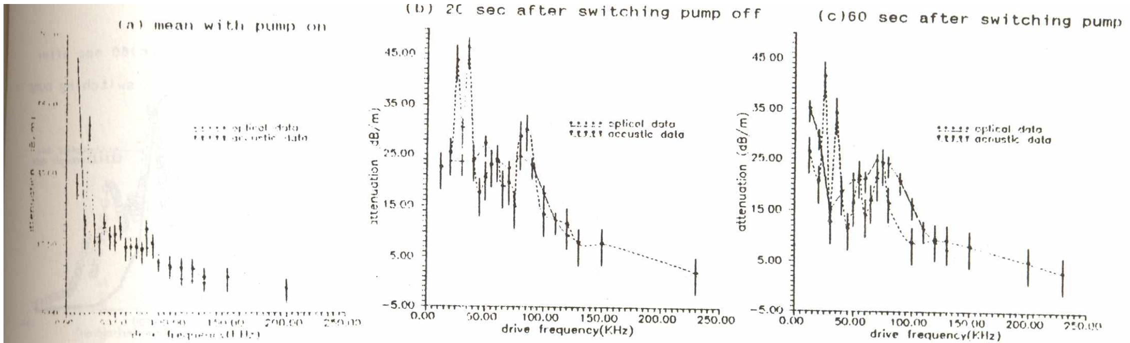


FIGURE 3. ATTENUATION AS A FUNCTION OF DRIVE FREQUENCY (TAP WATER)

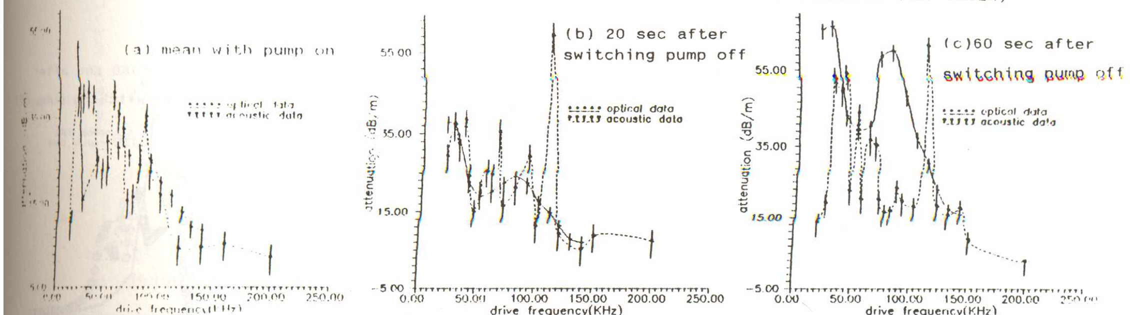


FIGURE 4. ATTENUATION AS A FUNCTION OF DRIVE FREQUENCY (8g/l SALT)

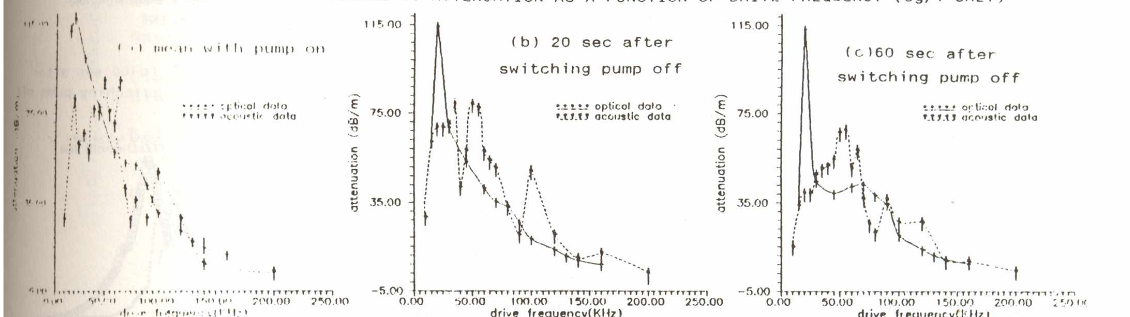


FIGURE 5. ATTENUATION AS A FUNCTION OF DRIVE FREQUENCY (22g/l SALT)

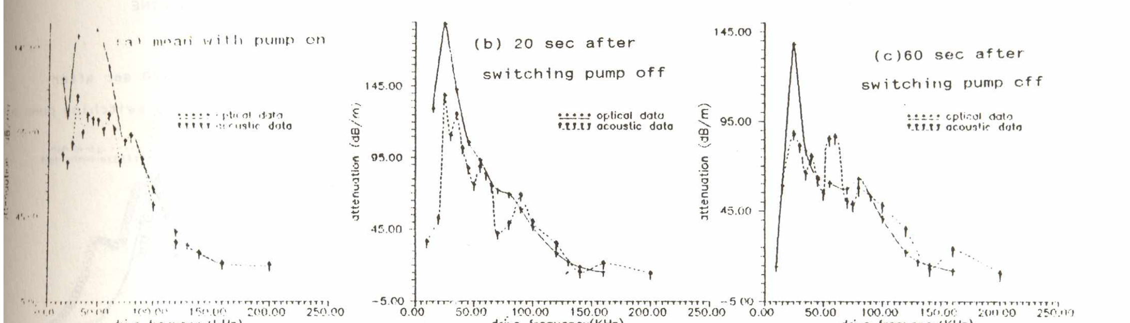


FIGURE 6. ATTENUATION AS A FUNCTION OF DRIVE FREQUENCY (35g/l SALT)

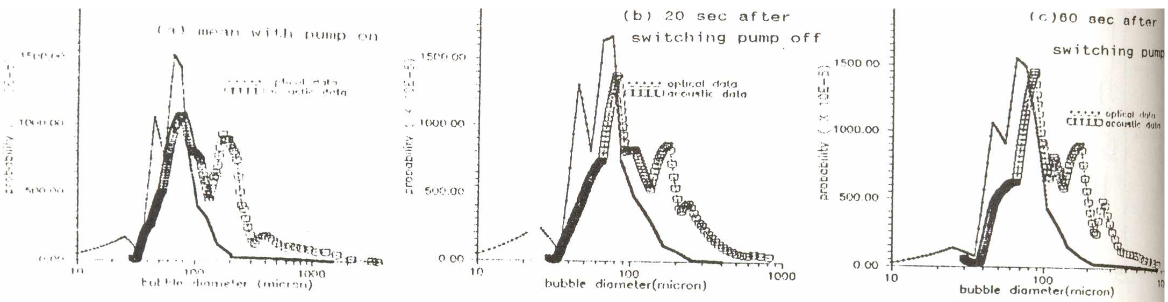


FIGURE 7. PROBABILITY DENSITY FUNCTION FOR BUBBLES IN TAP WATER

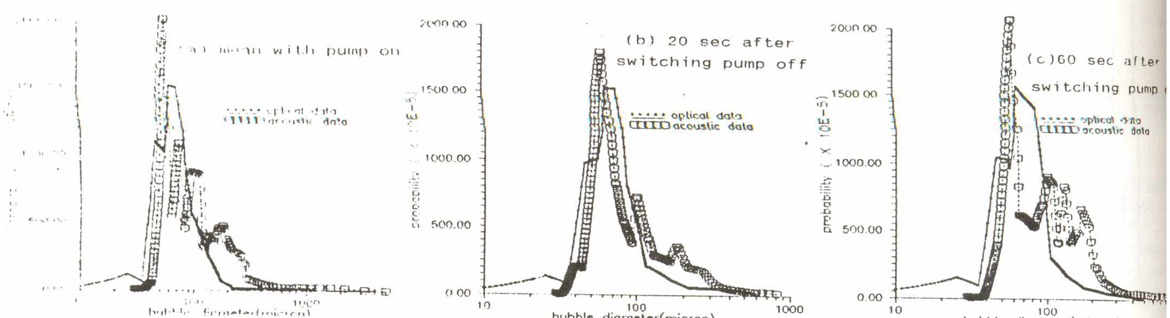


FIGURE 8. PROBABILITY DENSITY FUNCTION FOR BUBBLES IN 8g/l SALINE

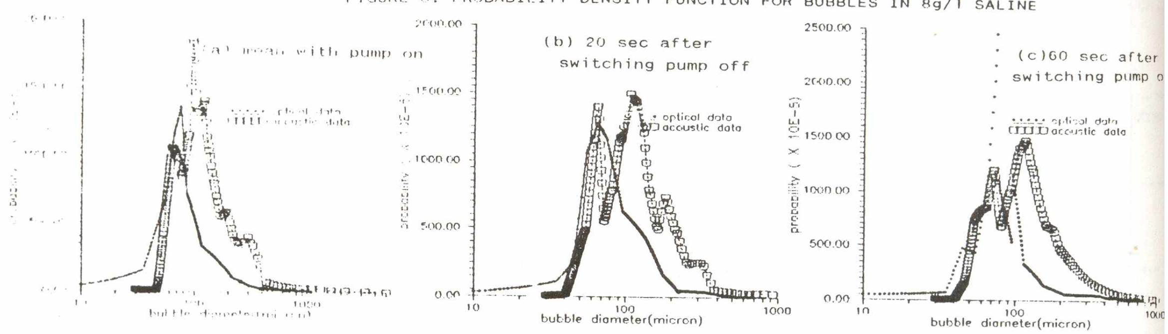


FIGURE 9. PROBABILITY DENSITY FUNCTION FOR BUBBLES IN 22g/l SALINE

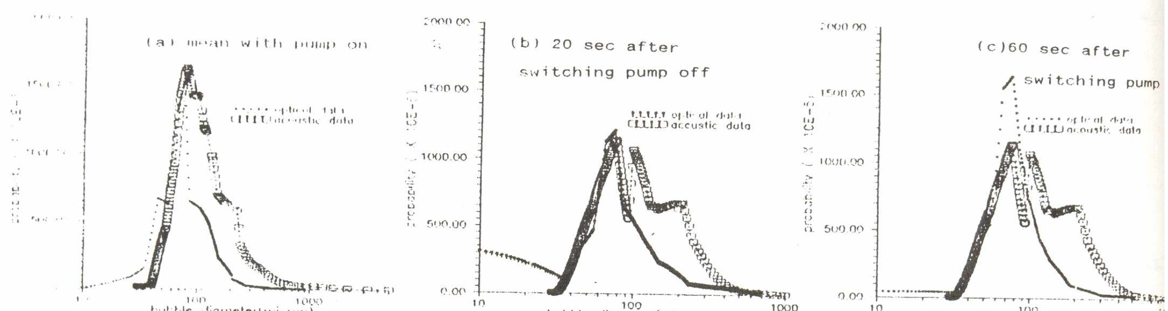
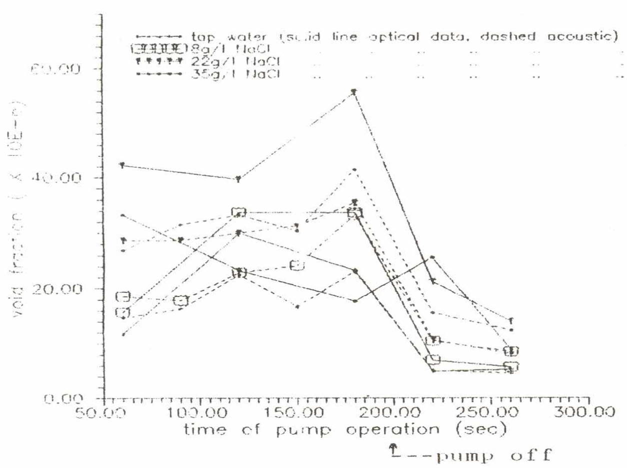


FIGURE 10. PROBABILITY DENSITY FUNCTION FOR BUBBLES IN 35g/l SALINE

TABLE 1.

	experimenter	technique	critical diameter (micron)	power law d>mode	power law d<mode
measurements at sea	Blanchard & Woodcock [6]	photography	80(peak)	-4.7	
	Medwin[7]	acoustic	20-120(min)	-4.0 (<80) -2.5(>80)	
	Kolovayev[8]	photography	140(peak)	-3.5	-4
	Johnson& Cooke[9]	..	80-120(peak)	-4.5	-5
	Løvik[10]	acoustic	50(min)	-4.2(<170) -2.6(>170)	
	Medwin& Breitz[11]	..	15(min)	-4.0(<120) -2.6(>120)	
	Glotov[12]	acoustic & photography	120(peak)	-2.0(<220) -1(>220)	-4
laboratory measurements	Monahan[13]	photography		-3(>500)	
	Monahan& Zeitlow[14]	..		-2.5(>500)	
	Gavrilov[15]	acoustic	8(min)	-3.5	
	Cipriano& Blanchard[16]	photography	200(peak)	-1.5	
	Baldy[17]	light scatter	60(min)	-4.0(<100) -2.6(>100)	
	Griffiths	acoustic& shadowgraph	60-90(peak)	-2.3	-3.0

FIGURE 11. TEMPORAL VARIATION OF VOID FRACTION.



5. CONCLUSION.

Although Glotov[12] used dual optical/acoustic bubble measurement techniques no simultaneous arrangement has been deployed until this investigation. In most cases reasonably good agreement between optical and acoustic data was observed. Bubble spectra exhibited peahens in the 60 to 90 micron diameter- range and a power 1 aw relationship was shown to exist between probability density function and bubble diameter of the from:

$$\mathbf{p(d)\ \alpha\ d^{-m}} \qquad m = 3\ d< \text{mode} \quad m = 2.3\ d>\text{mode}$$

Bubb1e persistence was increasingly evident as the salinity increased. Typical persistence levels for the 22g/l & 35g/l cases were 50% & 100% respectively in excess of the tap water & 89/1 cases. These resu1ts axe consistent with Scott [18] who observed a 50% increase ill persistence between 35g/l NaCl and pure water.

Correlation between optical & acoustic data improves if amended damping values are app1ied for 1arge bubbles; for small bubb1es typica1ly <60 microns accepted damping values are adequate. Tap water & 8g/1 thermal diffusion values are - 30% of the accepted distilled water values for large bubbles whilst the higher salinity cases require diffusion values of between -10% & 20% of the distilled water values.

The use of a filter pump to generate bubbles resulted in a stable population, of similar void fraction magnitude to those observed in ships wakes [19].Spectral peal, diameters are less than those detected in previous investigations but are comparable to minimum bubble diameters measured by Med win .et a1.[7,10,17].

This investigation has shown that bubble clouds, which exist under breaking waves or in ships wakes, may be emulated successfully in the 1aboratory using a fi1ter pump. The weaknesses of the dual measurement technique have been e1icited, namely uncertainty over diffusion (hence damping) values for larger bubbles and lack of discrimination between bubbles and solid particles in optical measurements. However with some modication simultaneous optical/acoustic techl1iques would appear to have a promising future, particularly with respect to identification of the true nature of bubble damping coefficients.

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GLOSSARY OF TERMS

α	K2/m ratio of second order stiffness to bubble mass
β	Surface tension moderating factor ratio of specific heats
γ	Radiation damping constant
δ_r	Thermal damping constant
δv	Viscous damping constant
δ_{TOT}	Total damping constant
δe	Bubble extinction cross section) single size bubbles

Minimization of the Transverse Effect in Electro dynamic Vibration Measurement

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ABSTRACT

The paper presents an analysis of the effect of cross vibrations on the accuracy of vibration measurement along the sensitive axis of the electrodynamics vibration transducer. Such transducer is calibrated using a shaker oscillating along the sensitive axis of the transducer, i.e. in the absence of cross vibrations. However, when the transducer is mounted to measure the vibrations of a rotating turbo machine in a certain direction, it is also subjected to cross vibrations in a plane perpendicular to the axis of measurement. It is shown that this cross vibrations affect the measuring accuracy, which is known as the transverse sensitivity.

The analysis presented in this paper -on a linearized basis- show that it is not possible to completely eliminate the transverse effect in electrodynamics vibration measurement, but it could be minimized by the appropriate selection and matching of certain design parameters of the transducer, mainly the product of the damping and transverse damping coefficients versus the quotient of the longitudinal natural angular frequency by the transverse one. It is also shown that the frequency range at which the transverse effect could be minimized increases with increasing the product of the longitudinal and transverse damping coefficients

BS18

Optical Fibre Sensor for Liquid Density

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ABSTRACT

This paper reviews the advantages of all-optical communication over conventional style based upon the conversion from electrical: ignal stream to light wave pulses or vice versa. In this advanced communication system, switching, multiplexing and amplification in optical frequency domain are key technology to realize. The recent progress of device and component developments in China, including Ti: LiNbO3 optical waveguide switch, WDM multiplexing couplers and are-earth element doped optical fiber amplifiers are introduced in detail.

INTRODUCTION:

Recently, all-optic communication are more and more interested in communication field because of its super-high power emission, long-distance transmission without pulse distortion and fast switching cross signal channels. For Realizing this new communication style, there are a series of theoretical and experimental research work to be completed, such as optical solution transmission theory ,and generation of solution pulses, development of rare-earth element Optical fiber amplifiers, photonic switching theory and devices, design and experiments of long haul optical communication system, to. As it is well known, Bell and NTT Laboratories have set up lotion transmission systems with high bit rates of 3-4GHz over a new thousands kilometers. In England, Erbium doped fiber lasers and amplifiers are actively developed and putting into practical use. Some initial research fruits and device samples have also been made in university laboratories in China. These topics are not only listed into National Research Programmes and supported in finances by Foundation Committees of Natural Science of China but also involved in special discussion or academic exchanging at

Seminars or conferences on communications .In 1990,two conferences have been held, One is special symposium on non-linear guide-wave optics and integrated photonics sponsored by Academic Committee of Fiber and Integrated optics which is a branch of optics Institute of China [1]. The other is symposium on photonic soliton communication and soliton lasing, sponsored by National Foundation Committee,[2] Participants consisted of researchers, professors and Ph.D candidates came from more than to universities. General progress on there fields will overviewed as follows.

1. PHOTONIC SOLITON THEORY:

Since 1973,the theory applied soliton on optical fiber communication was presented at first, the study of fiber soliton communication system has been progreseed rapidly in many country.

In China, the theory and experiment about soliton in optical fiber and optical fiber communication are also to be interested and very impotant projects.

Optical fiber soliton communication system is the non-linear optical fiber communication system can realize All-optical communication with super high rate and long distant transmission which the multiplication of rate and disdent for single chennal can be up to 29000 GHz.km. It is much better than linear optical fiber communication system with diepersionAAloss and repeater.

Many researches about soliton involve the follouing aspects:

(1) Fundamental theory and experiment including loss and compesation during soliton transmission.
(2) Soliton action each other
(3) Soliton devices
    including soliton laser
    sloiton switch
    sloiton coupler
(4) Soliton communication system

More concentrations focus the soliton theory in China. The fundamental theory includes to solve the non-linear Schrödinger equation and modified non-linear Schrödinger equation with high order non-linear term by method of exact analy tical solution, or numerical solution, or other else.

We study the soliton theory by the Hamiltonian method to obtain to know how the optical pulse becomes a soliton during the optical pulse propagation in fiber, and how to get the soliton laser.

2.. Experimental progress on Erbirm doped Fiber amplifiers (EDFA).

It is clearly know that, a segment of Er iron doped fiber, with concentration of 30-1500 ppm,is an active lasing medium for optical wavelength of 1.53-1.55um under pumping at a few florescence absorption wavelength of 807,980 or 1410 nm. The principles and structure are shown as Fig 1 and 2.

That reaches the gain-bandwidth product over 300GHz and is easy to connect with optical fiber transmission line, which has been demonstrated as a line of the lowest loss and super-great capacity.

The computation of interaction between radiation and medium

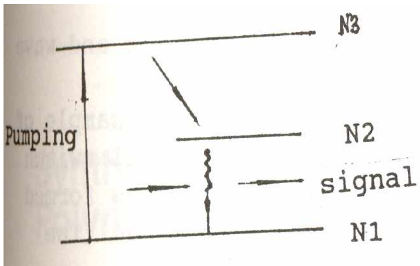

Fig.1

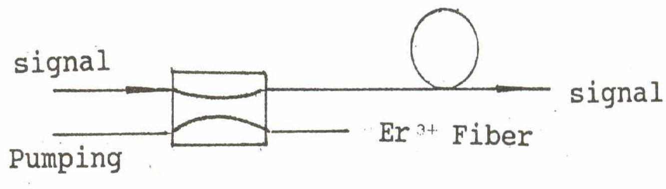

Fig.2

Based on quasi-classic theory was done in detail and the expression about optimum gain, pumped threshould, saturation value and dynamic range was obtained. The experimental system is shown as Fig 3. [3] The signal source is He-Ne laser at 1520 nm and Argon Laser is as a pump source.

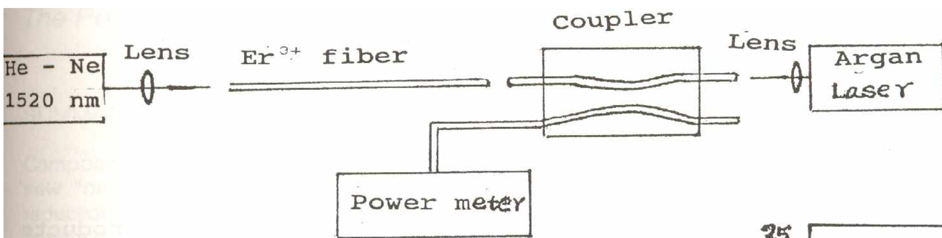

Fig.3

The fiber parameters are with concentration of 1500 ppm, length of 2 m and the gain of 10 dB was obtained. The relation between small signal gain and the absorbed pumping power is shown in Fig.4. The input-output characteristics are shown in Fig 5 and Fig 6

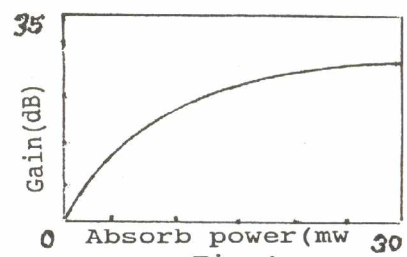

Fig.4

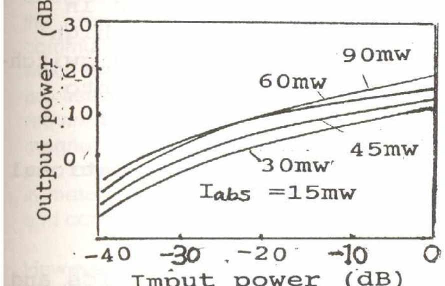

Fig.5

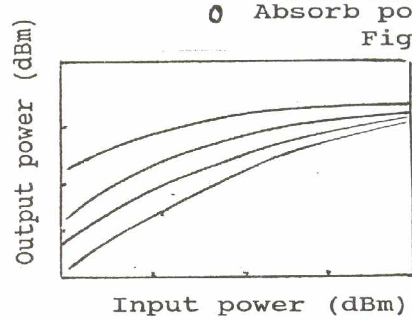

Fig.6

The theoretical computations are coordinate with experimental values. The further work is planning to use semiconductor laser as a pumping light instead of Argon laser.

3. Optical switching:

Photonic switching is the need of super fast, real time communication system. At present, the products have been developed in world famous companies, such as AT & T-bill Laboratory and Bell Core, NEC, NTT and Fujitsu, Hernrich-Herltz Ins. and BTRL. There are three

Schemes to realize switching: space-division, Time-division and wave length/frequency division

The research work has been done and some experimental sample of optical switch was obtained. A 3-branched waveguide optical switch on Ti: LiNb03 has been developed in China. [4] The 3-branches formed by 700 A -thick titanium was made on x-cut LiNb03 waveguide. The extinction ratio of branch A, Band Care 70%,67% and 72% respectively, as shown in Fig.7,measured at =33 nm and the estimated band width was of 2 GHz.

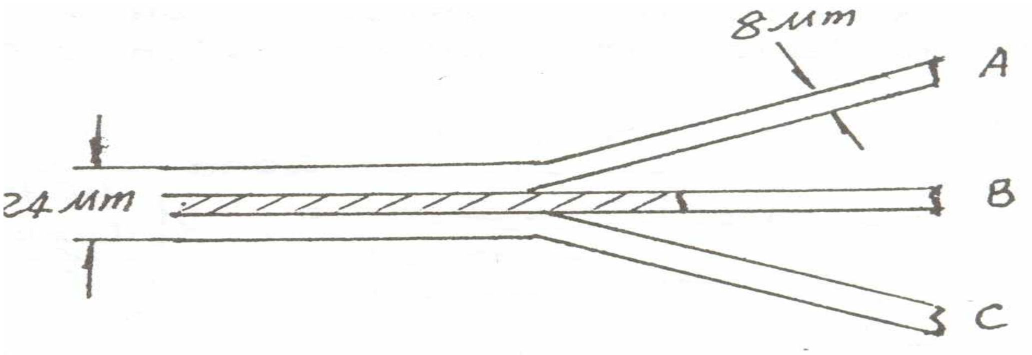

Fig.7

For Space-division optical components, The commercial products of monomode fiber wavelength multi/Demultiplexer have been provided in China. Here are performances of components:

Multiplexing Wavelength	Excess loss	isolation	working temperature
1330/1550nm	<0.2dB	>20dB	-20~100 c

Conclusion:

The initial Research work and experiments on all optic communication has been done in China. These has been listed in National research program. The further work is to developed high -power semiconductor lasers integrated photonic devices and switching technique to promote all-optical communication system into practical use.

Acknowledgement: This work was partially supported by the National Natural science Foundation of China.

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BS19

Synthesis, Properties and Applications of Metal (O) Polymer Composites

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SUMMARY

Composites of polymethyl methacrylate containing copper or silver have been synthesised by a new "one-pot” method. This method involves polymerisation occuring concurrently with the reduction of the metal to the zero-valent state. Such composites have potential applications in the communications and electronics industries and the relevant properties of these composites are being investigated.

INTRODUCTION

Incorporation of metal particles in polymer matrices can lead to conductive or to magnetic materials which have numerous applications in the electrical. electronics. and communications industry [1. 2. 3].

Composites of plastics and metallic alloys with suitable magnetic properties have contributed to the rapid development of magnetic materials which fulfill many functions as components in communications equipment. Motors transformers and generators require soft magnetic materials which are rapidly magnetised and demagnetised with minimum energy loss. Permanent magnets are used for magnetic instruments and telephone equipment in which constant field strengths are required. The combination of plastics and magnetic alloys extends the usefulness of common magnetic materials and makes possible the utilisation of magnetic alloys which could not previously be conveniently shaped or processed. The physical presence of plastic non-conductors in metal-polymer composites leads also to the minimisation of eddy currents. hysteresis losses and corrosive effects.

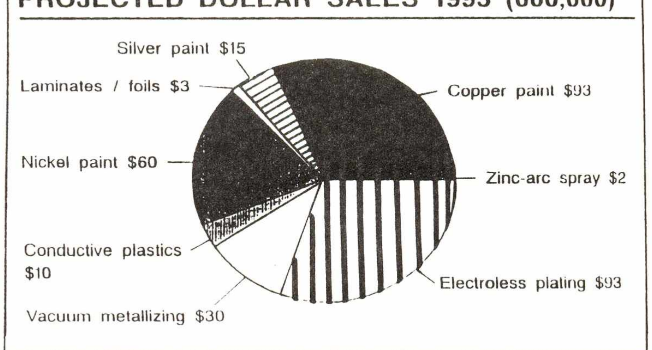
However, the magnetic properties of metal-polymer composites are only one aspect of their many applications in the electronics industry. On a tonnage basis 20% to 25% of metallised plastics are I used for conductive applications. Currently there is great demand for polymer composites I incorporating large quantities of finely devided metal particles homogeneously in polymeric I matrices. Conductive metal-polymer composites are used to provide electrostatic discharge (ESD) and electromagnetic interference - radiofrequency interference (EMI/RA) shielding. Meta-filled polymeric adhesives are widely used in the e!edronics industry as the assembly of components such as semi-conductors. Capacitors and resistor chips onto printed circuit boards. Other applications include bonding of diodes to printed circuit boards. the bonding of quartz crystals and the joining of components whose conductors are nichrome wires. In addition these materials are used as heat sinks and for joining components that are used in EMI/RR shielding ell

Table 1 [4] presents a list of commercially available metal-polymer composites. their trade names and their manufacturers. and in Figure 1 the importance of metal-polymer composites in the EMI shields industry can be seen

Table 1 Examples of commercially available metal-polymer composites trade names and manufacturers

Polymeric Type	Trade name	Features	Application	Manufacture
One-part silicon	Abelbond 190-3	Silver-filied,conductive	RFI shielding	Abelstik labs
One-part epoxide	Abelbond 36-2	Silver-filied,conductive	Die attach	Abelstik labs
One-part polyamide	Abelbond 71-1	Silver-filled conductive	Die attach	Abelstik labs
One-part epoxide	E-Solder 3205	Gold-filiter, conductive	Die attach	Acme chemicals and insulation company
One-part epoxide	Uniset A359	Aluminum-filled conductive	Magnets and speaker	Amicon corporation
One-part epoxide	Uniset C407	Silver-filled conductive	Die attech, capacitors resistors	Amicon corporation
One-part epoxide	Epo-TekH41	Gold-filled conductive	Military and aeroapace application	Epon Technology
Two- part polyvinyl acetate	E-Solder 3044	Silver-filled conductive	Dia attech for high temperatures	Acma chemical and insulation company
Two-part epoxide	FRI ECR-4200	Silver-filled conductive	Microwavw RFI shielding	Formulated Resins, inc
One-part silicone or fluorosilicone	Shield seal	Fillers silver, silver-plated nickel silver-plated aluminium, silver-plated copper, silver –plated glass, nickel conductive	EMI.RFI shielding for aerospace, defence and communication equipment	James walker & co Ltd.

Figure 1. Sales for EMI shielding methods



Generally the incorporation of metals into polymeric matrices is achieved by physical means ie by mixing the polymer or its precursor with the metal [5]. This approach leads to composites which incorporate the metal particles inhomogeneously and in a coarse form. Chemical incorporation of the additive into the polymeric matrix is also possible and has been exploited in many industrial applications [5, 6,7]. However chemical incorporation can only be accomplished with additives which have suitable reactive sites. Furthermore it generally leads to composites which contain only a small amount of metal.

We have developed a “one-pot” synthesis of metal-polymer composites which leads to homogeneous incorporation of large quantities of finely devided metals in polymeric matrices. It encompasses the concurrent polymerisation of monomers and their reaction with appropriate metal complexes to form metal particles.

EXPERIMENTAL

Methyl methacrylate. CuL2 or AgL and a Lewis base are heated in the presence or absence of B solvent and the reaction mixture dried in vacuo. The products have been characterised using gel permeation chromatography (gpc). ft-ir, hplc. glc. and differential scanning calorimetry (dsc).

RESULTS AND DISCUSSION

1. Preparation of metal-polymer composites

It is known that transition metal chelates can induce cationic [8]. Anionic [9]. And free radical polymerisation [10]. However, it is unclear whether this has coincided with a change in the oxidation state of the metal.

On the other hand, it is also known that metal chelates can undergo internal redox reactions with substances which have a Lewis base character. These reactions occur via the homolytic cleavage of a metal-ligand bond and generate free radicals [11, 12, 13, 14, 15, 16] which may initiate polymerisation. Thus, monomers which are also Lewis bases should induce internal redox reactions and consequently undergo free-radical polymerisation.

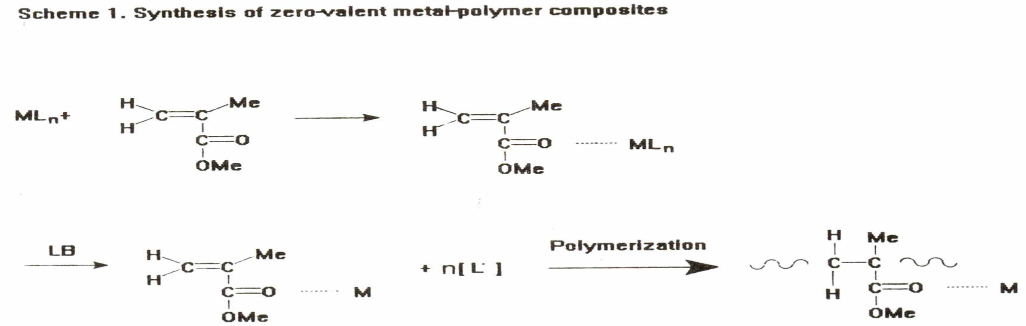
Synthesis of metal-polymer composites should therefore be achieved by heating together a metal complex (MLn) and a selected monomer. Thereby, causing reduction of MLn and the concomittant generation of ligand radicals. The latter then can initiate polymerisation of the monomer (Reaction 1).

ML_n + Monomer   n [L'] + Metal (O)-Polymer Composite   ..1

Thus, when the complex CuL2 and methyl methacrylate were refluxed together, Cu (O)-polymethyl methaaylate was obtained with a highly homogenous dispersion of metal particles. However, the reduction of copper (II) to copper (O) was difficult and required a long reaction time. Another disadvantage of this procedure is that it requires a monomer capable of inducing an internal redox reaction in a metal complex so as to lead to zero-valent metal particles.

In order to expediate the readion a Lewis base capable of leading to zero-valent metal particles and ligand radicals was added to the reaction mixture. Thus, when CuL2' methyl methaaylate, and Lewis base were refluxed together, a redox reaction occurred readily to give copper(O)-po/ymer composite in high yield (Scheme 1). In this way, copper (O)-polymethyl methaaylate composites with 'o.rying degrees of copper content (0.5 - 46 %) have been prepared. Composites with higher copper contents (> 75%) can also be prepared if required. The interaction of CUL2' methyl lethacrylate, and Lewis base was investigated both in bulk and in solution in methanol.

Scheme 1. Synthesis of zero-valent metal-polymer composites



Similarly the interaction between AgL methyl methacrylate, and Lewis base, both in bulk and in lethanolic solution, afforded silver (O)-polymethyl methacrylate. Composites with 5.6% and 14% sliver content have been prepared.

2. Characterisation of metal-polymer composites

All the reactions mentioned above afforded copper (O)-polymethyl methacrylate or silve~O)-polymethyl methacrylate with similar polymeric characteristics to pure polymethyl methacrylate. From the molecular weight distributions of Cu (O)-PMMA and Ag (O)-PMMA composites obtained in this study the relative molecular masses were found to be in the range 2,350 - 807,000. The colour of the Cu (O)-PMMA composites was copper brown and that of the Ag (O)-PMMA was grey.

Some properties of these composites relevant to the electronics and communications industries such as their electrical and thermal conductivity, their EMI/RFI shielding effectiveness, together with their mechanical properties are being studied.

CONCLUSIONS

The 'one-pot' synthetic method described above provides an efficient route to zero-valent metal-polymer composites. It has been extended to the preparation of Cu(O)-polystyrene and Cu(O)polyvinyl acetate composites and its use in the preparation of zero-valent Pd, and Ni is being investigated.

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Study of the Mechanical Properties and Microstructure on Aircraft Material AI-Li Alloys

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SUMMARY

A systematic study of the Youngs modulus (E), yield stress and characteristic microstructure in AI-Li-Cu-Mg-Zr alloys has been carried out.

The results show a dependence of the mechanical properties on predeformation, heat treatment and temperature. The mechanisms responsible for changing E and yield strength behaviours are discussed in terms of the experimental results.

INTRODUCTION

AI-Li alloys are well known for their high Youngs modulus and low specific density. Lithium with a 4% addition to aluminium the Youngs modulus is increased about 6% and the density is reduced 3%[1]. Li is one of few elements which has more than 1 at% solubility in aluminium and this brings about changes in the physical properties.

I. EXPERIMENTAL PROCEDURES

1.1 Chemical compositions

ALLOYS	Li	Cu	Mg	Zr	Fe	Si	Al
8090	2.4	1.16	0.62	0.11	0.14	0.10	Bal
8091	2.4	2.00	0.70	0.18	0.09	0.05	bal

1.2 Heat treatments

The mechanical test specimens were solution heat treated at 530°C for 1 hour and water quenched, then received 0-7% plastic deformation before artificial or natural and artificial aged to the peak hardness. The treatments are shown in Table 2.

Table 2 Artificial/natural ageing of alloys 8090 and 8091

Thermal-mechanical Treatments	Ageing temperature (^{0}C)	Time (hrs)
Un stretched	artificial ageing at 190°C	20hrs
4% stretched	artificial ageing at 190°C	20hrs
7% stretched	artificial ageing at 190°C	20hrs
Duplexed aged	natural ageing at 21°C	24hrs
Then	artificial ageing at 190°C	24hrs

The specimens for Youngs modulus test were solution treated at 530 C for 1 hour and water quenched, then natural aged for 20 hrs and artificial aged for 20 hrs to observe the contribution of precipitates on Young modulus.

1.3 Mechanical tests

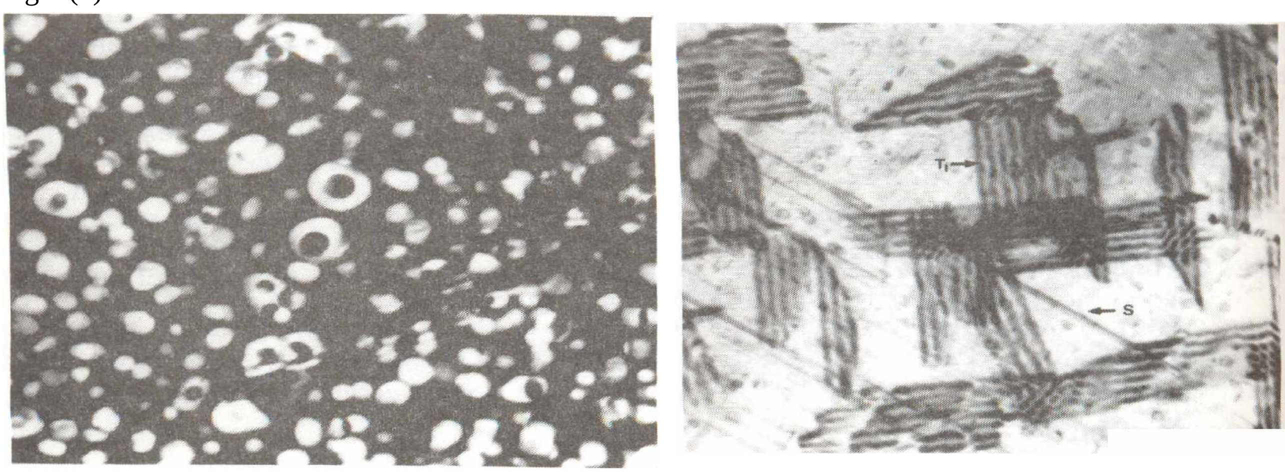
The tensile tests were carried out by an Instron machine at an initial strain rate of 1O-3s^{-1}1 The yield stresses of the test materials at a 0.2% plastic deformation were obtained from the test Load extension curves.

2. RESULTS AND DISCUSSION

2.1 MICROSTRUCTURE

The main strengthening phase in Al-Li alloys is 3'(AI3Li) phase, shown in Fig.3 (a). 3' phase is a coherent and ordered phase which always creates dislocation pairs during the plastic deformation. This deformation mechanism offers a special strengthening in ordered alloys (2).

S (AI2CuMg) phase was designed to precipitate on the dislocations in Al-Li alloys to reduce the strain localization which results from the planar slip of her arable Al3Li phase by dislocation pairs. Precipitation of S phase on the dislocations resists dislocation pairs cutting of 3' phase. A TEM photograph shows the S phase distribution in Fig.3 (b). T1 (Alu2CuLi) phase exists in high Cu content Al-Li alloys, it also contributes to the strength (4). The photograph shows T 1 phase distribution in Fig.3 (b).



a. δ' phase particles. b. S and T1 particles.

Fig. 3 TEM photograph of δ', S and T1 phase distribution in an Al-Li-Cu-Mg-Zr alloy 8091.

2.2 MECHANICAL PROPERTIES

Young's modulus measurement

The Young's modulus (E) measurements of Al-Li alloys 8090 and 8091 were carried out by a I Grind sonic instrument, and the E values were worked out from the resonant frequency of the test

Specimens. The experimental results show that E values are only slightly increase (about IGPa) compared with the solution heat treated specimens with the final natural and artificial aged specimens as shown in Table 3. During the natural and artificial ageing, &', S and some T~ particles largely precipitate, but E values are not obviousely affected by these particles. It indicates that E is not strongly influenced by these precipitates. It seems that the contribution of E from the Li in solution is more important.

Table 3 The data of Youngs modulus with various treatments

Specimen No	E on Various Heat Treatment Conditions Solu. Treatment		Natu. age. (20hr)		Arti. age	
	A(GPa)	b(GPa)	a(GPa)	b(GPa)	a(GPa)	b(Gpa)
1	83.4	80.7	83.4	80.9	84.8	80.0
2	81.8	81.7	82.1	82.4	83.7	82.4
3	80.7	80.9	81.3	81.4	82.0	81.5
4	81.4	80.8	81.5	81.0	83.3	81.8
5	83.9	82.1	84.4	81.7	84.8	82.1

a: alloy 8090, b: alloy 8091.
Solu.: Solution, Natu.: Natural, Arti.: Artificial.

Yield stress with temperatures

Al-Li-Cu-Mg-Zr alloys 8090 and 8091 exhibit a medium strength of about 550MPa. The yield stresses at 0.2% plastic deformation versus room and elevated temperatures are shown in Fig.4. The data show that the yield stresses are first increased with increasing the degree of predeformation for alloys 8090 and 8091. It is notable that as the pre deformation increases over 4%, the yield stresses are decreased for both 8090 and 8091 alloys. This may be caused by the large number of &' particles cut during the 7% pre stretch which makes planar slip become more easier during the later tensile tests.

The yield stress versus temperatures curves in Fig.4 show that for alloy 8090, the values of yield stress remain constant to around 180°C then drop. It has been explained by dislocation glide below 180°C and climb above this temperature (3). The critical temperature for 8091 is around 200.C due to there are more Sand T1 precipitates which delay the dislocations change from glide to climb to a higher temperature.

Although S and T1 particles contribute to the strength, in Fig.4 Unstretched and Duplex aged conditions. It is notable that for the same deformation condition, the yield stress of 8091 is lower than 8090. This decreasing of the strength may be caused by more Mg and Li were out off solution to form S and T 1 precipitates during the artificial ageing which reduces the solution hardening effect. A higher Zr content in 8091 prevents recrystallization process, so that smaller sub grains have been found in alloy 8091. The sub grains are arranged in small angle boundaries. Therefore they can still accommodate slip planar, as a result the yield stress of 8091 is lower than 8090.

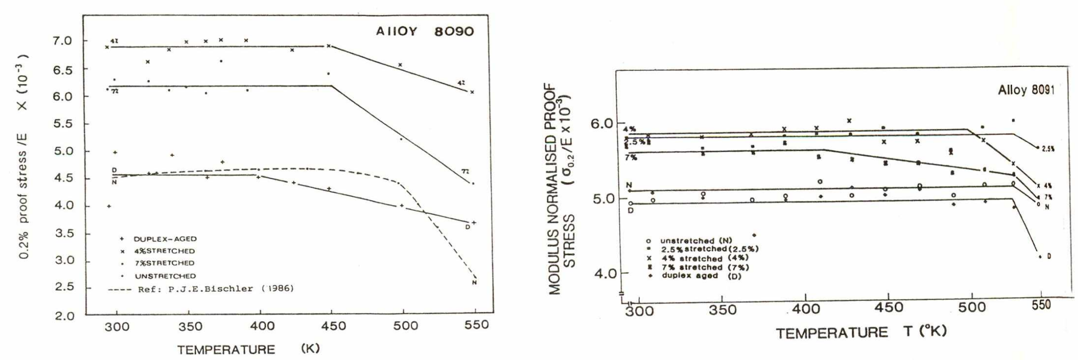


Fig.4 The yield stress vs temperatures curves of alloys 8090 and 8091.

CONCLUSIONS

1. The E value is only slightly influenced by the heat treatment in alloys 8090 and 8091 which indicates that the solid solution strengthening by Li makes the largest contribution to increasing E.
2. When the predeformation is larger than 4%, the effect of the sub grains on the strength is secondary to the effect of dislocation cutting 8' particles and thus making the planar slip passing through the sub grains and reducing the strength.
3. Precipitation of more Sand T 1 particles delays the dislocation transition from glide to climb.

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Continuous Optical Monitoring of Electrical Breakdown in Synthetic Resins

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SUMMARY

The Breakdown mechanisms of resin based insulation due to electrical treeing being investigated at NGR&DC. A continuous optical monitoring system has n developed to record tree propagation during high voltage tests. A motor driven scanning stage and TV camera controlled remotely via fibre optic links label data collection for analysis without interruption of the HV supply

INTRODUCTION

Synthetic resins are used throughout National Grid as part of the insulation switchgear, bushings and transformers. Resin based insulators take the m of filled castings, laminates of resin impregnated tape and resin bonded imposts. The insulation is generally very reliable and has a long service life. However, as with all materials it will undergo degradation when subjected to abnormal stress conditions - electrical, mechanical, thermal or environmental. One frequently encountered form of degradation is electrical being which takes the form of a dendrite structure of tubules propagating ;om a point of stress enhancement, for example a sharp metallic point (Figure I).

Breakdown of insulation by electrical treeing has been studied by many searchers [1, 2, 3,] however the experiments have taken place using different materials under a range of stress conditions and geometries. It has therefore 'en impossible to assess the relevance of particular physical or chemical properties to the mechanisms of electrical treeing. Consequently a Iodinated interdisciplinary research programme has been set up to study the different aspects of resin insulation breakdown due to electrical treeing. :e investigation of the propagation of electrical trees in characterized epoxy resin samples forms a major part of this programme.

ELECTRICAL TREEING TESTS

The electrical treeing process has three distinct stages:

Initiation -The period of time (varying from seconds to years depending on the applied conditions] when no signs of degradation can be observed or measured.

Propagation -The development of a network of narrow branched channels from a point of stress enhancement. The tree structures vary from dense bush trees to the more open branch trees (Figure 1).

Breakdown -Completion of the conducting path through the insulation causing catastrophic failure (Figure 1b).

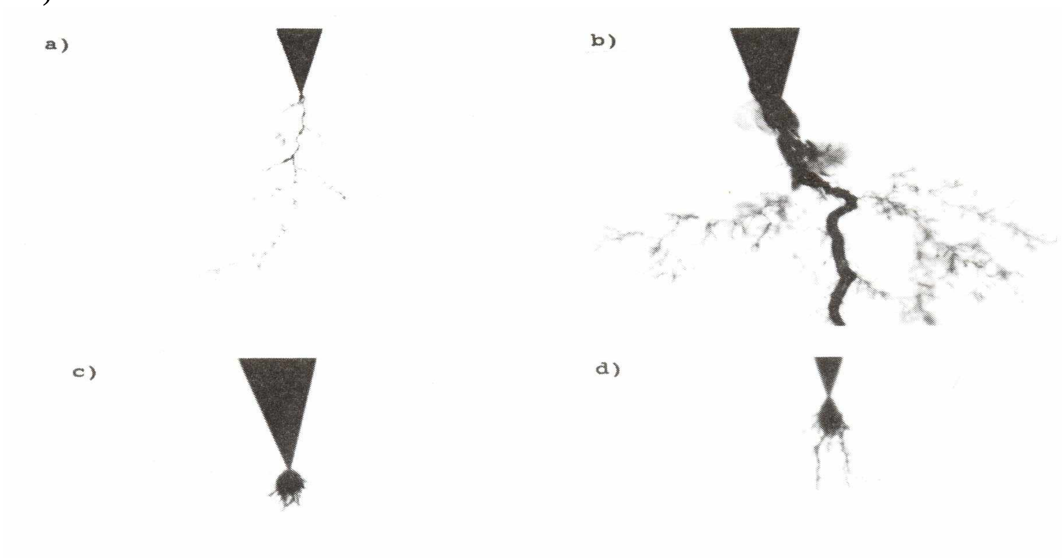

Figure 1 - Examples of electrical trees

a) Branch type tree during propagation (x35)
b) Branch type tree after breakdown (x20)
c) Bush type tree during propagation (x35)
d) Tree with both bush and branch characteristics(x35)

Laboratory tests to study the propagation phase of electrical trees are performed using a pointed electrode with known radius of curvature cast in a block of epoxy resin in the point-plane geometry (Figure 3). In these experiments the sample geometry was fixed with an electrode separation of 2mm and sample thickness of 6mm (to enable optical examination of the degradation within the samples).

The thermal history of the samples is carefully controlled to obtain reproducible samples. Measurements of physical properties, e.g. glass transition temperature, are performed to check that the resin is fully reacted. Sufficient time is specified between manufacture and testing to allow the matrix to reach a stable residual internal strain level. Voltages from 5 to 20kVrms, 50Hz are applied to study the propagation mechanisms of the electrical trees.

The use of an electrode with a small radius of curvature (typically 3pm) reduces the initiation phase considerably. The propagation of the electrical trees proceeds with the amount of branching and the maximum length of the tree increasing with time. Inspection of the samples usually involves removing the high voltage supply and observing the electrical tree using a transmission optical microscope. The propagation is typically characterised by measurements of the distance from the initiation point to the tip of the tree with time.

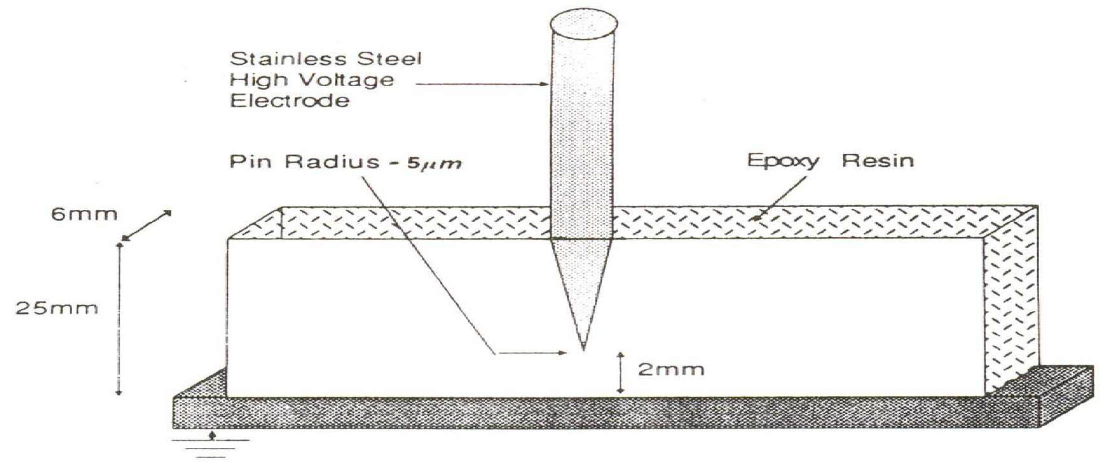

Figure 3 – Sample Arrangement

Although the above measurements give statistical information no details of the type of propagation behaviour, for example sporadic or gradual, can be obtained. In addition the effects of interruption of the high voltage supply are not known and may be introducing bias into the propagation statistics. An optical monitoring system has therefore been developed at the National Grid Research and Development Centre to observe electrical tree propagation continuously during testing.

3. OPTICAL MONITORING SYSTEM

The optical monitoring system is a modular system designed to obtain individual images of multiple samples to be studied and analysed. The purpose of the new system is to obtain images of tree propagation without interrupting the voltage application. The system is therefore split into two parts - control and test (Figure 3) - with fibre optic communication links to protect the operator from high voltage.

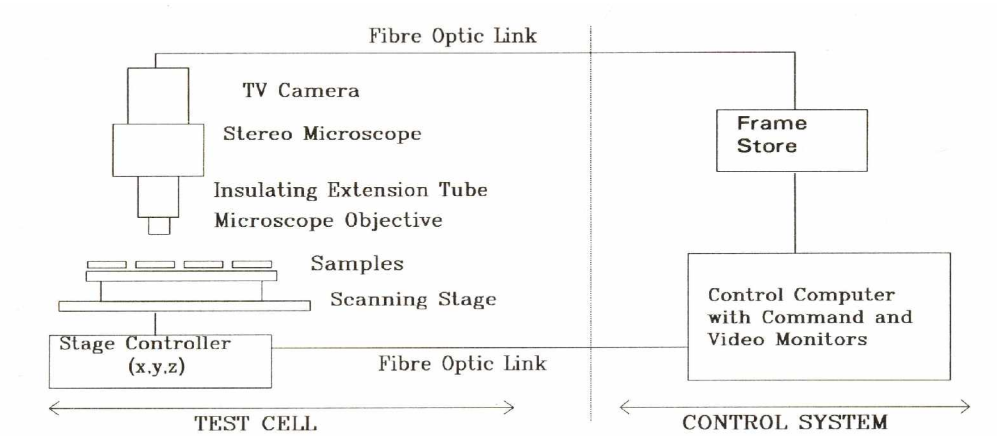

Figure 3 - Optical Monitoring System

The test rig consists of the high voltage apparatus, a motor driven stage, microscope turret and TV camera. Multiple samples in the HV circuit are positioned on an insulating stage extension, manufactured to allow the samples to be illuminated safely from below. The mechanical stage has a range of travel of 215 x 100mm controlled by stepper motors with lum accuracy. The stage is mounted on a microscope base for stability. The z-motion (focus) is then operated by a stepper motor fixed to the microscope focusing drive providing an accuracy of lum. The samples are observed using a Leica stereo microscope capable of obtaining images of the full field of interest Le. from the pin tip to the plane electrode. Parallel optics between the main microscope and the objective allowed for the insertion of an insulating extension tube for protection of the recording equipment. A video camera is positioned via an adaptor to record the required images.

The main functions of the control system are to position and focus the samples at the specified time intervals (from seconds to days depending on the applied test conditions) and to capture and reference the relevant images. Before the samples are energised they are successively aligned with the optical axis of the system (via software control). The coordinates of each sample are stored with its identifying code. The samples can then be automatically repositioned and refocused to within many of the specified coordinates. An interrupt function has been included to allow for alterations to preset data during a run e.g. refocusing compensating for tree propagation out of the plane of the pin electrode.

4. ANALYSIS

Once the images have been obtained at the specified intervals they can be analysed to study the propagation behaviour. The image files are transferred to a Cambridge Instruments Quantimet 570 image analysis system. Adjustments are made to the background shading to correct for uneven illumination and the portion of the image for analysis magnified and calibrated. The grey image is then amended to enhance the black tree structure against the white background. A binary image of the tree is produced and the required measurements obtained.

The standard measurement in previous tests was the rate of extension i.e. the change in length from the point electrode to the tip of the longest branch with time. However this type of measurement gives confusing statistics due to the different types of electrical tree structures e.g. bush or branch as shown in figure 1. Bush trees extend relatively slowly but the network of channels becomes denser. Branch trees extend quickly towards the plane electrode but with a much less dense channel network. It is therefore proposed not only to measure the rate of extension but also the extent of branching or dimensionality to give a quantitative characterisation of the tree structure. These measurements can then be statistically analysed to give information on the mechanisms and kinetics of tree propagation.

5. CONCLUSIONS

The continuous optical monitoring system designed at the National Grid Research and Development Centre for the investigation of the propagation of electrical trees is a significant improvement over the previous experimental systems. The quality of data is considerably better than in a manual system as images can be obtained continuously under identical conditions without errors due to operator interruptions. The apparatus is of primary importance to the characterisation of tree structures and the study of the kinetics of electrical tree propagation and hence the understanding of the degradation mechanisms of resin based insulation.

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IT1

The Changing Role of Engineers and the Image they Present

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No abstract supplied.

The Role of the British Library in Supporting Science and Engineering

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SUMMARY

The British Library is the national library of the United Kingdom and, as such, is one of the largest and most comprehensive sources of information in the world. Nearly half the Library's annual expenditure and staff resources is deployed in meeting the information needs of people working in science, technology, business and industry. This paper outlines some of the ways in which the British Library is actively supporting science and engineering.

Libraries throughout the world playa vital role in supporting information transfer and communication, two of the major themes at this conference. More and more information is generated and published each year and, increasingly, individual scientists, engineers and researchers in general are finding it difficult to keep up-to-date with the output in their particular spheres of interest. The British Library, as the national library of the United Kingdom, is very aware that timely and accurate information can extend scientific and medical frontiers, improve the environment and pave the way for the technology of the future. The right information at the right time can make all the difference between commercial success and failure, whether for a multinational company or a small, family-run business.

In the short time at my disposal I can only outline in general terms what services, products and facilities are currently offered by the British Library to scientists and engineers. It is important to stress that today's British Library is not only a storehouse of the written word, but a unique repository of information serving the needs of a wide range of users, including scientists, engineers, inventors, industrialists, and commercial companies, upon whose activities the economic strength of the nation depends.

The British Library has been in existence since 1973 when it was established by Act of Parliament from a number of existing bodies: the British Museum Library, the Patent Office Library, the National Central Library and the National Lending Library for Science and Technology. It is one of the largest and most comprehensive sources of information in the world, serving users and researchers from all parts of the globe, and nearly half its annual expenditure and staff resources is deployed in meeting the needs of those working in science, technology, business and industry.

The two main areas of the British Library specifically serving the needs of scientists and engineers are the Science Reference and Information Service (SRIS) in London, and the Document Supply Centre (DSC), based at Boston Spa, near Wetherby in West Yorkshire. Although separated geographically by 200 miles, SRIS and DSC work closely together to exploit their joint resources to the utmost to serve their users.

The main part of the Science Reference and Information Service is at present in Holborn, but it will be moving to the new British Library building at St Pancras in 1993. It is the national reference library for modern science, technology and commerce, as well as for industrial property, trade marks and designs. The literature collections are available on open access and expert assistance is provided by the reading room and information services staff. SRIS is used by thousands of customers from all walks of life, from academics to industrialists, from sophisticated regular users to those who simply need a single item of information. Engineers and technologists, for example, find SRIS' collection of standards, technical specifications and data books of great value, while scientists come to SRIS for information on up-to-date laboratory techniques and equipment.

Two hundred miles north of London the Document Supply Centre specialises in providing documents - either on loan or for retention in the form of photocopies - to satisfy requests received from researchers, scientists, industrialists and academics. Over three million requests are handled by the Centre each year, with a quarter of them coming from overseas. It is interesting to note that a recent report jointly published by CEST, the Centre for Exploitation of Science and Technology, and the Document Supply Centre, indicated that there is a broad relationship between the use of DSC and innovative activity. Analysing requests sent to DSC provides an accurate and up-to-date indicator of the areas of science and technology of most interest to organisations with a commitment to innovation. Chief industrial users of the Document Supply Centre in the UK are from the sectors with the highest industrial research and development expenditure, principally pharmaceutical, medical and chemical companies.

For scientists, the British Library's strength lies in the ability of SRIS and DSC to complement each other. Whereas it has long been accepted by most countries that a national reference library is essential to preserve the archive of the printed work, it was not until 1962 that Britain acquired a lending library serving the research requirements of industry, commerce, universities, polytechnics, government departments, research institutes and public libraries, by supplying original items on loan or by providing photocopies of journal articles. As yet, no other country in the world has a comparable organization.

I shall now outline briefly some of the ways in which the British Library, through the services and products offered by the Science Reference and Information Service and the Document Supply Centre, is supporting those active in science and engineering.

LITERATURE COLLECTIONS

The literature collections of DSC and SRIS form a unique information base from which services to scientists and engineers can be provided. They contain: 30 million patents; 3 million books; 271,000 journal titles, 265,000 conference proceedings; 2000 market research and industry reports; 3 million reports; 500,000 translations, 23,300 local authority documents; 200,000 Russian science and technology monographs; 500,000 doctoral theses; 2000 trade and business directories; 3500 company annual reports, house journals, manufacturers' catalogues.

In order to help researchers find the material they want, access to information in the collections is provided not only through the British Library's own catalogues and databases but also by searching hundreds of other databases available throughout the world, such as DATA-STAR, DIALOG, DIMDI, ESA-IRS, GENIOS, ORBIT, etc.

INFORMATION SERVICES

The British Library offers a range of services of interest to scientists and engineers. Specialist and general enquiry and information services can trace relevant references for users and also supply the appropriate documents. Most of the information services on offer are at present operated from SRIS, with the exception of the Medical Information Service, which is run from the Document Supply Centre. General basic enquiries are answered free of charge. In addition a range of priced, value-added information services have been developed, all of which can provide documents as well as information. The services are:

- Science and Technology Information Service
- Environmental Information Service
- Medical Information Service
- Biotechnology Information Service
- Japanese Information Service
- Business Information Service
- Patents Information Service

Other services available include DSC's Journal Contents Page Service, which provides on a regular basis photocopies of the contents pages of specified current journals in DSC's collection, and Current scan at SRIS, which provides subscribers with a regular watch of published patent applications according to an agreed subject or company profile.

DOCUMENT SUPPLY

The supply of documents to researchers, scientists and academics is one of the most valued of the British Library's services. The Document Supply Centre is the fastest and most comprehensive document supply service in the world, receiving on average 13000 requests a day, from more than 14000 registered users worldwide. A remarkable 87% of requests received are satisfied from DSC's own stock of 7 million items and it cooperates with other parts of the British Library, in particular with SRIS, and with other libraries nationally and internationally to supply items which it does not itself hold. Over 74% of all requests received by DSC are for items in the scientific and technological disciplines and this demand is reflected in the nature of the collections, over 60% of which consists of scientific and technological material. Documents can be ordered from anywhere in the world - by post, using prepaid forms and coupons, by telex, by fax, by telephone or by means of a range of online or electronic methods. DSC offers both standard and premium document supply services, the latter including an Urgent Action Service, for those customers for whom speed is of prime importance.

Document supply services are also offered at SRIS, where a photocopy service is operated. Photocopies of items in the collections are available for personal visitors, either on a self-help or while-you-wait basis. The Patent Express service at SRIS provides a document supply service from the British Library's collection of 30 million international patents. Patents are recognized as being a major source of technical and commercial information, playing an important part in creating and sustaining the growth in a nation's economy and its industrial strength. Not only is patent information disclosed much earlier and in a more structured format than other scientific and technological publications, but often the information is never published anywhere else.

READING ROOMS

The British Library's major reading rooms are in London. SRIS has three reading rooms and access to them is free. The Holborn reading room covers: engineering; business information on companies, markets and products; physical sciences and technologies, British, European and Patent Cooperation Treaty patents and trademarks. Chancery House holds foreign patents and trademarks and the Aldwych reading room covers: the life sciences and technologies including biotechnology; medicine; agriculture; mathematics; astronomy and earth sciences.

Together the SRIS reading rooms offer over 350 seats and are visited by 150,000 visitors annually. Most of the material is on open access for users to browse, with staff on hand to help readers identify the information they need and to suggest appropriate resources. Basic linguistic aid is also available for those using foreign language materials.

There is a small reading room at the Document Supply Centre with 40 reader places. Over 5000 readers visit it annually. The staff offers general help and guidance to personal callers requiring delivery of items from the main DSC collections. The reading room houses major abstracting and indexing tools and a quick reference section.

PUBLICATIONS

The British Library is a well-established publisher and now produces more priced publications than any other library in the world. Between them, DSC and SRIS publish a wide range of bibliographies, indexes, catalogues and lists of holdings, as well as specialist information guides, newsletters and more general trade books. The expanding publishing programme contains titles in traditional paper format, on microfiche and on CD-ROM. It includes titles from DSC such as: Current Serials Received; Index to Conference Proceedings; British Reports, Translations and Theses; Books at Boston Spa; Boston Spa Serials on CD-ROM. The aim of many of SRIS' publications is to keep researchers abreast of the latest scientific and technological developments and recent monographs published have covered topics such as acid rain deposition, the channel tunnel and the Green Belt. SRIS is also the publisher of the well-received journal Science and Technology Policy. Finally, DSC conducts a long-standing Translated Journals programme in partnership with specialist scientific bodies. The series of Russian scientific titles includes the Russian Journal of Organic Chemistry; Thermal Engineering; Organometallic Chemistry in the USSR.

CONCLUSION

This paper presents a general outline of the ways in which the British Library is attempting to serve the needs of scientists and engineers. The British Library believes that it is uniquely placed to provide such services, with the Science Reference and Information Service and the Document Supply Centre working together to offer a "one-stop shop" for information and document supply.

Advances in science and engineering are crucial to the future of the nation and the world. Both disciplines depend to a very great extent on the kind of accurate and up-to-date information which the British Library can provide. Through their joint efforts, SRIS and DSC are, it is hoped, making a significant contribution to scientific and academic Research. Aware that information is a major requisite for progress, the British Library will strive to maintain and improve the quality of the services offered to scientists, engineers and researchers.

IT3

Energy Technologies Transfer

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SUMMARY

We need expert contacts and a press review to get the latest (energy) news. We need some feeling and a lot of knowledge to identify technological trends. We need management skills to transfer the information to the engineers by guidelines, conferences and publications.

1. INTRODUCTION

This conference is a possibility to introduce our Association to a world-wide group of engineers and scientists. We will use this meeting to present our successful ways of technology transfer and to learn from others. Last, but not least, we take part to promote women in engineering and science - one of the aims of our Association.

1.1 VDI - SPOKESMAN OF THE GERMAN TECHNOLOGY AND ENGINEERS

The Verein Deutscher Ingenieure VDI (Association of German Engineers) is an independent, neutral and non-profit association with more than 115 000 engineers and scientists as personal members. About 8 000 thereof are honorary cooperators; the staff is about 300 persons located in Dusseldorf. Constituted in 1856, VDI nowadays is the largest engineering organization in Western Europe, the first address in Germany for competent, balanced advice in all fields of technology and engineering.

The Regional Structure of VDI is formed by 41 regional VDI Divisions allover west and east Germany. In about 400 working groups and annual 4 000 events they mediate to 200 000 participants specialized knowledge in more than 40 scientific and professional interesting fields. With Friendship Circles VDI is represented in 9 countries allover the world.

The Technical-Scientific Structure of VDI includes 22 Technical Divisions with 800 committees. One of these technical divisions is the VDI-Gesellschaft Energietechnik VDI-GET (Society for Energy Technologies). All committee members, engineers and experts from non-technical professions, representing science, industry and administration, ensure generally accepted high class results. 20 000 experts take part in our 100 congresses every year.

The VDI Professional Division "The Engineer in Profession and Society" is covering the coherence of technical and social developments, and promotes education and continued training as much as professional opportunities.

Subsidiary companies support VDI activities like the VDI-Publishing House with about 600 titles and the weekly newspaper "VDI Nachrichten" (VDI-News), the VDI Post-Grade Training Center, the VDI-Insurance Service, and two Technology Centers.

1.2 GET - The energy field: from solar to nuclear energy,
From production to end use

The VDI-GET *is* choosen as a typical example for the VDI activities. Nearly 11 000 VDI-engineers are specialized *in* energy engineering and, therefore, members of the GET. Only 15 % of our annual budget comes from the membership fees; the rest is fully financed by our activities. Our work *is* concentrated *in* 15 topical and 13 guideline committees. In 1991 we will run 12 conferences, one of them internationally. Up to now we have published 10 information booklets. In 1990 we edited 11 VDI-conference reports, 2 of them were also translated into English. All our guidelines are included *in* the 3 volumes of the VDI-reference book Energy Technology. Already *in* the 13th edition we edited the Engineering Reference Book on Energy and Heat *in* a German and English version. We have our own publishing organ, the monthly technical journal "Brennstoff, Warme, Kraft BWK" (Fuel, heat, power). On the occasion of political decisions with technical concern we write public letters. We support 27 working groups within the VDI-Regional Sections and sponsor 3 courses of the VDI-Educational Group. We have about 300 honorary collaborators and a staff of 6 persons *in* our Dusseldorf office.

Technically we deal with 5 main items:
- Fundamentals of energy technology ex thermo-dynamics, combustion, fluid mechanics
- Sources of energy/fuels e.g. coal, nuclear, renewable, waste
- Energy transformation and supply e.g. power plants, its components e.g. for environmental protection
- Use of energy e.g. turbomachines, energy conservation
- Energy economy/politics e.g. financing, safety, climatic change.

The scale of the German energy market *is* given by the following numbers (IZE):

Consumption of primary energy *in* 1988: 11 430 PJ
12.0 % nuclear, 2.4 % water and similar, 16.2 % natural gases, 8.1 % brown coal,
19.2 % hard coal, 42.1 % petroleum.

Final energy consumption *in* 1988: 7 440 PJ
Divided by sources of energy:
Electricity 17.3 %, solid fuels 9.0 %, natural and other gases 21.2 %, fuel oils 22.5 %, motor fuels 27.5 %, district heating 2.5 %
Divided by consumer groups:
Industry 30.2 %, household 26.8 %, traffic 26.2 %, others 16.8 %

But, we have an intensive look also on the European and world-wide energy market.

All activities have to be initiated and/or approved by our Advisory Committee and executed by our Board of Directors. The realisation *is* done by the staff of the VDI-GET.

2. COLLECTION OF THE LATEST NEWS

There are two main possibilities to get informed on the actual energy events.

2.1 Primary data ex from committees, conferences or visits

The most reliable information source *is* the direct contact with experts.

Our basic way to get neutral and widespred information on an important topic is to call together a committee. Depending on the theme this group contains engineers with all existing views concerning the topic. Normally 1/3 comes from research and development, 1/3 from the manufacturers' and 1/3 from the operators' side. If necessary we include also politicians, medicins, bankers or else. The theme and the group normally *is* fixed by our board of directors and advisory committee for 3 years. They meet min. twice a year, some every 2 months for one or 2 days to discuss together on their topic. The committee work *is* accompanied by our scientific staff with suggestions, reports and actions.

In addition we also take part in conferences ourselves to meet experts and exchange opinions. We even visit experts personally to get to know their view and to have a personal look at the technology in question.

2.2 Secondary data ex from the press

In Germany there exist about 600 energy relevant press media from daily newspapers with energy articles over technically specialized monthly journals to scientific TV-reports. There are also data banks, company brochures, technical books, conference programms, video clips and advertisements. Worldwide there are about 400 major energy press publications.

About 50 of all these we read and look at regularly. In addition we have a look on various press reviews. We also have a press review of our own concerning all VDI publications. On the other hand we make a detailed literature research on special items if necessary.

3. EVALUATION OF DATA

According to our opinion there exists only one---Tndex which information is important and which not: the number and intense of the shown interest in a special topic. We have to find out how often we read or hear something on an item. From that we have to create a trend. On the other hand we have to weigh the technical value of the information. So, in practice, if we read or hear something on energy we always ask ourselves: Is there a broad interest of engineers to know more about this subject? Do we hear on this item for the first time? Is it worth to consider it further? The result of this overlook is a huge GET-internal collection of all relevant items and news, which is updated, expanded or shortened according to the latest primary and secondary data.

3.1 Extraction of relevant information from all sources

From committees most information is extracted in the form of minutes, from conferences in conferences reports, from newspapers as foto copies, from TV as video tapes and so on.

3.2. Decision on information spread

When we find out a trend or a real novelty-we-discuss among ourselves who should know about it. That may range from one named person over ex all motor construction engineers to the whole public. Then we decide which method matches most with the item and the target group, and - what we can afford! Most of the information spread must pay itself!

4. MEANS AND WAYS OF PASSING ON THE CHOOSEN KNOWLEDGE TO THE TARGET GROUP Our mostly used methods are shown in detail in the following chapter.

4.1 Guidelines

A guideline is a public standard on technical items ex "VDI 2045 Acceptance and Performance Tests on Turbo Compressors and Displacement Compressors". Most of the guidelines are created to prevent discussion between different groups of interest already in the fore field ex in contracts. The item must be accepted by our advisory council and the scientific advisory council of the Association. It has to be checked with the DIN Deutsches Institut fur Normung (German Institut for Standardisation).

Then, as described above, a guideline committee is constituted. Normally 9 people of the 3 interests groups and one chair. man come together. It takes about 3 to 6 years until a draft in green colour of such a standard is published. After that date there is a period of 6 months in which the public can test the practibility of a new guideline. Everybody can correct errors or can make suggestions for improvements. Every opinion is collected. After this period of 6 months the guideline committee meets again to discuss and decide on the new ideas. Then a final version in white colour is published. Every 5 years the committee meets again to decide whether an actualisation is necessary or not.

After a longer period, sometimes never, when the technology is not changing too quickly any more VDI-guidelines are transformed into DIN-standards. Today most of our guidelines are translated into English. They often are a basic documentation of the technical state-of-the-art for international standardisation ex in CEN or ISO.

4.2 Conferences

A conference is the best way to create a close contact between the experts and all interested people.

The first step to a conference is done about 2 years in advance. We need a technical idea and the decision that in this case a conference is an advisable possibility of technology transfer. We then collect and evaluate the information as described above. From that results a collection of headlines or even a first draft programme. We then make a first calculation of the event. A conference budget is between 100 000 and 500 000 DM. The place and date of the conference is choosen as well as the necessary surroundings (hotel or university).

The programme committee is called together for the 1st time. They decide on the conference programme outline and invited speakers as well as the fixed place, date and social events. A Call for Papers is written and spread to about 3 000 to 5 000 people including the press. The conference rooms are booked. Our Conference Organization is involved. The conference report is announced to our Publishing House. The accompanying exhibition is given to our Exhibition Organization.

About 6 to 9 months later of the received offers of papers are listed and given for evaluation to the programme committee. The group meets a 2nd time to decide which papers are accepted and in which order they are presented. Then all speakers, chairmen and else are invited together with a detailed conference programme draft. A press release is written and spread. All invited persons send back a questionnaire with their personal data, the final headline and a short version of their papers. The final programme is printed and sent out to about 7 000 to 12 000 people about 4 to 2 months before the conference date.

During this time the final papers of the authors are sent to our office. They are given together with a foreword and conference programme our Publishing House. All authors are asked whether they want special prints of their papers in addition to the conference report. All participants of the conference receive a bill on the conference fee. The papers are given in advance to the conference chairmen to enable them to prepare a discussion. The food, beverages, flowers, visits and so on are ordered. The advertising material is prepared Le. Newspapers, press releases, membership forms. A participants' list is printed. The number of conference reports is fixed.

After 2 years of work the conference takes place! Afterwards we thank everybody for participation. During this whole time about 60 people worked on the conference to make it a success.

4.3 Publications

If we want to conserve some-knowledge for a longer-period and want to spread it to a bigger group of interested people we normally choose the way of a publication. This publication can be in the form of an article submitted by an expert member of one of our committees to a newspaper or magazine. Many times our texts are published in the VDI-Nachrichten or BWK. Another mean is the publication of the conference papers in a VDI-conference report.

But we also have topical committees who publish information booklets or even technical books. In this case a group of authors come together in a sub-committee. They first create a structure and a short version of the text. Then the topical committee discusses this content. After that the sub-committee starts a 2nd working round. One author per chapter writes his text complete with fotos and graphs with the agreed contents. The chapters are put together to a book after they have been equalized. The final text is agreed by the topical committee and then published in a circulation between 2 000 and 20 000. The advantage of this method is, once again, a neutral information.

4.4 Other methods

There are various other ways to pass on the information. We like to stress that we answer every year about 6 000 single questions of members and non-members concerning energy technologies. We are ourselves members of a lot of national and international committees to give way from our information to other institutions.

Multimedia Development for Engineering Education and Training DA Communication Challenge

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SUMMARY

Multimedia technology has much potential for enhancing the educational process. However, more attention has been given to the acceptability of multimedia to the end-user, the student, rather than to the instructor. At Southampton, computer scientists and subject specialists are working together to enable teachers to customize multimedia material in much the same way as they may adapt traditional teaching materials. This paper discusses progress to date and its implications for engineering.

INTRODUCTION

Multimedia technology allows the integration of text, graphics, video and audio data into a single, unified computing environment. As such it has the potential to merge the three previously unconnected fields of publishing, computing and broadcasting. During the 1990s multimedia technology will rapidly become more commonplace and more accessible to the non-specialist user.

New multimedia technology enables us to create environments that combine all that was exciting about interactive video with the power of text and data processing, and the visual impact of high resolution graphics. The use of such systems will be limited only by our imaginations. How quickly they will become commonplace depends on the cost of computer processing power, the rate of development of new technologies such as digital video and the availability of stimulating software environments for manipulating multimedia data.

This paper discusses the development of multimedia computing, including hypermedia techniques, and the potential it offers to education: specifically we are interested in the application of multimedia technology to engineering higher and continuing education. We discuss the barriers which currently prevent teachers from fully utilising and harnessing the tremendous potential of multimedia technology, and suggest how these may be surmounted.

THE DEVELOPMENT OF MULTIMEDIA COMPUTING

An early multimedia technology was the interactive videodisc. Although videodisc technology has been available since the late 1960s, education has been unable to realize its potential, primarily because of the high costs of disc production. An additional barrier is the fact that interactive video uses analogue technology, which means that the information stored on the discs cannot be distributed digitally. Any user wishing to access information from a videodisc must have a videodisc player and the videodisc itself at their workstation. This is has the effect of increasing costs.

Most examples of interactive videodisc material are in the industrial training sector where it can be both cost effective and educationally effective to produce videodiscs and related software designed specifically for training tasks. Education cannot afford to create a new videodisc with specialized software for each teaching or learning task and an alternative strategy is required [1]. A resource

Based approach must be adopted whereby each videodisc comprises a collection of material about a particular subject. The information may be general in its content or highly specialized but it must be capable of many different applications and relevant to a wide range of users. The Domesday discs [2], the IBIS disc [3] and the Cell Biology discs [4] are all examples of resource based discs.

Using resource based discs, teachers can develop tutorials and study programmes to meet their own teaching objectives. These may then be distributed with the videodisc or under separate publishing agreements. Currently a team, comprising computer scientists, programmers and subject specialists, is needed to progress such developments and the scale and complexity of the task inhibit teachers from embarking on such projects. The process may be compared with the production of a multidisciplinary textbook rather than the writing of a lecture or tutorial. Examples of tutorial software developed at the University of Southampton are described in [4] and [5].

Two recent technological advances offer greater opportunities for the adoption of multimedia in education. The analogue WORM (write-once-read-many) technology, such as developed by Sony, enables the user to place film, video and other photographic images directly onto a videodisc. This is particularly useful where the material to be transferred to the disc is already available (Le. no new film has to be shot). Many educational departments have large collections of photographs, slides and video information for use in teaching or research, that they can now, at relatively low cost, transfer to videodisc archives. The resulting disc can be used at the simplest level for effectively illusttating lectures and seminars or it can be used as the basis for a sophisticated, student-centred learning environment.

The second advance is the development of digital video in the form of DVI (digital video interactive) and CD-I (compact disc interactive). Both incorporate compression techniques which allow the development of full digital video technology and enable full-colour, moving video information to be stored on a chip within the computer and thus to be fully integrated with other types of digital data such as text, graphics and sound. Digital video will allow multimedia computing to achieve its full potential, in the same way as the laser printer made desktop publishing a reality.

THE EFFICACY OF MULTIMEDIA IN EDUCATION

If we are to successfully promote the use of multimedia in educational contexts we must be certain that it significantly enhances the learning experience and leads to increased learning effectiveness by the provision of a unique combination of materials and opportunities. The perceived benefits of multimedia are well publicised. Principally these emanate from the vast storage capacity of the systems, the power of images to inform, the efficacy of interaction and "doing" in enhancing learning, and the facility of self-paced study. However it is the perceived drawbacks which need to be addressed by designers and which determine whether or not the technology is likely to be adopted.

For the student the main drawbacks are associated with the limitations of machine-based learning, principally its impersonality, often exacerbated by a reduction in direct teacher contact, making learning an isolating and individualistic experience. Poorly designed packages may take the student along pathways which are slow, dull, irritating and unrewarding; the student may resort to unreasoned trial and error procedures which are conceptually and educationally unproductive.

From the teacher's viewpoint perceived drawbacks may reflect a fear of losing control and opportunity for direct supervision of the learning process, and a reduction in feedback response. Multimedia can certainly divert teaching away from mere presentation of information, releasing class time for deeper discussion of concepts and attitudes which embody understanding. Whilst this is likely to be educationally advantageous, we must recognise that the teacher may feel anxious and threatened by any perceived loss of control over the course content and the teaching/learning process; such negative feelings will discourage teachers from adopting multimedia in their courses.

To date more attention has been given to the acceptability of multimedia to the end-user, the student, whereas our premise is that the instructor, who is intermediate between the package/system designer and the end-user, must be the first and crucial target. Multimedia packages should be seen as aids to teaching and learning. Teachers must be encouraged, via the content and presentation of any package, to customize it by editing the software, in much the same way as they currently may adapt traditional teaching materials. Subject specialists may wish to create tutorials utilising the multimedia databases.

Secondly feedback and evaluation procedures must be incorporated so that instructors can check on their students' learning strategies and progress. The educational process normally incorporates opportunities for students to demonstrate skills and understanding by the production of original work, such as a literary composition, mathematical calculation or engineering design. Students should be able to utilize the constituent databases creatively and show their understanding of a subject by a multimedia "essay" or project: this sort of opportunity can prove highly motivating.

Limitations in software have previously limited interaction to simple selection of preferred alternatives, offering control over the pace and direction of study but little creative challenge. Whilst interaction is the key to the efficacy of multimedia for education and training, if all tasks are trivial the benefits of involvement are forfeited.

A THREE LEVEL MODEL FOR MULTIMEDIA INFORMATION SYS1EMS

So, in order to effectively utilize large information systems in education we must develop new, inherently interactive software environments. Hypertext and hypermedia interfaces appear to offer a possible solution to this problem. The term "hypertext" was coined by Theodore Nelson to describe the idea of non-sequential writing [6]. The concept embraces and extends the practices of accessing information via indexes and cross-referencing, both familiar procedures in the context of printed publications. A hypertext system is one which allows authors or groups of authors to link information together, create paths through related material, annotate existing texts, and create notes that point readers to the same or other units of information. In this way the author can create a database of nodes and links that can guide readers along a particular path or let them freely range through the information. Hypermedia refers to a hypertext system that has been extended to incorporate other media, such as graphics, video or sound, in addition to text Several projects have applied hypermedia to education, including the ILAB (Interactive Learning and Biology) project at the University of Southampton, U.K. [4] and the Intermedia project at Brown University, U.S.A. [7].

The ILAB project has been established to evaluate the use of hypermedia as an interface to multimedia information systems in education; the current user group consists of first year undergraduate (biology) students. The results to date are very positive and indicate that in general the students welcome the introduction of multimedia to their course(s) [8]. The interface has proved effective as a means of providing students with access to multimedia data, particularly in linking textual information to graphical animations and video sequences. However users who are unfamiliar with the subject matter need direct or indirect prompts. Directed paths or routes through the hypermedia network of links are one way of providing such prompts. Additionally tutorial modules can be included as nodes in the database, access to which can be provided by "buttons" and links placed at the appropriate points in the hypermedia system. The content of the tutorial material can be drawn from the multimedia database itself.

This suggests a three-level model of access to the multimedia information system - the database level, the hypermedia level and the tutorial level. The same information can be utilised multifariously, and simultaneously accommodate the needs and aspirations of students, teaching staff and subject specialists. It also encourages the resource based approach to the development of multimedia for use in education since the software can be developed in stages subsequent to the availability of the material in the multimedia database.

APPLICATIONS IN ENGINEERING EDUCATION

Engineering education could be greatly enhanced by increased use of multimedia. Several projects are currently underway at Southampton to test this hypothesis using the model described above in subjects as disparate as irrigation studies, robotics and mechanical engineering. Compared with many other subject areas, engineering education makes great use of visual and reference materials. In the classroom it is standard practice to make full use of overhead and slide projection facilities and in carrying out laboratory-based projects or design tasks students are increasingly expected to make use of computing facilities. Computer aided design (CAD) is now standard practice.

Multimedia provides a particularly appropriate tool for handling large databases such as currently embodied in Standards and design manuals. Using techniques such as simulation and surrogate travel, multimedia is invaluable for investigating field-based scenarios, and for equipment training.

Possible strategies and solutions can be investigated by trial and error, avoiding the risk, irreversibility, danger or cost which might be associated with direct, full-scale field operations. Multimedia also provides a means of exploring the multidisciplinary context of engineering problems; a successful engineering solution acknowledges and accommodates the inevitable interaction with the human and physical environments. However not all problems lend themselves to investigation via multimedia; some are less visual and some topics are already dealt with satisfactorily in other ways.

CONCLUDING COMMENTS

The combination of scope and power provided by the convergence of computing, audio and video technology has the capability to greatly enhance and enrich the learning process. In the context of education, and in response to the high development costs associated with multimedia production, a resource base approach is crucial. The nature of engineering problems and the engineering method of problem-solving seem to lend themselves to benefit from the attributes of multimedia.

Teachers and students will only accept and adopt multimedia technology if they perceive it to be "accessible" and we advocate three levels of access. Multimedia must cater to users who are not particularly conversant with computing and the procedures employed must not interfere with the pursuance of the educational objectives. Software needs to encourage users to interact with the database and authoring tools. The ability to be involved with and benefit from the creative capacity of multimedia will truly enhance the teaching/learning process and motivate students and teachers to demand access to multimedia facilities.

The 1990s will be the decade of multimedia technology: time will tell whether or not the computer scientists and software designers can work together with subject specialists and educationalists to bridge the gap which currently separates the technology from its potential position in education.

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IT5

Microcomputer Networking

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SUMMARY

Microcomputers are not only personal computers but also workstations which can be connected to a variety of facilities firstly by using a Local Area Network and secondly by linking to larger computing services to gain added functions such as file transfer, electronic mail, access to databases, etc.

INTRODUCTION

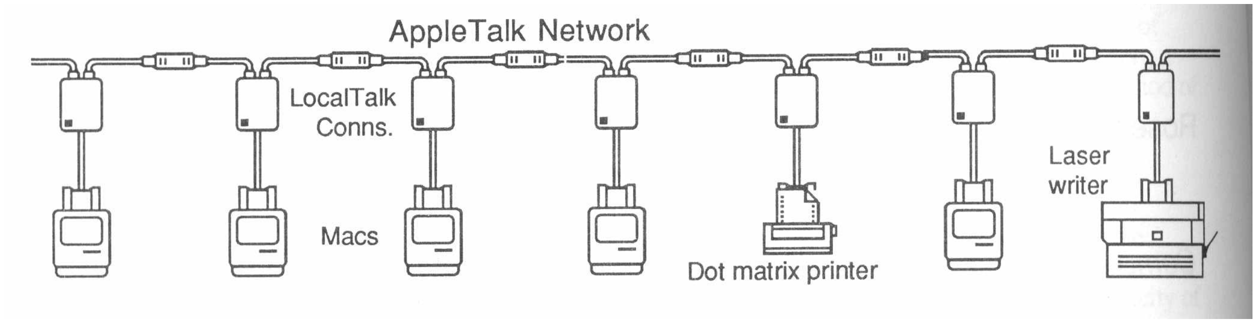
Microcomputers work well enough on their own, with perhaps a printer for output and a modem to connect to the outside world, so why network them?

Given a number of users in, say, a classroom:

- It is more economical to share a printer between several
- It is definitely more economical to share a plotter or laser printer between many users Software on a file server is shared. Software vendors are beginning to sell network licences
- Given a far reaching academic network, the 'outside world' from a university may well be another university in the same country or almost anywhere in the world. This is more convenient than expensive public telephone lines via a modem.
- A networked workstation does not necessarily need a hard disk because all the applications are on the file server so maintaining the integrity of hard disks is no longer a problem.

A SIMPLE LAN

Consider one of the most user-friendly networks, Apple share,[1], connecting a roomful of Apple Macintoshes.



In its simplest form the Macs share the printers on the network. Each machine has its own Local Talk connector and no extra software is necessary because it is already built in. Also the line is automatically terminated by the end Local Talk connectors.

Next, add a fileserver with disk capacity for all the applications, such as database, spreadsheet, word processor, graphics package etc. This Mac will need AppleShare fileserver software plus, if there is much competition for the LaserWriter, a print spooler. With this the printing is queued by the fileserver leaving the Macs free for the next task.

Limitations

- The time taken to launch any large application on all the machines, the speed of the Local Talk network being only 230.4 kb per second
- The maximum number of connections to a single AppleTalk network without a router is 32.
- There are no connections to the outside world without adding a bridge or gateway or using the second serial, or modem, port on each Mac to connect a host computer.

MIXED LANS

It doesn't matter whether you start from a network of IBM, Acorn, or Macintosh microcomputers the interconnection problem remains the same - they don't talk the same language or, in the jargon, they each use a different protocol and are different right down to the type of wire connecting them. For the IBM micro and its clones alone there are many different LANs to choose from.

Without wishing to get bogged down in jargon, there has been an International Organisation for Standards, ISO, [2] for some time and they have defined an Open System Interconnection Reference Model referred to as RM/OSI towards which manufacturers are working. This model consists of no less than 7 levels which define interconnections from the hardware interface, the lowest level, up to the user application, which is the highest level. (Apple claim that their AppleTalk defines a network protocol based on the full OSI seven layer model.)

The cabling system, working at the lower two levels only, which has gained the most support is Ethernet [3]. This started out with a thick, expensive and unbending co-ax cable and connectors, has progressed via 'thin' Ethernet co-ax cable towards unshielded twisted pair, all claiming to maintain a network speed of 10Mb per second within the limitations of cable length, etc.

To support an Ethernet network each station on the network needs some hardware, usually a circuit card plugged into the computer bus, and some software to support the intermediate levels of protocol. At a level above this comes the AppleShare software or Novell Netware [5] which is popular on IBMs and their clones. For the newer Macs, since AppleShare works over both Local Talk and Ethernet, the extra speed of Ethernet may justify the extra hardware cost. There is no extra software cost. Novell Netware, however, is a third party product and hence has to be purchased separately.

A Novell 286 network server offers support for Macs through the Mac V AP (Value Added Process) that converts between AppleTalk and Novell protocols. Alternatively, it is possible to plug a Local Talk PC card into an IBM micro and add AppleShare PC software it is unlikely that a single file server would be large enough to supply all the Mac software as well as all the IBM software, or that a single laser printer would suffice for all the combined printing needs. It is more likely that separate IBM and Mac networks would benefit from connection to a mini computer which could then provide those added functions which the groups of micro users need.

CONNECTING DIFFERENT NETWORKS

To cross over between dissimilar networks, beside spanning the physical distance between the two, requires a 'black box' to transport packets of data safely from one network to the other and unpack the data so that the receiving network can read it [6]. Very few networks have been planned right from the start to take account of the multitude of machine specific LANs that have grown up. Interconnecting these is possible if the standards used are sufficiently common so that the right sort of black box is available

BRIDGES, ROUTERS AND GATEWAYS

One useful sort of black box is a bridge. This is capable of connecting different physical media, for example the co-axial cable of Ethernet and faster long distance fibre optic cable. It can also convert high level protocols. as. For example, AppleTalk to an Ethernet compatible host. Local bridges are also used to segment an existing LAN whose performance is beginning to degrade by limiting the traffic to the segment for which it is intended.

Routers, as their name suggests are used to make routing decisions that determine the most efficient data path between two network segments. They are not concerned with access level protocols.

Gateways operate at the top three levels of the OSI model and are used when you have to interconnect systems with totally different architectures.

WORKSTATIONS

The objective of connectivity for microcomputers is to turn them into workstations, the idea being that the whole range of computing services is available from one machine on your desk. This includes

- using largish software packages, such as languages or computer aided drawing software, from a file server
- using the workstation as a terminal to an even larger graphics, or other, package

- preparing your program using you local word processor, then transferring the file to a larger computer for compiling, linking and running
- Much free or shareware software is held on computers around the world. Given the address of the remote site some item can be downloaded to your own machine, sometimes in several stages via an intermediate computer. (Binary files are usually turned into text and compressed so will have to be expanded and returned to their original binary form before they can be run.)
- searching your local library by author or by title to locate the book you need
- searching other databases to which you have access
- Sending and receiving electronic mail. Not only can this be very fast but also incoming mail does not intrude like the telephone but can be collected when you are ready.

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IT6

Communication within the Home

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SUMMARY

This paper looks at how current technology and proposed standards are leading towards sophisticated communications within the home.

In today's home there are a diversity of products available utilising electronics. This leads to improved reliability, reduction in size, and lower costs. The main driving force has been the development and widespread acceptance of silicon integrated circuits; there is little sign of this slowing as new silicon chips are still corning onto the market.

The next step is to link together these products to increase their functionality and usability. Any single manufacturer can provide a way of linking his own products. However in order fully to exploit the concept of integrated consumer electronics and thus the integrated home, a standard is required to enable multi-vendor interconnection. This must specify a common language and protocol required. This is what the ESPRIT Home Systems project has been looking at.

Home Systems aims to offer a standard communication infrastructure for the home When looking at what communications are required in the home the following general human needs have to be considered: - Productivity, Entertainment / Hobbies, Convenience, Comfort, Saving Money (energy Management), Peace of mind (security and safety) and Communication.

To enable various devices to communicate, a medium for transferring data has to be considered. No single medium is ideal in the home so a multi-media approach is required.

Media considered were Power Line (mains), twisted pair, Coaxial cable, Infra Red, Radio Frequency, and Plastic Optical Fibre (POF). POF is not currently used around the house and the technology is neither stable nor mature enough to be considered a viable proposition at the moment. Therefore this paper will not consider POF.

Mains wiring is already available in our homes, and there are many devices on the market which connect to the mains. Unfortunately this is not an ideal medium for communication, because it is an 'Open Medium', that is, information could

Inadvertently pass out of your house. In the case of 3 phase mains in the UK it means that you could be sending information to your neighbour 3 doors down. This problem has been reduced by the introduction of a unique house address, but as yet it is not clear how this unique house address could be administered.

Coaxial cable already exists in most homes, since the majority of people have televisions and videos. Its primary purpose is to transport high quality, high frequency audio / video signals.

Twisted pair already exists, provided the house has a telephone, this medium would be used in the DIY market, since it is straightforward to install.

Infra red has a limited use in the home, because like mains it is a slow medium, and would only be used for control. Currently it is used, for example, to change television channels.

In the UK radio frequency is becoming more commonly used with the acceptance of the cordless telephone (cr2).

Other factors to consider when thinking what media to use are; how easy it would be to retro fit a system into existing buildings, cost and complexity of installation, could it be aimed at the DIY market. Also what devices already exist in the home and how many might be conncted using the Home System. Diagram 1 shows the type of devices that are in common use around the home.

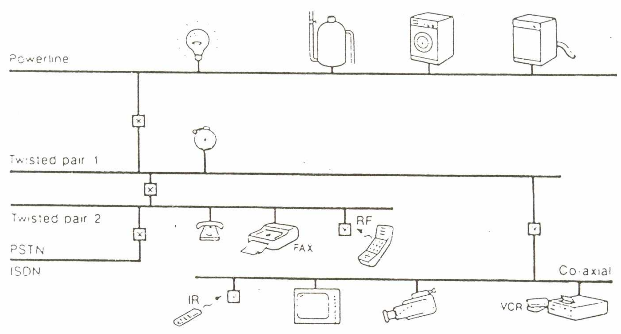

Diagram 1 Multi-media implementation

So far we have discussed what media already exist in the home, and the type of devices attached. The next thing to consider is how these devices are going to communicate, moving from type of service offered and what type of information is to be transmitted, to how information can be passed between media.

Home Systems will offer 3 types of service: - datagram, connected service and power feed. Taking the datagram service, this will be common across all media; it is the way of carrying control information between devices. It is the foundation service for the control of the network.

The connected service covers the real time transmission requirements of devices using Audio, television or telephone. Power feed service could be used to power devices, instead of connection to mains power or battery operation.

Communication between the media will be using routers. These routers pass datagram' s from one medium to another.

The communication between devices is made using datagram' s. The structure used is based on the 7 layer OSI model. Figure 2 shows the overview of the Home System Reference model. The datagram services offered by the network layer and above are the same for each medium. The Physical and Data Link layer services are different for each medium, because no two media have the same characteristics.

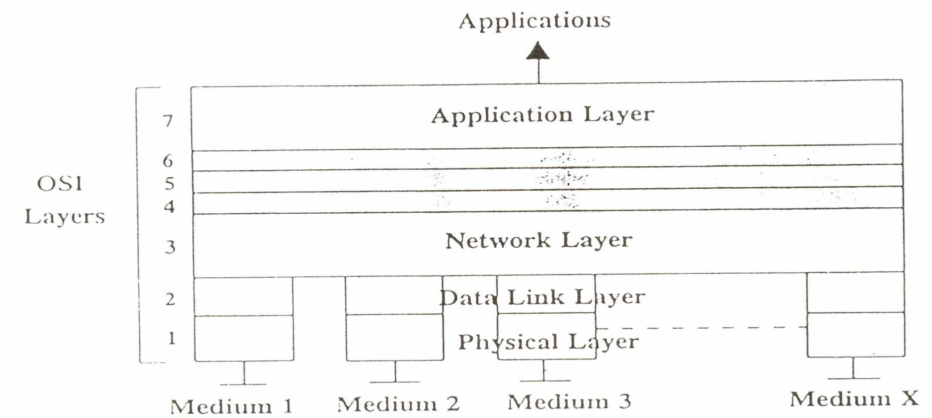

Diagram 2 Communication s Structure of the Datagram service

As can be seen from diagram 2 the Home System does not require the services offered by the layers 4 to 6, so for reasons of simplicity these layers are empty. Should any functions identified belong to these layers, they will be placed in the applications layer.

Once the type of service to be offered is considered then you have to consider the class of information to be carried. This falls into 4 categories namely:

Class 1	Low speed command and control data
Class 2	Telephony and low speed user data
Class 3	Analogue audio and low quality video
Class 4	VHF / UHF audio and video and digital audio

When the Home System has expanded to include several different devices, then a way of controlling the devices is required. Typically various controllers would be installed, dependent on the tasks required. Examples are telecontroller, entertainment controller, and security controller. Devices can belong to various controllers. If a device belongs to more than one controller then a form of priority is required

A telecontroller allows the Home System to be controlled remotely via the telephone network. It will take all incoming messages received from the telephone, interpret them and send the appropriate messages to the controller concerned. A typical

Telecontroller uses stored voice messages to talk to the remote user, and is controlled by a telephone keypad.

An entertainment controller will direct all commands relating to entertainment devices to the relevant device. Devices under the control of the entertainment controller include TV, video recorder, and Hi-Fi. For example the video recorder could automatically select the required television channel.

The security controller will control all commands relating to the security system. Devices included would be bell, video camera and video recorder. This shows that a controller can manage devices on different media. To give an example of facilities offered by the security controller: an intruder is detected, the security controller will switch the video recorder to record from the video security camera thus capturing the intruder on video. This would have a higher priority than recording from the television. It could also sound the alarm.

Here is an example of how a Home System could be used when you are not at home. You are going to be late home from work, so wish to delay the heating coming on and video your favourite soap. You telephone your house and, as no-one is at home, your telecontroller answers, you then enter your PIN which, if correct, allows access to the various systems menus. To delay the heating you select the energy management menu and delay the heating switching on. To program the video you select the entertainment manager and program the video (it assumes that there is a video tape in the recorder).

CONCLUSION

At present there is no fully automated home system, it can be seen that it could soon become a possibility for the future. The ESPRIT project has gone a long way in Europe to standardise the commands used and formats of messages so that various manufactures could link their products. This specification is currently being submitted to the European Standard bodies.

Other proposed systems do exist in the world including the Japanese Home Bus System (HBS) Communications and Telephone Standard, which was the basis for European system. In the United States of America, there are several systems, the most developed being the Consumer Electronic Bus (C E Bus), and Smart House (this system is only suitable for new houses and can not be retro fitted).

Communication Between the Operator and the Intelligent Factory Control System

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Summary

Despite the application of high technology, including artificial intelligence, the human operator is still an important part of the control of many complex devices, such as process plant, factories and fighter aircraft. This paper looks briefly at how these technologies change the human operator's job and how advanced control systems need to take account of the operator's needs for a skilled and interesting job.

Introduction

For the next few years at least, the human operator will remain an integral part of automatic control systems. Rather than designing control systems which optimise the facilities of the computer-based controller, we should also be designing the operator into the control system, so that the performance of computer-based control system and the human operator are both optimised.

The Need for a Human Operator

Control systems are being designed with more and more built-in intelligence, in the form of expert systems and the more advanced version, Intelligent Knowledge-Based Systems. With the development of such complex pieces of equipment, some would ask whether there is still

A need for a human operator on the plant. Is the human operator a source of error and sub optimality in the system, or does the human operator have an important and necessary role to play?

Let us suppose that it could be shown that any system which contained a human operator would be less than optimal. What sort of system might that be, within foreseeable technology? The vision that comes to mind would be of a fairly simple system, with few control parameters, low risk operation and low cost consequences. A well-designed desalination plant might fit the bill, with plenty of on-line sensors to detect the plant's failure to produce water fit for consumption.

Compare such a plant with those where high technology is being concentrated, such as in military applications. In aerospace, advanced fighter aircraft still rely heavily upon the human pilot, even though the pilots are no longer able to fly the aircraft under manual control. In the quest for maneuverability, modern fighter aircraft have become so unstable that microprocessors are required to make the millisecond adjustments required to the aircraft's control surfaces.

Despite the application of high technology to these aircraft, the fighter pilot is still in the cockpit, although assisted in the actual tasks of flying the craft and aiming and firing weapons. The pilot's role is to perform those tasks which the computer-based systems can not yet manage, although with the advances in artificial intelligence, there would seem to be fewer and fewer tasks requiring the pilot. For example, Pomeroy and Irving [1] are developing a Pilot's Associate which will be capable of:

1. "Assessing external threats and target environments,
2. "Assessing the internal status of aircraft systems,
3. "Planning the mission route, and replanning to respond to changes in threats or targets, or to accommodate equipment faults,
4. "Planning optimal tactics to perform mission goals within constraints of threat or target behaviour and aircraft performance limits; and
5. "Planning emergency actions to correct faults to mitigate their effects."

Many of the papers on applications of advanced technology concentrate on the technical aspects of the control systems, without explaining the role that is left for the human part of the system. So, we need to consider how the control system and the human operator are to function together, so that the performance of both will be as effective as possible.

What can we offer the Human Operator?

Expert systems and IKBS have been applied to process control and factory automation with a number of goals in mind. These have included:

Capturing expert knowledge so as to reduce staffing levels and/or employ less skilled staff,

Provide a better quality and more consistent product,

Make more efficient utilisation of the available resources of plant and input materials.

These goals are oriented to the standard business objectives of using money and resources more efficiently and capturing a larger slice of existing and new markets through better service to the customer. But the staff are a very important part of the organsiation's resources, so how is their effectiveness to be maintained and improved by the introduction of new technology?

MAINTAINING SKILLS

Many applications solve this problem by assigning staff to the more intellectually demanding and interesting parts of a job, once the simpler parts have been studied and automated with the help of intelligent control systems. The nature of a process control job is repetitive and continuous, so the operator's interest in thejob must be maintained. If the operator loses interest, and devolves responsibility for all control tasks to the automatic control system, then several important consequences ensue.

If the process control task, for example, has been de-skilled to the point that the operator has nothing more to do than confirm the computer's recommended control actions, then the operators cannot maintain their own control skills and it becomes more difficult for new operators to acquire and practise those skills. Hence, there needs to be some means whereby the operator can be offered a skilled job with the opportunity to practise and maintain those skills. In the case of the automatic control system breaking down or failing to cope with an unusual set of circumstances, then the operator if the last repository of understanding and ideas for effecting recovery.

COPING WITH ABNORMAL CONDITIONS

While the operators do not want a boring and trivial job, neither do they want a job that is too stressful or with the consequences of a mistake being too drastic. The Three Mile Island disaster is an often-quoted example where the operators were overwhelmed by the enormous number of alarm signals that went off in the first few minutes. In such highly stressful conditions, it is all too easy for the operators to make a wrong diagnosis of what has happened and fail to correct that diagnosis in the face of so many pieces of evidence. So, the operator needs to be helped with some pre-processing of enormous quantities of data so that the operator's attention can be focussed on solving the problem in an appropriate time-scale.

There are two ways in which the automatic control system can cooperate with the operator here. The first way is for the control system to detect that the plant or process is moving away from set point and respond by informing the operator that it will take over some of the low-level control tasks which are still performing correctly, leaving the operator to concentrate on locating and diagnosing the faults. The system could also make the operator's job easier by

Diverting flow away from the likely locations of the fault or gradually reducing the rate of flow of material.

The second way in which the system can help the operator is to help process the alarm data and present some possible diagnoses of the fault condition. If things look dangerous, the system could go as far as to suggest tests to distinguish between the faults, possible recovery or shutdown actions and monitor the recovery of the plant as the control actions are carried out, replanning as required to adjust to evolving conditions. (Refer back to the tasks performed by the Pilot's Associate.)

FEELING SAFE

While we would not want to offer the process controller a job as exciting and glamourous as that of the fighter pilot, there are many ways in which the Pilot's Associate is similar to the decision support and control system required by the process operator. An important difference between the two jobs is that the operator is expected to perform efficiently and with minimal damage to the environment, whether human, economic or ecological. So the control system needs to be designed to support that important requirement. It is not sufficient to place legal regulations around the operator's task to ensure due responsibility, if the job itself works against those responsibilities.

Hence, the operator must also feel safe in the job, not only safe from hazards, but safe from the legal and organisational consequences of a mishap. This requirement has many layers of meaning. It implies that the hardware and software must be constructed with appropriate attention paid to the safety critical aspects of their use. The operator must feel comfortable with the distribution of autonomy in the system and that the control system will not take actions that the operator is not aware of and does not understand the reason why. Furthermore, the operator must be and feel adequately trained in the operation of the plant. Faced with a complex plant or factory and a complex control system, the operator has a highly challenging task. The skills and conceptual understanding required must be properly taught to the operator so that the operator can feel comfortable and confident in the performance of their job.

Acknowledgements

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A Computer Based Process for the Exchange of Information Between CAD Systems and Manufacturing Systems

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SUMMARY

There often a need for two or more isolated, commercial computer systems to communicate. An exchange system has been created which acts as a server to allow the bidirectional communication between two or more client processes. Its use in linking a commercial CAD system with a coordinate measuring machine is discussed.

Introduction

Computer Aided Design (CAD) is a term applied to the use of computers in the design process. In the past CAD usually meant a two dimensional draughting package. With the advent of workstations and personal computers the CAD systems came into an era of their own. Today CAD systems are widely used in areas of design applications e.g. conceptual interpretation, manufacturing, architecture, planning. Here the product could be a car body design, an engine design, an architectural drawing, a sewage layout plan. This increase in the application of CAD has therefore created a need for it to be able to interact with the other existing downstream processes like manufacturing, inspection, analysis etc.

The result has been the development of a large number of stand-alone software systems dedicated to specific tasks. In this paper, a system that provides a bridge between such isolated software systems is discussed. In the application give the two software systems being so connected are a commercial CAD package and a coordinate measuring machine (CMM).

In this application, geometric data needs to be extracted from the CAD system, processed and sent to the CMM. The measured data is subsequently extracted and sent to an analysis package.[2,4] The exchange is built so as to facilitate the bidirectional communication between two or more such concurrent processes.

The Exchange and its Connections Library

The prevalent method of communication between CAD and CMM systems in the industry is via plotted drawings. These drawings have the quality control inspectors' constraints, methodology and comments incorporated. The measured or inspected data is then printed out and submitted for analysis and reporting. However, the large number of systems involved makes the entire process laborious and prone to misinterpretation and inaccuracies.

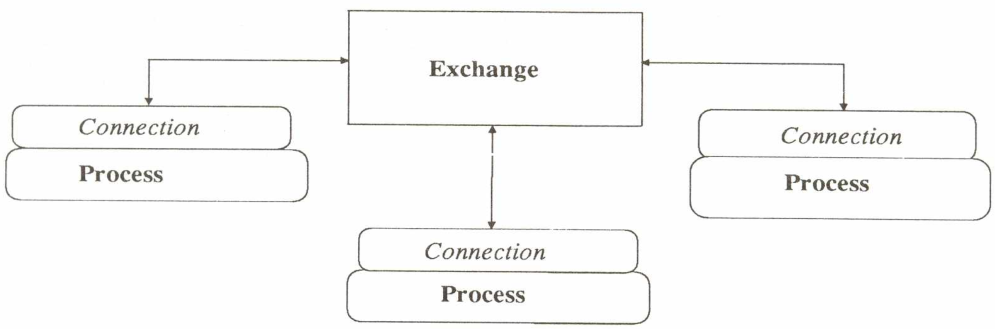
What is required is a system which is capable of handling bidirectional communication between a large number of processes. This is possible in the. UNIX environment because of its multi-user and multi-tasking capabilities which could also support concurrent processes. The UNIX facilities for interprocess communication (IPC) and networking are mainly used. The exchange has been implemented like a client/server model. The exchange establishes itself as the server process at a pre-defined address. The server, when willing to offer its advertised services, binds a socket to a pre-defined address associated with the service and then passively listens on its socket. In SunOS most servers are accessed at well known Internet addresses or

UNIX domain names [1, 6].

In the client/server scheme there exists an implied asymmetry in establishing communication between the client and server. Hence the exchange has to exist in order for other processes to connect to it. Since several clients may try to connect more or less simultaneously, a queue of pending connections is maintained in the UNIX system's address space. When a connection is requested, it is listed in the queue. Once the connections are accepted the exchange will enable interprocess communication in accordance with a set of conventions. This comprises a protocol that must be implemented at both ends of a connection.

To manipulate and direct the transfer of data, a protocol i.e. a set of rules, data formats and formalities is defined and implemented within the exchange. In order for the client processes to communicate with the exchange legitimately, they require to link with the connections library. This enables the client process to comply with the protocol quite simply. The connections library is intended to aid implementors by providing a framework that promotes code sharing and minimises implementation effort. To structure and unify the external view of the communication as well as the internal system implementation, a set of commands have been formulated. This set of commands typifies the protocol structure, they are described later.

Utility routines that hide many of the more complex chores of communicating are stored in the connections library. The routine used for opening a connection with the exchange server is open_connection (name). Here the calling process sends its name by which other processes can identify it. To send a message to another process the routine used is write_connectton (msg). The routine used for receiving a message from the exchange server is read_connection (msg). To close the connection the routine is close_connection ()



Communication via exchange

Figure 1 illustrates the basic structure of the exchange system. The exchange can be run as a foreground or as a background process. When testing or debugging any of the connecting processes the exchange is run in foreground mode. This enables it to display the text of the messages passing through it. Under normal day-to-day operations the exchange would run as a background process with the user unaware of it.

Protocol and Data Structures

A protocol is a set of rules, data formats and conventions that regulate the transfer of data between participants in the communication. [1]. The exchange maintains two related data structures which provides a practical means of implementing andsupporting the protocol. The data format of the messages received by the exchange is of the form: command word, source process name, destination process name, reference number, identification number and the message data. The exchange keeps track of the names that are bound to socket numbers, establishes connection with new processes, and transfers data between sockets, keeps a list of process names with their status codes, and keeps messages awaiting retrieval in a dynamically linked buffer.

The exchange dynamically manipulates the client data using in-built procedures and a prototype message structure. When a new connection is established the connection name, socket number, and the status type (which is set to active) is stored on one of the data structures. This data structure is called 'Socketlist'. When any interaction takes place with the now established connection the exchange looks up the Socketlist to get full information about the process. If the interaction with the exchange consists of a communiquè for another process, then the exchange uses the second data structure 'Messages'. Here the source process number and destination process number according to Socketlist are stored along with the reference number, identification number and the communiquè data.

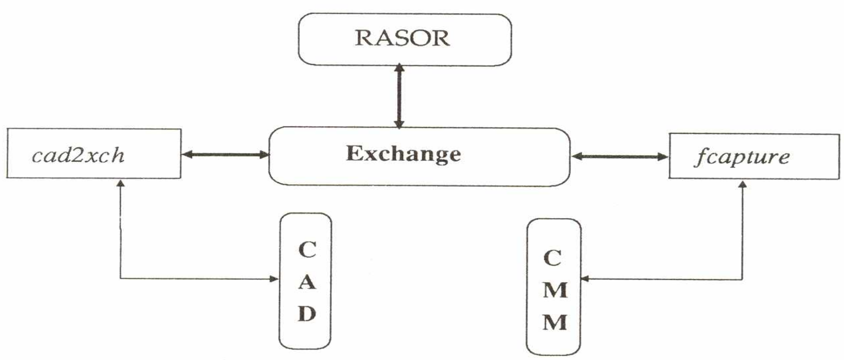
The exchange is equipped with a set of user-interactive commands which enhances the flexibility of the system. These commands also form the protocol convention. When an interaction takes place with the exchange it is always headed by a command word. This enables the exchange to provide an appropriate service to the process whether it be querying, sending or receiving a message. Some of the often used commands are "send", "get" and "query" which are self explanatory. Some of the other commands are "dir", "list", "display on", "display off". The command "dir" which is short for directory enables the user to examine the connections that are made with the exchange, their status, and their respective groups. The command "list" allows the contents of the messages held at exchange to be displayed along with their source and destination addresses. The commands "display on" and "display off" enable to user to control the terminal display.

The Chief-User Process

The exchange is enpowered with greater versatility with the addition of commands such as "sendas", "getfrom", "queryfrom", "queryas". These commands enable the creation of a super process known as the chief-user. The chief-user can control the inputs and outputs of processes using the "sendas" and "getfrom" commands. Also the chief-user can be used to emulate the CMM or the CAD systems. The chief-user can have a large number of dummy processes running via the same socket. This is achieved using the "openas" command of the exchange. These facilities of the chiefuser make it indespensible while testing the communications link with a new process. The chiefuser can disconnect a process from the exchange by simply using the "remove" command. Thus the chief-user process is the most powerful process connected to the exchange.

The Exchange Link between CAD and CMM

The objective of the exchange is to enable bidirectional communication between two or more processes. This is adequately demonstrated by the flow of information between two isolated commmercial systems, a CAD and a CMM package. A third process, an in-house software system called Rasor, is also involved. Figure 2 illustrates the linking of the CAD and the CMM processes via the exchange.



'igure 2. CAD - CMM Link via exchange

The CAD system that is used in this case is CADDS4X produced by Prime Computers and it runs on a SUN Sparc workstation. The use of CADDS4X's programming language "cvmac" is made. This is used to transfer geometric information about a component to a small separate process. This process is called' cad2xch' and it interacts with the exchange.

The CMM system which is used for the inspection of a component is a Mitutoyo machine. The CMM is controlled via a Mitutoyo software package called the "GEOP AK" which runs on a Hewlett Packard Pc. This requires the link of a non-UNIX machine to the UNIX environment via a serial port. Kermit batch files have been written to extract and send data across the network. The measured data is captured by a program called "fcapture" which has been linked to the connections library in order to communicate with the exchange, and further on to the CAD system.

The program which manipulates the geometric CAD data, creates the measurement path, analyses the measured results and generally directs control over the systems is called RASOR [3,5] and is shown in figure 2. Included below is a sample of the communications that can be observed on the exchange. The two new connections are CAD called "mac" and RASOR called "brd".

....
THE EXCHANGE
....

```
displayon
New Connection: mac
New Connection: brd
From: mac [brd 0 ready]
To: brd [ready]
From: brd [mac 0 geom sel cpl 1]
From: brd [mac 0 msgs GNE COMMAND]
To: mac [geom sel cpl 1]
To: mac [msgs GNE COMMAND]
From: mac [brd 0 start]
```

Conclusion

We have seen that in the design to manufacture there are often isolated software systems processing information. There are advantages in connecting these together so that data can be shared.

Under UNIX, a system called exchange has been created that allows two or more separate processes to pass information between themselves. This is based on UNIX sockets. Each process has its own address name and the exchange manages the flow of information between the systems by maintaining a list of pending messages each flagged with a destination address.

The use of the exchange has been demonstrated in linking a CAD system with a CMM.

Acknowledgment

I would like to extend my gratitude to Professor Tony Medland and Dr Glen Mullineux for some of the important ideas in structuring of the exchange. And to Dr Themis Sittas and Dr Jaffer Hassan for the almost uncomplaining help in the testing of the system

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Improving Communication in Small Manufacturing Companies Using the Grai Method

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SUMMARY

The successful implementation of computerisation to manufacturing companies relies on successfully understanding the company's requirements in the early stages. This paper looks at some aspects of using computerisation in the smaller manufacturing company and the GRAI method is introduced as a tool to help in the process.

INTRODUCTION

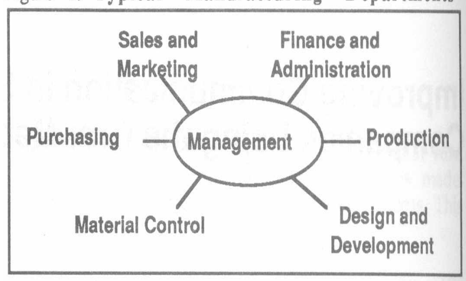
Through the Mechanical Engineering Department at Surrey there is a collaboration with a number of small manufacturing enterprises, including an association known as MIDAS (Manufacturing Industries Development Association in Surrey). Over several years, consultancy, research and Teaching Company projects have been undertaken with these companies. All of which have generally been aimed at gaining a better understanding of how the companies operate and improving their performance, often in connection with their plans to implement some form of Advanced Manufacturing Technology. Some of this experience is used as a basis for this paper.

THE USE OF COMPUTERS IN MANUFACTURING

For many years now computer technology has been put to use in manufacturing environments. Initially as an advanced calculator in the accounts department. This function extended to cover inventory control, which naturally led on to bills of materials and manufacturing instructions. Nowadays computerised technology is available to integrate all aspects of the manufacturing business: from design to manufacture; to planning and finance. Indeed today's manufacturing manager has a large choice of options available for all aspects of the manufacturing process. The problem is choosing which configurations are the most appropriate. Computerised tools can be applied in a departmentalised way throughout the business. However, the full benefits of computerisation as a business communication tool will only be felt if there is an integrated strategy across the whole organisation. Similar data is required in different areas of the company, for example Computer Aided Design (CAD) and Material Requirements Planning (MRP), both require product structures or bill of materials. Re-keying the same information for different systems is costly, time-consuming and prone to errors. Computerisation introduced as part of an integrated strategy will have benefits beyond the localised department.

Ideally a company would spend time understanding the requirements of the different areas, before developing an integrated strategy prior to implementation. For a number of reasons this rarely happens and many companies have not experienced the total benefits of their investment in computerisation.

Figure 1: Typical Manufacturing Departments



THE IMPLICATIONS FOR SMALL MANUFACTURING ENTERPRISES

All the indications are [1, 2, 3, 4] that the number of small manufacturing enterprises is increasing and will continue to playa significant part in the UK economy. Today's market place is ideal for smaller enterprises who, without many levels of bureaucracy, can respond quickly and efficiently [5] to the varying customer demands in variety and customisation. Although small companies tend to be very flexible and their informal communication channels very efficient, they generally run under a very tight regime as resources are usually fully stretched with the day to day running of the company. To survive such companies also have to look at ways of improving their operations, including the effective use of computerisation. However, very few small companies can afford to spend time and money developing an integrated strategy for computerisation. Indeed the expertise required is rarely available within the company. Consequently any investment in computerisation tends to be on a piecemeal basis over several years depending on departmental whims and the money available. This can potentially lead to duplication of information and incompatibility of systems.

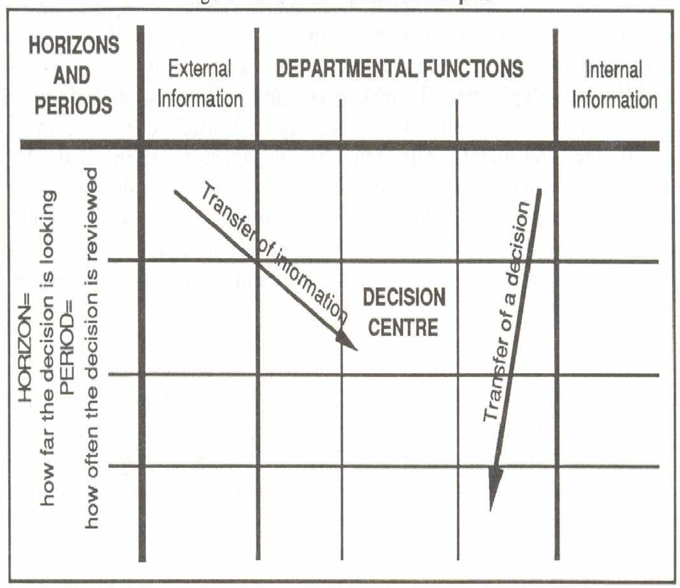
TOOLS TO HELP UNDERSTAND COMMUNICATION LINKS

When an integrated computing strategy is developed for a company the first stage is understanding how the company is currently operating from the point of view of existing communication links. This should be aimed at identifying any deficiencies in current systems in order that improvements can be made before proceeding with specifying computing requirements. There are various tools available to help understand how companies operate including: Dataflow diagrams, IDEF, Profile Analysis and GRAI [6, 7, 8, 9]. Each has been developed for its own particular purposes and detailed discussion is beyond the scope of this paper. However, the GRAI method has been found to be particularly effective when dealing with small manufacturing companies.

THE GRAI METHOD

The GRAI methodology was developed at Bordeaux University, originally as a tool to help specify requirements for Computer Aided Production Management Systems (10, 11) and has since grown to consider financial measurements within a company in the form of ECOORAI (12). The GRAI grid is a graphical tool to help map out where and when decisions are made within the company; how these decisions are transferred and on what information they are based. The basic GRAI grid principles are shown on the following page. Vertically the grid is split into hierarchical time frames which represent horizons and periods. Horizons are the length of time over which the decision is aimed at and periods are how often the decision is reviewed. Horizontally it is split into key activities that are carried out by functions within any company. Internal and External information are represented by columns at either end. Each box on the grid represents the carrying out of a decision, ie. it is a decision centre. The boxes are linked together by thin arrows which represent the transfer of information and thick arrows that represent the transfer of a decision.

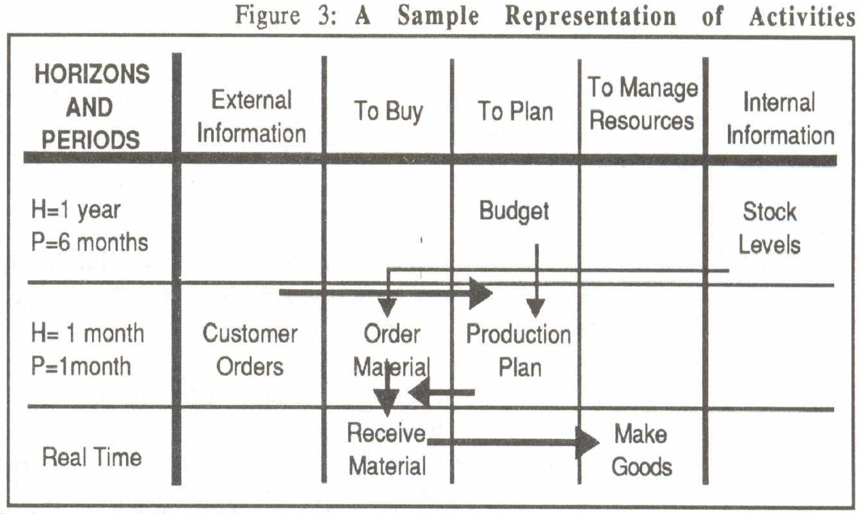
Figure 2: GRAI Grid Principles



The grid is built up by identifying the key activities within an organisation and understanding where people get their information from to carry out their jobs. This can be done by talking to the various managers of the and working down through the organisation where necessary. Once an initial grid has been drawn it can then be discussed within the company and amended or acted upon as required.

The problem of getting people within smaller companies to release time is the crucial one. This can be overcome if the managers themselves accept the necessity to change i.e. they believe they own the problems to be solved and determine the changes themselves rather than having them foisted on them by some external agent or consultant. But this task in itself takes time. Therefore the need is for tools which are simple to apply in the first instance, and produce results which are readily assimilated by and recognizable to the managers involved.

Figure 3: A Sample Representation of Activities



This is where GRAI scores as a useful tool, Most of the tools available produce graphical results to help represent and then analyse a particular situation. A graphical representation is seen to be valuable as it is less ambiguous than textual descriptions and can act as a vehicle for discussion between the originator and representatives of the organization under study. The diagrams produced by GRAI Grids appear to be far more accessible to the non-expert than some other methods. It also stresses diagrammatically the interconnectedness of the operation of the various functions within a manufacturing organization. They highlight how decisions and actions taken in one area have important consequences elsewhere which can effect the competitiveness of the business. The realization of this point by the mangers interpreting these diagrams for themselves is the beginning of the acceptance of a need to develop explicit integrated strategies crossing the normal functional boundaries.

CASE STUDY

The GRAI grid was used with a small telecommunications company who wanted to improve their internal paperwork flow prior to the introduction of a Computer Aided Production Management system. Interviews were carried out on a fairly informal basis with all the departmental managers and supervisors using an outline questionnaire. An initial GRAI grid was drawn up and used to present to management the findings of the consultant. Although the management knew that the company was operating on a reactive, firefighting basis they were unable to quantify what the current situation really was. The GRAI grid proved to be very useful at getting people to see what was going on and start to think about how to improve the situation themselves. Several key areas were identified and improvements made prior to purchasing a computer system.

CONCLUSION

When dealing with small companies looking towards implementing some form of computerisation to help their communication processes, consideration needs to be given to the lack of resources available to deal with such a project. If a company is going to be successful with such an implementation it is important that the requirements of the company are understood very early on in the project. The GRAI grid is useful for this for the following reasons:

- An initial GRAI grid can be drawn up after only a short series of interviews of the key managers in a small company and it takes little education for nonexperts to understand its principles.;
- It encapsulates the whole organization very graphically and succinctly in one diagram;
- It stresses the communication or lack of it across departments and the impact the actions or decisions of one part of the organization on another;

There are also some drawbacks to using the GRAI approach as far as small organizations are concerned:

- It requires an "expert" to draw up and interpret the grid initially
- It does not in itself make reference to the type of business the organization is engaged in, which is important when considering computing tools available for the processes used

It is recommended that such a grid could be used in conjunction with other graphical tools depending on the situation, to aid the understanding of communication flows within an organisation.

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IT10

Emerging Technologies for Military Command and Control

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SUMMARY

This paper provides an overview of the operational application of emerging technologies to military command and control. It focuses primarily on the technology of knowledge-based systems (KBS). Details are provided of a research programme underway in the Maritime Division of DRA which is engineering a major KBS technology demonstrator and trialling it on board a Royal Navy warship. The prototyping approach adopted illustrates a possible route by which emerging technologies can be transferred from the research environment to the real world.

INTRODUCTION

To successfully engage in combat, a military leader must have effective command and control of his forces. This is true whether the forces consist of divisions or armies, groups of tanks, a naval flotilla, a squadron of aircraft or some combination of these assets. To be able to exert effective command and control, a commander needs intelligence about the numbers and disposition of the enemy, and of its capabilities as well as an assessment of its intentions. Superior command and control by a commander including the ability to make correct decisions can often offset the disadvantages of having forces that are inferior in number to those of the enemy. This has been illustrated in the outcome of countless engagements over the centuries.

In the last few decades the speed and range of warfare has been increasing rapidly. The pace of technological advance has lead to enhanced sensors, the introduction of new types of weapon systems and the arena of warfare expanding to now include space. As a consequence, the command and control function is becoming more complex than ever. In order to conduct defence management, a command team requires support from a combat management system with the capability to operate effectively in this complex environment. New technical solutions are required in response to the operational need. Advances in technology particularly those in computing techniques need to be exploited in order to meet the demands of future command and control.

COMMAND AND CONTROL

Key elements in the domain of command and control are:

Data Fusion
Situation Assessment
Resource Allocation Planning
Reactive Resource Allocation

Data Fusion is the formulation of a coherent tactical picture by fusing together in real time all the information available to the command post from a wide range of disparate sources. The data is by no means limited to real-time information, gathered by surveillance sensors, but includes also nonreal-time information derived from intelligence, sightings, local events and tactical plans.

Situation Assessment is the derivation of an intelligent assessment, in tactical terms, of the environment of interest to the command post. The tactical picture is interpreted in terms of the deployment, capability and effectiveness of all forces involved. Possible examples of the assessment process include: assessment of possible or actual threats, assessing the outcome of an engagement and assessing the extent of knowledge on both sides about each other.

Resource Plannin1: is the deployment of resources in anticipation of a future situation through planning goes on before and during a mission using knowledge, including intelligence, to predict what might happen and how own forces should be deployed to counter any threats.

Resource Allocation is the deployment of resources necessary in response to the prevailing situation such as immediate direction and control of own platforms, sensors and weapons.

THE NAVAL DOMAIN

In the naval domain it is generally accepted that shipborne command and control enjoys inadequate automated support today, will become substantially more demanding in the future, may well need to be undertaken by fewer men, and has thus far proved largely intractable using conventional data processing methods. The emerging technology of knowledge-based systems (KBS) is a prime candidate for underpinning decision support in command and control. Knowledge-based systems have the ability to represent and reason with a richer spectrum of knowledge than conventional systems and so can address more unstructured problems such as command and control. In addition to this principal characteristic, knowledge-based systems offer other advantages such as improved visibility of their encapsulated knowledge and the ability to explain their reasoning processes.

A research programme was initiated within the Maritime Division of DRA some eight years ago to investigate the potential and role of knowledge-based technology in naval command and control. The approach adopted in undertaking KBS research was the policy of conducting "hands on" research through the development and evolution of prototypes in various areas of the battle management domain. Such a prototyping approach allows the benefits and shortfalls in the underlying tools and technology to be identified, facilitates learning by experience, and produces tangible assets that can be used as test beds for investigation of wider KBS issues. Additionally it enables the functionality of the application to be developed and refined in conjunction with the user, through the conduct of laboratory and/or field trials.

Because of its perceived role in providing the foundation for command and control, tactical picture compilation through multi-sensor data fusion was chosen as the first area of study. A data fusion laboratory demonstrator was, prototyped, enhancing the functionality of the system with each iteration. In parallel the realism of the test environment was also enhanced. Commencing with test scenarios based on a limited set of of simulated input data, the test environment gradually evolved in complexity through the introduction of real data recorded at sea during naval exercises.

Further evaluation of the capabilities of knowledge-based technologies was undertaken within the research programme. Laboratory prototypes were constructed which addressed the other key functions of command and control namely situation assessment, resource allocation and resource planning. The laboratory demonstrators, although offering only illustrative examples of possible

Capabilities, allowed an initial assessment of the technology. The premise that KBS may be used to provide automated support to the command team was validated to a sufficient level to warrant further investment.

However in today's economic climate with its growing demands on defence budgets, it is essential not only to formulate technical solutions to operational problems but also to determine whether or not those solutions can be engineered for the real world and whether or not they can be procured within a reasonable time-scale and budget. With typical costs for development and production of today's new command systems reaching several hundreds of millions of pounds, it becomes essential that the decision to enter full development is based on firm evidence of achieving equipment performance within budget. A Technology Demonstrator Programme offers a route for conducting a more in-depth appraisal of a technology than can be undertaken in a laboratory environment. It is a risk-reduction exercise which allows operational and procurement issues, many of which are beyond the scope of laboratory prototypes, to be addressed.

A requirement to comprehensively assess the emerging technology of KBS in command and contro11ead the Maritime research programme to construct a Technology Demonstrator System (IDS). The IDS, which commenced development in 1988, will be trialled ashore and at sea on board a Type 23 frigate, the latest class of warship of the Royal Navy. This activity builds on the expertise and experience acquired though development of laboratory prototypes and also complements previous research through the exploration of life-cycle and procurement issues.

The TDS is a real-time knowledge-based demonstrator for performing the command task of multisensor data fusion for surface warships. Data fusion is the process of automatically combining data from all of the sources, real-time and non-rea1-time, available to a command team in order to form a comprehensive, accurate and timely tactical picture of the real world upon which tactical decisions can be made.

The naval demonstrator is currently in an advanced state of development. The application software is being engineered in four distinct phases with development of Phase 2 software now complete. Two hardware systems have been procured, one of which has been installed on board the Type 23 frigate HMS Marlborough for a comprehensive period of trials at sea. The IDS is being set to work during the remainder of 1991 with the trials programme commencing, both ashore and afloat, in 1992.

EXPERIMENTAL PROGRAMME

Although the construction of a knowledge-based data fusion technology demonstrator represents a major research investigation in its own right, maximum advantage is being taken of the opportunities which it offers. A number of research activities are being undertaken in parallel with IDS development, and further activities will utilize the demonstrator upon delivery. An overview of two of these research activities is provided below. The complete set of experiments and supporting activities which utilize the IDS as a test bed is known as the Technology Demonstrator Programme.

One of the research activities underway is that of developing a training programme to train the command team of the trials ship. These operational users are a vital ingredient of the trials and evaluation of IDS and thus need to understand the concepts of this new technology. The computer-based training package currently being produced will itself make use of emerging technology of multimedia input devices. This allows a variety of input material such as text, animated graphics, photography, video and sound to be coordinated into a single training programme.

Prototyping has played a leading role in the overall research programme and particularly in designing the Man Machine Interface (MMI). The TDS user interface has adopted a WIMP (Windows, Icons, Menus, and Pointing) style to display, on high-resolution, colour work-stations, the tactical picture generated by data fusion. It is debatable whether WIMP style interfaces could be

Classified as emerging technology as this interface format is now widely available on commercial hardware. This is not the case in the domain of command and control. Issues which have been investigated as part of this research topic include use of colour, symbology, layout of windows, and information content of windows and design of menus. The MMI prototyping activity will continue during the trials period. Feedback from the command team on the technology and the MMI specification will make an important contribution to the overall evaluation of TDS.

Assessment of the role and value of emerging technologies, primarily knowledge-based technology, to naval command and control is the main objective of the IDS evaluation programme. A comprehensive appraisal requires the IDS to be reviewed from a number of different aspects including:

a) Determining how well the complete system of man and machine performs its task of data fusion. How complete and accurate is the tactical picture? Is the picture timely?
b) Assessing the performance of the IDS machine only. Does it correlate data when it should? Can it process the necessary volumes of data in real time?
c) Assessing the operator's contribution to IDS. Do the operators override the conclusions reached by the machine? How often?
d) Investigating the organizational implications of knowledge-based technology on command teams. Is operator workload reduced? What are the implications for manpower savings?
e) Assessing the value of the output of IDS to the overall command and control function. Does this technology increase the operational effectiveness of the ship?

The process of conducting an evaluation of IDS has already highlighted areas where additional advanced computing techniques might be harnessed. Measurement of the run-time performance of the demonstrator has triggered an investigation of the possible application of parallel processing. The requirement for displaying data in a timely and pertinent manner from the wealth of data available in the system has instigated research into adaptive interfaces. As the evaluation programme advances other emerging technologies will no doubt be considered.

THEATRE MISSILE DEFENCE

The question of whether the emerging technology of KBS can provide a foundation for command and control has recently become a subject of interest to Theatre Missile Defence. The TMD research programme is examining defence options that can be used to eliminate the threat posed by tactical ballistic missiles. The command and control functions of data fusion, situation assessment and resource allocation are equally appropriate to TMD but they will require considerable research and development in light of the complexity of this domain. TMD offers a range of opportunities for utilization of KBS technology. The mutual interest in this technology by the United Kingdom Ministry of Defence and the United States Strategic Defence Initiative Office has lead to the formulation of a collaborative research programme between the two parties to explore the underlying techniques and tools for command support.

The IDS will be the major demonstrator available in the initial phase of the collaborative programme for use as a test bed for various aspects of research experimentation. Exploration of the feasibility of KBS techniques in the domain of TMD will be pursued through development of two laboratory prototypes. Construction of three distinct demonstrators will provide a wider applications base for highlighting both the common aspects and the individual KBS requirements in the separate warfare domains.

ACKNOWLEDGEMENTS

Acknowledgement is given to the many people from Industry and from MOD, both uniformed and civilian, who have contributed to this work.

IT11

An Overview of Communications & Information Technology

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Communications & Information Technology (IT) has become essential to the successful operation of most businesses.

The paper is intended to give a basic introduction to the past and present state of Communications & IT and its future trends. This will include emerging technologies such as the development of cable-less systems and mobile communications, video conferencing, expert and intelligent systems.

The value of Communications & IT to the operation of a business, and a description of the typical Communications & IT services which will contribute to its success, will then be outlined.

The final part of the paper will review effects of Communications & IT systems and services on building design and the concept of "Intelligent Building".

Content of this paper is based on research and experience gained over seven years in the field of Communications & IT consultancy.

The Use of Computer Packages in Design and in the Preparation and Management of Civil Engineering Contracts.

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Severn Trent Water Limited, United Kingdom

Over the last decade three computer packages have been introduced by Severn Trent Engineering to increase efficiency in design and in the preparation and management of civil engineering contracts.

Two of these, computer aided draughting (complete with intelligent design programmes) and Qumic (used for the preparation of bills of quantities and for monthly valuations), were commercially available systems tailored to Severn Trent Engineering's requirements.

The third package, known as CHAT (Computerised Hydraulic Analysis of Treatment Works), was designed by Severn Trent and developed in conjunction with Loughborough University.

All three are now considered to be essential tools for the engineers designing Works which are part of Severn Trent Water Ltd's massive capital investment programme.

IT13

Communicating about Design: Architectural Features of Expert Systems which Co-operate in Design Activity.

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SUMMARY

The specific features of expert systems capable of co-operating with a user in engineering design activity are outlined. A second generation expert system architecture known as the Competent Expert System architecture is described by reviewing the features of it which are particularly relevant for application to design tasks. Attention is focused on the aspects of design concerned with trade-offs and defense of design decisions and the demands these aspects of design make on explanation facilities.

INTRODUCTION

The 1980s have seen a shift in emphasis, away from single-dimensional performance evaluation of expert systems in terms of their ability to give the "right" answer, towards performance expectations which will result in systems which the user perceives to behave logically and which can explain their conclusions. This has become one of the major motives for the development of second generation expert systems in particular. Second generation expert systems focus on enriching the semantics of the representation and control of explicitly represented reasoning knowledge, factual knowledge about a domain, and the task progression. They are an attempt to create deeper systems which overcome some of the limitations of their shallower, first generation ancestors with regard to human-computer interaction, problem solving flexibility and extensibility [1]. It has been acknowledged for some time that user acceptance of expert systems may depend critically on the provision of appropriate interfaces. Specifications of the roles of many expert systems include reference to the requirement that they assist a user, co-operate in carrying out a task, suggest actions, and give guidance on a justifiable basis.

Clearly the output from a knowledge based system like any other kind of computer system needs to present information to the user in understandable terms. In an expert system specifically, the dialogue structure needs to be both intelligible to the users of the system and relevant to their perspective of the problem. This extends concern beyond the vocabulary and graphical conventions with which the user is familiar to the

Way in which components represented in these terms are used to reason about the task which the user and system are co-operating to carry out. The ability of the expert system to explain the basis of its suggestions and to justify its conclusions at any stage of the problem solving process is determined by the extent to which user and system share a model of the task.

COMPETENT EXPERT SYSTEMS

The Competent Expert Systems (C.E.S.) Architecture is a second generation expert systems architecture which has been developed at Brunei University and which has been applied to fault diagnosis [2] and intelligent data handling [3] applications. Competence modelling, which forms the basis of expert systems based on this architecture, has been undertaken for a variety of engineering tasks. Recent research on engineering design [4] has involved knowledge elicitation from primary distribution system planning engineers in a U.K electricity distribution company for the purposes of modelling their competence.

Competent problem solvers are taken to be ones who have, through experience, structured their factual knowledge of a particular domain in an effective and efficient way for the purpose of carrying out the tasks at which they are deemed to be expert. The structure of the factual knowledge is determined by its use. In a model of competence the structural organization of the domain knowledge is made explicit as is the strategic knowledge which enables the expert to operate effectively and to make use of the specific data relating to the current task, directing progress towards a satisfactory conclusion [2]. In an expert system based on a model of competence explicitness is effected through identifiable computational structures.

Human experts will order their questions or pursue information according to what is useful to them in pursuing a line of reasoning thus demonstrating their competence in a particular domain. The conversation structure is based on the strategies being pursued and a knowledge of effectively structured domain facts. Thus, for example, irrelevant or inferable information is not requested. It can be argued therefore that an expert system which contains a competence model will be inherently capable of participating in intelligently structured interaction with the user, to which the user can relate naturally.

DESIGN TASKS

Expert systems which have been developed for problems classified as design tasks are often based on modelling the activity as a problem solving task which can be represented (implicitly or explicitly) as a hierarchy of goals, where "solving the problem" consists of traversing the goal tree making use of "establish and refine" procedures in a recursive fashion. It has been noted that a goal structure arranged as a hierarchy lacks the ability to adequately represent the interacting sub-goals which design tasks entail. (See for example [5]). The trading-off between parameters or components of the design is described as being at the same time difficult to handle and urgently in need of further research (e.g. [6], [7]). Reasoning about design in terms of trading-off is handled poorly in architectures which support hierarchically structured goal trees.

Expert systems for design make special demands on explanation facilities. In design there is a need to defend a proposed design by relating it to its alternatives that is by explaining why one design has been proposed in preference to another design, or in preference to a similar design, and why trade-offs have been made in one way rather than another.

REPRESENT A TION OF TASKS AND REASONING

The C.E.S. architecture, like some other second generation architectures, supports explicit representation of the task structure. It is believed that representation of the task structure, if it accurately models the human designer's approach, can lead to the provision of relevant explanations, and if considered from a wider

Perspective, can promote partnership and co-operation between man and machine by the sharing of a common model of the design process [5], [8], [9]. The task structure captures what the designers can do in terms of decomposition into possible sub-tasks. The way in which designers actually go about a task in a particular situation is dictated by the particular circumstances in which they are using their expertise. Reasoning is represented by the dynamic modelling capabilities of the expert system architecture in terms of movement through the task structure informed by the situation-specific data.

The C.E.S. architecture supports the modelling of tasks as a set of sub-tasks to be carried out in sequence or as dictated by a set of strategies which are explicitly represented as possible means of achieving a task (or sub-task). The logical bases for selecting a particular strategy to achieve a task are explicitly represented as conditions which must hold for a strategy to be considered suitable or to be excluded from consideration. The conditions for achieving a task using a particular strategy relate to the situation specific data i.e. the current state of evolvement of the design. The architecture thus supports the modelling of designers' competence as reflected in their ability to be flexible, through choosing an appropriate strategy to achieve a task based on an understanding of the logical bases of the strategic choices available.

Dynamically, the C.E.S. architecture permits movement over the task structure to take the form of a graph search, directed by the data currently relating to the design. Thus, viewed statically, task decomposition is tree-like but access to tasks is not enabled solely through the static route provided by the task tree. Additional routes are provided through strategies attached to each non-terminal node in the task tree which can direct movement within the task tree via conditions which determine which tasks to attempt next on the basis of the current state of the design and the history of the tasks so far attempted

EXPLANATIONS CAP ABILITY

An expert system architecture which has explicit representation of the task structure and of the strategies which are available to effect movement through it has the potential to provide answers to queries of the "why", "how" and "why not" varieties .In the C.E.S. architecture "why" explanations are concerned with why a particular sub-task instantiation was created. An explanation is given which includes abstract elements provided by the explicit task structure and concrete elements which explain the particular circumstances giving rise to the sub-task instantiation. The explanation facility makes use of the conditions explicitly encoded for strategy selection which determine the sub-task instantiations. Explanations make reference to the available choices, the basis for choosing among them, and the particular circumstances that satisfied the conditions for the strategic choices which have been made. Using these resources, explanations about "why" particular choices were made can be provided in the context of the options that were available.

The "how" type explanations use the same resources to describe "how" a particular sub-task instantiation was accomplished. These explanations make reference to the choices available and "how" the specific circumstances which applied to the particular situation determined the way reasoning proceeded.

In the context of a particular "why" type explanation the reasons why alternatives were not pursued can be requested through a "why not" explanation which describes, in abstract terms, why a particular alternative sub-task or strategy was not selected when it was an option at a certain point in the progression towards completion of the overall task. This sort of explanation can only be provided by an expert system in which alternative choices are explicitly represented, since to explain why a choice was not made the system must be able to refer to what alternative options were available at a decision point as well as to the one which was selected in the particular circumstances presented.

Engineering designers make use of a body of knowledge associated with the domain within which the design falls, suitably structured for the purpose of design. They take a disciplined approach to the development of the design which may be described in terms of a suitable task structure. Design progression is

Critically appraised to detect unsatisfactory aspects and to provide information leading to improvements in the developing design and to its progression towards completion. As design progresses, the designer acquires information which affects the way in which further progress is made or attempted. The architecture of any expert system which tackles an engineering design task should offer the basis for modelling these aspects of design behaviour.

An architecture which supports competence modelling acknowledges the central importance of both the reasoning behind design decisions and the knowledge structures which skilled designers have built up through experience to suit their purposes.

Design criteria beyond functional usefulness are at work in design activity, and in the final choice of which design is selected and recognized to be a good one. One concrete component of the defense of a particular design may be provided by an explanation of why one design is favoured over another i.e. by comparison with alternatives. Defence can be supported in part by explicit representation of strategies and their logical bases since these provide the essential raw materials for such explanations.

CONCLUSIONS AND FURTHER WORK

Design is characterized by the need to make trade-offs. Designers make trade-offs on the basis of their experience, their purpose being to produce a satisfactory or even a good design. In non-trivial design activity trade-offs cannot be avoided. An expert system architecture for design applications must be capable of modelling trade-offs adequately. The Competent Expert Systems architecture provides for explicit representation of the conditions under which strategies link the task structure into a graph dynamically during the design activity. It is therefore intrinsically capable of providing a strategic explanation facility. A trace of which tasks have been instantiated, which tasks they were entered from, and under what conditions they were entered, can form the basis for a design log which records the system's reasoning. Knowledge about what has been attempted (and why) enables designers to make decisions about what to attempt next (or what to re-attempt under different conditions).

Currently work is under way to extend the C.E.S.architecture with procedures which examine the design log and reason about (evaluate) the progress made so that design decisions involving trade-offs and compromises based upon explicitly represented design commitments can be made. This work is supported by empirical research to improve understanding of how designers operate on real problems. By this means it will be possible to identify and develop the further structures and procedures needed to enhance the C.E.S. architecture to improve its ability to model the making of useful trade-offs, and to provide a defence of design decisions.

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IT14

Quality Design

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SUMMARY

This paper compares the accuracy of the Taguchi orthogonal array and random sampling approaches to performance noise estimation. System quality - measured in terms of quality factors - are evaluated from data generated from each sampling technique in turn and reliability of prediction assessed. It was found that the Monte Carlo method gave more reliable estimates of quality, moreover computational costs were independent of system dimensionality.

I.INTRODUCTION

Tolerance design activities [1-3] which employ random sampling techniques to assess the effect of tolerance variations on system performance have been successfully applied to circuits. Robust design techniques [4-6] have also been applied with similar objectives to system design with considerable success. In particular, the work of Taguchi in the area of quality enhancement via robust design has recently generated much discussion and criticism. This paper focuses on the first phase of the quality enhancement problem: quality estimation. The aim is to compare the quality estimation techniques of Taguchi with Monte Carlo methods to determine which gives more reliable results for continuous system design. In this section, the noise problem is defined and the objectives of the statistical experiment stated, a critical look at the random and deterministic sampling methods follows in sections 2 and 3. Experimental results from a 7 -dimensional example are presented in section 4 and finally, conclusions are drawn in section 5.

1.1 Problem Definition

The problem is to predict the effect on system behaviour of variations (i.e. noise) in parameters (Taguchi's noise factors) of the system. System parameters are subject to 2 types of variation (i) random and (ii) deterministic. Random variations occur throughout product life: first, during the fabrication process - manifest as unit -to unit variations in component parameters as the product leaves the production line. Second, during the operational phase being induced by random effects (e.g. interference, power supply fluctuations) in the operational environment .Deterministic variations (product wear) occur mostly in the operational phase of product life more so when the product is constantly in use.

Noise Characterisation

Random variarions encountered in a parameter during the manufacturing phase are typically characterised by a tolerance range with an associated probability density function (pdf) derived from fabrication process measurements. Random variations in the operational phase are much more difficult to characterise since the operational environment can vary widely with time and application environment. Deterministic variations are also difficult to characterise because the physical variables (temperature, humidity etc) causing variation are usually difficult to model. Characterisation of noise is therefore in general restricted to the manufacturing phase, the results of this being extrapolated to the operational phase in the sense that designs which exhibit parameter noise insensitivity during manufacture will also do so during operation.

Statistical Experimentation Objectives

The aim of statistical experimentation is to study the effect of parameter noise on system performance: representative parameter sets are generated and system performance evaluated via physical experimentation or computer simulation. Often of interest in these experiments are quality characteristics - predefined figures of merit which can be translated into quantifiable measures called quality factors. Four examples are:

(1) Performance variance - mean squared deviation from mean performance

(2) Yield - probability of acceptable performance

(3) Performance deviation from target - mean of performance deviation from target performance

(4) Extent of performance failure - mean out-of-spec performance deviation

The estimation of quality factors - one important objective of statistical experimentation - usually involves the evaluation of multidimensional integrals a complex problem analytically. This task is simplified by replacing continuous parameter space by a set of discrete points thereby reducing the multidimensional integration to discrete summation over sample points. A further aim of experimentation - not dealt with in this paper - is the optimisation of one or more quality factors by a procedure referred to as tolerance or robust design.

2. RANDOM SAMPLING

This is the intuitive approach to the characterisation of noise associated with the parameters of a system since the type of parameter variations usually considered are random. The essence of the procedure - often referred to as Monte Carlo analysis is the following: instances of the system are generated at random based on the multivariate pdf associated with the parameters; corresponding performances are evaluated. The pros and cons of the random method are:

Pros

1. random sampling is consistent with the random nature of noise
2. replication of the system in a random sequence permits a statistical estimate of error for quality factors [7]
3. computational effort is independent of system dimensionality for a given level of accuracy of results [7]
4. quantisation of each parameter takes place to a number of random levels equal to the number of system replications thereby permitting high resolution of scan of each parameter tolerance range
5. Any form of parameter noise pdf can easily be handled since all that is required is an ability to sample from that distribution
6. No a priori knowledge of parameter quantisation levels is required since these are generated randomly.

Cons

1. Procedure may be expensive if high accuracy is required
2. Individual parameter contributions to noise cannot be assessed easily
3. Spurious clusters of samples may occur (especially for small numbers of samples) thereby biasing results

3. DETERMINISTIC SAMPLING

Deterministic sampling involves selection of parameter combinations as prescribed by a special array. Examples include orthogonal, Hadamard and Latin Cube arrays. This paper attention will be directed at orthogonal arrays (OA's) - employed by Taguchi. The procedure for deterministic sampling is to select an appropriate OA, generate instances of the system according to rows of the OA and evaluate performance for each instance.

The pros and cons of this method are:

Pros

1. Deterministic sampling ensures that spurious associations or clusters of points do not arise
2. Since samples generated are orthogonal in the combinatoric sense, the relative contributions of individual parameters to overall performance variation can be assessed (e.g. via analysis of variance).

Cons

1. Since the number of quantisation levels per parameter is few compared with the total number of systems generated, quantisation of individual parameters is crude relative to the Monte Carlo method.
2. Actual parameter statistical distributions are not reflected by the OA method.
3. The absence of replication means that errors in quality factors cannot be easily computed.
4. Deterministic sampling via OA's suffers from the dimensionality curse: as the number of system parameters increases, the number of OA samples required for experimentation increases.
5. Procedure may be expensive if system dimensionality is large. 6. some knowledge of appropriate parameter quantisation levels appears essential for best results

4. EXAMPLE

The system investigated was a seven parameter voltage reference circuit (figure 1) in which the performance of interest was the output voltage Vout constrained as follows:

Vout 2.6 volt

Vout 2.4 volt

Target Vout = 2.5 volt

Of the seven parameters, six (Wp1, Wp2, Wn1, Wn2, Pvth, Nvth) reflected fabrication noise and one (VDC) operational noise . Each parameter had noise contributions specified as a uniform pdf within the tolerance limits shown in fig 1. Correlations existed between 3 pairs of parameters as follows: (Wp 1, Wp2), (Wn1, Wn2), (Pvth, Nvth) giving a total of four independent system parameters. The effectiveness of random versus deterministic sampling was assessed by evaluation of the following four quality factors:

1. variance of Vout
2. probability of acceptable Vout
3. deviation of mean Vout from target
4. mean out-of-spec deviation of Vout

4.1 Experiment

OA method The minimum size standard OA (OA L9) for a problem of this size - 9 samples was selected. Sampling was carried out 100 times, on each occasion each parameter pi was quantised into 3 levels:

1. Pi^{o}
2. Pi^{o}+ CK, ti
3. Pi^{o} - CK ti

Where Pi^{o} = nominal value of ith parameter (i=1,2, ...)

Ti = tolerance limit of ith parameter

ck= constant for the k^{th} expt (k=1,2, ...100)

= 1 - 0.01 x (k-1)

(I.e. ck = 1, 0.99, 0.98, 0.97.......................0.01)

This procedure allowed a ranget2f 100 different levels to be explored. Results obtained for the distribution of two quality factors are shown in figure 2.

Monte Carlo method A similar set of experiments was performed on the same circuit using random sampling. A Monte Carlo analysis employing 9 samples was carried out in parameter space a total of 100 times, each time varying the random seed to alter the distribution of samples obtained. The resulting quality factor distributions are shown in figure 2.

Verification Experiment In order to assess accuracy of prediction of quality factors, a Monte Carlo analysis using 1000 samples was carried out to determine the "actual" values of quality factors (shown also in figure 2).

4.2 Observations

After careful consideration of the above results, the following comments are appropriate:

1. The Monte Carlo method gives quality factor estimates with less

Variance than the OA method i.e. a more reliable prediction of quality
2. The accuracy of results obtained by the OA method is extremely sensitive to quantisation levels.

5. CONCLUSIONS

It has been demonstrated in this paper that for the purposes of analysis of the effect of parameter noise in systems where parameters take on continuous values, the Monte Carlo method is superior to Taguchi's orthogonal arrays. The former consistently gave more reliable estimates of yield, performance variability, deviation from specifications and deviation from target. Moreover, the Monte Carlo method exhibits two other advantages over the orthogonal array method: (i) it is more easily adapted to handle any form of system parameter statistical distribution and (II) for a given level of confidence of estimation of quality; computational effort is independent of system dimensionality, being only a function of sample size. The latier is to be contrasted with the OA situation in which the size of OA appropriate to a problem is a function of system dimensionality. It is however recognised that if parameter space were discrete in nature (e.g. cake mix problem [8]) the orthogonal sampling approach may perform equally reliably.

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Figure 1: Voltage Reference Circuit

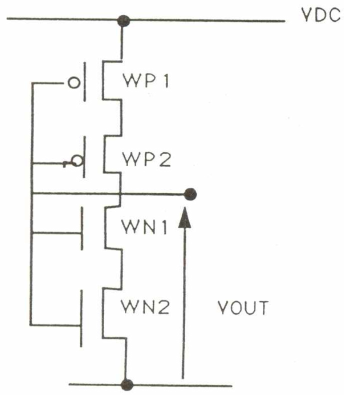
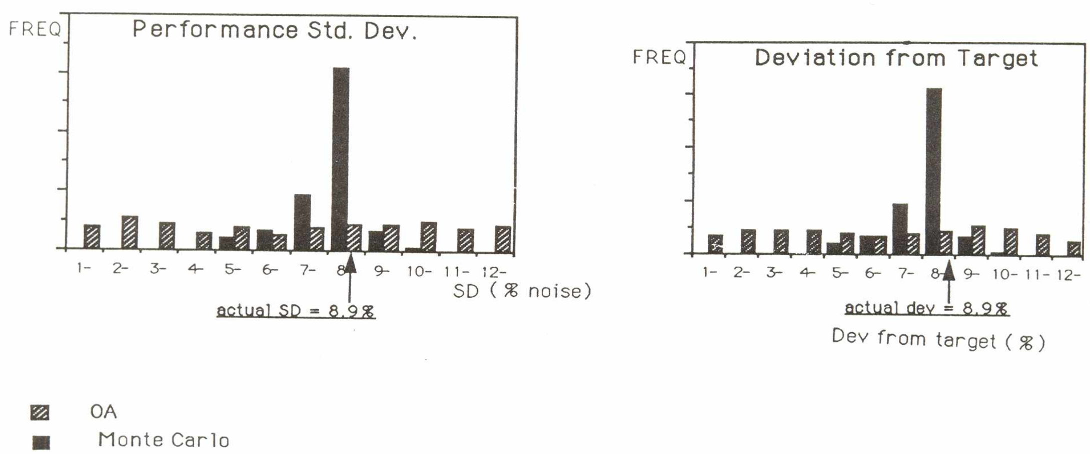


Figure 2: Distribution of Quality factors



Experimental Data
actual = determined by a 1000 sample MC
Spec1:Vout>2.4volt
Spec 2:Vout<2.6volt
Target:Vout=2.5volt

Design Parameters:
W1=5microns+ 40%
W2=2.5microns + 40%
VDC=5volt + 10%
VTH=VNOM + 20%
(VNOM:PMOS=-0.6, NMOS=0.9v)
W3=2XW1
W4=2xW2
L=1.25 microns
Model= BSIM (Spice level4)
Sample size = 9

Recursive Adaptive Lattice Algorithms in Estimation and Control

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SUMMARY The recursive adaptive lattice algorithm in estimation and control is considered. A general method for designing a cascaded orthogonal model, which allows for the use of prior information about the model parameters is outlined. The properly initialized lattice has proven to be very efficient in indirect adaptive control systems. Moreover, it provides for the possibility of automatic tuning to the varying model order as presented in this paper.

I. INTRODUCTION

Within the last decade the successful application of the lattice structure in adaptive signal processing [1] has inspired the corresponding research in adaptive estimation and control [2-4]. In view of all the possible gains in applying the lattice model to control it appeared to be necessary to establish a more profound insight into the state space aspects of the model. Towards this end, the least square prediction problem was solved through the equivalent transformation of the direct (tapped-delay) realization of the linear predictor into the lattice form [5]. The well-known orthogonality condition was translated into pure algebraic constraints imposed on the model structure. Satisfying these constraints led then to the equivalent lattice model.

The basic property of the above mentioned approach is that the transformation matrix is precisely defined from the system theory point of view, which then allows the straight forward use of prior information about the model parameters for the initialization of the algorithm [6]. This aspect is very is very important if the lattice is applied as the model estimator. In addition, since the estimation of the input is embedded into the model [2], the possibility for proper initialization seems to be crucial when a closed-loop adaptive system is considered; that is when the input signal is generated by the given controller [7].

The aim of this paper is to summarize some of the results pertinent to the lattice initialization and to indicate how they can be applied to the

Indirect adaptive control system. The particular stress is laid upon the automatic tuning of the model order.

II. THE EQUIVALENT LATTICE ARMA ESTIMATOR

Consider a linear ARMA (n-1)-th order predictor of the form

$X_t^{\wedge n-1} = \theta_t^{\wedge n-1} X_t^{\wedge n-1}$ (1)

Where $X_t^{\wedge n-1}$ $[Y_t^{\wedge n-1}$ u $X_t^{\wedge n-1}]$ (2)

Is the (2x1) estimate of the model output (y) and input (u), \n-1 is the (2nx1) matrix of the legged measurements, whose elements are of the form

$X_{t-k} = [-Y_{t-k} \quad U_{t-k}]$ k=1, 2 …n-1 (3)

And $\theta^{\wedge n-1} = [\ \theta^{\wedge n-1}_{1,t},\ \theta^{\wedge n-1}_{2,,t} \ldots\ldots \theta^{\wedge n-1}_{n-1,t}]$ (4)

With $\begin{bmatrix} \theta^{\wedge yy-1}_{k,t} & \theta^{\wedge yun-1}_{k,t} \\ \theta^{\wedge uyn-1}_{k,t} & \theta^{\wedge uun-1}_{k,t} \end{bmatrix}$ (5)

is the matrix of the unknown parameters of the output and input model.

It is well known that the least square estimator is based on determining the parameters so that the estimation error is orthogonal to the data vector up to the time t-1. If the measured vector is taken for the state vector, then the linear predictor can be represented in the controllable canonical form of an all-zero model of the n-th order. Defining the equivalent transformation of the state space basis as

$Z_t^n = T_{n,t} X_t^n$ (6)

the following lattice estimator is obtained [5]

- First order model

$q_{1,t} = \lambda_{,t} q_{1,t-I} = X_t\, X`_t$ $\qquad$ Z1,t=Xt,1

p1,t $= \lambda_{1,} P_{t-I} + X_{,t-I}\, X`_{,t-I}$ $\qquad$ εt1=$X_{,t}$

s1,t λt s1,t-1 +xt-1 $X`_t$ $\qquad$ $\zeta_{1,t} = X_t$P1,t $X`_t$

for i=1,2, ……n-1

- Parameters

$\Gamma_{i,t}$ =S`I t $P^{-1}_{i,t}$ $\qquad$ βi+1 =-s I,tqi-1,t

- Model' s states and output

Z i+1,t+1 = Zi,t +βi+1,tεti $\qquad$ εt i+1 = εti +r I, tzi,t (7)

* co variances

$$p_{i+1,\,t+1} = p_{i,\,t} + \beta_{i+1,\,t} s'_{I,t} \qquad q_{i+1,\,t} = q_{i,\,t} + \gamma_{i,t} s_{i,t}$$

$$s_{i+1,\,t} = \lambda_t s_{i+1,\,t+1} + ((z_{i+1,\,t}\,\varepsilon^{i+1'}{}_t) / (1 - \zeta_{i,\,t})) \qquad \zeta_{i+1,\,t} = \zeta_{i,\,t} + z'_{i+1,\,t}\, p^{-1}_{i+1,\,t}\, z_{i+1,t}$$

while the corresponding transformation matrix is

$$T_{n,\,t} = \begin{pmatrix} T_{n-1,\,t} & 0 \\ & \\ t^n_1 \; \ldots . t^n_{n-1} & I \end{pmatrix} \tag{8}$$

while its elements are generated by the following recursion

$$\begin{pmatrix} t^i_{t+1} \\ \\ \tilde{o}^{i-1}_t \end{pmatrix} = \begin{pmatrix} I & \beta_{i,\,t} \\ \\ \gamma_{i-1,t} & I \end{pmatrix} \begin{pmatrix} (0 \quad t^{i-1}{}_t) \\ \\ (\tilde{o}^{i-2}{}_t \quad 0) \end{pmatrix} \tag{9}$$

with

$$\tilde{o}^{i-1}{}_t = [\, I \;\; -\tilde{o}^{i-1}{}_{1,\,t} \;\; \ldots . \;\; -\tilde{o}^{i-1}{}_{i-1,\,t}\,] \tag{10}$$

III. THE INITIALIZATION OF THE LATTICE ALGORITHM

Suppose that the parameters of the (n-1)-th ARMA proces input model are known. In order to start-up the lattice recursion it is necessary to translate them into the co variances $q_{1,\,o}$; $p_{i,\,o}$, $s_{i,\,o}$ i=1,2,... ,n-1.

The initialization procedure is based on the following recursions for the stationary model (for i = n-1,n-2,..., 1)

$$\begin{aligned} &\gamma_i = -\theta^i{}_i && \beta_{i+1} = p_i \gamma_i,\, q_i^{-1} \\ &\beta_{i+1} = t^{i+1}{}_1 && s_i = -\beta_{i+1}\, q_i \\ &t^i{}_m = t_m{}^{i+1} + \beta_{i+1}\theta_m{}^{i-1} \quad m = 1,2,\ldots,i-1 && p_{i+1} = p_i + \beta_{i+1} s_i' \\ &\theta_m{}^{i-1} = \theta_m{}^i + \gamma_i\, t_m{}^i && q_{i+1} = q_i + \gamma_i s_i \end{aligned} \tag{11}$$

from which it is seen that if T_n,P_1 and q_1 are given it is possible toevaluate the remaining co variances for all i. Dependening on the prior information about the input signal the transformation matrix can be constructed via an iterative procedure through which the two (marked) expressions for (3 in (11) are matched [6].

IV. RECURSIVE IN ORDER LATTICE ADAPTIVE CONTROLLER

Once the adaptive lattice estimation has been established it can readily be used to design an indirect adaptive control system. So far the minimum variance [4,7] and the optimal [7] adaptive schemes has been designed.

Analyzing the performance of the adaptive systems it is apparent that, if the model is of the order (n-1) and if the parameter estimation is

Assumed to be perfect, then theoretically the co variance $q_{i,11}$=const for i n.

The above observation has led to the definition of the following algorithm in which the order of the adaptive system is automatically adjusted.

THE ORDER TUNING ALGORITHM

- Design the lattice adaptive model of the order N (where N is the .upper limit of the expected order of the process to be controlled) and built the corresponding optimal adaptive system.
- Start controller with order n=N
- In every estimation step

  IF I$q_{n,11}$ - $q_{n-l,\,11}$1 < ζ_1 THEN n=n-l, ELSE

  IF $q_{n,11}$ > ζ_2 THEN n=n+l ELSE no order update

  ζ_1 is the given small constant (depends on the accuracy), while

  ζ_2 is determined as the product of the estimated output disturbance co variance and the length of the data window.

V. CONCLUSIONS

The necessary element for designing the lattice adaptive control system has been discussed. It should be pointed out that the performance cf the control system strongly depends on the proper initialization with the a priori known parameters. In addition, the adaptive lattice controller has proven to be less sensitive to the output disturbance variance as well as to the length of the constant data-window. However, the major advantage of the lattice adaptive controller lies in its capability for the automatic order tuning.

It should be stressed that the presented algorithm is very efficient only due to the fact that the lattice model is recursive in order. Namely, applying the same idea to any other classical model structure will be prevented by excessive numerical calculations, since in that case each possible medel should have to be estimated separately.

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"Women in Projects - or Projects for Women?"

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International lending agencies (e.g. the World Bank) and bilateral aid agencies (e.g. the Overseas Development Administration) have developed stated policies regarding the participation of women in projects funded by them and implemented in association with overseas governments. In every sector, the imperative to enhance the role of women is recognised. However, is the trend in reality for the greater involvement of women in all projects and the opportunities these provide, or no more than the implementation of a few women-centred projects projects for women - such as those based on mother and child health care and small scale-operative/income-generating activities? The latter type of project is essential and to be welcomed but should not be a substitute for encouraging the equal involvement of women, particularly as scientists, engineers and technicians, in mainstream development projects.

A personal view is given of the potential not being tapped and actions are suggested for increasing women's involvement in such projects, particularly in the planning stages of the cycle.

Project examples from the Sudan and from East and Central Europe are used to illustrate the points being expressed.

TT2

Technology Transfer - A User's Guide

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SUMMARY

For all working in independent research and development it is important to understand the process of Technology Transfer. I answer a number of the common questions this activity causes and offer a simplified outline of the process.

It is important to understand Technology Transfer and the mechanisms of the many different forms it can take. In what follows I shall concentrate on transfer for profit although there are many important non-profit transfers, for example, whenever you have a paper published in a scientific journal. I do not intend to comment upon the merit of the profit vs. non-profit route but what is important is that you control the process such that you have a choice between the routes and that you do not find out too late that you have been forced down the non-profit route.

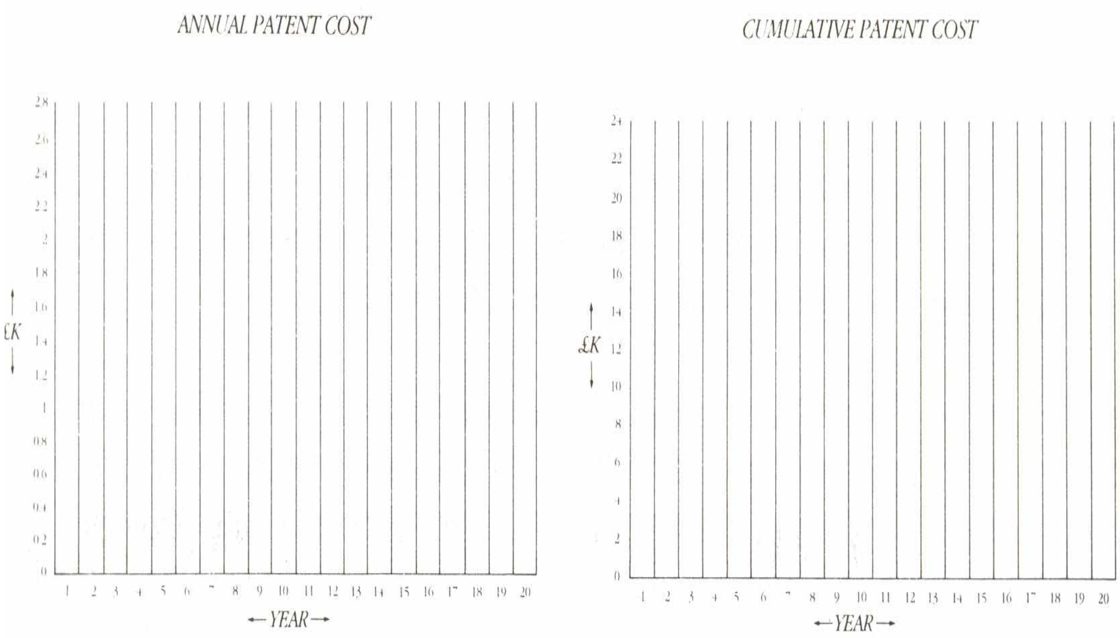
WHO ARE THE BTG?

The British Technology Group, BTG, is a public body that has been involved in technology transfer for over 40 years. It works with the major universities, polytechnics, hospitals and public research laboratories to bring their technology to a world wide market by finding suitable manufacturers to produce their products. The current number of patents held by BTG is approximately 7,000, the money invested by BTG in University projects is approximately £9 million and in industrial projects £11 million. Our licence income in 1989-1990 was £23 million. Although a completely unique organisation in its size, approximately 180 employees which span the fields of engineering, pharmaceuticals and electronics, and experience there are many other organisations and individuals currently involved in technology transfer. For example, most universities have their own industrial Liaison Divisions or Bureaus. Whether you turn to BTG, your University or try to go it alone should depend upon the scale of the project concerned. If international patenting and income is likely to be high - you will need the help of an organisation with resources such as BTG.

IPR - WHAT IS IT?

The term you will often encounter in technology transfer is IPR, intellectual property rights. This covers all the forms in which your results may manifest and it is important to identify in which category your results fall.

Patents - This is the strongest form of IPR. In return for disclosing your idea to the public, via a published patent, you are awarded the right to stop anyone else making, using or selling your invention for a set time, usually 20 years. The costs involved in obtaining a patent should not be underestimated, to maintain a patent in three territories for its 20 year life will cost upwards from £25,000. Also, it should be remembered, in order to stop infringement of your patent you may need to take legal action which will add to the cost dramatically.



TYPICAL PATENT COSTS

Approximation of costs to be expected for an invention of no *special technical complexity*, handled by private practice including:

• U.K. Patent Application • 3 other European Applications • U.S.A. Application

There are three requirements laid down by the patent system, for an idea to be patentable:

1. The idea must be novel
2. The idea must have an inventive step
3. The idea must be useful to industry.

Copyright - This is an unregistered right that exists whenever a piece of literary or art work is created. It also covers the important area of software. Although copyright allows you to stop direct copying of your work, unlike patents it doesn't give exclusivity, that is someone else can for example, write the same computer program provided they do it independently.

Registered and Unregistered Designs - These two types of right are intended to cover the artistic appearance of an object and not its function. In fact the major group that is not covered by this right is an object that could be described as "must-fit" or "must match" .

Trademarks - These require registration and give an exclusive right provided they are maintained and also, very importantly, used. These however tend to be less common than other forms of IPR in technology transfer.

Know-how - This can be considered as covering all the other work that has gone into your project which does not fall into the other categories. Although difficult to quantify, and there may be many ways, different for each project. I personally estimate know-how in terms of man-hours involved in the project. Another important know-how group is patentable results that you have decided to keep secret, perhaps because you think you can extend their profitable life beyond the 20 year patent life, in this manner.

BUT IS MY IDEA TRANSFERABLE?

The 3 step DIY Evaluation

IDENTIFY

(1) Novelty or Significance of the technology.

(2) Market and Manufacturers

(3) Your control of the IPR

IN WHAT WAY CAN I TRANSFER IT?

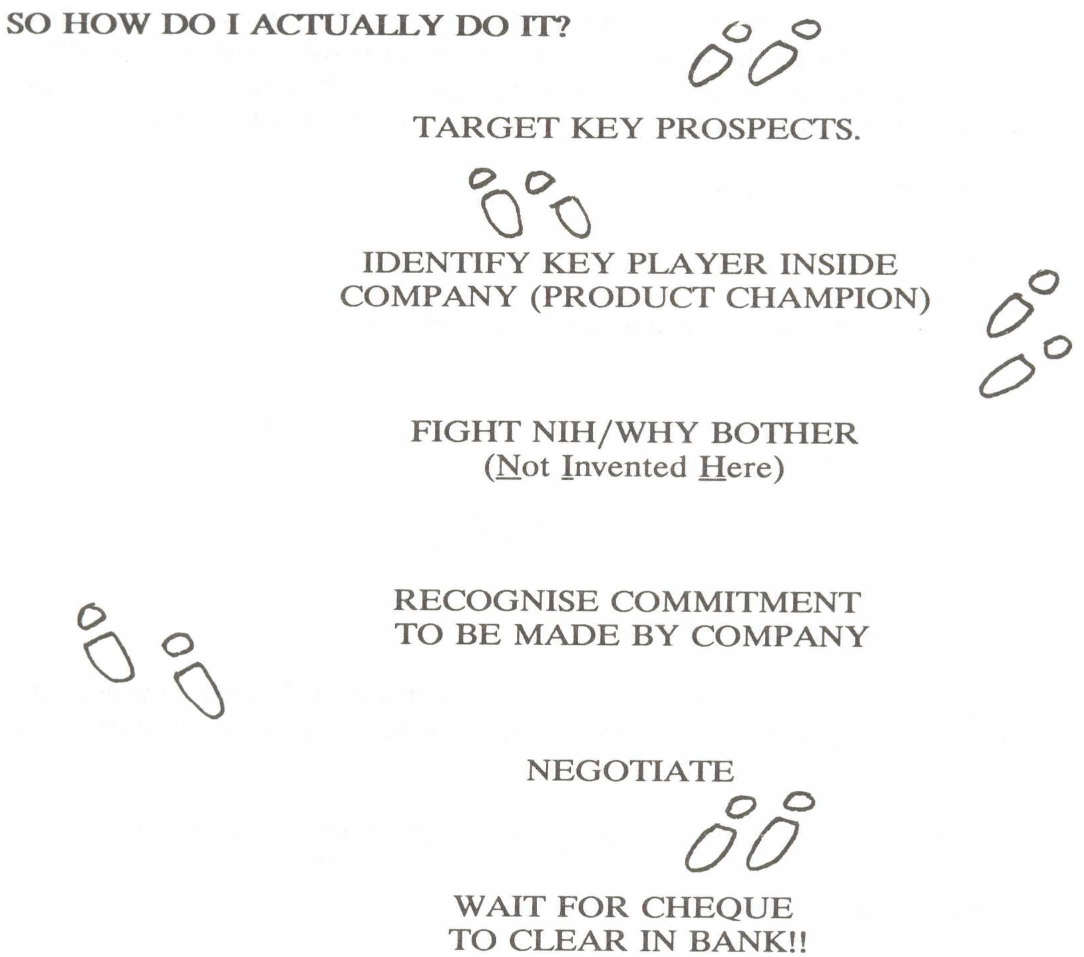
This obviously depends upon a good number of factors such as the item concerned, the type of IPR you have, how big the market is and so on. There are a number of methods you can use however:

1. Manufacture the item or use the process yourself to make items to sell.
2. Sell it for a one off payment to a third party.
3. Licence it to a third party.

The third party may either be an industrial concern already in that market or one wishing to enter it.

Option 3 - Licensing your idea to a third party has a number of attractions, namely you can be as creative as you like with the licence terms. For example, linking your return to the value of the company sales in a way of ensuring you benefit well if the idea really flies. Another good idea is to have some type of minimum royalty payment per annum, which the least the licensee pays even if he makes no sales. This ensures companies do not take ideas and sit on them.

However, it should be stressed that it is not necessarily a simple matter to draw up a licence agreement. For me to advise you to do this would be similar to advising you to convey your own home - okay until something goes wrong



CONCLUSION

For a process that can be described simply it must be stressed that an accurate summary would be "whatever can go wrong, will go wrong, and eve if it can't go wrong it will go wrong". For that reason I would stress your probably best bringing in the experts - and that's why BTG is here to help.

Technology Transfer in Nuclear Fuel Manufacture

Dr Sue lon

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SUMMARY

The high capital cost of nuclear power and the need to consider long term arrangements when making investments has led to significant international collaboration in the nuclear industry. This paper describes licence arrangements and successful technology transfer between BNFL in the UK and Westinghouse in the United States in the area of nuclear fuel design and manufacturing.

INTRODUCTION

The nuclear power industry in each of the major countries using this form of energy has approached the fuel cycle in different ways because of differences in history, geology and socioeconomic traditions. Not all countries carry out all parts of the fuel cycle and there is significant international trade between those involved. During the 1980s with the focus being placed on safety and environmental matters and the high capital cost of nuclear power and the need to address the long term rather than the short term both suppliers and customers began to review their strategies for further development of the industry.

Both suppliers and customers have long time scales and requirements for high capital investment. The utilities which run the power stations require secure sources of services for the life of their reactors and have very few suppliers to choose from. Similarly suppliers require a reliable outlet for their services in order to justify and recover the increasing cost of investment and particularly over the last few years have looked increasingly to greater internationalisation, technical collaboration, joint venture collaboration and even equity participation of both customers and competitors. This has meant that technology transfer within the nuclear industry is widespread and it has been common practice for competitors to licence products and processes across all parts of the fuel cycle in attempts to minimise overall costs. This paper addresses one particular aspect of the nuclear fuel cycle, fuel manufacture, in describing how collaboration in the 1970s led to long term relationships between US and UK fuel fabricators and successful ongoing collaboration into the 1990s. It begins by examining BNFL's world leading process for the production of the feedstock for fuel for

Most modern reactor systems. It then goes on to describe the PWR technology developed by Westinghouse in the United States and adopted by the UK for its ongoing nuclear programme.

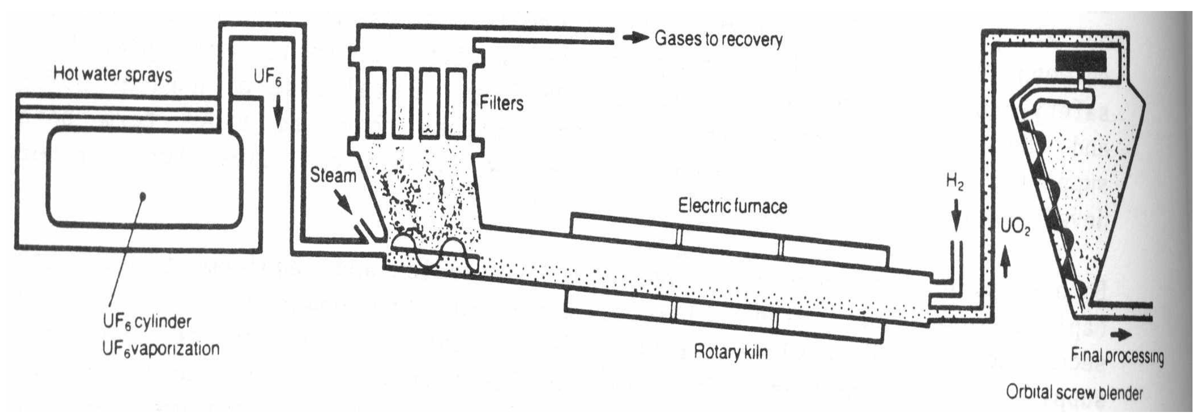
BNFL's IDR PROCESS

Since the start of the nuclear power programme many different reactor systems for cost effective efficient power production have been tried and tested. Gas. Water and liquid metals have all been utilised as heat transfer media to extract the energy from the fuel with a greater emphasis being placed on the former two. The principles of fuel fabrication in each system are similar to some extent in that in all cases the cladding is designed to be the primary envelope encasing the fuel to protect it from the heat transfer medium and to contain the products generated in the fission process.

The starting material for all manufacturing processes associated with fuel fabrication is uranium ore concentrate. For most modern reactor systems the concentrate is purified and converted to uranium hexafluoride. This is then shipped for the enrichment of the U235 isotope to the requisite value to separate facilities. After return in enriched form it undergoes conversion to ceramic grade uranium dioxide.

There are several different routes for the conversion of uranium hexafluoride to ceramic grade uranium dioxide. All require the elimination of fluorine down to the tens of parts per million and all must produce a chemically pure product with less than a few hundred parts per million total impurity. The process used by BNFL since the 1970s is called the Integrated Dry Route or IDR process.

The process involves the direct conversion of UF6 to U02 in a single stage rotary kiln (Fig 1) and as such has many operational and economic advantages over alternative multi-stage wet routes.



Being single stage it is very economic having low capital. Operational and manpower costs. It has minimal environmental impact with a single liquid effluent stream which is non uranic. The hydrogen fluoride which is produced is a saleable non uranic bi-product. The uranium dioxide produced is consistent with a high chemical purity: the physical and ceramic properties are consistent with little or no variation needed in downstream processing. The powder produced is readily fabricable into high quality fuel pellets which can be tailored to a wide range of specifications. The process was originally developed for the advanced gas cooled reactors in the UK. but its superiority over alternatives in terms of economics and elegance was recognised at early stage and this led BNFL to develop a means to adapt its use to LWR fuel fabrication.

The advantages of the IDR process were recognised internationally and, as a result, the process was licensed to Franco BeIge de Fabrication Combustiles (FBFC) in France and Westinghouse in the USA. Prior to the operation of FBFC's own IDR plant at Romans in France, BNFL supplied much of the powder requirements for the extensive French PWR programme from its Springfield’ s plant near Preston in Lancashire. When Westinghouse came to install new fuel fabrication facilities at their plant in Columbia in South Carolina they chose the BNFL IDR process to form the front end of their prestigious automatic fuel manufacturing line. BNFL has existing customers for the process allover the world. Powder produced by BNFL is supplied on a regular basis to other fuel fabricators in Spain and Germany. Interest continues to be shown in terms of product sales to new customers and in the process technology by other fabricators installing new or replacing existing capacity. More than 12000 tonnes of IDR powder have been produced worldwide for fabrication into fuel pellets for thermal reactors.

WESTINGHOUSE PWR TECHNOLOGY

In the late 1970s the UK Government undertook a review of its thermal reactor strategy and decided to adopt the PWR system for the next generation of nuclear power plants. In wishing to maintain its position as the major supplier of fuel cycle services to the UK nuclear industry, BNFL needed the technology to design, licence and manufacture PWR fuel. Although BNFL had many years experience in LWR technology, principally for BWR type reactors, it was not in a position to offer PWR fuel designs at that time. In order to be a such a position there was a simple choice to be made, either develop the technology in house, or acquire it from an established supplier. The former approach obviously required a major commitment both in terms of finance and resource to design, develop, test and licence the fuel and the associated plant and equipment for its manufacture. However, the attendant disadvantages of cost, time-scale and the credibility of an untried fuel design in an already well developed mature and competitive market led BNFL to conclude that the acquisition of the technology was the preferable option. The choice by the UK of the Westinghouse PWR system naturally led BNFL to approach the Westinghouse Nuclear Fuel Division with a view to entering into an agreement for the transfer of PWR fuel technology to BNFL under licence, in the same way that BNFL's IDR technology had been transferred for Westinghouse use in the United States. Such an arrangement would minimise the costs and shorten the timescales for acquiring the technology and would enable BNFL to offer state-of-the-art PWR fuel designs to its customers for as long as the agreement was in place. Westinghouse were at that time and still are one of the world's leaders in PWR technology capable of providing the complete rector system, or as required its various parts, i.e. the nuclear island, nuclear steam supply system, fuel components, support services, etc. Their technology is used in more than 75% of the world's operating PWRs and over the years they have gained considerable experience in licensing the technology, in particular in Europe and the Far East.

Licence Agreements were therefore drawn up between BNFL and Westinghouse to enable to transfer and use of PWR fuel design and manufacturing technology by BNFL. Due to its previous experience in LWR technology, BNFL was able to very quickly familiarise itself with the specifics of the PWR technology and effect the transfer of the information from Westinghouse. As a measure of the speed and success of the transfer of technology BNFL was able to directly and actively support Nuclear Electric at the Sizewell 'B' Public Enquiry during the early 1980s. Following the Sizewell 'B' Public Enquiry BNFL has continued to support Nuclear Electric's design and licencing work for the

UK's first PWR. Under the licence agreements with Westinghouse, BNFL constructed, commissioned and qualified a production unit to manufacture PWR fuel rods and fabricate finished fuel assemblies. A small number of demonstration assemblies were manufactured for a US utility by early 1984. This fuel has been irradiated to burn-ups in excess of design requirement and has performed as expected, thereby providing further demonstration of the successful transfer of the technology. BNFL has regularly seconded engineers to Westinghouse to work in various areas of PWR fuel design, enabling the transfer of technical aspects of fuel and core design and providing insight into the background of Westinghouse's vast PWR fuel and core design experience, in particular direct design experience of PWR for various utilities. In this process BNFL acquired total familiarity with Westinghouse methodology and practice and is now able to provide its customers with a complete design and manufacturing service for PWR fuel.

Westinghouse's credibility in the PWR market and the support back-up it provides to BNFL through the licence agreements were important factors in assisting BNFL with its penetration of the PWR market and the securing of the UK business which was obtained through competitive tendering. In February 1990 BNFL was awarded the contract for the supply of the fuel for the first charge of Sizewell 'B', the UK's first PWR, on a contract won on merit against strong international competition from other well-established fuel vendors. This achievement was seen as a significant milestone in meeting BNFL’s corporate objective of becoming a recognised fuel supplier to the PWR market and has provided clear justification of the benefits of the licence agreements with Westinghouse.

ONGOING COLLABORATION

For reactor fuel fabrication the importance of having a sound integrated manufacturing process and comprehensive quality assurance programme cannot be overstated, for example a PWR core contains over 15 million uranium dioxide pellets nearly 210 kilometres of zircaloy tubing and the fuel rods alone require about 120 thousand welds. Five years or more may elapse from the time a fuel region is designed until complete operational data becomes available for performance feedback into manufacturing.

Commercial nuclear fuel fabrication is focused on providing quality products. Throughout manufacturing, attention is placed on the precise control of processes, procedures and tooling to reduce product variability. The first priority in design and fabrication of all nuclear fuel is to maximise operational reliability and this in turn demands a constant focus on quality products and processes. Westinghouse and BNFL both operate under a TQM philosophy. Both organisations participate in joint development programmes and continue to gain from technical collaboration to optimise common processes and offer advanced products under the licence agreements.

With the increasing requirement for fuel of the highest quality and the demands on fuel performance for higher burnups, increased plant availability and lower fuel cycle costs, ongoing collaboration between BNFL and Westinghouse which began with the licence agreements between them will continue to ensure that customers worldwide are provided with the quality fuel cycle service they have come to expect.

ACKNOWLEDGEMENT

The author gratefully acknowledges the contribution of Rod Grimoldby, BNFL's Fuel Division Sizewell IB' Project Manager.

Appropriate Technology Transfer in the Third World

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SUMMARY

The process of introducing appropriate technology in Third World setting needs to be designed to suit local conditions. Common elements from three projects include sufficient preparatory work, geographical concentration, indigenous workers, and selection of technologies to suit existing technical skills.

INTRODUCTION

A considerable body of work now exists on designs appropriate to the Third World, but selecting the right technique for local conditions and introducing it so as to be accepted and sustained still poses problems. Three water projects from different national offices of World Vision (WV) International, a relief and development charity, illustrate alternative approaches.

SENEGAL

Technologies introduced into communities of the Louga region of Senegal include: hand pumps (India Mark II modified design), small-scale irrigated gardening using water from pumps, and improved wood-burning stoves.

The project area lies within a 30-mile radius, served by a relatively good road system, with trading networks and a degree of indigenous technical expertise. Bicycles and horse-drawn carts are common, and blacksmiths and bicycle mechanics operate in the villages; this suggested that local volunteers could be trained as pump maintenance mechanics and that the market system could supply spare parts. 397 pumps have been installed; this represents a significant local impact, a deliberate strategy aimed at achieving a greater depth of change in the area and at securing sustainability by creating the "critical mass" of villages needed for commercial networks to take over supply of spares and marketing of produce after the project ends.

To deal with the transfer of water technology, a specialised unit was set up - the Water Extension Training (WET) team. The WET team are Senegalese nationals, as are most of the project staff, minimising problems of communication. The approach

Adopted for education is to train volunteers from villages, who then become educators. Volunteers are unpaid but generally receive some compensation in terms of prestige, and the idea of reciprocal favours fits into the social structure.

The first activity carried out in a community is animation - an initial preparation for understanding the process of change in which villagers are invited to participate - carried out by five "bush animators" travelling the region. As a pre-condition to drilling a well, villagers, assisted by the WET team, establish a management committee for organising contributions by the community in cash and in kind; communal funds, manual labour for clearing the drilling site and afterwards for maintaining it, and meals for the drilling crew. This is important in establishing commitment and a sense of ownership, formalised in a contract drawn up with WV.

Pump maintenance is on two levels; daily care and cleaning, and periodic repair and maintenance. Volunteer "responsables" are trained in each community to supervise daily pump care. Villages have devised their own strategies for enforcement of correct pump use and hygiene - for example, a system of fines paid into the community fund for infringements of rules, such as stepping on to the concrete apron wearing sandals or allowing animals to stray into the pump area. The second level of maintenance is carried out by "bush technicians" - usually community members with some prior technical skills who are trained to carry out all but the most major repairs. They are equipped with the necessary tools - including lifting gear for access to underground components - on a loan basis and are paid out of communal funds. 29 have been trained and equipped. At an evaluation of the project in 1989, the system was found to be working satisfactorily; broken pumps are normally repaired within a few days, and a technician observed at work was methodical and competent. [1]

To provide support and training for gardening, a network of "bush consultants", analogous to the bush technicians, has been set up, usually experienced farmers who are given additional training and are able to advise villagers on subjects such as pest control and fertilisers. 32 have been trained so far.

Training on the construction and use of stoves is again by local volunteers, usually women trained as community health workers. The model of stove is interesting in that it was designed by a local woman. It replaces the traditional three-stone hearth, and is constructed from mud, sand and horse dung. Methods used for training volunteers include: picture books designed for non-literate participants, question and answer sessions, and practical demonstrations. 55 volunteers have been trained.

GHANA

The programme in Ghana, run by an all-Ghanaian team, has much in common with Senegal. However, the Ghana programme has progressed rather differently. One reason for this is historical; the Ghana programme started in 1984 in response to a drought, as a relief rather than a development project, leading to an initial emphasis on rapid production of wells in areas of greatest need, spread over a large number of locations. Following an evaluation in 1989, and learning from the experiences of the Senegal programme, the second phase of the project was re-designed to include a more substantial element of education and to limit it to a single region, the Greater Afram Plains.

The two main technologies introduced are India Mark II hand pumps and improved pit latrines. 442 pumps have been installed. to date. As in Senegal, volunteer villagers are trained in pump maintenance; 186 so far. However, the level of maintenance of which they are capable is less advanced than in Senegal. One reason for this is the relatively lower level of indigenous technical expertise in the Ghanaian villages. Infrastructure and trading networks are less developed; in some villages wheeled transport is rare, and metal-working skills are absent.

A significant finding of the 1989 evaluation was that pumps were better used and maintained in villages which had long-term development programmes, even after these had ended, than in villages which were provided with wells but had no long-term WV presence. [2]

The introduction of improved pit latrines got off to a slower start than did well drilling. One constraint was the government standard for village latrine, the Kumasi Ventilated Improved pit (KVIP) latrine. While an effective and durable design, it is relatively expensive and beyond the reach of most families. It is used primarily for latrine blocks serving whole villages. Communal latrines, however, are seldom as well used or maintained as private facilities, it is more difficult to promote a sense of ownership for public buildings constructed by an outside agency than for self-built structures using local materials, and the cost of the KVIP has prevented enough being built to meet the need. One positive observation made during the KVIP programme was that school latrines, supervised by teachers, are better used and looked after than public blocks, and are useful in teaching children good hygiene practices.

Based on the lessons from the early programme, the new strategy places emphasis on family latrines, using the simpler and cheaper Blair design with maximum use of local materials .Families will be taught how to construct their own latrines, and assisted with the purchase of materials such as concrete. KVIP latrines will be used where public latrines are necessary, with a preference for providing them for schools.

MALI

The Seventh Region of Mali, where a project centred at the town of Menaka operates, is more isolated and has a less developed infrastructure than either Senegal or Ghana. The inhabitants are mainly Tuaregs, nomadic pastoralists with a non-cash economy and a very simple level of technology. Existing technical skills include blacksmithying and mud brick building, but wheeled vehicles are a modern introduction.

When the project started in response to the drought of 1984/5, it was anticipated that water would be a major element, with the idea of developing gardening around wells as in Senegal. The nomadic pastoral system had collapsed with the loss of livestock, and it was thought that the appropriate response was

To assist pastoralists to adopt settled agriculture using groundwater, rather than relying on rainfall. However, further study showed that the traditional transhumance system of moving herds to areas of pasture during the rainy season and back to sites with permanent water in the dry season is actually the best way to utilise the fragile ecosystem. The project therefore adopted a dual approach, re-establishing and improving the pastoral system, and at the same time promoting agriculture at dry-season watering sites as an alternative income source and a fall-back in times of drought. Families were assisted to re-establish herds by means of a revolving loan fund of core breeding stock, while better herd management was encouraged, with smaller, higher quality herds. Apart from vaccination, this part of the programme involved little new technology, as the Tuaregs are expert pastoralists. The other part of the programme involved the introduction of radically new techniques. Traditionally, Tuaregs do not work on the land, and there was some cultural resistance to the idea. The approach which proved most effective was to build on the success at one particular site, Intadeny, by assisting project participants there to form a working organisation. One local individual, Ibrahim Ag Albaltanat, a school teacher, quickly assimilated the new techniques and established himself as an effective leader of an independent indigenous organisation, Groupement d'Artisans Ruraux d'Intadeyne (GARI) , formed under the guidance of WV.

Techniques introduced at Intadeny include: improved hand-dug wells, small-scale irrigated gardening using wells, sub-surface dams and recharge wells for replenishment of groundwater, regeneration of pastures using rock or earth dykes to halt rainwater run-off and reforestation. Improving traditional wells, rather than drilling boreholes, was selected as appropriate due to the level of existing technology. Traditional wells are improved by cement lining to prevent collapse and a surrounding wall for safety. The idea of a wall was not entirely popular, as it requires a different technique for hauling up buckets; users have been found balancing on top of the wall to draw water. The idea of dykes to hold back rainwater run-off similarly met resistance, and imagination was required to present the new techniques. One effective approach was analogy; pastoralists readily appreciate that water needs to be contained in a bowl for animals to drink, and containing run-off behind a dyke allows the ground to "drink". Once the effectiveness of dykes was demonstrated, the technique was more readily accepted. Requests for assistance are now regularly received from other sites and work is being extended in collaboration with GARI.

CONCLUSIONS

Elements common to successful projects include geographical concentration, the use of local workers, sufficient preparatory work before introducing new technologies, and selection of technologies compatible with existing skills and infrastructure.

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TT5

Transfer of Technology: Problems Experienced

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SUMMARY

This paper deals with problems experienced by developing countries in acquiring/using foreign technology. This complex phenomenon involves identification, evaluation, selection and adaptation of technology to local needs. Indigenous development capability and local skills playa pivotal role in any technology acquisition process

Technology has always proved a powerful tool in human civilizations. In our times, this has become indisputable. The development process is the productive utilization of existing technological knowledge. According to modern economic theory, the rate of growth of GNP depends on the productive factors of human labour, land, capital and technological progress. The last factor has come to be seen as one important key element in a nation's economic development. In particular, interest has focused on the extent to which transfer mechanisms affect the ability of recipients to acquire and generate indigenous technological capability.

Third world countries share a recipient status in technological exchange. Pakistan being a developing country has neither the resources nor an industrial base strong enough to engage in original research and development work. Our aims can best be achieved by obtaining technology transfer from reputed international sources and subsequently building upon this base.

Some setbacks towards technological development are:

- Lack of a strong national infra-structure to assist in carrying out the functions of identifying, evaluating and selecting appropriate technology

- Technologies selected for acquisition and assimilation often lack active local participation required as a pre-requisite for its success.

- All of us in less developed countries face the problems of limited manpower, scarce fund~, insufficient societal support, low incomes in our scientific communities and resulting brain-drain.

- Standardization of equipment used by various organizations in the country is required at the national level.

- Want of active participation of the universities for industrial problem solving.

- The imports of technology in package form rather than completely knocked -down form.

- High-tech international procurement is generally not linked to local manufacture/assembly. Consequently, a major opportunity to train and cultivate a high level experienced core of people is usually missed. Personnel should be trained and well-versed in a wide variety of disciplines including, but not limited to, documentation, design, procurement and sourcing of parts & sub-assemblies, specialized manufacturing, testing and calibration techniques [1].

TRANSFER OF TECHNOLOGY: EXISTING PRACTICES.

Technology transferred to Pakistan has mostly been through some technology licensing, mainly turn-key projects and a few joint venture cases [2]. However, it has mostly been a machine transfer process rather than a true technology transfer. Pakistan's expenditure on technical services, like other developing countries! forms a significant proportion. There is a pressing need for Pakistan to achieve an advanced state of industrialization.

Technology import pre-supposes information and expertise to judge the merits of technology and the best means for its acquisition. However, concerned enterprises often do not possess the means to assess and make a choice among alternative technologies, to determine the appropriateness of technology for their needs, and to negotiate fair and reasonable terms for its acquisition. As a consequence, prospective technology acquires may find that their bargaining position in their dealings with technology holders is relatively weak and consequently the latter may present the former with a technology "package" tied to commercial, financial and other inputs. The National Centre. for Technology Transfer (NCTT) has been set up with an aim towards streamlining the technology transfer' process in Pakistan. It is striving for technology management, promotion and utilization. It also aims at providing match-making service to the technology suppliers and receipients.

Further, once selected, the adaptation and absorption of technology is by no "means easy. Local enterprises initially lack technical, engineering and managerial expertise to carry out adaptation and absorption. The institutions of research and development, therefore, form yet another component which is essential for transfer of technology as it provides necessary base for imported technology, on which the latter can be grafted to generate self-sustaining and growing systems [3]. Such R&D centres are now being established at the national and organizational levels. Industry is slowly gaining confidence in local R&D. This link has to be strengthened as production technology is the essential means for transfer of technical & scientific achievements into materialized wealth.

In some instances, technology transferors do not provide information on technological advances existing at the time of negotiations, thus limiting the technology transfer to a technology that is out of date [21. It is, however, important to remember that in technology transfer, the willingness and capabilities of the recipient to "extract" knowledge is as crucial as the readiness of the transferor to provide it.

An important aspect overlooked is the technical support required for equipment imported in package form for enhancing and modernizing production techniques. This includes troubleshooting equipment, skilled technicians *I* engineers, complete mechanical drawings, circuit diagrams and troubleshooting procedures. The import of technology package has been employed in developing countries because of a lack of industrial experience, corporate skills and indigenous consulting firms. Its main setback is that it increases the dependence on foreign capital, machinery and materials, and accordingly weakens the demand for indigenous research and development. Therefore the policy for technology to be acquired on a case-by-case basis should be directed towards a greater involvement of national firms *I* consultants in the industrialization process. In this context unpackaging means renouncing-to the most feasible extent-operations such as turn-key contracts, by having recourse as far as possible to local enterprises in the acquisition and adaptation of technology [2]. As regards raw materials and goods (components, tools etc) preference should be given to those available or producible in the country. It is generally noted that once your licensor discovers that you will find ways and means of indigenization with or without their help, their attitude changes and they become more helpful. It is more a matter of mutual understanding and using the acceptable diplomacy to bring about the desired results rather than trying to write a faultless agreement for transfer of technology. It is unreasonable to expect that technology can be transferred: It must be acquired. purchased, built up bit-by-bit or stolen (if you like!).

LINKAGE OF R & D WITH INDUSTRY

Technological change follows an exponential growth pattern. Moreover, indigenous transfer of technology from R&D centres. into the national production system supplemented with adaptation and modification would help. reduce the technology gap for the development of "appropriate" technology for' self-reliance [4].

The Vienna programme of Action recognizes that the development of strong linkages between the producers and users of research and development is one of the priority challenges facing developing countries in their drive to reinforce their indigenous scientific and technological capacities [5].

Pakistan has adopted several measures in varying degrees to develop S & T infrastructure, the R&D base for the development of indigenous technologies and methods to disseminate such information’s generated for the use of local entrepreneurs. PCSIR [6], the country's largest R&D organization concentrating on industrial research has all along been handicapped in respect of commercialization of its efforts aimed at achieving self reliance. It is claimed that around 500 processes have been developed, out of which 328 processes have been commercially purchased by the local industrial community between 1953-84. These results are far from satisfactory [51.

IMPORTANCE OF TECHNICAL MANAGEMENT

It is self -evident that, however well-conceived, no policy in science and technology is self -propelling. Policies have to be executed by concrete people, By scientists and technicians in the scientific community. Effective and appropriate placement of technical people is very important for efficient utilization of their capabilities. That is why the development of the human resource potential should be at the heart of science and technology development, and. why the development of a strong and vibrant science and technology community is the prime concern of technical management. Science and technology managers have to be pragmatic. They are responsible for results relevant to concrete development problems in society. Managers have to produce results regardless of society's insufficient appreciation for science & technology. Inadequate facilities, and sometimes hazardous conditions in the search for the first or the best approximation to the truth.

CONCLUSION

It must be understood by the decision-makers and planners, industrialists and enterpreneurs that technology acquisition is a complex phenomenon for which proper approach, direction, planning and coordination is required to achieve the national objectives. Every country which has followed an aggressive policy of technology acquisition has found ways around, embargoes imposed against them and we are no exception. The embargo imposed by the United States in 1965 only led Pakistan to diversify its sources of defence supplies and produce more indigenously. Further proof has been offered by the recent advancements in the nuclear sector and the latest developments of laser range-finder, surface-to-surface and surface-to-air missiles. Roughly 80% of the components used in these missiles were locally produced at a fraction of the international price. The remaining 20% imported components could be manufactured locally, but as the cost would have been much more than those of the imported ones, it was found more economical to acquire them in the finished form from outside. One can only conclude by saying that the quality of education and training and the development and exploitation of human intelligence are the real resources of a nation.

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TT6

Women in the Indian Electronic Industry

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INTRODUCTION

The mid 60's have seen an unprecedented industrial growth in India. A global electronic industry has emerged in India with multi-national investment encouraging labour intensive operations. This industry enables employment of a docile low-wage work force; the majority of whom are women. They help to minimise labour costs and international competition in production.

This paper looks into the human element of women in the electronic industry. The aims and objectives of this paper are to examine: (1) Criteria utilised to recruit women in this industry; (2) Type of work entrusted; (3) Wage pattern, job stability and job satisfaction; (4) Unionisation and attitude of male colleagues.

METHODOLOGY

The concentration of electronic industry in Western Maharashtra since 1960 provided the necessary infrastructure for data collection. A wide panorama of multi-national, multi-million, large scale (LS) industries interspread with medium scale (MS) and numerous small scale (SS) units are in existence in the industrial belt. The categorisation of these units are defined through the following classification (see Table).

The sample comprises 112 women working in LS, 96 in MS, 169 in SS industries. The total sample comprises 377 women drawn from 2 LS, 3 MS and 18 SS units. Data were collected with a questionnaire which had 82 questions supported by an interview and observation.

DISCUSSION AND DATA ANALYSIS

Indemnificatory data indicates that a major group from all the three types of industry falls into the 21-45 years age group. Considerable numbers of women are married with the majority having 1 to 3 children, while a few even have 4 to 6 children in the family. The children range in a greater number of cases between less than a year to 10 years. Most of the respondents are 1st, 2nd or 3rd in place of birth order. This is an important factor for these women are working to support the family. Women have to travel between one and 30 km to work, and most of them utilise the municipal transport or walk to work. the number of hours out of the home and the expenditure incurred is directly related to the distance of work, mode of transport and salary received by them. Hindu women form the single largest group, followed by Christians and Muslims, but Sikhs, Zorashtrains and Neo-Buddhists are marginally represented, whereas the Jains are conspicuous by their absence.

Table Classification of the electronic industry

Criteria	Large scale (1)(LS) unit	Medium scale (2)(MS) unit	Small scale (3)(SS) unit
Wage structure	Industrial wage board directives	Industrial wage board directives	Not well defined
Service conditions	Well defined	Well defined	Not well defined
Organisation	Formal/large multi-national	Formal/Indian entrepreneurs	Informal/small (5-25 employees)
Perks/ facilities	Bonus Creche Canteen subsidised	Bonus - -	- - -
Employment rules	Strict Social scrutiny Unionisation	Not too strict Social scrutiny Unionisation	Hire and fire Policy Not always Unionized
Location	Industrial Area	Industrial Area or Non-industrial Area	Garage/private Residence

The plausible explanation lies in the demographic set-up and tradition of the country. The "Pardah" system, non-security and marriage, quick divorce and lack of education have made Indian Muslin women unemployable. Christian women have established their monopoly in nursing, pharmaceutical companies, stenotyping, telephone operating, primary and secondary teaching, and as secretaries. Jain women usually help their menfolk in trade and commerce. Very few from the blue-collared workers have high scholastic achievements. Most of these women belong to homes where the parents, in-laws and husbands have received marginal

Education and hold low status and low remunerative jobs, such as clerk, tailor, barber, cook, labourer, railway driver, and technician; less than 3% were professionals.

CRITERIA FOR SELECTION

Passing 9 and 10 is obligatory for employment in the electronic industry. A pre-medical employment examination ascertains the ability to sit at the assembly bench for 8 hours. On-job training is given to women in all three types of factory. Though there is a feeling that industry exploits women, from this sample, women who have got jobs in the electronic industry are: (1) Marginally qualified with low scholastic profile; (2) The employment potential would be in the clerical profession or nursing; (3) Though they have long, structured hours of work, their wage compensation and perks in LS and MS units are ample rewards; (4) Working in a factory is considered prestigious; (5) The chances of finding a husband for the unmarried employee are better in industry.

The only drawback envisaged is in SS units, which have a hire and fire policy. These exploit women, because women with lower educational qualifications prefer working in SS units instead of seeking employment as domestic labour.

TYPE OF WORK ENTRUSTED TO WOMEN

Almost all the women in the three groups of the electronic industry have repetitive, monotonous, mechanical work on the assembly benches, they are either winding wires, sealing units or assembling ancillary parts. They are given 15 days of on-job training which makes them eligible to carryon their work. Skilled labour is invariably recruited from among men.

WAGE PATTERN, JOB STABILITY, JOB SATISFACTION

As seen from the table of classification of electronic industries, we find that the wage received by women is equitable with that of men, and salary structure is adhered to the industrial wage board directives. Therefore, a woman working for 8 hours with five or more years of service gets between Rs4.500 to 5.000 per month, which includes a bonus. Some of the electronic factories have facilities of transport or creche, as well as subsidised meals. This gives an indirect wage advantage to the women. None of these facilities are provided in the SS units for women. Individual bargaining, lack of perks and nonfacility of transport, creche or food put these women in a low wage category. The MS units definitely have an industrial wage board formula, but may not have other facilities of creche, transport or transport, but are eligible for bonuses. They have job security like the LS units. Job satisfaction amongst the LS units is higher than MS units and lowest in SS units. Though the most significant aspect is the money they receive, most of the women working in this industry rate themselves lower than the profession of a teacher. The highest level of professional status according to all the groups of women working in the three types of unit is that of a lady doctor and an engineer.

UNIONISATION AND ATTITUDE OF MALE COLLEAGUES

Women in the electronic industry have entered it as part of a low wage work force which helps to face mounting domestic and international competition as a way of reducing labour costs. Women do not replace skilled male workers and comprise mostly low skilled assembly workers. They work because their wage is necessary for the betterment of the family. They keep a low profile in union activities, and the turnover rate of women in the electronic industry is quite low because women prefer to stay with the job they have, as the wage pattern of job, together with the perks that go with it, seem to satisfy them more than the job I itself. In the domestic chores women are reconciled to repetitive, monotonous, tedious work. They utilise this attitude built from domestic chores to their jobs where they continue repetitive, monotonous work on the factory benches.

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The Communication of Environmental Needs

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The last few years have seen a major upsurge in environmental awareness among the British public. Concern for the ozone layer, the tropical rain forests and the state of our own beaches has rarely been greater. But how is such interest affecting industry? Why do some industries, some companies or some individuals still regard the environment as 'something to pay lip service to' while others are fully committed to reducing pollution, conserving resources and protecting wildlife and landscapes?

With a few notable exceptions, environmental consultancy is a relatively young industry in Britain. It is nevertheless the role of such groups to ensure that environmental policies are implemented, that measures to mitigate against environmental damage are identified, and that environmental enhancement opportunities are seized. Environmental Consultants must work with industry if real progress is to be made. Liaison is replacing confrontation, but more quickly in some industries than others. Environmental consultants therefore have a vital role to play in ensuring that this process continues, that compromises are reached and that future development is sustainable development.

Much of the resistance to environmentally beneficial change is due less to arrogance than to ignorance. If environmental theory is to be put into practice, a massive exercise in communication and education is required. Industry must be convinced that long-term benefits are worth short-term costs, even where such costs cannot easily be quantified. This paper examines some of the problems encountered, and the successes achieved, in this transitional period. It discusses the need to develop an improved understanding of environmental issues, and builds on a theme promoted by the Nature Conservancy Council 'think global, act local'. Everyone can make a contribution and the paper demonstrates the critical role of the individual, be they director, engineer, secretary or manager, in achieving environmental objectives.

Engineers are Becoming Ecological Literates

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"Are Engineers Ecologically Illiterate?" - this was the title of an article which appeared under my name in the Spring, 1986 issue of U. S. Woman Engineer, Magazine of the Society of Women Engineers.

Having graduated from two of our country's finest educational institutions, the Ethical Culture School and the Massachusetts Institute of Technology, I had received diplomas from each without having taken a single course in biology. I had never even heard the word "ecology", much less known its meaning, until 1952. Beyond a doubt, I was an environmental illiterate.

Because the engineers and policy makers were as ignorant as I, a great many inadvertent mistakes were being made. Let me site an example:

Under federal law of several decades ago, certain streams which periodically overflowed their borders were condemned and marked for gutterization. Florida's Kissimmee River, the headwaters of South Florida's water supply, was straightened and channeled until it resembled an oversized drainage ditch -- all in the name of flood control. The results were disastrous there and downstream.

It took a number of years before it was finally realized that the river should be allowed to flow free once more -- to have its many oxbows restored, even though some inevitable flooding would again occur. Today, an experimental dozen miles have begun the restoration of the river to its meandering flow, with its twists and bends as it had been, but with suitable assists for through boating.

The Kissimmee feeds into the great storage tank for all of the southern part of the state's water supply -- Lake Okeechobee. This huge body of water is badly, if not fatally, polluted by waters from the dairy and sugar growing industries as well as the cities and towns near its banks. The lake seems literally to be dying, as engineers, industries, politicians, federal, state and local agencies, haggle over a solution to the problem. Should rake Okeechobee turn belly up, what about the dying up of the downstream water supply, the Everglades, that great sponge which stores the water for its neighbors in the south?

The year 1990 marked the twentieth anniversary of Earth Day -the beginning of the awakening of true environmental awareness and concern throughout the lam. This new am gradual awareness now circulates the globe, for natural resources are no respecters of boundaries.

Not only water pollution but air pollution as well, our punctured ozone layer, the rain forests, the greenhouse effect these have become not only of national but of global concern.

Where do engineers fit into this new consciousness -- they, the creators and builders of so many mistakes of the past? In a news release early in the year, the Army Corps of Engineers (responsible for the Kissimmee debacle) sent out this message: "We engineers must look at our work in a broad social and environmental context as well as in technical and short span economic terms."

As far as Florida projects are concerned, the Army Corps stated in a news release issued in Jacksonville and dated January 18, 1990, "We can achieve a balance between the demands of the tremerx10us growth in Florida am the delicate environment that abounds in this state, but it must be done by cooperation and common purpose. Working in concert with local, state and other federal agencies, we can achieve that balance and build environmentally sound projects. We are all concerned about the environment -- as individuals and as public servants."

Not only the Army, but the United States Navy, too, is lending a hand, producing a film, among other activities, stressing environmental problems on its bases.

The Air Force, also, is playing a part, as for example, in the panhandle of Florida, where the red-cockaded woodpecker is an endangered species. The Eglin Air Force Base in the panhandle is initiating a scientific study of the bird's situation on the large woodland area of the base.

Thus, the military is beginning to assume a significant role in protecting our environment. They are starting to become ecologically literate.

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This now takes us full circle to the education and training of our country's engineers. Are they becoming ecologically literate?

To search an answer, I, as a '22 alumna of MIT, became interested in what my own alma mater was doing.

A May 25, 1990 article in the New York Times informed me that an environmental course (without credit) was cancelled because of the slight attendance. I i1mnediately wrote to the Alumni Association, stressing my firm belief that no potential engineer should be given a diploma without a required and accredited course in biology.

The answer was prompt. Dr. Iaurence M. Lidsky, Professor of Nuclear Engineering, wrote: "Many people at MIT agree with you that it is imperative all MIT students (and indeed our faculty) be more sensitive to the context within which the practice of science and engineering takes place."

He then went on to say that many (though not all) students were being exposed to global environmental issues. For example, the civil Engineering Department has now established a B.S. degree in Environmental Sciences and Engineering, designed for students “who wish to acquire an in-depth knowledge of fundamental physical, chemical and biological processes, coupled with analytical and computational skills suitable for addressing the

Crucial problems and human impacts on the environment .The new programs will provide the education necessary for students planning careers in environmental engineering, management, and planning for further graduate study."

“The Context Support office has offered a variety of programs for both students and faculty, in addition to well attend workshops by both groups on the topics of global warning, animal rights (with differing points of view), and "Is Nature Dying?"

An MIT colloquium titled "Green on the Planet" was an undergraduate seminar on "What Are We During to Our Environment?", providing students the opportunity to look at environmental issues from the standpoint of goods const:m1ption and waste production at MIT.

Then there was the pilot of a new subject, "Ethical Issues in the Work Life of Engineers and Scientists". Though this effort was poorly attended, as reported in the New York Times, the subject according to Professor Lidsky is "very much alive and well!"

The Departments of civil Engineering and Earth, Atmospheric and Planetary Sciences have recently established a center for Global Change Science, an interdisciplinary center involving both research and education, building on the long established MIT programs in meteorology, oceanography and hydrology.

This year's Technology Day featured a debate on the subject, "Is It Getting Hotter on Earth or What?" The two scientists who spoke had sharply different points of view on the possibility of global warming. The theme of Technology Day in 1990 was "100 Years of Earth Science at MIT, celebrating the achievements of the department of Earth, Atmospheric and Planetary Science."

The matter of a new undergraduate requirement in biology has been the subject of much discussion lately. Dr. Lidsky states optimistically, "It will likely be voted into the curriculum by the faculty within the next year, since it is clear that the education of all MIT students must include our understanding of topics in modem biology. Furthermore, the aesthetic and moral Parts of education need to be stressed if the environment is to get the respect it deserves. In other words, MIT is trying hard to put its technical teaching within the border of human context. Concern for the environment would naturally follow."

This outline of what MIT is doing in environmental education should inspire and no doubt has encouraged other engineering schools to create their own environmental programs.

Here's another example, this one about a state institution, written by a staff writer of Fort Lauderdale’ s Sun Sentinel:

"Boca Raton -

Armed with a $300,000 grant, Florida Atlantic University is making a bid to become an internationally recognized center for the study of subtropical environmental problems.

Administrators propose to carve a unique niche for FAU in the world of environmental academia by creating a combined research and educational program that would tap into the environmental expertise of 65 of the university’ s faculty members.

Center researchers would be "thinking globally, but acting locally," tacking ecological problems unique to South Florida and other subtropical regions of the world, said Stanley B. Andrews, director of sponsored research at FAU.

'You really can't study too many environmental programs without recourse to an international backdrop,' Andrews said.

A search is under way for a renowned scholar in the environmental field to work with faculty, administrators am graduate students to plan the program, said Sheila Mahoney, an FAD biology professor am chairman of a university committee that proposed the program. She said planning could take as long as a year.

Among its educational objectives, the program would incorporate environmental concerns into courses at FAU am create new classes on environmental topics. It might produce an interdisciplinary environmental degree program, administrators said.

Administrators envision an eclectic curriculum that could range from environmental engineering courses to those that would explore environmental philosophy am environmental ethics.

'We even have a theater person who is very interested in dramatizing some of the critical problems in the environment for a larger audience,' Andrews said. 'There are many universities in Florida with specialized programs in environmental topics, but ours would build an environmental program throughout the entire curriculum, across every department. '

In setting its sights on solving regional environmental issues the school will not ignore its campuses, Andrews said. FAU aims to become more 'ecologically sensitive' by launching demonstration projects on its own turf that could include xeriscaping [growing native plants that require little water] am solar power applications, he said.

. . .

How about <u>your</u> alma mater? Is it doing enough? It is working toward a required course in the natural sciences for <u>all</u> potential engineers, whatever their chosen field might be? Could you let them know how you feel?

Furthermore, do you, as a professional engineer, know enough yourself? Do you need to update your knowledge? You may have a job to do.

It was Aldous Huxley, famed British author, who said, "Everything that gets done within a society is done by individuals." And isn't this where we - you am I -- come in?

TT9

Rebuilding Afghanistan - A Problem of Communication?

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SUMMARY

After 10 years of war, Afghanistan's infrastructure needs substantial inputs of aid. However, communication problems can affect the success of projects there. These problems include overcoming both the problems of interpersonal communications and the logistical and long distance problems. In addition media communication is necessary to ensure support from donors.

1. INTRODUCTION

Afghanistan could never be considered a hospitable country. Jagged mountains in the north and centre are permanently capped with snow while their rivers evaporate into the arid sands to the south. Winters are harsh with temperatures of -20 or even -30 commonplace and the summer heat can be searing, rising to 30°C or even close to 40°C.

Prior to 1979 the country outside of the main cities such as Kabul, Kalat and Kandahar had remained largely unchanged for years. Income was derived mainly from the cultivation of almonds, apricots and grapes, the latter of which were dried locally. Many of these crops found their way to Europe and Afghan almonds and raisins were a common sight in the shops 15 years ago. Crops were transported to the main centres of habitation by nomadic traders who, with their camel trains, performed a dual role of transporter and wholesaler.

Other crops were grown for local consumption, wheat and maize on irrigated fields with rice on the river banks. Apples and peaches were plentiful in the south of the country with a wide range of other fruit and vegetables being grown in small kitchen gardens. Mulberry trees, with their extensive root system and resistance to rot, were used, along with willows, to line river banks. Sheep and goats were herded by young children to feed on the scrub found in remote areas. Farming techniques had remained unchanged for centuries, but the tried and tested methods ensured an ecological system that remained in equilibrium.

In 1979 the Russians invaded Afghanistan in order to prop up the communist government. During the ensuing war that lasted a decade the rebels grouped themselves into different parties of mujahideen. Party headquarters were usually located across the border in Pakistan with aid and arms coming from Pakistan, the arab countries and the west. The Russian troops held the large cities and the main roads, but failed to make any

Inroads into the inhospitable rural area .The men in these areas would join rebel groups fighting around the main centres of population, leaving the land to be tended by old men, young boys and in a very few locations, the women.

2. COLLECTING INFORMATION - THE PROBLEMS BEGIN

Before any aid program can begin, information is need in order to assess:

The needs
The priorities
The costs
The difficulties

In 1990, one year after the Russians departed and with an uneasy stalemate over most of the country, I went to Afghanistan to assess the infrastructure problems in a remote rural area in Central Southern Afghanistan. I was working on behalf of a charitable organisation called Health Unlimited. Although they had had health and education projects in the area for 5 years, with expatriate teams working there during that time, I was the first technical person to visit the area. My brief was broad: to assess the problems of the area, carry out any projects I could while in the area and propose a future technical program for Health Unlimited.

Communications problems became apparent even before I had left the UK. Because previous team members had been non-technical, although they had written extensive reports, they had not collected much of the information I needed. Detailed information about the climate, geology and topography, as well as the availability of engineering materials and equipment, was completely lacking. I gleaned as much as I could from photographs and from talking to previous team members. This tried my powers of communication of technical matters to non-technical people.

Once at the project base I was able to start collecting information from my own direct observations. However, communications continued to be a problem. The most obvious difficulty was the language barrier. The language of the area was Pashtu, a notoriously difficult language for which few books existed. The only English speakers in the area were the health workers who were generally too busy with their work and further training to be available to help me. This problem is experienced by many of the expatriots working in Afghanistan. Interpreters brought in from outside the area must be carefully vetted to ensure that they are of the right tribe and lineage. Even then, they may not be accepted in an area where they are not known. Health Unlimited have tried to find interpreters in their base town, Quetta, in Pakistan. However, in spite of the large number of highly educated refugees in the town, they frequently found it impossible to find translators who were acceptable to the local people.

Even after I had acquired a reasonably good grasp of the language, my communications problems were not over. Many of the people I was talking to and whose needs I was trying to assess had never left the area in which they had been born and brought up. They worked to a different religion, code of ethics and priorities. Their perception of life was completely different from mine. What I might feel was essential to them might be irrelevant. The introduction of latrines serves as an example of this problem.

Worms and diarrhoeal diseases were endemic in the area. Both problems are easily solved with the introduction of well designed and sited latrines plus a clean water supply. However, neither of these problems really affected the men. They did not collect the water and had the whole valley at their disposal as a latrine. The women were confined to the home, but their needs received a far lower priority and it therefore became extremely difficult to raise local support for a sanitation project, although I could see that the benefits would be substantial.

The difference in cultures brought a further problem in communication. When we are in our own cultures we devise our own methods of assessing the truth and validity of a statement. In a totally alien culture one's norms for judgment no longer apply. If people said they had a problem, were they exaggerating? Were the costs they quoted genuine or inflated for the benefit of foreigners? These problems were particularly highlighted in an irrigation rehabilitation project where labourers were paid to repair and improve the system. Did the local people really pay other people to do the work or would they have done it themselves left to their own devices?

3. COMMUNICATIONS FOR SURVIVAL

Solving the communications problems to allow accurate information to be collected and assessed is only half the battle. There is then the problem of physically communicating this information with one's head office and possible funders, besides the general desire to <keep in touch' with one's family and friends. The nearest town with a post office is in Quetta, a minimum of 3 days journey, although it may take a week or more in the spring. For 3 months in the winter travel is impossible. Under these conditions organising projects becomes very complicated. Projects may well be delayed by a year as it is impossible to travel in, collect the necessary information, write up the proposal and get it back to the donor agency before the appropriate season for the work is finished.

There is always the question: what is going on? One of our team members had to return home in December due to a relative's ill health. It was fortuitous that the news reached her when she was visiting Quetta otherwise she would not have heard about the problems for 3 months. As it was, the rest of us in Afghanistan had only vague rumours that she was returning until she actually arrived back at the project in March.

This is one area where technological developments can change things dramatically. In the past, due to the hazards of travel to the project and security problems in general, radios were just not practicable. However, briefcase telecommunications satellite communicators now mean that expatriots in even the most remote sites can keep in touch and this may transform project working in the future.

4. LOGISTICS

The need for aid towards the rebuilding clf Afghanistan's infrastructure is immense. In the area I looked at alone there was a huge need for river control works, irrigation development, sanitation, reforestation and energy saving/producing projects. Most of these require substantial inputs of materials and this raises another problem of communications in Afghanistan: the lack of any physical network for transportation. There is one Tarmac road in Afghanistan that sweeps in a semicircle from Kabul to Kandahar. This was severely damaged by tank traffic and bombing during the war and several of its associated bridges have been destroyed. Elsewhere Afghanistan's roads consist of little more than dirt tracks which alternate between seas of mud and dust. Since the war deviation from the main routes is perilous due to mines, so if a road becomes blocked, for instance when a lorry gets stuck in the mud, no other traffic can pass and all must wait until the way is cleared.

Improving the roads would dramatically reduce the difficulties of bringing aid into Afghanistan. However, apart from the problem of finding the funding, the problem of agreeing routes and priorities is no less fraught than in the UK, so the roads are unlikely to improve in the near future.

5. FINDING THE FUNDING

There was a time during the mid 1980s when the plight of Afghan refugees was the subject of media interest with well known television personalities such as Sandy Gall writing about their experiences. This led to an influx of aid. Since then, however, the plights of the horn of Africa, Eastern Europe and now the Gulf have superseded Afghanistan in the media. The need to communicate to potential funders is ever present and media influence should not be forgotten - it can turn a trickle of aid into a flood.

6. THE FUTURE

In this paper I have looked at how different aspects of communication affect the success of providing aid to Afghanistan. However, even if improvements in all these aspects took place, Afghanistan cannot expect to emerge from its current state unless a further form of communication improves - communication between political factions. Until then, Afghanistan will continue to be an area of skirmishes and strife which will prevent the full rehabilitation of the country.

Environmental Study of Uruguay

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The National Environmental study has many relevant aspects. One is the formulation of a document that presents the environmental situation of all the country in the various aspects of conservation, pollution, toxics, ecological tourism, impact assessment, urban ecosystems, information, sustainable development, regulations and institutions. This presentation will be a synthesis of the document. Second, actions and policies to be applied presented as projects and third, a discussion about how institutions can manage environmental problems and some proposals on education both formal and non-formal, taking NGO's as promoters of actions in environmental protection.

This work was performed with the financial assistance of the lnteramerican Development Bank (IBD) and the technical assistance of the OEA. Experts on different areas and from different countries worked together with national experts to make the document and identify the projects, set the priorities and policies.

The author of this presentation is the coordinator of the work on the National Counterpart and she has worked in it since the preparation of the project to the financial institution in 1989 through all the performance of the study and at present in the profiles and feasibility.

Rural Women and Environmental Awareness: Effective Means of Communication

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NEERI, Nagpur, India

SUMMARY

A project for generating environmental awareness amongst rural women has been launched in nine villages around Nagpur, India. The project involves usage of various communication means. The effectiveness of these means is evidenced by the active interest shown by the rural women in the environment development activities being planned.

1.0 INTRODUCTION

A cumulative impact of various intricate undesirable life related systems is "Degeneration of Environment". Creating environmental awareness, generating respect for environment or rather building an "Environmental Culture" in the society is the only effective way of preventing such a situation. Building "Environmental Culture" means everybody knowing the real meaning of 'Environment' and also everybody realizing the need to conserve and protect it. The most convincing way of doing it is imparting Environmental education to one and all

In India, where majority of population inhabits the villages, "Rural Environment" is to be given a significant consideration while thinking about environment and making it safe, healthy and happy. In our country, the problems of rural environment are much more different than those of the urban environment. These problems pertain to over population, improper housing, lack of sanitation and wholesome water supply, illiteracy, ignorance and as a result of all this, frustration or an apathy towards development projects. This makes the situation worse as the development programmes being implemented by the Government or the voluntary agencies do not yield the desired benefits for the community in the rural areas.

In the rural areas, women carrying out the responsibilities related to domestic and wage earning chores viz., agriculture, cattle rearing, dairy, poultry, cottage industries such as cane work, handloom etc., on an equal footing, should have an equal share in the environment upkeep of the village. Sadly, this has not been realised all these years and women are supposed to have no say in any of the related matters.

As a result of the observations made in the water supply and sanitation decade 1981-90, it has been now realized that women should be involved in the environment development projects, viz., water supply, sanitation and health, right from their inception. The first step of such an involvement should be environmental awareness.

With this background a project, "Generation of Environmental Awareness Amongst Rural Women with specific reference to water, health and sanitation" has been launched in nine interior tribal villages around Nagpur, India.

2.0 THE PROJECT

2.1. The Preparation,

To plan the education programme using various communication means, it was necessary to assess the actual requirements of the target group, viz. the rural women. This was done with the help of an Exercise, "Educational Diagnosis", "carried out by using personal interview schedules. The schedule referred to the women's knowledge regarding:

- Hygiene: personal and household's hygiene practices
- Water: Storage, proper usage, disinfection practices and water- borne diseases
- Sanitation: Garbage, drainage and excrete disposal practices
- Environment in general: Why tree plantation?, environmental pollution and how to prevent it etc.
- An assessment of formal education level of the women was also done.

Simultaneously, a survey relating to the existing environmental conditions in the village was undertaken. This had a reference to general environment in the village, source of drinking water, drainage and excreta disposal methods, prevailing diseases as well as epidemic outbreaks in the recent past. Besides this, efforts were also made to assess the socio-economic standard of the village in general. This exercise "Community Diagnosis" ascertained the nature of development programmes likely to be taken up for the betterment of the village environment. As a result following important facts were revealed:

- The women though not entirely ignorant had very little know-how about the water borne diseases, their source of infection, transmission and control

- The diseases were attributed to many blind beliefs such as: lot of sweets eating results in scabies, to religious rituals not being followed properly results in infanct morbidity and mortality etc.

- The co-relation between environment and health was not at all envisaged

- Concept of diseases being contagious and the spread of water borne diseases through faecal-oral cycle was not heard of

- There was a total apathy about kitchen garden and planting trees. Water scarcity was the reason for it. That the trees donate 02 was not at all understood.

As such it was necessary to incorporate information related to all these issues in the environmental education programme. And the most important thing was to deliver it in an effective and attractive way with lot of consideration, patience and persivierance as the formal education of the women was also very meagre.

The villages chosen were rather small with 75-100 households each. From each village 5-10 enterprising women with some formal education say up to primary were chosen for our educational programme. These women in turn would serve as effective educators and motivators for the village community.

2.2 The Communication Means

Having completed the exercises referred to above, it was easy to design and use various communication means for environmental education so as to achieve the desirable effects. These means were:

Personal Contacts

The women chosen were contacted personally and efforts were made to make them more interested in our programme. Interestingly, the women's age group ranged from 16-60 years. These women showed some leadership qualities as well as seemed to be enterprising.

Group Meetings

These meetings were required to create an atmosphere of environmental awareness in the village. Besides the selected women, all other women in the village and girls in the local school were also invited for these meetings. Various issues relating to village environment were discussed e.g. improper drainage in the village etc.

Environment Awareness Camps

For the selected group of women three days' camps were organized. In these camps following activities were undertaken:

- Exhibition on "Environment" with the help or charts, small working models, slogan hoardings etc.Viewing there exhibits made women more vocal with each other
- Games were played in the closed classroom as women were shy of playing outside. These games were designed to bring home importance of co-operative activities, inculcating good habits etc.
- Puppetry -small skits on "Environment" were shown with puppets. The colourful puppets aroused the curiosity and women started discussing as to how they could also make some puppets
- Demonstration - Some pilot models were constructed during the camp so that women actually learnt the details about the construction. These models included, 2 pit water seal latrine, soak pit compost pit, and smokeless chulah. Proper usage of these amenties was also demonstrted
- Class Room Tutorials - Having used such means so as not to make the camp contents boring and monotonous it was easy to conduct tutorials. Preferably educated women social workers working in the field were invited to talk on varios topics as:

- Environment and human life
- Personal hygiene and health
- Water Borne diseases
- Environmental sanitation
- Environmental upkeep and community participation
- Child care

The local language was used for all these deliberations

* Audio-Video Slides - The slides on all these subjects were shown and proved to be very attractive and stimulating for discussion amongst the camp inmates

2.3 Impact

- Some time is yet to be passed to evaluate the long-term impact of the whole exercise. But the immediate and short term impacts have been very encouraging. The women who in the beginning were very much doubtful about their own role in any programme on environment became very confident and vocal gradually. In the concluding session of the camp, they came forward to speak from the dias and requested the village authorities (men) and the guests invited from district headquarter to improve the environment in their village.

- The women asked for help to organise some social organisations such as Women's club, children's day-care centre etc. in the village. They thought that they will use these organisations for their environmental projects and to spread the message to other women and community in general.

- The women took special interest in charts, slogans and puppets. They expressed a desire to learn to make these things themselves so that they could organise some income generation activity. They thought it was feasible to supply these things to the schools and village community development offices in the vicinity, earning some money as well as spreading the message.

- Projects such as tree plantation, kitchen garden, making soak pit and compost pit in all the house holds by donating labour on a cooperative basis were discussed with enthusiasm. Some work has already been initiated.

3.0 CONCLUSION

The communication means adopted for the environment education seem to be yielding the desired effects, viz. generation of environmental awareness in the selected group. These women are also interested in communicating what they have learnt to others in their village and want to motivate the community to participate in environment projects.

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Improving People's Understanding of Our Planet Involving the Public in Scientific Research Expeditions

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SUMMARY

Addressing the need to improve public understanding of science requires many diverse approaches. One successful approach is 'participant-funded' expeditions through which the public can both learn about science and contribute significantly to scientific research.

INTRODUCTION

A recent survey in Britain reportedly showed that only 63% of the populations know that the Earth rotates around the Sun [1] and in New Zealand, for example, many people appear unaware that the largest city, Auckland, is at risk from volcanic eruption. These examples endorse the long-recognised need [2,3] to improve the public understanding of science, an issue addressed by the Royal Society in 1985 [4]. In this paper a system that enables lay-people to participate in scientific research expeditions is discussed and the benefits and limitations of such an approach are considered with reference to an example.

THE NEED TO IMPROVE PUBLIC UNDERSTANDING OF SCIENCE

Modern society is based on science and technology and hence some scientific literacy is becoming essential for everyday life. More critical perhaps are such issues as the future integrity of the physical environment, the supply of physical resources and the supply and quality of food stuffs; these issues need to be addressed by sound decision making which is scientifically informed. Improving public understanding, therefore, is not a luxury; it is a vital investment for the future well-being of society [4]. However it is not only a question of improving factual knowledge, equally important is the need to improve understanding of the nature and methods of science and the uncertainties involved [2,5]. Birke [1] has suggested that the public are not as 'ignorant' as recent surveys indicate; rather they are conversant with the science relevant to their lives. She concluded that 'publics' want access to science in different ways and hence it is important that attempts to 'popularise' science are diverse in approach.

APPROACHES TO IMPROVING PUBLIC UNDERSTANDING OF SCIENCE

Science is rarely news and the disparity between the scientific and journalistic modes of operation has often resulted in an awkward relationship [4]. However, Nelkin [6] considers that the popular presses are paying increasing attention to science through both feature articles and economic and business news. Television and to a lesser extent radio provide other popular, immediately accessible formats; in Britain the regular television science programmes have audiences of about 15 million people [7]. These media are quite successful in communicating. Science and are very effective at reaching large numbers of people but they are subject to the constraints of attracting audiences and hence are limited to the most 'popular' items. Furthermore, audience participation is entirely passive and the scientific uncertainties are discussed little [5].

Interactive science museums or science centres are becoming increasingly popular following the example of the San Francisco Exploratorium, indeed currently in New Zealand, with a population of only three million, five. Science centres are being established. Although such centres often enable the visitor to interact directly with exhibits, concern has been expressed [1] that the contradictory and complex nature of science is minimised.

Many adult education institutions or extra-mural studies departments of universities offer the public courses in science, some of which include more interactive activities such as field trips. These provide an excellent opportunity to combine education and travel [8], thereby enhancing both. A further development of this is the 'participant-funded' research expedition in which volunteers contribute financially and participate directly. Clearly these may not have widespread appeal but the impact of such participation in scientific research extends beyond the individuals involved. Expeditions attract media attention and show that lay-people can usefully contribute to scientific research countering the notion that science is exclusive and mysterious. In addition, the participants take back direct experience and improved understanding of science and the scientific method to their communities.

'PARTICIPANT-FUNDED' SCIENTIFIC RESEARCH EXPEDITIONS - AN EXAMPLE

In 1990 I co-led an expedition to study the Taranaki volcanoes of New Zealand which was sponsored by Earthwatch, a US organisation that co-ordinates 'participant-funded' expeditions. Egmont Volcano, which last erupted in 1755AD, was the main target of this expedition; it is a classic conical-shaped volcano rising from sea-level to 2500m. The objectives of the research were to investigate the structure and geological evolution of the volcano in order to understand better its past activity and hence provide some constraints on the potential hazard it presents for the future. The tasks involved in the expedition included measuring the gravity and magnetic fields of the volcano, topographic surveying and collecting rock samples.

Seventeen individuals from the USA and Australia participated in the expedition as volunteer research assistants, they ranged in age form 17 to 70 with approximately half over the age of 50. Their backgrounds extended from high school student to computer engineer and company manager and they had a corresponding range of skills and experience. Seven scientists and four post-graduate students were involved in the expedition.

The Benefits

The scientific benefits of 'participant-funded' research expeditions, beyond the funding of expeditions, include more effective data collection and considerably greater data coverage in the

Time available. In this case the remote wilderness nature of Egmont volcano requires that for safety, researchers operate in teams of at least 3-4, a practice made considerably more efficient with a single scientist and a team of volunteers. The volunteer research assistants bring a range of skills and experience with them to the expedition, whether in computing, mountaineering or catering, they make a significant contribution to the scientific endeavour and operation of the expedition. In addition, the scientists have the opportunity to share their interest and enthusiasm for science with interested individuals, indeed it has been suggested that this is their obligation [4]. On the Taranaki expedition some evening lectures were given and as the expedition progressed and the volunteers became more familiar with the project, questions arose that were hotly debated.

The benefits to the volunteer research assistants include the opportunities to support and be fully involved in worthwhile scientific research, to gain an appreciation of the difficulties involved in such research and the uncertainties in scientific results and, also, to meet people with similar interests. Collecting high-quality scientific data in challenging environments where logistic difficulties, weather conditions and instrumental problems all have to be overcome gives volunteers a considerable sense of achievement and also experience of the challenges and frustrations that are involved in science of this nature.

For post-graduate students involved, not only do they gain the experience of participating in a major scientific research expedition, but they have the opportunity and challenge to explain their science to lay-persons; it has been suggested [9] that all young scientists should practice explaining their science in lay-language.

The Difficulties

The difficulties in this approach include the need to maintain a high standard of data quality and to balance the needs and interests of participants with the scientific goal. A high standard of data quality was achieved by operating in small teams of 4-5 people which included a graduate student or scientist as a nominal team leader. The team leader taught the volunteers how to operate the scientific equipment - a task that requires care but is not much more difficult than using modern domestic electronic items. The standard procedure of taking multiple readings was carried out by the volunteers and team leader and if the readings proved unacceptably discrepant, additional readings would be made. In this way all the participants contributed to the scientific endeavour without compromising data quality and indeed, we found that most of the volunteers quickly became adept at reading the instruments.

Balancing participant's interests with the pursuit of scientific goals requires flexibility in approach. On this occasion there was a considerable range of tasks involved and every attempt was made to ensure volunteers participated to the degree they wished; some were keen to participate in arduous high-altitude surveys every day whilst others preferred surveys along which took less stamina and agility. It was essential each evening to plan the next days surveys according to the scientific aims and predicted weather and then allow volunteers to choose tasks within that overall plan. It is an approach that appears to have been successful, one volunteer wrote afterwards:

> "None of you ever made us feel as though we were just 'packhorses' or just' a financial means to an end'. We always felt well respected 'almost' equals".

Outcomes

The scientific outcome of this particular expedition is a significant and extensive suite of geophysical data. In terms of improving public understanding of science, the expedition attracted

Attention from the local and national newspapers and radio which promoted considerable interest in both the volcano and its associated hazard and also the contribution that lay-people can make to scientific research. Since the expedition some of the volunteer research assistants have given talks, for example, at their service clubs. Others have been featured in their local newspapers or have written articles for magazines. The high school students' interest in geology was confirmed and he has since started a course at university, he wrote:

> "The trip was far better than I thought it was going to be - and I thought it would be the best thing that had ever happened to me. I really learned a lot and had the time of my . life helping you gather information about Mt Egmont".

Others have been stimulated to take courses:

> "I'm thinking of taking a course in geology this fall - I took it when I was in engineering school but at the time I couldn't drum up an interest".

CONCLUSION

The need to improve public understanding of science is well recognised [e.g. 4] but to achieve this many different approaches are necessary ranging from passive media presentations to actively involving lay-people in science. Each of these approaches will appeal to a different audience but all are essential. Much scientific fieldwork is repetitive and does not require observational or technical skills beyond those of most adults; hence lay-people can make a significant contribution on research expeditions. By participating in scientific research lay-people better understand the aims and methods of the science and they gain an appreciation of the difficulties and uncertainties involved, and have the opportunity to work closely with scientists, this greater understanding is taken back into their communities. One participant in the Taranaki expedition wrote:

> "Not only was it a great learning experience in something I'm very interested in but it was such a warm and fun experience".

When this is the generally held view of science, scientists could consider they have been successful in their duty [4] to communicate science.

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TT13

Energy Conservation in Leicester City, England

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SUMMARY

Energy conservation is the responsibility of every citizen. Many channels are available to raise public awareness of the technical, financial and environmental implications of energy saving. The lack of technical understanding in many households is a barrier to information transfer. Leicester City Council is committed to 'getting the message across'.

BACKGROUND

Leicester was designated the first 'Environment City' in the United Kingdom, in July 1990. This is an ambitious environmental initiative to find practical answers to the problems of creating a more environment-friendly way of life in a working city. The Environment City campaign has drawn together a partnership of local authorities, voluntary bodies, businesses and individuals to tackle a broad range of environmental issues simultaneously. Targets for the environmental standards to be achieved have been agreed locally by this partnership, through specialist working groups, covering major themes of environmental concern. These are: - energy, transport, waste and pollution, food and agriculture, economy and work, and the built, natural and social environments.

DOMESTIC ENERGY CONSUMPTION IN THE UNITED KINGDOM

In the United Kingdom there has been a tradition of relatively cheap energy. There is no tax on domestic energy. However, there is a tax of 17.5% on energy saving commodities such as low energy light bulbs and insulation products. Energy consumption in the domestic sector accounts for approximately 30% of all the energy used in the UK. There is great potential to reduce this by as much as a quarter. For an investment of capital approximately equal to its annual energy bill, a house can have cavity wall and 10ft insulation installed. This gives a pay back period of four years. This has to be done by persuasion, as there are no legal requirements or obvious short term financial benefits for people to invest in energy efficient measures. One of the main barriers is the fact that on average, people move house every six years, so someone else reaps the benefit of the investment.

Increasing the thermal efficiency of buildings is now widely recognised as the cheapest and quickest method of reducing carbon dioxide emissions, so helping to alleviate the problem of global warming. Citizens must be encouraged to think of long term benefits to the environment rather than short term financial returns.

THE CITY OF LEICESTER

Leicester is a medium sized city in the centre of England with good communications by road, rail and air. It has a cosmopolitan population of about 280,000; approximately 25% of the citizens are of Asian origin. There are also smaller communities of West Indians, Eastern Europeans and Chinese. A large population of students is in residence during term-time.

The City Council has set a target of reducing the energy consumption in its buildings by 50% by the year 2025, resulting in a reduction in carbon dioxide emissions from 60,000 tonnes per year to 30,000 tonnes per year. The Council has had a long standing commitment to the efficient use of energy. As early as the mid 1970's an Energy Conservation Working Party was set up to establish an energy policy which was agreed by the City Council in 1980. Energy consumption in the municipal buildings has been reduced by 16% over the last 10 years, a total saving of 90,000 tonnes carbon dioxide. A detailed Energy Action Plan was launched in November 1990. The 80 point plan covers action in the Council's own offices and other buildings; the council house stock; advice to householders; development of combined heat and power and renewable energy sources and transport initiatives. It is hoped that by working to the plan the ambitious target of halving energy use can be met and even surpassed.

In Leicester City Council's own housing stock the action plan builds on past work; all 31,000 homes have some 10ft insulation, and the cavities of 7,000 of the 12,000 homes with cavity walls have been insulated. However, most of the dwellings in the city, both private houses and council dwellings, are over 50 years old, with solid brick walls. They are both expensive to insulate effectively and expensive to heat. To establish priority estates for thermal upgrading, the National Home Energy Rating (NHER) will be used to measure the energy efficiency of dwellings in terms of running costs. This rating combined with information on the size of a dwelling can produce estimates of the energy running costs. The computer programme is then used to optimise the choice of energy efficiency improvements. Using the NHER the worst of the housing stock can be identified and refurbished in the most financially and thermally efficient way.

"GETTING THE MESSAGE ACROSS"

In order to encourage owner-occupiers, private landlords and housing associations to insulate their properties and to save energy, a number of initiatives have been instituted.

THE ECO HOUSE, AN ENVIRONMENT-FRIENDLY SHOW HOUSE

Leicester Eco House is a new and ambitious enterprise which aims to demonstrate practical ways of improving the quality of the home environment and lessen the global impact of our actions. The house, which is owned by the City Council, is set in a large garden. The house is full of working demonstrations and interactive displays to demonstrate how we can all live in a more environmentally friendly way. The formerly derelict house has been renovated in a project developed by Leicester Ecology Trust to include a high standard of loft, wall and floor insulation. Demonstrations include low energy water heating, heat-exchange ventilation techniques, solar panels on the roof and environmentally friendly domestic appliances and products and home waste recycling. Other special features include a 50W wind turbine generator, a heat pump and an organic fruit and vegetable garden. There is also an 'energy playground' for children. Admission is free to the public.

LOW ENERGY LIGHT BULBS AND THE HOME ENERGY EFFICIENCY SCHEME

To illustrate to people in their own homes, that they can readily reduce energy consumption, low energy lamps are being sold to council house tenants at a considerable discount as part of the Council's environmental protection strategy. Unfortunately legal constraints prevent the lamps being sold to anybody but council tenants.

The council is also encouraging its tenants and other householders who are eligible, to take advantage of the Government sponsored Home Energy Efficiency Scheme (HEES). This enables householders, who are on a very low income, to obtain a Government grant to insulate their loft, hot water tank and pipes and to draught-proof their doors and windows for about 5% (£15) of the real cost (£275). Government incentive schemes not only help to reduce the cost of energy efficient measures, they also help to convince people that the investment must be worthwhile if the Government is prepared to subsidise it.

ENERGY ADVICE AT THE CONSUMERS ADVICE CENTRE

Advice on heating and energy conservation is available free to people at the City Council's Consumer Advice Centre, a drop-in centre situated in a busy City street. The Centre has a full time energy advisor who provides practical impartial advice on energy related matters. The advisor also answers enquiries and requests for information on the environmental impact of all types of energy related products for the home. There are over 1,000 requests for information each year, the majority of consumers seeking advice on loft insulation, central heating, double glazing and condensation. Displays of energy related products are exhibited in the' shop window' to stimulate people to seek further information in the Centre.

ENERGY ADVICE IN THE CITY

Advice sessions are held for council tenants in their own estates around the city. Advice can then be much more specific and a visit to the home made if this is needed. Many of the enquiries at these 'surgeries' are by people who are in fuel debt. Fuel poverty occurs when people find themselves unable to pay to heat their homes to an adequate standard, (21°C in the living room and 16°C in bedrooms). There are many contributory factors; the high price of energy, thermally inefficient properties, expensive to run heating systems, the weather, Government policy and the lack of energy education and awareness of relative costs. Fuel poverty is becoming endemic in the UK because it has the worst insulated and ineffectively heated housing stock in Northern Europe. The effects of fuel poverty are far reaching. They are felt not only by the individuals who live in the cold, damp dwellings, but by the whole of society in indirect costs. These include additional sickness, family problems with the strain of debt, and other social problems that go with inadequate housing world wide. The old, sick, unemployed and disabled people and one-parent families are frequently those seeking advice. Liaison with charities and welfare groups tries to make sure that the people who are most disadvantaged in society have advice they can understand and utilise. People in fuel debt are not in a position to save energy as they cannot afford to keep warm. They need advice on how to make the best use of gas and electricity so that the money they have can be spent to the best advantage.

EDUCATION AND PUBLICITY

There are many opportunities for consumers to use energy in the home more efficiently. Decision-making and procedures in the day-to-day running of a home can be full of bad practices and misconceptions. Few people understand

The relative costs of the different fuels, or how best to use their heating controls and thermostats. Individual advice can help only a small proportion of house holders, so a city-wide information and education programme has to rely on publicity.

The civic magazine 'Link' which is delivered to every residential address .in the City, regularly carries articles on how to reduce domestic fuel bills. Leaflets are displayed in public places for people to take home to use. There are many information leaflets published by the Government, charities and commercial firms available. Approximately 25,000 leaflets have been taken from displays in Leicester during 1990-91.'Handy Hints to Save Energy in Your Home', are the most popular. This leaflet is full of straight forward, easy-to-follow advice of how to achieve significant savings without spending too much money. Displays of energy saving ideas are held in Neighbourhood and Sports Centres throughout the year. An opportunity to 'get the message across' is rarely missed.

CONCLUS ION

The build-up of carbon dioxide and other 'greenhouse gases' in the atmosphere is now widely accepted as contributing to the threat of global warming. The ever increasing demand for energy must be halted. It is hoped that by alerting the citizens of Leicester to an ever increasing number of local and global environment issues, that they will recognise the need for strong and positive action now. 'Environment City' provides the framework in which a pro-active energy conservation campaign can be pursued. Pressure must be put on Government to remove the tax from home insulation and low energy products, and to change the law on Councils being able to sell products at a reduced rate. Grants must be made more widely available for upgrading thermal efficiency in the home. It is hoped that the 1990’s will be the decade of environmental action and the Environment City Campaign will be seen as a leading international initiative.

TT14

Developing Countries - Communication Priorities, Bottlenecks and Appropriate Strategies

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250 million people in India consume less than 3/4 of the needed calories; clean drinking water is a luxury for about 75 percent of the World's rural population. Here it is proposed to point out priorities in rural development in India and suggest appropriate strategies of communication. Family health and income augmentation are among priorities. Our programmes emphasize balanced nutrition through indigenous foods, clean water and immunisation against infections diseases, and education for saving. Bottlenecks - Poverty, illiteracy, lack of exposure, superstitions, and traditionally low social status of women, poor infrastructure and rapid populsation growth are the main bottlenecks we face in rural communication. Strategies and approaches - The work has to be carried out in a phased manner: establishing rapport with the community, identification of needs, programme planning and implementation (with ongoing evaluation and course correction) and final evaluation. At each phase communication approaches and strategies have to be appropriate to the target groups. Strategies tried and found successful include mass singing of hymns and prayers (as entry points); home visits and health - check up camps (to identify needs); and role play, puppet play and thematic play (to drive a message home).

TT15

Technology Transfer and Its Impact on Human Development

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SUMMARY

Using two case histories on technological development and transmission as a basis, a model is evolved that links the nature of human society to technology and development. An extension of this model to forecast future trends highlights the need for sustainable, optimum and appropriate technologies and resource investments in a globally free market environment, to ensure future development

INTRODUCTION

Based on the author's Ph.D research, this paper is concerned with technology transfer and its effect on human development in a historical context.

An approach to survival requiring use of artefacts, tools and materials to modify the effects of an hostile environment, is essentially technological (1). The Western or industrialised nations have chosen a predominantly technological approach as the premier survival strategy. The results of this technological approach have been so spectacular, that it has become a universally accepted model for human development. (2)

Many people have tried to understand and explain changes caused by technology. As a result, what has emerged gradually is an inter-disciplinary contextual history approach, seeking to comprehend the whole complex of social, economic and political relationships out of which technology grows. (3,4) Recent trends in historical research, tend also, to emphasise the interpretation of past events rather than a clear cut chronological description of these events. (5)

TECHNOLOGICAL DEVELOPMENT AND TRANSMISSION

In keeping with recent trends, an inter-disciplinary contextual history approach is adopted for the present paper. Two case histories on technological development abstracted from Bambrah (5) are presented in Table 1. The first is for Kenya, a developing country chosen from among those countries that face the bleakest future for the rest of this century. (6, 7) The second is for Britain, a contemperary 'developed' country and the first industrial nation. (8, 9) For ease of comparison the two histories are presented side by side, using a sequel tabulation of historical data.

TABLE 1.TWO CASE HISTORIES OF TECHNOLOGICAL DEVELOPMENT

KENYA			BRITAIN		
TECHNOLOGICAL CHANGE	TRANSMISSION MODE	DRIVING FORCE	TECHNOLOGICAL CHANGE	TRANSMISSION MODE	DRIVING FORCE
Pebble tools	Indigenous	Resource discovery	Flint tools	Migration	Continental explorers
Hand axes	Indigenous	Resource manipulation	Agriculture	Migration	Migrants searching for land
Stone tools	Indigenous	Increased resource usage	Wood & metal tools	Migration	Continental settlers
Wood, leather & bone	Indigenous	Fabrication 7 resource adaptation	Peasant economy& goods	Migration	Settlers & traders from the continent
Agricultural tools & know-how	Migration	The Bantu searching for agricultural land	Money taxation & urban isation	Colonization	Roman overlords seeking espansion of their empire & wealth
Cloth, & building know-how	Migration	Arab traders & settlers	Land tenure & market systems	Invasion	Conquest of the Romans by the Normans
New crops& sailing technology	Invasion	Portuguese conquest of the Arabs	Feudalism & change in land owner ship laws	Invasion	Anglo-sexon wars & conquest of the Normans
Caravan routes and technology	Invasion	Arab conquest of the postuguese and slave trade	Defenece weaponry	Local aggression	Need for freedom from servitude
Social upheaval	Colonization	European missionaries & explorers	Land & resource management	Indigenous	Reorganization land ownership & labour forces
Military weapons social chaos	Colonization	Expansion of European empires	Scientific discovery	Indigenous	Transformation of man's perception of matter
Transport infrastructure	Colonization	Expansion of British empire	Industrial revolution	Indigenous	Ability of manipulate matter self endowment
Industry & new land tenure laws	Colonization	Reorganization of productive forces & labour	Empire formation & expansion of trade	Free trade	Search for industrial raw materials for self endowment

Table 1 CONTINUED

New type of Entrepreneurs	Colonisation	Reorganization of productive forces	Expansion of international trade	Free trade & Resource transfer	Raw material accumulation & markets for processed goods
Military training	Colonisation	Second world war needs of the British	Development of communication & transport	Free trade & resource transfer	Capital to finance war & ease movement of goods
Defence weaponry	local aggression	Need for freedom from servitude	Structural change abandoning free market	Protectionist trade	International stagnation economic hardship
Subsist and se If develop	Indigenous	Reorganisation of land ownership & labour forces	Heavy inv- estment in technology	Export promotion & trade barriers	New basis for international finance and GATT treaty
Basic infrastructure for urban areas	Mass transfer of technology	Aid assisted economic development	Nuclear capability computers& laser beams	Competitive trades & markets	North/south disparities & conflicts, oil food etc crisis
Rural development	Import substitution	Need for self sufficiency	Information and bio technologies competitive trade	Competitive trade	East/west conflicts, debt food & energy crisis
Beginning of industrial growth	Export promo	Economic growth & survival	Super industrialization	Competitive trade	Economic growth environmental & peace crisis

It is clear from the histories contained in Table 1 above that the context within which technological development has occurred in the past has changed 31gnificant1y over time. Thus, while primitive technology was an essential survival tool for man, today's technology is an integral part of human life changing not only man's behaviour and ways of doing things but even the nature of his civilisation. Presently centred around industrial and economic growth.

THE TECHNOLOGICAL TREND MODEL

A descriptive analysis of the two case studies using nature, society and technology (particularly its transmission) as the organising concepts as suggested by Kates (10) is contained in table 2. Essentially, a trend model linking technology to other dimensions of human development, this analysis attempts to accomodate in our present understanding not only the growth and transmission of technological knowledge over time, but also the development context (resource discovery f01lowed by agriculture, land management, empire formation and expansion and currently economic development) within which this change occurs.

CONCLUSION

An extension of this model to forecast future scenarios for technological advance calls for major changes in our thinking about technology. This change in thinking calls for sustainable, optimum and appropriate technological and resource investments in devising policies and instruments of control of future

Human development. It is suggested that to attain this end, a new world order based on free trade is a necessary pre-condition.

TABLE 2: TECHNOLOGY TRANSMISSION AND HUMAN DEVELOPMENT

LIFESTYLE/NATURE OF SOCIETY	TRANSMISSION MODE	DEVELOPMENT CONTEXT
Primitive	Indigenous	Resource discovery and manipulation
Settlers & traders	Migrations	Search for agricultural land & trade
Conquerors	Invasions	Expansion of power and land ownership
Imperialists	Colonization	Empire formation, social upheaval, reorganisation of land ownership, labour &productive forces and military training
Freedom fighters	Aggression	Need for freedom and self defence
Independent states	Indigenous	Self management of the economy, Land ownership, labour and productive forces
Inter- connected Nations	Free trade & transfer	Economic and industrial growth, Inter- national trade links & resource needs
East/West & North /South blocks	Competetive & protectionist trade	Energy, debt, environmental & other global crisis, advancing technology, increased consumerism & resource limits
New World Order?	Free market trade	Sustainable, optimum and appropriate technologies and resource investments

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Relevance of Technology Transfer as an Impetus to Technology Innovation in Developing Countries

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Summary: Full exploitation of science-technology base depends I on ready access to , and the effective use of the scientific knowledge and technical know-how already 1n existence. There must be conscious effort to utilize these resources through technology transfer and appropriate technology adaptation for improving the rate of technological innovation. Technological advances derived from the innovation process also contribute to an expanding science-technology base, which in turn, provides a stronger foundation for further economic gains. The large pool of talent of our country must be used gainfully to make available the positive results of R & D to the society with the help of effective technology transfer.

Preamble: The role of science and technology in improving the quality of environment and standards of living in a modern society is well recognised. Scientific and technological activity gives rise to science technology base; that is the total accumulation of technology knowledge and resources developed [1].

The existence of a large science- technology base is useless unless the genius of invention is combined with the skills of entrepreneurship, management, marketing and finance to strengthen economy and improve the quality of life. Further, the dynamic nature of the science-technology base (technological change) encompasses scientific advances, engineering know-how, availability of better materials and resources, improved industrial processes including manufacturing methods, and more efficient design Techniques [2]. It is the continuing process by which new discoveries and experiences gained through R & 0 are added to the science-technology base every day. Technological innovation is the process by which technological advance is translated into competitive goods and services and is a prime determinant of the effectiveness by which technological progress is translated into higher productive output in the national economy. Elements of the existing science-technology base can be more closely coupled Lo the innovation process with the help of technology transfer in order to spur productivity growth.

Technology Transfer: Technology transfer may be considered as application of technology to a new use or user. The activity involves principally the increased utilization of the existing science-technology base in new areas of application as opposed to its expansion by means of further R & D. Its importance lies in its ability to stimulate and strengthen the innovation process.

The four principal elements for economic growth are illustrated in the Figure1.The science and technology base provides the principal foundation for achieving productivity growth and economic progress. Technological innovation is the key link between economic progress and the science technology base .A stronger economy, in turn, generates growing capital resources, a portion of which may flow back for reinvestment in more innovative ventures and further productivity growth. Technology transfer acts to strengthen the linkage between the innovation process and the science-technology base. However, the flow of technology shou1d not be construed unidirectiona1, that is, from in the science-technology base. There is an equally important feed buck link where technological progress resulting from the innovation process also acts to broaden the science technology base in conjunction with the R & D input .Thus, a ba1anced bilateral flow of technology is an important aspect of technology transfer if substantive benefits are to be realised.

The techno economic progress of a country depends upon these principal elements involving a long chain of events. Failure of any link in the chain will hamper the progress.

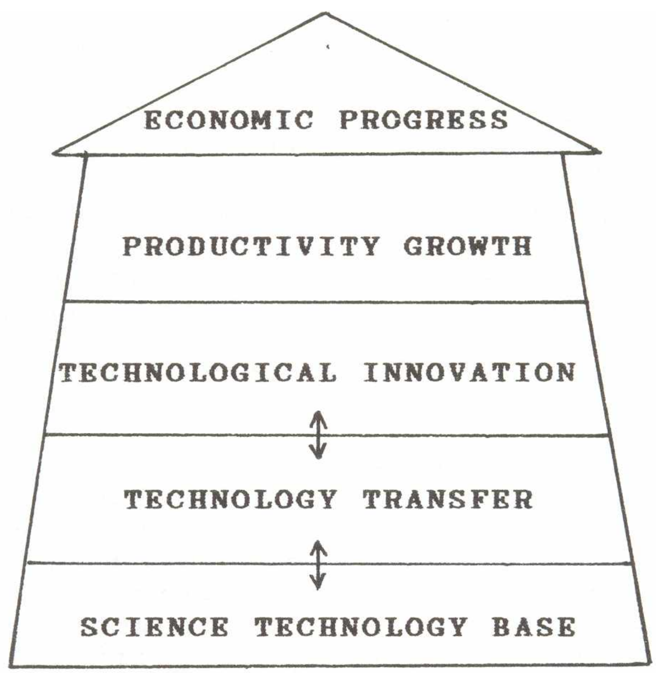

FIGURE 1 : THE TECHNOECONOMIC INTERFACE

Technology transfer in developing countries: Technology transfer methods cannot be generalised for any country. Each country has its own methods of utilising technology. For instance, Japan applied the tool of innovation and imitation rather than invention in the application of technology by adoptiong techniques from other countries which were already advanced technologically. On the other hand, the Chinese closed their economy from outside emphasing the policy of self reliance. In the process, China developed its own salient technology which led to: use of renewable / abundant materials, regional self sufficiency for essentials; simplification in production and use and small scale, self managed production units.

The general trend, however, is to acquire the techniques already developed in other countries and adapts them to the country's need.

Indian Experience

Industrial Sector: India has the third largest trained scientific and technical manpower of nearly three million and occupies the tenth position in terms of industrial base, highest in the third world. Thus, India has the required skill base which is necessary to carry out technological innovation as well as to contribute to the science-technology base the country has. However, a monopoly exists over the latest technology and whatever technology is made available through technology transaction has associated with it a high price, both economical and political. Therefore, the country has earlier imported energy and pollution intensive industries which now require a thorough replacement/overhauling /augmentation with the help of modern technology to transfer them into energy efficient manufacturing processes and whose effluents & emissions can meet the stringent standards set by the regulatory agencies with reduced investment on pollution control measures. High technology enables a country to produce at cost effective rates, improve its competitive position and allows the introduction of new products in the market whereas technological obsolescence leads to rapid loss of marketsl3]. Recognizing the necessity of high technology and difficulties associated with its import from developed countries, self--reliant growth of country's economy is essential.

Rural Sector: Indian experience in the application of science and technology (8 K T) in rural development, especially in integrating the rural techno-structure with the urban organization and marketing has been rewarding. This is because the rural technology is now concentrating on locally available raw materials (wood and other agro products, hides and skins, nun conventional energy sources, etc.) with marginal dependence on urban sources (iron & Steel, chemicals, electricity and fossil fuels) with a view to face high costs and uncertainties of supplies. The needed technology transfer is affected by National Research Development Corporation (NRDC) which has been created to develop and arrange exploitation of indigenous

Know how inventions, patents and processes emanating from all type of research institutions in the country. It has come out model (figure 2) [4] which provide the basic framework for choosing appropriate technology suitable for the rural areas.

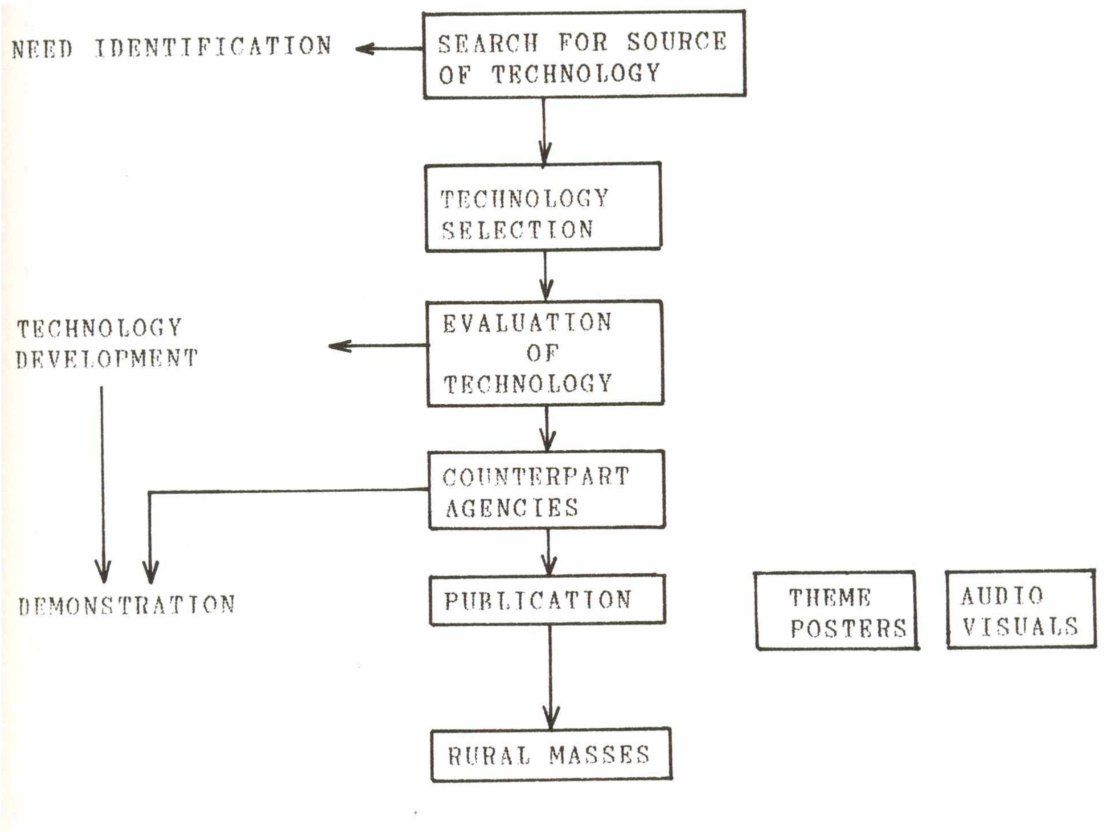

Figure 2. The NRDC model for appropriate technology transfer for rural masses.

Science and Technology Mission - NEERI'S Contribution: The country has over 130 specialized R & D establishments, financed by the Central and State Governments with hundreds of zonal centres or regional sub stations [5].I n addition, research is also undertaken at the traditional universities and the Agriculture universities .To exploit the existing science technology base of the country through technology transfer, the nation's seventh plan's thrust areas covered thirteen multidisciplinary and inter. institutional science and technology missions, which aimed at finding time hound and result.-oriented tasks of considerable importance and of economic value.

The National Environmental engineering Research Institute (NEERI) Narpur is one of the National Laboratories under the Council of Scientific & industrial research India. While fulfilling its commitment towards National and Societal Missions, NEERI made significant achievements in the following, R & D areas: environmental monitoring, environmental biotechnology, hazardous waste management; environmental systems.

Design, modelling and optimization, environmental impact risk assessment and environmental policy analysis.

The processes and technologies developed in the institute are transferred for commercial exploitation via a technology utilization division of the Institute to the NRDC or prospective users.

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Discussion on the Balancing of Personality, Image and Confidence to Promote Effective Communication Between Engineers.

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SUMMARY

This paper shows that communication can take place more easily and effectively when people choose to make it so. By recognising that control of one's outward image and behaviour in a positive manner can gain positive results, one can manage communications to the advantage of all concerned.

Human behaviour may be likened to an iceberg: the proportion we reveal belies the hidden depths of the whole.

However, whereas the proportion above the surface in an iceberg is more or less constant, the amount that humans reveal fluctuates enormously from moment to moment. Depending on our feelings, our belief systems, our attitudes and motivation, we respond to and give out differing signals which in turn are interpreted through similar processes in others.

It is this complex interplay of reaction which makes up communication.

Everything we do or say is conditioned by our psychological make-up and its interaction with others. This process commences, when face to face with another person, with the way we look. The colour of our skin, the clothes we wear, our basic sex send out signals and messages which if interpreted correctly promote positive communication or, if incorrectly, the opposite.

Yet, as we tell the world about ourselves through our image, many people seem oblivious of the effect they are having.

Fashion promotes its seasonal "look"; media stars create stereotypes that we copy, and our childhood conditioning forces us into dress habits which linger into adulthood. Consequently, we become victims to a whole host of conflicting concepts and pressures which in turn affect those around us.

It is this conflict which, we believe, if resolved can develop confidence in oneself and effective interaction with others.

Confidence begins within one, and flows out in personal image and ultimately in behaviour towards others. Yet initially, all one sees is the shell - the clothes we wear and the way we

Wear them.

> "Clothes are an outward form by which others judge the inward form of the individual - for this they can see, whilst others they cannot."
>
> Queen Mary to the Prince of Wales

Take the Drudge. This is the individual who is not supported economically or emotionally; the person who feels that life has got the better of them. We see these people sleeping rough, or weighed down with children and painfully short of money. We also see them in good middleclass households: economically sound but dominated by family obligations and starved of any real personal choice in the way they run their lives.

Getting out of this role is difficult, if not virtually impossible. It demands a huge effort of will to overcome the mental barriers of financial and/or psychological depression, yet it can be and is done.

The Tolerant is more common: the people who live their lives in obligation. This is the acceptable face of drudgery, and we all fall into its trap. It encompasses the "haves", the "oughts", the "musts". The individuals who refuse to make choices about their lives, and use obligation as a means of justification.

We see it is bland clothes - black, white, navy or grey, unadorned and of highest quality: these people are clean, neat and practical.

"I prefer black because it is so convenient."

A delegate on a Personality, Image and Confidence course

Finally we have the Active Participants - the people who see life as a celebration. They try to see each day as a challenge, and respect others as contributory to this challenge. They take time out to look smart. They prepare for their lives, asking themselves what choices should they make today, and why.

To them, clothes are a language: a vehicle to obtain what they want without causing offence; in effect, "power dressing" with a small "p".

This is where true confidence emerges. If an individual has an idea of what he or she requires and the choices he or she is required to make, then he or she will go out and make them - but make them in a way that is truly assertive. And in doing so, communication becomes positive and effective.

So, how do we change from one state to the other and, more importantly, how do we maintain it?

Firstly we must avoid becoming the unconscious "victim". The victim reflects drudgery and tolerance. The victim shrieks of lack of worth and self esteem, and occurs at every level. The stereotype is seen in the clerk or secretary with the fairisle cardigan, flat shoes and untidy hair swept into a bun. It is seen in the "give it to Sheila" syndrome: Sheila always gets it because she is too submissive to do anything else. Her one claim to fame will be a week after she leaves the firm, when somebody finds that the coffee hasn't been made!

Men reflect this in cheap ties, polyester socks and shabby suits. They enter their work as grey people and leave as such. They take refuge in ritual and bureaucracy, and only come to life when change threatens their routine and it behoves them to fight for the status quo rather than be energised by the opportunity to do things differently.

In effect, these people use their lack of self esteem "to get off the hook", unwittingly seeing all interactions as a lose/win conflict.

The other side of the coin is equally dangerous. This is the Tart: the male or female who shows

His or her lack of confidence in another way. They are self-centred and aggressive, and see life as "win/lose" or "lose/lose"; either I win and you lose, or we both do, but you'll never beat me.

They are the stuff of over-bright, over-tight clothes. Everything is just slightly "too much", from the startling tie to the sharp suit, from the teetering heels to the inappropriately short skirt.

The secret is to find a middle way; to recognise situations and respond accordingly.

The Active person approaches every situation on its merits. He or she dresses one message from top to toe. There is a cohesiveness, which allows everything the individual wishes to say to come through. Therefore, the accessories tone with the clothes; the clothes are well cared for and smart (they need not be expensive, however; the key to good image is to be able to team a chain store blouse with a designer skirt so that nobody knows the difference), and the whole ensemble reflects the situation the individual is in.

The best example of this is the British police force. The helmeted "PC Plod" is non-threatening and cosy, projecting images of primary school road safety lessons, and always available to give directions or tell us the time. We feel at ease with this image, and communication is consequently easy.

Put "PC Plod" is a car with a siren and kit him out in a flat cap with a chequered hat band, and we sense alarm. There is a greater sense of purpose, and we go onto the alert and our communication with them is more wary.

Put him on a motor cycle with jackboots and helmet, and we feel threatened and ill-at-ease at his appearance.

Such is the language of clothes, and we can use it to promote the response we require. Wear a tailored suit and white blouse with appropriate accessories, and it signals forcefulness and purpose. Remove the jacket, and a more approachable person emerges. Take off the jewellery and pull out the blouse, and we have - a waitress! Very rapidly the Active Participant can become the victim!

Men are excellent at playing the clothing uniform game. There is a whole litany of jackets on, jackets off, ties or no ties, smart casual or informal.

If one can play these games and retain one's internal integrity, i.e. recognise that one has a choice <u>not</u> to play the game, then it is easy to fit in and thus become influential in the situation. The danger with a lot of corporate men (and, increasingly, corporate women) is that they become the game. The uniform wears them, and without realising it they begin to drift into corporate tolerance, becoming managerial victims on the way.

Once image is conquered, the transformation to "win/win" communication becomes easier. "Win/win" is about both parties getting what they want from an interaction. It recognises everyone's right to a hearing, and a right to be treated with courtesy and care.

In maintaining self-esteem in others, one elevates them to a higher level of communicative consciousness. It is saying to an individual "You may think you are a victim, but I say that you are not. You have as much right to exist as I have, and I shall get what I need from you without threat or manipulation and leave you feeling good about the conversation." The methodology is to stay calm, to be persistent in one's views and to go back to one's requirements regardless of the pressure from the other party.

If one meets an equally confident person who feels that his or her rights should be respected, one has to move to negotiation. "Win/win" is about compromise. It recognises that very often a middle way is available which will suit both parties and obtain the necessary outcomes.

The strength of this approach is that it leaves both sides motivated and satisfied. Its perceived weakness is that it is time-consuming, arduous, and gets in the way of making decisions.

One accepts this, and recognises that there will be occasions when one party has to dominate either to break an impasse or to meet a deadline. What the detractors fail to realise is that where a truly assertive atmosphere exists, people will recognise and accept this state of affairs. Based on numerous experiences of negotiated decisions, they will accept the odd" defeat" on the way.

The problem with the transfer from aggressive, adversarial behaviour to assertive, balanced behaviour is that the victims of the aggressor take far longer to trust in the change than the aggressor does in changing. Thus a vicious circle can develop where the aggressor, in meeting opposition to his or her "new style", reverts back to what is easiest. This in turn convinces the victim that change has not occurred, and everyone reverts to the status quo.

The Active individual does not let this happen. He or she actually recognises that aggression exists and at times must be given in to. Once again it is a matter of choice. By recognising that the battle is being lost, one can choose to withdraw strategically and continue to win the war.

Many people feel that these transitions and choices are creating clones; that in following the concepts of assertive image and behaviour, one will become a cipher and let go on one's true personality.

This is not so. One's true personality becomes the driver for image plus behaviour, but it is a true personality under control. It recognises the forms and conventions of interactive communication, and chooses the path of least resistance.

This is exemplified in the apocryphal story of the IBM manager who wore a sports coat to work to avoid being promoted. He recognised the company culture, and put up enough barriers to overcome his problem.

The philosophy of assertive image and behaviour is to remove unnecessary barriers.

By all means at home, in the bosom of the family, dress as a victim - but choose to do so. By all means go to work in bare legs and a summer dress - but choose to do so, and recognise the possible hurdles this will place in trying to achieve respect .from colleagues.

This philosophy has often been accused of being retrogressive and prejudicial, the suggestion being that we should be promoting a society where outward image does not matter, rather than defending hidebound responses to image. One certainly would like to see a less hidebound attitude within British industry and society in general, but one has to be pragmatic. These prejudices exist, and have to be countered.

If women are to continue to make their mark, they have to recognise the prejudices that exist, and counter them. Assertive behaviour and image can go a long way towards building the confidence to do this.

We also believe that this is not necessarily restricted to women. As industry develops a more flexible attitude to the turbulence of the contemporary market place, so the need for a flexible and responsive human resource is emerging. To obtain this flexibility, aggressive "Tart" behaviour is no longer appropriate and the need to change to an assertive style is emerging.

Thus in conclusion, we can see that our individual personalities are a complex web of beliefs and feelings which we show, consciously or unconsciously, through our outward image and behaviour. By recognising this fact, and by developing skills and techniques in the way we dress and the way we behave, we can choose how we wish to be seen and perceived.

This choice builds confidence, and that confidence allows us further choice. Thus we build an assertive spiral which allows us to communicate positively with all the other "icebergs" we bump into in our daily interactions.

Communication Between Humans - Inter-Human Relations

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SUMMARY

The spectacular achievements of science and technology have made man" Greedy”. This has snapped all the finer aspects of inter-human-relationships. The bonds of love and affection are severed. It is for the ICWES to inculcate the lost goodness is man and make all men equal so that real happiness comes to every home.

BODY OF THE PAPER

"This life is short, the vanities of the world are transient, but they alone live who live for others, the rest are more dead than alive" ….………………………………Vivekananda

This century has seen spectacular achievements on the scientific and technological side, landing men on the moon, putting men and women in space, the Russians and Americans docking their space-ships in mid-space and exchanging pleasantries, Satellites hovering round the world spreading messages at lightening speed and so on but the distance between human beings has assumed astronomical distances. This is because; man has never been true to his birth.

Man has been put at the pinacle of the Geneological tree of evolution but he does not live true to himself, he does not hesitate to kill his kith and kin. Vivekananda said" All the maladies that afflict our people today, all the troubles of our body-politic proceed from one single source, and it is that man has devalued himself. He has not realised his own dignity and

Worth as man; he has not recognised the dignity and worth of man in his fellowmen".

The visible or tangible human relation today is exploitation-intellectuals exploiting the common man, the rich exploiting the poor, man exploiting women and women exploiting women. This is the root cause of terrorism in human behaviour, rape and indulging in such low level of life. This is because we are not educated; getting a B.A., M.A. or Ph.D is not education. David Good all the British High Commissioner in India put it rightly, when he said" Education must inculcate the idea of inter-human-relationship" I may go a step further and say <u>inter-human service.</u> The beauty and the happiness of being together and the "Philosophy of Service." Thus the one and only ideal which is of current importance and necessity is inter-human-relationships. What is this inter-human-relationship that is conducive to human happiness and welfare? According to <u>Carl Marx</u> the oppressive type of exploitation is economic exploitation. People with surplus resources use it to exploit others. Gandhiji said" To possess more than what is necessary is to rob another man of his needs." Vivekananda goes a step further and says "These surpluses can be used for the betterment of others" This he calls" Service." For this to happen, people like us should sit and think together. As a neuro-endocrinologist, I can say that of all the species, man is the only inter thinking species. I would urge people to do inter human thinking so that a common purpose of "Service" can be evolved. "Service" as propounded by all the enlightened people of the world is the finest form of inter-human-relationship. But the true meaning is camouflaged by conventional religeous dictations which failed to develop the natural human conduct that is service-that is inter human relationship.

This leads on to the next aspect of inter-human relationship that is the evolution of moral and ethical sense. Man is a social animal, so he is confronted with the challenges and presence of other human beings. He can react to this in a friendly or hostile manner. It is a recorded fact that even the lowest of low men did show some consideration for his fellow beings. This according to Biologists is the starting phase of moral and ethical behaviour in human relationships. According to Charles Darwin evolution meant survival of the fittest. It was Thomas Huxley who advanced this science and said evolution at the human level meant "ethics." The 20th century Biologist Julian Huxley gives a spiritual orientation to the evolutionary processes and contends that man's evolution is not biological but

Phycho-Social. This takes evolution to the higher spheres of mental organisation of knowledge, ideas and beleifs that is ideological instead of physiological or biological organisation. Julian Huxley opines" In the light of our knowledge man's most comprehensive aim is seen not as mere survival, not as numerical increase, not as increased complexity of organisation or increased control over his environment but as greater fulfilment the fuller realisation of more possibili ties by human species collectively and more of its component members individually." Huxley further goes on to say, "Once greater fulfillment is recognised as man's ultimate or dominent aim, we shall need a science of human possibilities to help guide the long course of psycho-social evolution that lies a head." Swami Ranganathananda justifies this by saying "It is the science, the science of human possibilities that constitute the spiritual core of the world's religions". This brings out that every man has a lower self, where the soul is confined to the physical organism but in a "moral man" it expands beyond his physical self, enters into the psyche of others and allows the pshche of others to enter into him, thus establishing material affection and understanding. Man has to learn to suppress the lower self and manifest the higher self, then only the right type of inter-human-relationships become established. It was Wordsworth who said "Unless he erects himself above himself, how poor a thing is man".

Being a neuro-endocronologist, I would explain this thus. Mammals developed homoeostasis. This helped in the steady upward evolution of the brain content in man, nature perfected the demarcation of the brain into the lower brain or cerebellum and the higher brain or cerebral hemispheres. The former attending to the physical needs of hunger, thirst, sex etc., while the latter evolved specifically to attend to the human fields namely psycho-social, moral and spiritual. This naturally brings in the question, why are not all human beings not psycho-social, moral or spiritual. This is because man pressurises his higher brain for satisfying his sensory pleasures. This stultifies the higher brain and reduces it to be a "tail piece" of the sensory apparatus. The noted neurologist, Grey Walter said, "For mammals all, homoeoatasis meant survival but for man emancipation". To relieve the higher brain of its mundane duties is to help it to become truly higher. This is known as "disciplining of the mind." This is palpable. When a child grows, physical growth and mental growth go side by side. The former through proper nourishment and the later through proper education. These two

Should lead him to the third growth that is spiritual ethical awareness and social feeling. Education does not mean getting master's degree or a Ph.D. Vivekananda described it aptly when said, "Modern education has created intellectual giants c moral pigmies". Modern education has made man greedy. The result is he has become self centered and has lost the sense of serve. and fellow feeling. According to Hinduism every man is basically good. Real education should make this innate goodness blossom, so that man learns to serve his fellow human beings with love and compassion.

Inter-human-relationship requires sacrifice of the highest order Mere assemblage of people is lika a heap of bricks. Unless bricks are cemented together, a house can not be built. : Assemblage of people have to be cemented by bonds of love in affection which we call inter-human-relations. This bond cannot be brought about by an act of parliament, nor can it manufactured by supplying materials nor by an injection of vaccine or a hormone. It must be manufactured from within. Now is for a body like the ICWES whose members are endowed w: moral, ethical and intellectual powers to go out to the people educate them and inculcate in them the idea and beauty brotherhood of man and finer aspects of inter-human-relationship: The highest service a man can render is to convert the beast in a man and make him realize the good in him. When every man realises this, all men become equal. There is a sanskrit say: which says "Equality is the basis of all happiness”.

10 HC

Body Language: A High-Tech Way to the Top

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So much emphasis has been put on technological development and innovative opportunities that communication skills have been neglected and are lagging behind, especially the COMMUNICATION skill called BODY LANGUAGE. To increase the number of women in high-tech positions, body language could be their secret to success.

This descriptive-based presentation is directed to those who desire to increase their abilities to lead, to persuade, to support, to control and to rise in rank in this highly technical world.

This workshop will be demonstrating the skills needed to read the feelings and silent messages sent by audiences, by supervisors, and/or by employees. It will show how to look the part of an interesting and interested professional. Audience members will practice examples of how to control their body messages and send only the signals they wish to communicate.

Body language, when harnessed, is an important tool to better understand and be understood by others. It can give you power and control, can help you keep the upper hand in negotiations, and can bring you success in both your personal and professional lives.

Demonstrating and practicing BODY LANGUAGE COMMUNICATION skills will be the scope of this workshop presentation. It is humorous and fun as well as enlightening.

Multi-Function Problem Solving in Organisations: Getting to the Heart of the Matter

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Mosaic Management Consulting Group. Bristol, U. K.

Kickstart is a technique which enables problem-solving to be implemented very quickly in an organisation where the situation demands it. Quality Improvement Teams - an essential tool in the problem-solving process and part of the established Mosaic programme for implementing Total Quality - are normally set up with Facilitators from the client organisation. The Facilitators in turn having been trained by Mosaic following the initial Quality Awareness stage of the TQM process. Typically, the Awareness stage can take six months, with another six months for Facilitator training, and it is only then that Quality Improvement Teams can start work, each reporting perhaps six months or a year later depending on the complexity of the problem they are asked to solve.

Kickstart by-passes the formal route by using an experienced Mosaic Consultant as Facilitator: this can reduce the time taken to reach a solution by as much as 60%. Whilst Mosaic's TQM philosophy is to use in-house Facilitators for Quality Improvement Teams, in some situations an external Facilitator can overcome organisation and human relationship difficulties by being above the 'politics', asking apparently 'silly' questions (obvious to the client participants but frequently getting to the 'heart' of the problem), and by maintaining discipline within a group of people who know each other too well. Planned meetings cannot lightly be missed or cancelled when the participants know the Facilitator is being paid specially to be there to run them.

An Urgent Need For Results

Union Carbide is a major chemical manufacturer and producer of industrial gases, operating on a world-wide basis from headquarters in the United States, with European manufacturing and distribution plants in the Low Countries, Germany, France, Switzerland, the UK, Italy and Spain. ODI in the US had already identified several key business improvement issues needing to be addressed during the early Review and Determine stage of the Quality Awareness programme in discussions with Ucar's European Quality coordinator in Geneva, and it was jointly decided that these would best be handled on an exclusively European basis. This would ensure a sympathetic culture relationship and simplify short notice attendance at one or two day QAT meetings in different locations. Hence the ODI division of Mosaic Management Consulting Group in Bristol were asked to appoint a Facilitator for Quality Improvement Teams in several critical business areas.

Merilyn Parker Armitage, the ODI-Mosaic Consultant selected to set up and run the QIT programme, has been involved in Quality Improvement Teams since the concept was first introduced into the UK. Since then I have trained some 60 QIT Facilitators from a whole range of different organisations, and my experience includes consultancies in Geneva and Belgium working in management development programmes. This was an ideal background for the Union Carbide project when I would be working with multi-national, multi-lingual groups.

Union Carbide wanted quick results from the Quality Improvement Team process, and for this it was important the teams should have a high profile, thus emphasising the urgency. The brief given to the QIT Team Leaders laid down a very tight time-scale of only four months to reach one or more solutions in areas as diverse as gas production, Europe-wide product distribution, and specialist equipment design.

Quality Improvement Teams

Firstly 'ownership' for the problem was established through appointing a Sponsor for each team from a senior position within the organisation, who acted as the team's 'mentor' and ensured the enthusiasm and support of the Union Carbide Board. Each team consisted of 4-6 people comprising a cross-section of skills and operational levels, with a Team Leader nominated by the Sponsor.

The initial introductory meetings - not apparently necessary for the participants but important for me as Facilitator - concentrated on the hopes and fears of the team members and brought much of their working and human relationship frustrations out in the open. Attitudes - even from a Team Leader - such as "I really don't see why we need another meeting to solve those problems: just leave me alone and I'll work them out", and "We spend far too much time in meetings as it is", were typical. It was the Facilitator's job to turn these negative sentiments into the constructive thinking necessary if any useful progress was to be made, and I used a structured problem-solving process to help concentrate their minds.

Using Structured Problem-Solving Techniques

The first stage of the process - the need to state the problem very specifically - occupied most of the first day, with as many as five flip-charts full of listed problems in the Specialty Gas Plan Team, whose job it was to examine the whole bottled gas production facility at Ucar's Oevel Works in Belgium, where an enormous range of industrial gases are produced and 'bottled' in cylinders. I sorted the flip chart problem list into the 'fishbone' pattern to break it down into manageable areas for detailed identification. This worked very well, and we were fascinated how the one which was eventually selected as being the fundamental problem from this 'mishmash' had been almost hidden amongst the others.

The team achieved a problem statement by the end of the first day:

- Our present systems and organisation structure allow us to achieve on time and on spec performance only at the expense of unsustainable supervisory effort, entailing a prohibitive cost.
- We need standards, methods and procedures to enable our people to run an efficient, safe, healthy and environmentally acceptable operation. Doing this will result in less hassle and greater competitive advantage.
- We are aiming to be the 'best' specialty gas plant.

Although I was concerned this statement was still too broad in its definition, I was reluctant to push the Team Leader into refining it further at that stage, as I had now at least got him to go along with the whole process, and I know he felt we were going too slowly anyway.

We ended the meeting taking a first glimpse at the second stage of the process - Data Analysis - so that the team could collect data ready for the next meeting two weeks later. The team were now very prepared to put in a lot of hard work collecting and analysing data - not least the Team Leader - and I arranged to meet him prior to the next team meeting to go through what had been collected, and to have a look around the plant so I knew what everyone was talking about.

Log-Jams In The Production Process

The data collected highlighted the known log-jams in the processing of special gas orders in the laboratory and cylinders through the plant itself, and It was apparent I that the paperwork generated by the computer was a significant factor. One revelation showed that they were shipping a huge number of empty cylinders around I the plant, and how more efficient cylinder usage could represent savings measured in millions of dollars for Union Carbide.

At the Solutions stage, the real turning point was reached when the team sorted out in detail the procedures necessary for the three basic groups of product lines, each of which required a different process, paperwork and planning, and could not be 'mixed' efficiently on an 'as required' basis.

We had a major issue at the Implementation stage, when the team solution was put to the Product Sales Manager, who had not been a team member, and when the Sponsor invited the Specialty Gas Sales people to sit in at what the team thought was going to be an informal presentation of their report. In the event, everyone was impressed and enthusiastic, mainly because they could see that the team had done its homework. The Action Plan was very complex, but the Team Leader had worked through it step by-step, and the result was an excellent plan.

The Just-In-Time Solution

As a direct result of this Quality Improvement Team's work, the Oevel Plant will transform during the next two years into a Just in Time manufacturing site. Following a structured process pointed them to the very simple heart of where this transformation lay and gave them the courage to allocate resources to it.

The ‘Distribution' Team

One of the major contributing factors to the success of the 'Distribution' Quality Improvement Team was that three members were also on the 'Gas Production' Team, and by the second meeting it was noticed they were applying experience gained on one team to the work of the other.

There was some destructive group dynamics at the first meeting, and they didn't reach a problem statement until the next time, but by then they had started to get the hang of listening to each other, and after that we moved very efficiently through the rest of the process.

The greater part of the Data Analysis stage for this team consisted of studying detailed costings and the complex logistics associated with the distribution network for thousands of cylinders containing a vast range of different gases. Until this analysis, Union Carbide had not appreciated that its main business was actually shipping cylinders around, irrespective of what they contained! Like the 'Gas Production' Team, the solution appeared elegant: combine the shipping of Specialty Gases and Package Gases. But the implementation plans were necessarily very complex.

It also became evident through the process that the problem both the 'Gas Production' and the 'Distribution' Teams were working on would help each other. The two teams were working on two ends of the same supply chain, and the solutions would dovetail, thus benefitting the customer with on-time delivery.

More Human Relationship Difficulties

Another Quality Improvement Team was taken from the Union Carbide Industrial Services group based near Utrecht in Holland. UCARIS operated separately from the Gas Company, using nitrogen in a process to clean pipelines and petrochemical catalytic crackers. The problem centred on the necessity to develop a new generation of equipment which would meet all appropriate health and safety standards, plus improving ease of operation.

Still a very young division - when the priority was to get business and worry about administrative and organisational systems afterwards - UCARIS was not the ideal environment in which a Quality Improvement Team could be expected to work. Added to this was the language difficult, as the membership of the team had to consist of equipment operators who spoke little English (necessitating translation for most of the meetings), and the background uncertainty caused by the possible sale of the division by Union Carbide. Despite these problems, the team eventually worked well together, the breakthrough coming at the second meeting when they appreciated the health and safety aspects of the design were as much for their benefit as for their customers or the regulations.

Relationships were difficult at most of the meetings, and frequently some blunt language had to be used to control arguments between those tough operators mostly ex-salvage seamen and the team member from management, but the Analysis stage was completed successfully by the time the decision was finally taken to sell the division.

The Quality Improvement Team process helped the members to appreciate the value of working as a team, and should help them during this time of uncertainty.

Solutions on Time

Except for the enforced 'hold' on the Ucaris project, all the Union Carbide Quality Improvement Teams reported by their deadlines, demonstrating that even extremely complex problems can be tackled and tangible results obtained in only a few months by means of the Kickstart process. Using an experienced Consultant Facilitator, difficult working and communication relationships can be overcome quickly and the team motivated to arrive at worthwhile and constructive solutions through an orderly and logical process.

Since then I have trained in-house Facilitators from other Union Carbide plants in Spain, Italy, Germany, France, Belgium, Switzerland and the UK. Union Carbide's Quality Co-ordinator for Europe has allocated a previously identified key issue to each of them, and they then set up their own Quality Improvement Teams, using the problem -solving process to report back with solutions and detailed recommendations for action.

HC5

Packaging the Truth

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SUMMARY

When communicating, the source, message, channel and audience are controllable variables influencing the success or failure of communication. Audience feedback should be used to measure the success of objectives - the first stage in any effective communication programme. An effective campaign carefully targets well-researched attitudes, beliefs and behaviour with specific messages.

INTRODUCTION

Most people, particularly scientists, are aware of the value of information and information technology. Public sector bodies, corporations, universities, trade and professional associations spend much time and money gathering, processing and analysing information. However, few organisations give appropriate priority to the presentation of information - its 'packaging' - believing that good information stands alone; this is rarely true. People are not born good or bad communicators. Effective communication is a discipline.

TO COMMUNICATE OR NOT TO COMMUNICATE

For almost every organisation, there are benefits of good communication and costs of bad, (including nil communication). For example, a university highlighting successful discoveries will gain credibility, a factory who does not tell neighbours about it's plans to control pollution could be forced to close, and a bad press comment can lead to public ridicule. Every organisation has public relations, whether controlled or not.

OBJECTIVES

A communication programme without objectives is like a study with no hypothesis. The definition of objectives often arises from a definition of an organisation's main need or problem. Communication objectives normally begin with: "to educate, to raise awareness, to inform, to position", stated as objectives which can indeed be met by communication. Agreeing objectives ensures that colleagues have a common understanding of the programme; it focuses activity and provides a means for measurement.

TARGET YOUR AUDIENCES

There is no such thing as "The General Public". Target audiences can include any of the following groups; consumers, neighbours, the business community, regulators and employees. These need to be narrowed down, defined on paper and studied - their organisational structure, decision chains, communication methods and potential impact on an organisation.

We operate in a world of people, not just information and economics and today's communication professionals will always take into account that people are not always rational beings. The emotive (attitudes) and the logical (beliefs) aspects of an audience's behaviour must be addressed.

Attitude research may be required. For instance, a manufacturing plant needs to know how neighbours feel about living nearby. If these attitudes are not kept in check, complaints can build and fester out of proportion - making life difficult for the company's management.

OPINION LEADERS

Opinion leaders in these groups will influence attitudes greatly, because the most influential persuasion process is 'word of mouth'. Considering the audiences listed above, the opinion leaders could be respectively; journalists, the local shopkeeper, analysts, environmentalists or union leaders.

As individuals, opinion leaders are known to attend closely to the media, analytically and critically. Even if a magazine carrying a damning article is not widely read, it may be read by a group of influential opinion leaders. These people, if willing, can be very influential endorsers.

SAYING THE RIGHT THING

Careful consideration must be given to the messages. Each audience will have differing interests and likely arguments should be anticipated. For controversial issues, careful message preparation of supporting facts, figures and authoritative endorsers should prepare the organisation for any attack. Management tends to be reluctant during this stage because 'difficult issues' can reveal operational weaknesses. The communication professional must be prepared to ask the most unpopular questions, and assist in developing the answers. This can be the most time-consuming and difficult part of the communication process.

The 'PR wash over' is no longer adequate. For example, Nuclear Electric mounted a publicity campaign with the main message - 'nuclear electricity is green because it does not contribute to global warming'. Because nuclear power is not generally considered a safe environmental option, Nuclear Electric was not taken seriously. The company was awarded Green con of the year by a leading British environmental group with considerable adverse publicity.

Whatever the basic message, it must be true and reasonable, because being publicly exposed as a dishonest organisation destroys years of investment in goodwill and contact building.

Although it is not usually the aim of a communication programme, carefully prepared messages 'put out' by an organisation tend to become management attitudes.

KNOW THE ENEMY

Many companies are inclined to fight back under enemy attack. However, an organisation and its enemies should be competing to win over 'people on the fence'. (In an election, it is this group which changes the result from one year to the next.) Enemies and their own communication activities must be closely watched, but not necessarily reacted to. Trying to change the enemy's attitude is rarely successful because strong opinions are based on a well developed logic structure, and in the case of an enemy this structure is likely to be based on different foundations to your own.

METHODOLOGY

"The medium is the message - and the massage". Letters. Advertisements, targeted media articles, leaflets, newsletters, displays, videos, presentations and meetings among others, are communication tools which can be employed. Determining the medium (or channel) involves careful analysis of message complexity, potential reach, emotional and persuasive impact of the medium, and money.

The message should suit the medium. For example, an article on a new medical discovery should be written in a technical style for a medical magazine where other specialists appreciate the subtlety of detail, and understand the technical jargon. An article on the same topic would be written in more readable style for a general science magazine such as "New Scientist" or "Scientific American" - although this can be frustrating for the author, without jargon, the article can still be technically accurate.

PUTTING A PLAN INTO ACTION

The first consideration when implementing a programme of any type is to consider the resources - time, internal resources and budgets. A full-blown communication programme is rarely quick or cheap, and cannot be carried out in 'spare time'. Quick action and follow up is vital, particularly when dealing with media deadlines, delicate creative and VIP egos, print production schedules and the fact of life that anything you need will not be approved by management until the last moment.

EVALUATION

A programme should be evaluated against its objectives. This emphasises the need to set realistic, measurable objectives. The objectives can also be measured using attitude research, media coverage analysis, and measuring changed levels of contact between an organisation and its audiences. Because attitudes, beliefs and behaviour are intangible and the effects of an organisation's communication so wide-ranging - there is still much debate over fiscal evaluation of communication programmes.

Computer Supported Cooperative Working: Supporting Communication at Work

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SUMMARY

The application of Computer Supported Cooperative Working in the workplace may require a rethinking of traditional organisational structures if its full potential is to be realised. Studying patterns of information flow within an organisation can provide insight into its "unofficial" or covert structure.

INTRODUCTION

Computer Supported Cooperative Working (CSCW) is multidisciplinary research area involving computer science, system theory, linguistics, cognitive studies, organisational theory, anthropology, social sciences, and management studies. It is entirely concerned with the sciences of the artificial [2] although its applications are as far ranging as human cooperative ventures, particularly those where people work with the assistance of computer systems. Applications of CSCW include office automation, manufacturing systems, computer conferencing and communications such as multimedia systems. An important motivation for CSCW has been to improve the participation of human users in the systems design to enhance its ultimate usability. According to two dominant views of CSCW the goals are to build user-centred systems (the American view, presented in [3]) and to increase democracy in the workplace (the Scandinavian view, see [1]).

In our discussion of CSCW, we will draw our material from the application of computer systems in manufacturing, since this is an area of increasing automation where the human enterprise of engineering is assisted by computer systems. As computer

Systems have been introduced into manufacturing in a piece-meal fashion, this has often resulted in "islands of automation" consisting of standalone systems. Each system is not capable of making full use of the information it has and there is no overall coordination of information amongst the standalone systems. Information exchange between systems may also be hampered by incompatible operating systems and data formats. Individuals must work with the computer system where previously they were able to work with other intelligent agents. Uncooperative systems have thus been introduced into the workplace where previously humans worked cooperatively.

According to one interpretation, the one we shall consider here, these problems are the result of systems design methodology which fails to take into account the full complexity of the organisational structure of the enterprise where the computer systems are to operate. The suggested reason for this is that it is not sufficient to address these problems by developing a system model reflecting the overt organisational structures [1], which are frequently based on hierarchical models of the manufacturing enterprise. This is because most of the truly collaborative human activities in a manufacturing organization seem to reflect another kind of structure, the "covert" structure, which is not totally hierarchical in nature but involves lateral interaction among people working together.

Therefore, an explanation in terms of organizational structure suggests that the design of computer systems based entirely (or even predominantly) on hierarchical architectures is misguided because in actual operation the computer systems become elements of the lateral, covert structure. Consequently, there is a mismatch between the system design and its use in a collaborative environment. For this reason, the computer system may be seen at best as irrelevant to the needs of the application domain, at worst as an obstacle to the smooth running of the human activities.

If we accept this analysis as a reasonable explanation of current design problems and attempt to design according to covert organizational structure, we must start with a method for identifying and explicating the covert organizational structure. Its description should then inform system design in the way that

1 According to Chris Hutchinson, School of Information Systems, Kingston Polytechnic, the overt structure represents the public view of the organization given in brochures, and other publicity material. Covert structure, on the other hand, is "a tangled network" of patterns of communication among people in the organization. (C Hutchinson, personal communication)

Overt structure cannot do adequately. For example, the analysis of information flow within an organization based on the overt structure shows two main directions, that is, top-down and bottom-up. The top-down flow shows how work is delegated from the strategic level at the top to the tactical level at the bottom (showing how work is increasingly specialised), while the bottom-up flow shows the patterns of reporting to successive levels of abstraction of information from the tactical level at the bottom to the strategic level at the top. The opportunities for feedback are limited by this model and there is little or no representation of lateral interaction.

CASE STUDY

A case study was made of the peripheral product business division of a large U.K. computer system manufacturer. The group organisation chart of the company and the more detailed organisation chart for the individual business division studied reflected the formal delegating and reporting lines of the organisation, but were found to be of little use in determining how work within the business division was actually carried out in practice.

The key to understanding the business division was provided by applying methods of qualitative data analysis to individual worker's accounts of their work within the business division. These accounts specifically addressed who worked with who, on what, to what purpose and in what order. For example, an important activity within this division was the review of designs. In the recorded accounts, the expression, design review, is used with different meanings as the following excerpt illustrates:

"…we then go into a formal procedure which is called design review... actually we start at phase 0 ... for example this week... sorry... next week we have... desi9n review 0 for a three and a half inch size 2Mb floppy disc driveengineering, quality people ... we're all on design review we get together and decide what it is that's needed... so we then identify a list of suppliers that is then in the next desi9n review..." [TW1/3]

Application of an extended form of systemic networks enabled the various meanings of "design review" to be clarified and this activity within the division to be better understood. Here the

Resultant systemic network is given in Figure 1 below. Examples such as this show how the patterns of use of domain terminology can be taken to be indicators of the way in which people structure their activities in an organisational context.

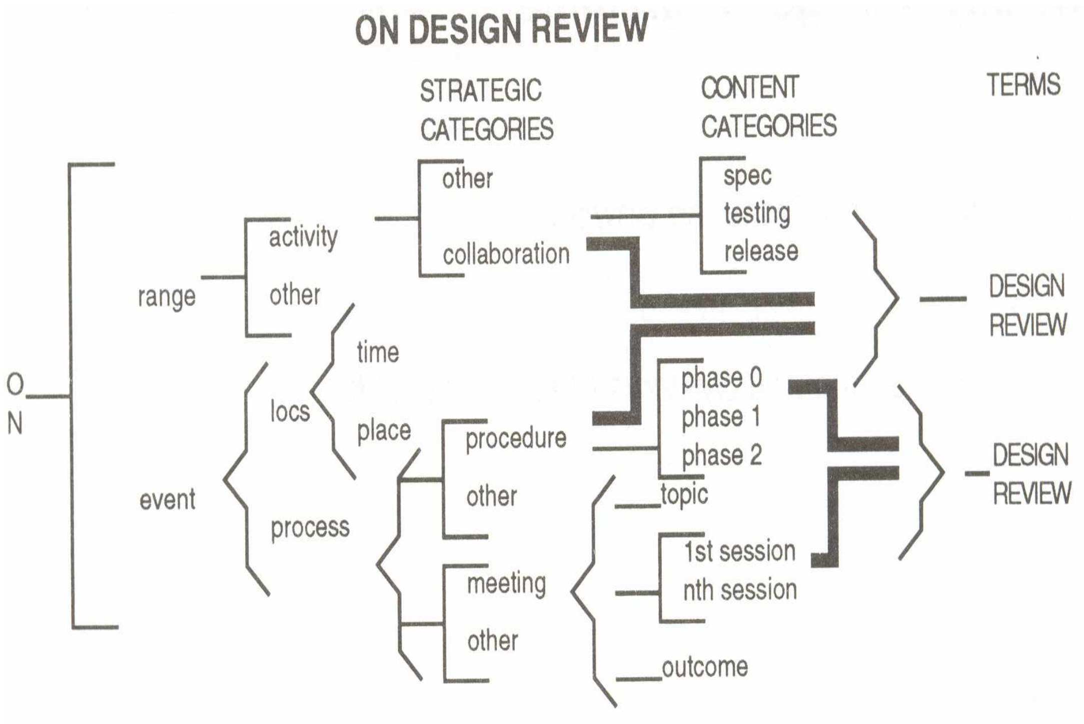

Figure 1 Example of Extended Systemic Network

CONCLUSION

CSCW must not merely support the overt structure if it is to provide for cooperatibve working in actual practice. Research on the study of information flows is shown to illustrate one way of identifying covert organizational structures that are at work.

It is argued that covert organizational structure is manifested in the patterns of information flow within an organization and these patterns can be studied and described by developing methods for qualitative data analysis. In particular, the systemic network formalism can be extended, so that it may be used to describe data about communication within a group of collaborative agents.

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Education and Training for a Successful Total Quality Change Programme

Jayne Eagles and Catherine Bowser

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INTRODUCTION

Lucas Industries PIc had a "significant emotional event" in the early '80s when it made its first ever loss. This event provided a trigger for Lucas to adopt a well-structured approach to decentralise into autonomous business units with each unit accountable for their plans to obtain world-class competitiveness.

To assist Lucas businesses in their competitiveness achievement plans Lucas Industries Plc established a company called Lucas Engineering & Systems Ltd. This Company was developed to provide expertise in modern systems engineering methodologies which could be applied to the redesign of business processes.

Lucas soon became well known for the redesign of its businesses using the systems engineering approach, and, as a result Lucas Engineering & Systems Limited was asked to support companies external to Lucas in their similar aims of achieving world-class competitiveness.

Lucas Engineering & Systems Ltd has now supported in excess of 400 successful projects across 5 continents in both Lucas companies and those of key business partners like Rolls-Royce, British Aerospace, Westland Helicopters and Hawker Siddeley Group.

SYSTEMS ENGINEERING APPROACH

Lucas Engineering & Systems Ltd is able to support a wide range of projects from a basic business health-check to the redesign and implementation of complete manufacturing systems. In every project the aim is to create a measurable competitive advantage for the business by simplifying processes and eliminating wasteful activities to increase effectiveness.

Typical redesign projects include the product introduction and manufacturing processes, materials flow management, supplier development, design for manufacture and quality systems.

In each case engineering, manufacturing, organisational and human resource skills are brought together in a single project team, called a "taskforce". The taskforce is essentially temporary and is disbanded once a business-wide solution has been implemented.

Whatever the project, systematic and regular training for both managers and taskforces is an essential element of the process.

TRAINING

The training framework to support change is given in Figure 1.

This divides into 3 stages of project focussed training: Change Programme Workshop, Product Workshop and Project Team Training, supported by a solid foundation of scheduled training courses and open learning programmes.

The change process is launched in a business with a Change Programme Workshop which is an awareness programme for the executive and senior management team. This is typically two days long and, through discussion of competitiveness benchmarking, systems engineering methodologies and practical case examples, the management team will develop a shared understanding of the need for change for their business. Structured syndicate work throughout will then enable the managers to plan their projects and communication strategies for the change process.

The Product Workshop is used to ensure that the local management are also made aware of the concepts and methodologies, whilst providing them with a forum for detailing out the specific projects and developing project terms of reference for the taskforces. Support is also given to the management team in their project team selection.

Taskforce Team Training takes the total quality and systems engineering awareness a stage further. Here teams are tutored through a case study which allows them to apply the concepts to a simulated business situation. With further inputs on systems engineering tools and analytical techniques, they begin their taskforce work by developing a project plan against their project terms of reference.

TRAINING FRAMEWORK TO SUPPORT CHANGE

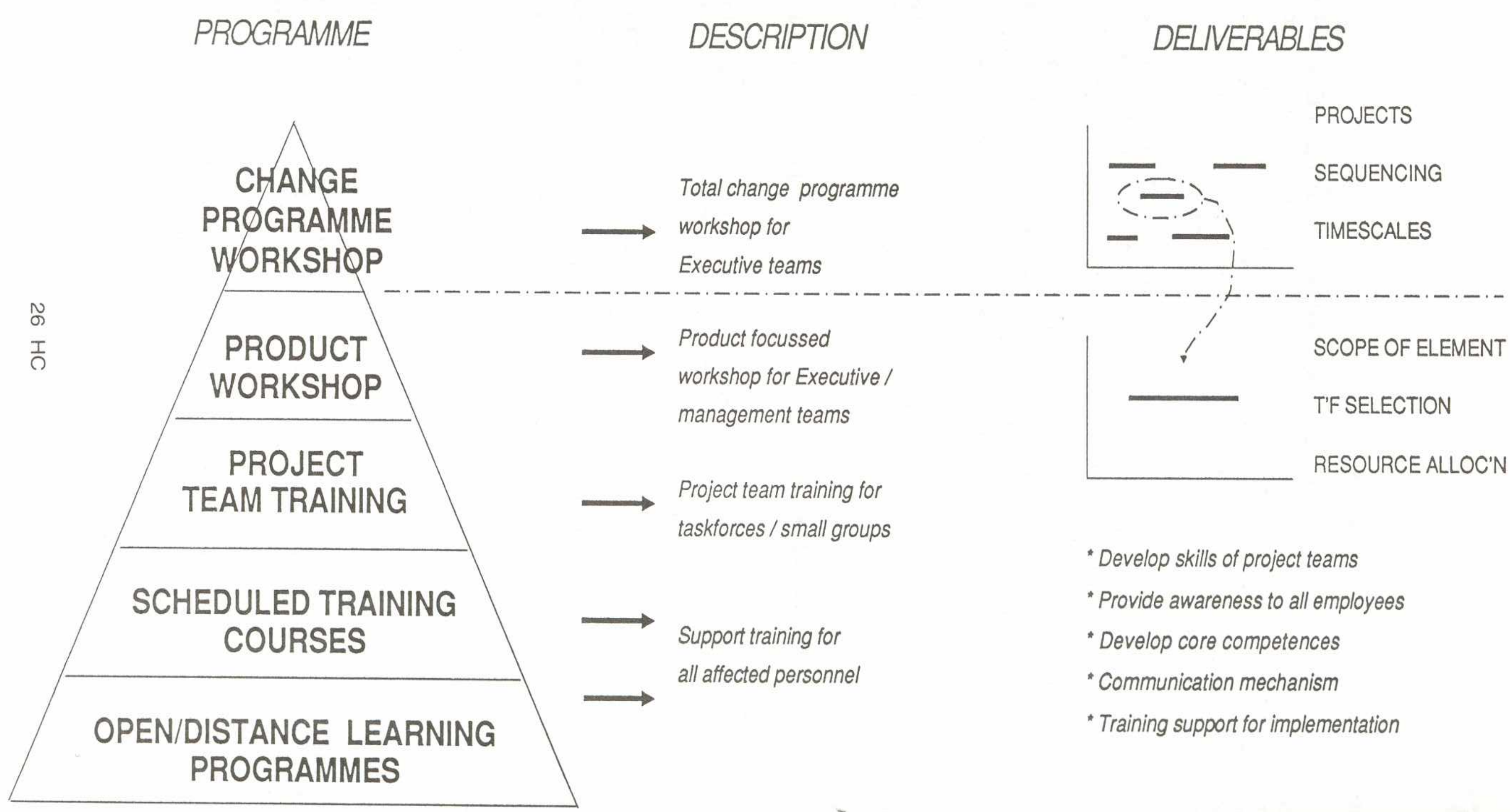

FIGURE 1

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A key feature of the taskforce team training is the formal launch presentation at the end of the week where the team presents their project plan to the senior managers. This allows for a final check of the understanding of the terms of reference for both parties and an agreement on the approach to be used by the taskforce.

Throughout the design and implementation phases of any taskforce, further training needs become apparent for people affected by the changes. A series of scheduled training courses and open learning packages provide an infrastructure of training which can be configured to support any business in their change programme.

These programmes include Manufacturing Systems Engineering Foundation courses, Cell/Module Leaders training and specific skills training in Design for Manufacture and statistical Process Control, for example.

COMMUNICATION

The people in for business are seen as most critical asset for achieving company goals, therefore an effective communication strategy is particularly important in companies quality objectives through their change programmes.

Figure 2 shows that our purpose in communicating is to address the issues of; sharing a business direction, integrating the business effort, developing organisational openess and trust and stimulating involvement in decision making and improvement.

It is therefore these issues that are addressed in determining the approach to communication, both through out the taskforce life, and as an on going communication strategy for the business.

It is important therefore that at the Change Programme Workshop stage of the change process the communication strategies for the business are considered. Further detail will be added by the taskforce team including design and implementation of the most appropriate method of communicating the task force team work to the business at all levels. This can include such mechanisms as, taskforce team review meetings, notice board bulletins, group briefings and circulars.

The components necessary to creating an effective communications environment have been outlined earlier. Figure 3 gives some examples of mechanisms that can encompass and address integration, involvement and direction. It is inherent in the design phase of the taskforce team that the most appropriate integrating mechanisms will be identified and designed, with follow through to implementation.

THE MODEL OF ORGANISATIONAL COMMUNICATIONS

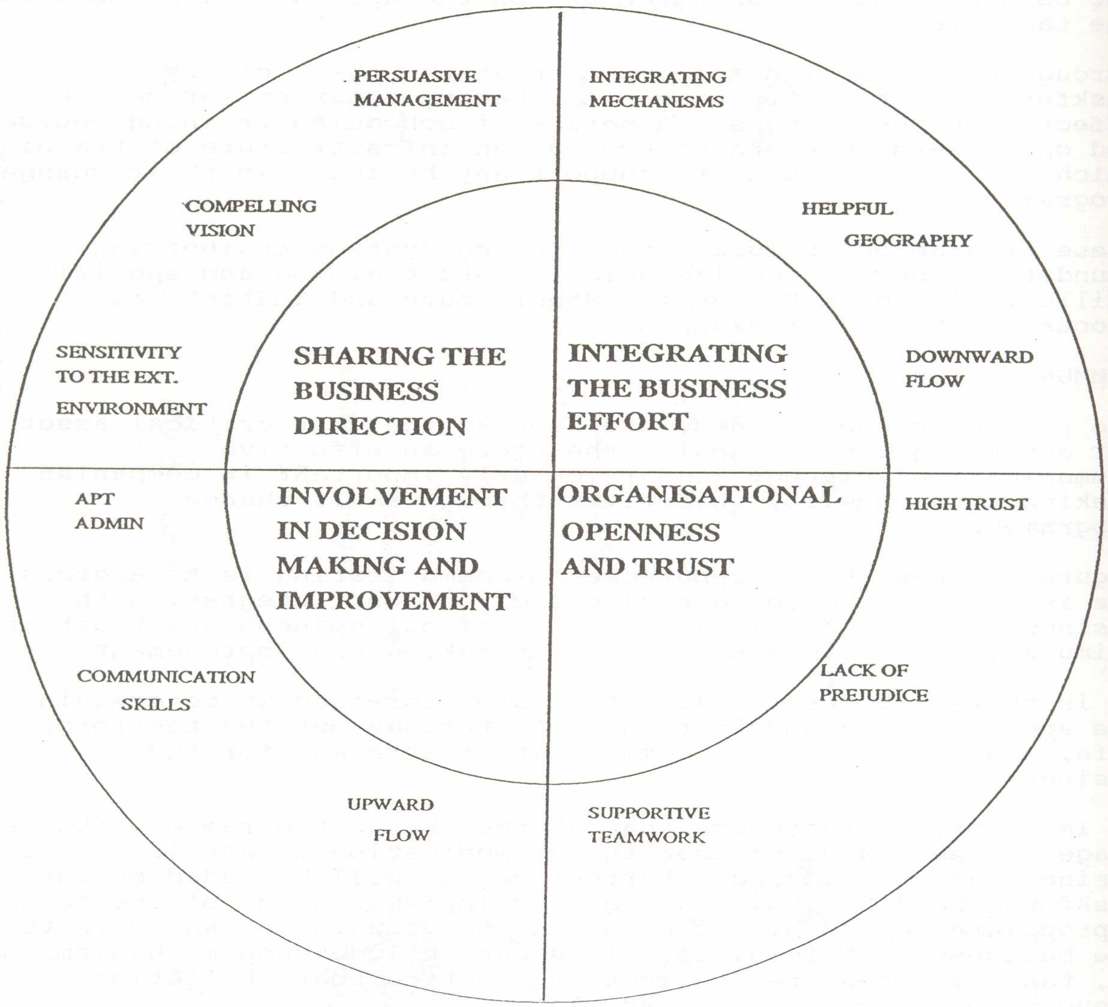
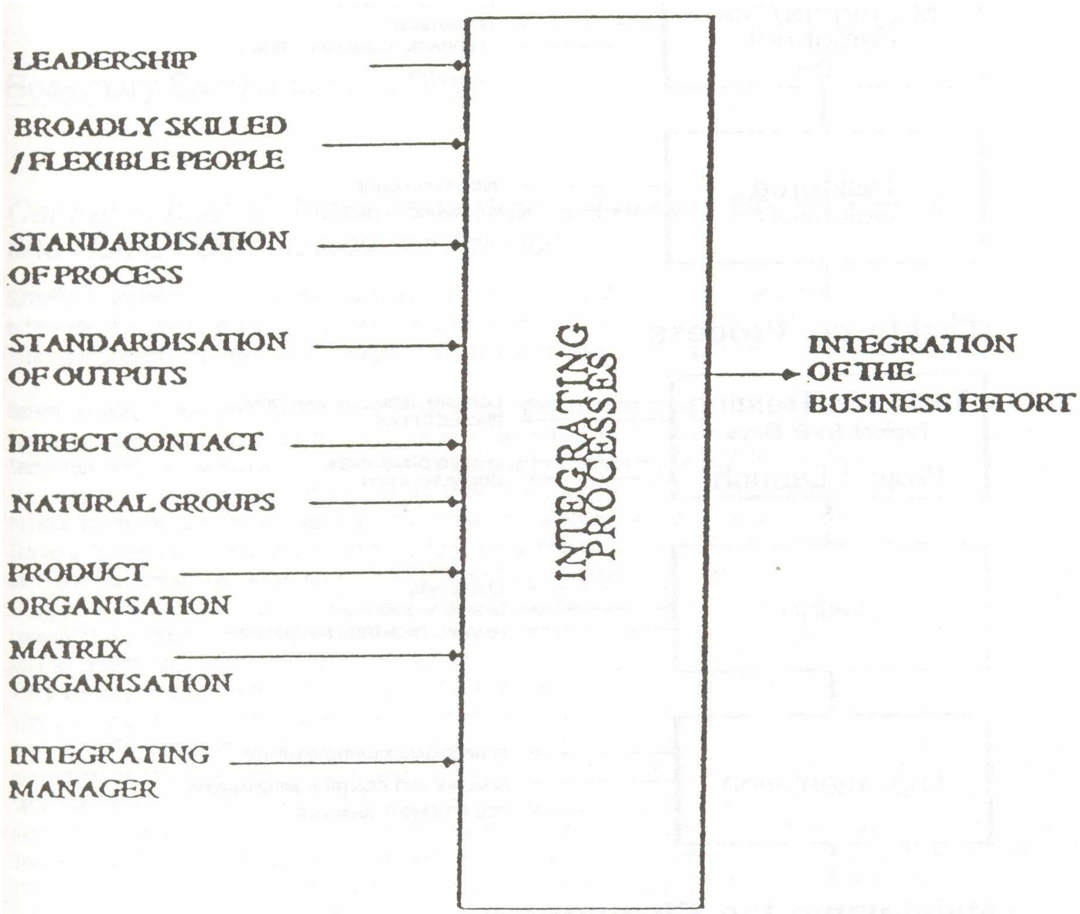


FIGURE 2

INTEGRATING THE BUSINESS EFFORT



CONCLUSION

As has been described, the taskforce life cycle is one of continued training and communication, with regular review and feedback, see Figure 4. This ensures that everyone is familiar with the terminology and concepts of the systems engineering approach and that support and encouragement is given throughout the change process.

The changes are made to stick by disciplined audits and appraisals followed by a business-wide dedication to continuous improvement.

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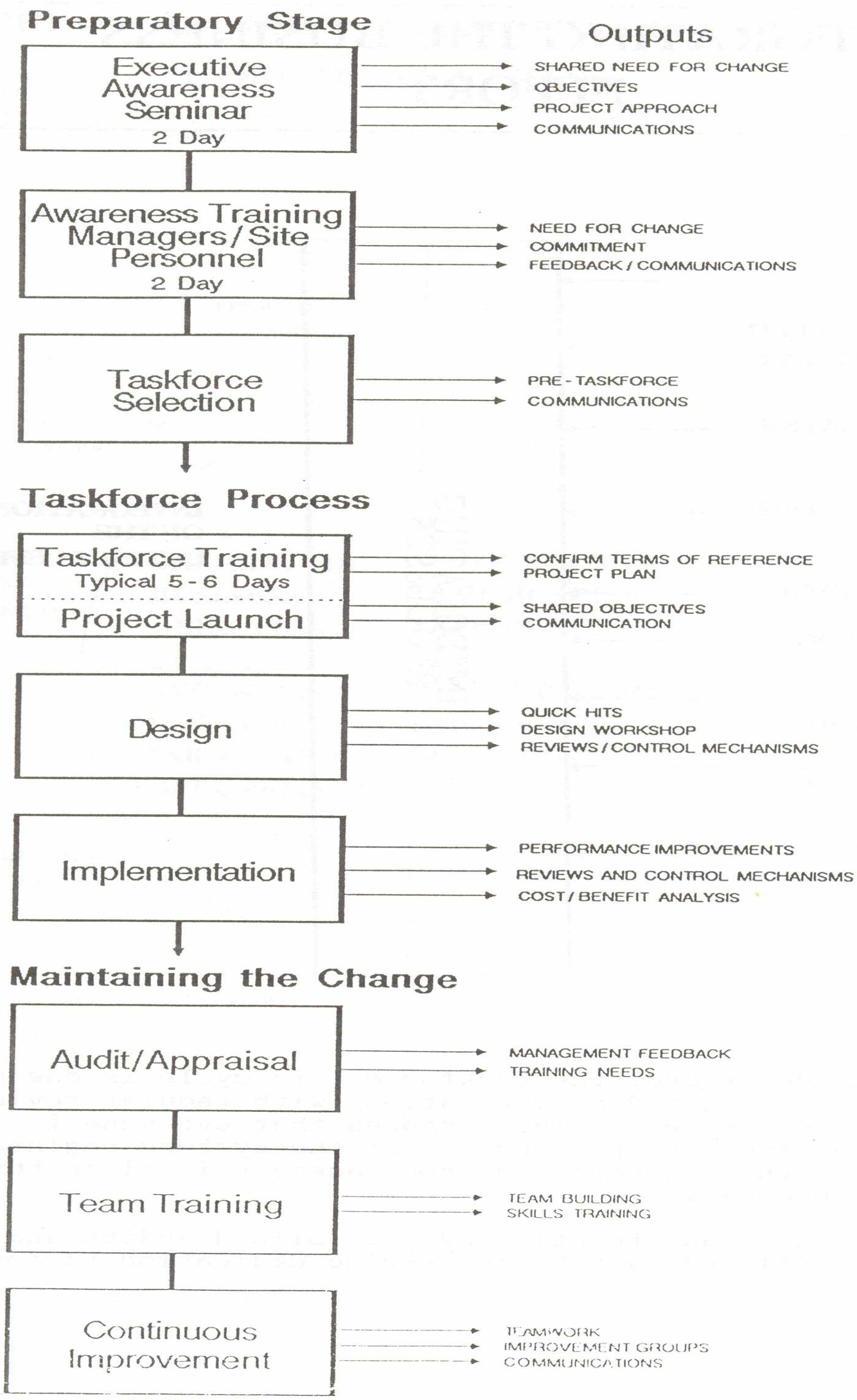
Taskforce Life Cycle



HC8

Human Communication: Issues in Education and Training

Rosemary Sage and Pam Shaw

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SUMMARY: Advancement of society depends as much on improving the QUALITY of its communication as the QUANTITY. Collaborative enterprise of science and arts disciplines developing a total approach to education and training can help to achieve this aim. This paper presents the promotion of integrated initiatives underway at central School of Speech & Drama.

Modern science, through processes of classification, has revolutionised thinking. 300 years ago we world have explained unusual events in supernatural terms. Now. physical sciences allow us to understand the basic mechanisms that control the world and technology produces the systems to use them which has greatly expanded our methods of communication. Such developments have led to the rapid growth of prerise, scientific language whose vocabulary far outstrips other words in general use. There is a need to balance increasing quantity in communication with that of quality by developing research and practice in the human sciences. The word ‘communication’ has an interesting history coming from the Latin verb "to talk together, confer, discuss and consult". It is related to "communitas" which means not only community but fellowship and justice in men's dealings with one another. Society is based on the possibility of people living and working together for Common goals hence the word cooperation. Without communication. cooperation is impossible and as a result of talking together we share knowledge, information and experience as well as understand, persuade and control one another.

There are many forms of communication including facial expression, gesture, touch, visual signs, mathematical& scientific symbols, music, dance and most importantly the spoken and written word. Range is as varied as means stretching from a simple command (stop - conveyed by expression, gesture, pictorial signs, flashing lights of agreed meaning or words) to elevated expressions of thought and feeling in literature, drama, painting, sculpture, music, religion, philosophy and science. Advanced technological societies are now linked to a vast and complex network of communication. Through radio, television, telephone and satellite we can witness events in any part of the world at the time of happening. In the Bulf war, it was amazing to realise that images of allied bombs descending on Baghdad were being transmitted simultaneously over a distance of more than 3000 miles, in 1815 news of allied victory in the Battle of Waterloo took 3 days to travel the 200 miles to London and 44 days to reach New York. Latest technology has made the universe one in a way it has never been before and with expansion in communication knowledge the world is open to us all. What we make of this depends on our education and environment. Society expresses itself and teaches it’s members through the totality of its communication. Those wishing to enter public life are naive to overlook the possession of good (or poor) communication skills. Recent headlines have drawn attention to a war of words between Iraq and the Allies highlighting the cultural divide of East & West and seeming to render communication impossible. President Bush's style of talking has been examined thoroughly and uncomplimentary (The Observer). John Cole, the BBC's Political Editor, has defended himself against remarks on his speech (Independent on Sunday). Moreover, recent upheavals in the governing political party have provided opportunities for analysing how Mrs. Thatcher's communication training altered her way of speaking to present a more favourable public image. Pam Shaw's opinion has been sought m changes noted in John Major's spoken delivery since he became Prime Minister. Central School has taken seriously the need for improve education and training in communication influencing course development in 2 radical ways.

Firstly it has pioneered joint components of speech therapy /teacher under-graduate training in an effort to devise a model that takes dracy into literacy and encourage a framework for collaborative approaches in communication education. At a post graduate level an Advanced Diploma in communication (first stage MA/MSc) is being developed to provide a total approach that integrates interest and skills of a range of practitioners (trainers in industry, teachers, speech/drama therapists & theatre arts professionals) .

Secondly we have launched a STEP up Unit (Speech, Theatre, and Education & Professional Update) which is able to offer a variety of in house and implant courses in communication to industry and the professions. We also create tailor-made courses for individuals

And groups in business and commerce and offer expertise in English as a foreign language. These developments are built on an a.'1alysis of communication and market needs and the next section outlines- some theoretical underpinnings.

A DEFINITION & MODAL COMMUNICATION

"Oracy", .language" and "communication" are often used synonymously by professionals. None has attempted a unifying model because of the complex physical, psychological, social &: linguistic phenomena involved. FORM,CONTENT & USE are the 3 components usually employed to identify communication:

1. FORE refers to patterns of sound, rhythm and syntax. Sound elements combine to make units of meaning in words and sentences.
2. CONTENT identities information given in messages. It derives from TOPICS and depends on interaction of knowledge and context resulting from information processing on three separate but complementary channels (described in next section).
3. USE applies to language function in receiving and transmitting information for various purposes as well as the establishment and maintenance of relationships.

In the communication Professions speech therapists have traditionally concentrated on FROM (sounds/syntax) whereas teachers have been primarily concerned with CONTENT (topics) and trainers in industry with USE (functions in business transactions), Certain aspects in communication come to be emphasised by different experts at the expense of others. At Central School the aim has been to merge perspectives for a more integrated approach to communication theory and practice.

Research begar with a Trent Regional Medical Research council Study (sage 1978-B-6) [1] which sought to define communication needs in educational settings and understand why some people fail to learn effectively through the medium of spoken and written words.

Functions of communication are summarised below to hang on 4 main "hooks" CONTROL, CLARIFICATION, CONTEMPLATION & CONNECTION: 1.CONTROL is enormously important in organising talk for getting things done. In order to accomplish tasks (e.g.: making a drink or writing a memo) we have to be able to talk through the activity silently in the mind and monitor its progress. It may be necessary to Consult others or vice versa and the abilities to request, inform and instruct are essential to the progression of tasks. Without the skill to organ is a talk relevant to situations we have no means of controlling what happens.

2. CLARIFICATION is achieved through a series of brain functions involved in processing messages. These include abilities to RECOGNISE information, RETAIN it so that the mind can REASON and think about it and RELATE it to previous knowledge stored in brain memory which is RETRIEVED to effect an appropriate RESPONSE. Speech therapists have particular expertise in the area of information processing and understand how and why this breaks down.

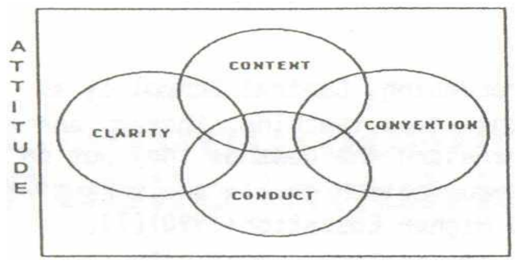
3. COMTEMLATION is the communicative process that produces ideas. We use it to predict outcomes to situations, empathies with other people's feelings and views, devise ways of explaining problems and selecting solutions. Teachers have developed ways of facilitating this creative process. The DRAMA METHOD has allowed opportunity to explore alternative worlds through role play and become a powerful learning approach at all levels of education and training.

4. CONNECTION is the communicative mode by which we establish and maintain relations with our self and others. Through "inner language" we talk inside the mind so motivating and sustaining action. Our "outer language" enables us to speak and listen to others and involves not only words but tone of voice and gestures. Mehrabian (1987) [2] reminds us that only 7% of meaning comes through words, whereas the voice carries 387. and gesture and facial expression 557 of the message. Thus, communication is the sum of many processes and skills which must be developed and practised to be effectively used in daily life.

To develop these successfully Central School's professional training has sought a framework to consider the necessary skills. This development is set in the context of the prominence which oracy and literacy have achieved on educational agendas over the decade. In Britain this is reflected in unprecedented activity at the level of policy making (Frater, 19B7) [3] putting, for the first time, speaking & listening alongside reading & writing in a new national curriculum assessment programme. Similar developments have been taking place in other countries in the guidelines produced by various states in Australia and provinces in Canada (Madure, 1987) [4]. These changes are rooted in a new emphasis on the centrality of language for acquiring knowledge and understanding. Oracy is viewed as the condition for this and we need to clarify how learning to talk develops into talking to learn.

There has been little investment in oracy to literacy research in Britain in spite of concern over competence illustrated in recent figures suggesting falling standards in reading (TES,22.3.91) and information by the Institute of Directors (Octobtr,I990) that school leavers have insufficient communication skills to cope with workplace demands. In the 1980s Trent Regional Medical Research Council supported a project to study children failing in school (Sage, 178-86) [1] which attempted to integrate perspectives in communication behaviour and develop interactive solutions. The framework in these studies has been used as a collaborative model of training for teachers and therapists at Central School and is now described.

AN INTEBRATED MODEL OF COMMUNICATION ANALYSIS



In this model 4 components are identified within the constraints of the attitude, opportunity, personality and intelligence of any participant in the communicative context.

CONTENT refers to message information processed through three channels:

HAPTIC (touch, movement & sense of position in space), AUDITORY (ears) & visual (eyes). In normal processing the brain integrates information across channels. For example, in reading we process visual shapes and transfer them into the hap tic modality for correct spatial location (pbd, nu, MW etc}, they are also mapped into the auditory channel and knowledge of spoken language is used b give meaning to print. Therefore, we can appreciate that if spoken competencies and information processes are not developed reading for- meaning will be affected. Communication content can be monitored through observation of topic initiation and continuation in dialogue.

CLARITY applies to correct/ incorrect use of sound and sentence patterns used to represent real/ imagined experience.

CONENTION locates conversation moves - requests! Open/closed questions, contributory and maintenance comments that form to structure of everyday talk.

CONDUCT describes self presentation abilities which maintain and transfer social structures in communication. Included are positive/negative Reponses and meaning conveyed/not conveyed in dialogue.

These components have been integrated into a language and communication profile that enables monitoring of talking performance in group activities. It will be used as a means of unifying interests of trainers, teachers and communication therapists in workplace and learning contexts.

It allows the consideration of such features as personal learning/communication style, levels of discourse, activities, resources, and group organisation giving a picture of the facilitating and constraining factors in talking exchanges. It is then possible to plot personal performance on the oracy to literacy continuum

ORACY TO LITERACY

Listen &: repond to conversation
Request & direct
Show & tell (here to now topic)

NARRATIVE DISCOURSE:

Replay: - retell past experience
Recount: - summarise & explain topic
Report: - describe & evaluate event
Relate: - tell story of actual/fictitious events
Listen & respond to talk on unfamiliar topics
Argue & persuade
Write a note (here & now topic)

WRITTEN DISCOURSE:

Replay: - record personal experience
Recount: - written summary & explanation
Report: - written evaluation
Relate: - narration of factual/imaginary experience (setting, evert, action, result, reaction)

Identifying components continuum enables the right opportunities to be devised fat proper development. Research indicates that a total approach to communication development does achieve learning success ti1en selective methods aimed at individual component have not produced desired results (Sage, 1986 [1] Morrison, 1991 [51 pan, 19H91[6]).

COMMUNICATION FOR TOMORROW

This paper ha: outlined a need for increased quality in Communication and sought a solution by merging interests and skills of SCIENCES (analyses &, hypotheses testing) and ARTS (developing creative mind powers) in order to initiate new perspective. in education and training, Science and engineering have increased the speed, range and quantity of human communication. However technical prowess is not all; we need a greater understanding of man's communicative behaviour and sufficient knowledge to make intelligent decisions in personal and social affairs. The humanities ties are as essential to such knowledge and understanding as the

Sciences bringing perspectives of communicative performance together with personal information processing. Central School is an institution that embraces education and training in both disciplines allowing study of bath elements from teaching, therapy and theatre arts. Practical communication studies for undergraduate students have allowed them to understand the demands they put an others then undergoing assessment of behavioor. It has enabled them to take stock of their own communication skills and target areas for improvement. This is in line with the management profile of the Council for Industry and Higher Educations) [7]. Spoken and written communication abilities underpin academic achievements, analytic/group skills, imagination, creativity, decisiveness, maturity, practicality and capacity for work. Central's courses in effective communication for those in industry and the professions have provoked the following comments:
'Workshop activities looking at how personality affects communication have helped me to talk with others more successfully.. (Police Inspector)
'Central's communication opportunity Groups have saved my company thousands. I now have expertise in areas that we previously had to buy in', (company Director)

"I' ve been in a communication profession for years but realise after the course there are many areas where I could be more Effective, University Lecturer)

"The course has given confidence and helped me understand my communication strengths". (Education Inspector)

"Very different from the usual Presentation Courses' (evaluation form), this last comment refers to the unique profile analysis and individual tuition offered on all Central' s courses. Participants have not taken their communications skills for granted but sought to develop them more effectively. As world knowledge doubles every two year' s we have to cope with the problem of absorbing mare

Presenting a need to improve our communication capacity to receive and transmit information efficiently. This vast growth in communication has gone hand in hand with industrialization; good spoken and written communication skills have become synonymous with economic success.

However, we have recently begun to question whether standards are being maintained as results of poorer reading levels have beer leaked. Teacher's Wonder- if children are having less chance to develop talk as more time is spend watching television and -video. Certainly working mothers have limited opportunities to play, read and converse with their offspring. Surveys conducted on 30 parents of children attending language therapy (Sage, 1968& 1988) showed that in the 60s 75% of parents read daily to their children whereas in the 80s only 5% did so. Many teachers of long experience remark that today's children have less developed oral abilities than formally. Although there is no substantive evidence for this the much-quoted decline in oracy and literacy standards must be taken seriously. We can find evidence of unsuccessful communication both socially and politically between racesr, rations and individuals.

Many feel pessimistic because of our failures to communicate successfully in spite of the refinements at our disposal. Although the community-sense of society is notably weak, this pessimism is open to challenge. Emerging knowledge and greater understanding of the processes of interpersonal communication offer splendid opportunities if we use them wisely. They can help to remove the mental and emotional barriers to harmony and improve the prospects of the world.

Advancing technology of film, radio and television gives us chance to enrich the content of our minds but personal instruction will always be necessary to facilitate individual skills. Patrick Cold stream (1987[8]), Director of the council for Industry and Higher Education, has written that .an institution that required language competence explicitly in every aspect of its teaching processes would deserve the widest possible industrial support". The statement continues saying the Council attaches much importance to this and would welcome experiments in this field. At Central School we are in a unique position to attempt such experiments given the existing common interest in communication. We are now poised to apply the results of our research and practice and it is hoped that industrial support will be forthcoming to back Central's constructive and optimistic approach.

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Communicating the Nuclear Safety Message at Public Inquiries

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SUMMARY

The authors were all involved in presenting the CEGB safety case at the Hinkley Point 'C' Public Inquiry and discuss the problems associated with communicating technical issues to a variety of audiences simultaneously, namely the Inspector, professional and lay objectors, and the general public.

INTRODUCTION

In this country, Public Inquiries to investigate the desirability or otherwise of major engineering projects are conducted on an adversarial system. Evidence is presented from both sides on the economics; safety and environmental impact of the project, and witnesses are cross-examined. The Inspector legally qualified and usually without a technical background, sits with assessor’s experts in the fields in which evidence is presented - who assist him in forming a judgment on the issues involved. At the Hinkley Point 'C' (HPC) Public Inquiry into the application by the CEGB (now Nuclear Electric plc) to construct a pressurised Water Reactor on the North Somerset Coast, objectors comprised national organisations such as Friends of the Earth, local pressure groups, local government bodies, and individuals. Some objectors could afford to employ their own expert witnesses and Counsel, others either preferred to 'do it themselves', or lacked the funds for such luxuries.

The technical background and financial backing of objectors obviously has a profound impact on the extent to which the applicant's case is tested. CEGB safety witnesses faced detailed questions from well-briefed Counsel and technical experts on issues concerning the design of plant to withstand external hazards or to respond to potentially dangerous on-site events, on the epidemiological and biological evidence on radiation risks and so on. They also had to face questioning from members of the public; genuinely worried about the risks posed by the operation of nuclear plant, but whose only sources of information were the media. All of us were involved in preparing evidence on safety issues, and in supporting witnesses. In this paper, we give examples from our own experience of dealing with this variety of communications problems.

RADIATION RISKS AND LEUKAEMIA CLUSTERS

The subject of childhood leukaemia in relation to nuclear operations is perhaps the most emotive to have been canvassed at the Inquiry. This was reflected in the large number of submissions from individual objectors and small pressure

Groups. Cross-examination of CEGB witnesses, though for the most part carried out courteously and in an objective manner, did sometimes become emotional, and in many cases was based on material from the press. It became clear during the Inquiry that to many people any statement from the CEGB indicating that there might be arguments against a causal link between nuclear operations and the existence of childhood leukaemia clusters was mere prevarication.

At the time of the Inquiry attention focused on radioactive materials discharged into the environment from these plants as a potential cause of leukaemia in their vicinity. (Since then, attention has shifted towards other possible explanations.) The CEGB case was not that excesses of childhood leukaemia did not exist near certain nuclear sites, but that there were very good reasons for concluding that radioactive discharges from the sites were not the cause of the excesses. In the Proof of Evidence on the subject, and during cross-examination, many of these arguments were put forward as to why, in the words of the Proof itself "It is extremely unlikely that a causal relationship exists between discharges from nuclear power stations and leukaemia clusters."[l] These arguments were rehearsed many times. To those of us on the nuclear industry side, in the light of these arguments, the statement just quoted does not seem unreasonable; but as one cross-examiner put it "Really, it very much seems to somebody in my position you simply don't want to believe a link could exist". Even a statement to the effect that there are strong arguments against such an hypothesis provoked objections.

The Inspector, in his report to the Secretaries of State, pointed out: "Any person unacquainted with the full range of technical evidence available on ionising radiation and leukaemia can be forgiven for adopting a short and seemingly logical train of thought. The process of reasoning is that ionising radiation can cause leukaemia and other cancers, concentrations of childhood leukaemia have been discovered near some nuclear installations which discharge radioactive material which emits ionising radiation and, therefore, it is the radioactive discharges from the installations which have caused the excess cases of leukaemia. When the evidence on the matter is considered it can be seen that such a process of reasoning is almost certainly flawed. There are a number of solid reasons for concluding that the excess childhood leukaemias, or leukaemia clusters, ascertained to exist near some nuclear plants are most unlikely to have been caused by radioactive discharges from the plants."[2]

MAJOR ACCIDENTS

The case which we were trying to make in this area was that, though the consequences of a major accident could be unacceptably high, the possibility of such an accident at HPC was so remote that the risk was acceptably low. We argued that this was because of our two design safety aims with respect to accidents: firstly that accident with any real likelihood of happening should have acceptably low consequences, and secondly that accidents with unacceptable consequences should not, in practical terms, occur. The evidence we put forward in support of these arguments included a Probabilistic Risk Assessment (PRA) for accidents resulting from plant failures. This included estimates both of the probability and consequences for accidents of the scale of Chernobyl.

The main objections to this case were (a) the consequences of the more likely, smaller accidents were not in fact acceptable, (b) the PRA could not be guaranteed complete and therefore the risks were underestimated, and (c) accidents with unacceptable consequences were possible however small their probability and therefore the PWR should not be permitted.

The difficulty we had in this area was due to the subjective nature of some of judgments on what is and what is not acceptable. Where there was

Disagreement about the actual value for a specific probability or consequence, the difference was not significant and the Inspector tended to accept either a compromise or 'reasonable worst case' figure. Using these, he had no doubt that the consequences of the accidents in the first category mentioned above were acceptable at their predicted probabilities.

He concluded that the uncertainties in the PRA were unquantifiable, and accepted neither the objectors' proposed factor of 10 increase in all estimates, nor our judgment that the uncertainty was likely to be much less than a factor of 10. It proved impossible to convey to the Inspector and to the objector the concept that the reducing contribution to risk of each newly discovered fault sequence gives confidence that those still to be discovered must contribute even less. However, he concluded that the estimates of risk were so far below his judgment of the 'maximum tolerable' that it was very unlikely that the risks would be unacceptable.

He was quite clear that the consequences of a Chernobyl-scale release were unacceptable, as indeed were we in our evidence. He also agreed that such a scale of release was possible at Hinkley Point 'C' although he accepted that the design differences between HPC and Chernobyl meant that an identical accident could not happen and such a large scale release was in fact very much less likely at HPC. However, he was strongly critical of our use of the phrase "will not in practical terms occur", suggesting that it would assist public confidence and allay some reasonable suspicion if we said that some accident probabilities were so low that action to reduce them further is not justified.

On the question of whether our PWR design had made the probability of Chernobyl-scale accident low enough, the Inspector said he relied not only the low value of the estimated risk, but also on the engineering competence the CEGB and the Nuclear Installations Inspectorate. In the end, consequences of a major accident were a significant disadvantage, but they not outweigh the benefits of the project.

EXTERNAL HAZARDS

External hazards are events that originate outside the boundary of the power station which can pose a threat to its safety. Examples are earthquakes, aircraft crashes, and extreme weather conditions. The risks are specific to the location of the reactor, so it is necessary to re-assess these hazards for each potential site.

For the HPC Inquiry, the CEGB attempted as far as possible to use a methodology and set of assumptions consistent with those used for Sizewell 'B' hazard assessments, so that the differences in the assessments would be clearly due to the difference in location.

The evidence presented to the Inquiry was effectively unchallenged with the exception of that provided to support the resilience of the plant to aircraft crash. This was a difficult issue as the assessment work was incomplete at the time that the evidence was being compiled. Revision of data and the receipt of internal comments meant that the assessment was updated during the course of the Inquiry. This put the CEGB in the awkward position of having to conduct what should have been internal discussions in public.

This would not have been important if it had been possible to put over the point that the assessed frequency of an uncontrolled release of radioactivity due to aircraft crash was very low and that refinement of the analysis was unlikely to affect the conclusions. When dealing with very small frequencies (of the order of one in ten million) the precise value of the frequency is not as important as

Its value relative to other hazards.

The absolute value of the estimate was challenged on a variety of points, some justified, others not. The point needed to be conveyed during cross-examination that, despite some weaknesses in the assessment (many arising from the attempt to be consistent with the Sizewell 'B' method) the effect on the final result was not significant in the context of the overall risk from hazards because only small variations in very small frequencies were being debated.

It was found to be virtually impossible to make this point during cross-examination. Engineers are more used to presenting technical cases to a receptive audience which wants to understand and examine the case in context rather than accentuate weaknesses. The engineer explains his or her approach then receives questions aimed at clarifying issues.

The adversarial situation at a public inquiry is inimical to this approach. There is no opportunity to establish a rapport with the questioner by explaining one's views and inviting discussion. Questions from the cross-examiner are intended to highlight weaknesses, and are technically specific but not in context. The questions may be valid in themselves, but taken out of context imply that the safety case is far less sound than it actually is. One lesson for witnesses is that a direct answer is better prefaced by a short statement putting the question in context.

In the event, the main point that, whilst the results of the assessment of risk could be changed, the overall conclusions remained unaltered was communicated to the Inspector who reflected this in his report. However, an observer who had not extensively studied the written evidence and who based his or her conclusions only on the Inquiry proceedings and on documentation produced during cross-examination would have found the case difficult to understand and would not have appreciated its relevance to the overall safety of the station.

CONCLUSIONS

It is doubtful, certainly in the case of such major and contentious projects as the construction of a nuclear power station, whether any minor party to a Public Inquiry feels that they have had an adequate opportunity to express their own views or to examine weaknesses in opposing views. It has to be borne in mind that the principal purpose of an Inquiry is to persuade the Secretary of State and the adversarial system favoured in this country may be adequate for this purpose; members of the public unfamiliar with the full range of arguments seem, however, in the Inquiry sessions to be treated to a sort of academic fencing match, with the sole object being scoring points off the 'other side'. However, most people attending the Inquiry have made up their minds one way or the other and are there to 'cheer on' their own team. Whether the public at large is influenced in the slightest is a very doubtful question.

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An investigative study into the influence of television advertising of analgesics on the consumer decision-making process

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The motivation for this investigative study can be ascribed to the fact that television advertisements advocate the use of analgesics for the treatment of the aches, pains and headaches of everyday living. The marketing of analgesics to the consumer has contributed to the increased sales observed in OTC analgesics worldwide. However, consumers frequently underestimate their intake and appear to be largely unaware of the potential, serious side effects.

The methodology involved a structured questionnaire administered by personal interview to a nonprobability test sample (certain sections of the South African population). Results indicated that the degree of perceived harmfulness increases with increased education levels. Increased perceived risk increases the search from credible information sources, thus providing an opportunity for the community pharmacist. Considering the education levels of large sections of the South African population, these results are significant. It is thus recommended that pharmaceutical manufacturers adhere to the societal marketing concept and in their re-evaluation of promotional expenditure, stimulate the involvement of the health care professionals as a significant source of information in the consumer decision-making process.

Daphne Jackson Women Returners Fellowship Scheme

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In 1985 a Fellowship Scheme for Women Returners to Science and Engineering was launched by the late Professor Daphne Jackson. The principle objective of the Scheme has been to provide a way back into full participation in a science or engineering career for qualified women who were unemployed or under-employed because of having taken a career break for family reasons. It has been done this by providing flexible, part-time fellowships in university departments. More than 50% of the funding has come from industry, with the remainder from charitable bodies and institutions.

A typical fellowship has lasted 2-3 years. The programme has consisted of two integrated parts: (1) retraining in recent developments and new experimental, theoretical or computational techniques, and (2) a research project of interest to the academic department and the sponsor.

The Scheme itself is now entering a new phase, for which the experience gained since 1985 provides the foundation. It is the intention of the Department of Physics of the University of Surrey that the Scheme founded by Daphne Jackson, its late Head, should become a securely-based activity with assured support on a long-term basis. Steps are now being undertaken to ensure that this is the case. The informed support of the whole community of Women Engineers and Scientists is something that will help make this enterprise succeed, and its suggestions and help will be heartily welcome.

Career Guidance Activities that work

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SUMMARY. Descriptions of a number of pre-college engineering/science/math career awareness and intervention programs carried out by the author with girls. Parents, teachers, counselors, organizations.

This will describe as many career awareness and intervention programs in which the author has taken part in the last five years as time and space permit. Some are national programs, some are international programs, and some are local programs designed by the author. Some have been carried out several-times and others were one-time events. The students reached have ranged from school beginners through college age. Many have been accomplished through the Space Coast Section of the Society of women Engineers.

EXPANDING YOUR HORIZONS is a national program sponsored by the Math/Science Network (2727 College Ave., Berkeley, CA 94705). Last year over 20,000 girls took part at 67 sites in this career conference for girl's grades 7-12. Parents. Counselors and teachers. Its purpose is to give girls a' look at science and math career options. The one-day conference opens with a keynote speaker followed by role model sessions. After a group lunch. Girls take part in a choice of two of the hands-on lab sessions provided by the host university while adults participate in a panel discussion on “How can I help?” by industry human resources personnel, enlightened guidance counselors and women in engineering

In the 1990 version the keynoter was an anthropologist. the first woman president of the Florida Academy of Sciences; in 1991 the keynoter was a Native American princess who is also a major in the US Air Force and Chief of Intelligence for Air Force Technical Applications Lab. This year approximately 20% of those girls and women attending were US minorities. For the $50 site registration fee EYH sends both student and adult information for hand-out packets. Society of Women Engineers information was added.

FAMILY SCIENCE is also a national program from Northwest Equals (Portland State University. PO Box 1491. Portland. OR 97207-1491) funded by Chevron USA. During four 1 1/2 hour sessions. Families do fun simple science activities together, relate science to future studies and careers, and involve parents in their children's education while learning how-to skills and strengthening ties between home and school. Our Family Science has been

Targeted to include many minority families because these are less likely to be doing activities that relate science to daily life. Public schools with high minority enrollments were sites for two programs while the third was at a site developed for at-risk students by the National Technical Association, an organization for Black engineers and scientists.

Family Science has been a joint venture between the Space coast Science Center and Space Coast Section SWE. Science Center education personnel were trained by Family Science but the Center had no funds to carry it out. Space Coast Section obtained a grant from Hewlett Packard for the operation. Each evening's session opens with try-me science teasers followed simple hands-on science and math activities. Women engineers, women engineering students and minority engineers ana scientists serve as role models and care erg awareness audio-visuals are used.

A DAY IN THE ENGINEERING PARK was developed by Florida Section SWE as a teacher In-service for middle/junior high school. (Grades 5-9) guidance counselors, teachers (especially of math and science) and district administrators. The object is to make these people aware of how women, minorities and handicapped are preparing for and doing science/engineering work. In Florida every student must make a plan in the 8th grade for the final four years of high school so the program aims to reach students through their counselors. Each half-day session features women engineers telling. About their educational preparation, work and job satisfactions then serving as guides for plant. Tours to see women, minorities and handicapped doing their jobs; visits to engineering college labs with professors discussing their disciplines and. showing lab activities with women engineering students as guides; a description by the engineering college dean of how to prepare for and succeed in engineering colleges and finally, women role models explain their preparation and jobs and then offer to come to schools. Attending teachers are then gain the opportunity to write career guidance modules for their classroom from the day's activities competition for cash prizes and publishing of their modules.. This was awarded the SWE national Corning career- guidance prize for three years as the; most innovative career guidance project; in the US.

NAVIGATIONAL AIDS TO THE FUTURE was a joint project of Space Coast Section with the Girl Scouts of America and the Space Coast Science Center through a $3000 grant from the US Association of Science and Technology Centers. Recently the Girl Scouts revised their program to include a number of badges in modern science and technology. Most leaders were unprepared to assist girls so the program first trained these leaders who then brought their troops to overnight lock-ins at the Science Center. Leaders received science career awareness training. Interacted with women engineer role models and planned their troop's lock-ins. The night's activities were designed to help leaders and Scouts earn specific badges. Members of Space Coast Section provided sufficient activities each in each session for most girls to earn two science/technology badges. At the same time. Leaders were learning how for do this themselves. In just the first year, over 200 girls earned an estimated 60u badges. They were rewarded with free passes to the Science Cenfer for their families paid for by the grant. Navigational Aids to the Future has been successfully repented in two subsequent years.

FRONTIERS IN PHYSICS DAYS were sponsored by the American Physical Society's Education Office under the college-high School. Interaction Committee with the American Association of Physics Teachers. This program has two major goals: up-date the knowledge; of physics teachers in current physics through personal interaction with physicists and form cooperative networks of college and high school physics teachers.- Each day is held in conjunction with the national meeting of a special interest group of AFS. The

Teachers' program begins with a discussion of a current physics topic by a physicist followed by demonstrations for the physics classroom by specially trained Physics Teaching Resource Agents of the AAPT. During lunch the teachers sit at tables with physicists and college physics instructors. In the afternoon. Teachers are divided into groups corresponding to-their geographical locations and they form networks electing temporary officers and planning at least their fist network meeting. College physics teachers join in as full partners and also as resources.

BRIDGES TO PROFITAABLE INTERACTION developed from the Frontiers programs. Two different versions have been done so far. In the first version, which was part of a Frontier in Physics Day? Representatives of organizations with programs for women and minorities in science described the resources they could offer physics teachers to attract these groups and then distributed information.

In the second version last summer at the national convention of the Society of women Engineers. "Bridges" invited organizations with programs to attract women to engineering to describe their resources available to SWE. Group discussion then centered on ways SWE members could use these resources in their career guidance programs.

SCIENCE BY MAIL (Museum of Science. Boston. MA 02114) has scientists serve as pen pals to student's grades 5-9. Families or other small groups with children of those ages. Three times a year. Packets are mailed to students with instructions on now to use the contents for simple experiments and open "what it?" question! Students mail their responses to their scientist pen pals who comment on the solutions. This has been so successful that Boston Museum now helps many other science centers in the US participate.

STUDENTS EXPLORE AND EXPERIENCE PHYSICS is a half-day workshop targeting students- in grades 5 and 6 in inner city schools with large minority populations. The American Physical Society arranges demonstrations by physicists followed by opportunities for the students to do simple related experiments.

A NASA GRANT TO SOCIETY OF WOMEN ENGINEERS encourages girls, especially minority, to become aware of engineering careers and to pursue activities that will prepare them for engineering studies. There are several specific actions. Eighth grade girls enter the higher Education Outreach Program through a college residential summer program followed by year-long mentoring and science activates that IS repeated every year until high school graduation. The Big Sister program has women engineers mentor girls grades 8 through high school to improve their science and math studies. For minority girls, grades 8 through 11, who simply enter a project in any science fairs? The Space Camp program permits them to apply for a week at Space Camp. About 10-20 girls are selected in each junior and senior division to take part in simulated space Training and missions at the camp.

This is a sampling of guidance activities which have been successful in some way. The author will be pleased to hear about your activities or to answer questions.

Women Returning to Software Engineering

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DUE TO RAPIDLY CHANGING TECHNOLOGY, PEOPLE WHO TAKE CAREER BREAKS FROM THEIR JOBS IN SOFTWARE ENGINEERING HAVE GREAT DIFFICULTY IN RETURNING TO WORK IN THE AREA. THIS PAPER DESCRIBES A COURSE THAT ALLOWS OUT OF DATE SKILLS TO BE UPDATED.

INTRODUCTION

As a discipline Software Engineering first emerged in the late 1960's but it was not until the 1980's the term became widely used. Software Engineering is concerned with the problems inherent in the design and construction of large computer systems. Prior to the 1980's this work was often called analysis/programming, the work involving people skills as well as technical. Projects were then and still are usually large beyond the capacity of a single individual, involving interaction with both the client and the user.

People who take career breaks from their jobs in Software Engineering have great difficulty in returning to work in the area. There has been such a large change in the vocabulary of the work place and the technology. The thought process has not changed but the technology has. Where once companies set their own guidelines now there are industry wide standards. Systems programs are now largely written in C as opposed to Auto-Code. Ten years ago computers were isolated in air conditioned rooms and work was often submitted via operators, now computers sit on desks and most Software Engineers have their workstation networked to the rest of the company.

Many employers will not even interview someone who has not worked in the industry for two years let alone those women who have stayed at home to raise a family. These women who are now anxious to return to work are forced to take menial jobs because their skills are out of date. Forward looking employers offer

People taking career breaks the opportunity to keep in touch by part-time working or working from home. This does not serve everyone. Not all employers are so flexible, in addition, families move and commuting is not always desirable with a young child. Hence there is a need to offer courses that will enable those with existing skills to update themselves after taking a career break. Reading University devised such a course Women In Software Engineering Update (WISE UP). Large computer manufacturing companies with bases in the Thames Valley offered a lot of support in designing and running the course. Smaller companies provided speakers and work placements. Women without paid employment cannot afford expensive training. This course was fortunate in obtaining funding from the Training Agency so that it was free to all participants. The course was short (12 weeks) and very intense, the majority of the participants in the two courses run so far are now working in the Software Engineering industry.

COURSE CONTENT

The WISE UP course was designed to enable women to regain confidence in their existing skills in computing and to update and consolidate their knowledge of Software Engineering. The course covers the entire software lifecycle from feasibility studies, through analysis, design and implementation, to maintenance, the use of methodologies and tools are considered at each phase of the lifecycle. A full technical syllabus includes the following topics:

Why software engineering?

a) Definition of software engineering
b) Review of software life cycle
c) Problems with software development

Project planning

a) The project schedule - phases, deliverables and milestones
b) Cost estimation
c) Team structures and management

Requirements analysis

a) Functional and non-functional requirements
b) Types of requirements
c) Languages and processors for requirement specifications

System design

a) Architectural and detailed design
b) Characteristics of good design
c) Design methods - including Jackson and Yourdon
d) Data design
e) Introduction to formal methods

Program design

a) Design guidelines
b) Design tools

Program implementation

a) Standards and style

a) Programming language evaluation
b) Portability and reusability
c) Programming in C
d) Introduction to UNIX

Testing
a) Stages and types of testing
b) Program testing, verification and inspection c) Black box and white box testing
c) Test plans
d) Test harness
e) Regression testing

Maintenance
a) The system lifespan
b) Maintenance activities
c) Factors affecting maintenance costs d) Change control

Topics covering the entire lifecycle
a) Difficulties of estimation
b) Configuration management
c) Changing schedules and requirements d) Quality assurance
d) g) Documentation
e) h) SSADM

In addition to providing technical skills it was felt necessary to provide sessions on confidence building. During the two courses run so far, the groups themselves did as much for boosting confidence as the timetabled sessions. However these sessions covered essential topics such as cv preparation and interview techniques, as well as allowing the course members to meet women who had successfully returned to work in computing. One interesting snippet was what Software Engineers wear, in the old days programmers often wore jeans, what do modern Software Engineers wear?

THE TRANSITION

Returning to work requires not only updating of technical skills but organisation of the domestic routine. One of the biggest problems is child care, one local secondary school finishes at 2.20 and most primary schools close by 3.30. The WISE UP course took account of this problem and worked a reduced day (9.30-2.30), while allowing participants 24 hour access to computer equipment. This made the days very intense, but the general consensus was that the amount of work completed on a reduced day was similar to that for a full day as a rate in excess of normal was acceptable for five hours.

The group provided a lot of mutual support in dealing with domestic problems (e.g. where to advertise for a nanny share) and with job hunting (sharing of knowledge of vacancies).

Industrial placements made up an integral part of the course, with participants spending 18 days on a small project in one of the companies supporting the course. The placement provided each of the participants with an insight to the workings of a modern computing environment. Each of the projects offered by the companies was a real task that would benefit the company. For this reason the women felt they were doing a worthwhile task and consequently worked in a professional manner. However both sides accepted that this was a training exercise and mistakes were acceptable.

FLEXIBLE WORKING

Some companies offer home based working, which is easily achievable with a computer terminal, a telephone line and occasional face-to-face meetings. This option did not appeal to the participants of the WISE UP courses: they wanted the stimulation of working with people outside the home. However most of them did not wish to commit themselves to full-time employment, while they were responsible for school-age children. Many employers are unwilling to consider part-time working for professionals. Those employers who have taken on WISE UP participants working flexible (and shortened) hours have found that the quality and quantity of work achieved is so high that they are anxious to recruit from the next course.

One of the most attractive (to WISE UP participants) working schemes is school-term time only. Other arrangements that are currently being worked by WISE UP "graduates" include 21 hours per 4-day week, 25 hours at mutually convenient times, 30 fixed hours per week and full-time working under flexi-time. One woman interleaves two part-time jobs to achieve a nearly full-time week.

CONCLUSIONS

One of the most pleasing results of this course is that women who had been to numerOU3 interviews in the past with no success, have after attending WISE UP been able to choose between job offers. At one interview, there was a choice between a "WISE UPPER" who had not worked for ten years and another woman with a similar background in computing, the latter was told that with updating she would be considered. The "WISE UPPER" was offered the job. Thus it is evident that training for Software Engineering returners is essential and should be more widely available since computers are now an integral part of all businesses. In most regions of the country, the training offered is at a very basic level and does not make use of existing technical skills. Moreover the training must be regional, because women with home commitments are unable to travel long distances or live away from home. However they do need the ability to use the latest equipment so distance learning is an unsatisfactory option.

The maturity that home and childcare has enhanced, including time management and the setting of objectives, coupled with technical updating leads to highly competent and professional employees.

The Gender as a Parameter of the Environmental Design Research

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The social construction' of gender is introduced as a parameter of analysis into the research of the environmental des1gn. By environmental design research, we mean the study of the mutual relationships between human beings and the man-made environment at all scales. This subject is referred to a seminar course held by two members of the faculty (S. Lada and V. Tentokali) for fourth and fifth year students at the Department of Architecture (1987-89).

The seminar is divided into three parts. The first part introduces the theory of Women's studies, focused on their inter-disciplinary character. Among the psychological theories on the interpretation of the differences and similarities between human males sand females, emphasis is given to the social structural theories. According to these, the identity of the genders is determined not only biologically but also socially through a social process, or construction, which is called the 'sex-gender system' or 'socialization', and results in 'subjectivity by gender'. Furthermore, the cross-cultural and historical character of the soc1al construction of genders is argued. The second part deals with the introduction of the social construction of gender as parameter of analysis into the research of environmental design, leading to the double hypothesis: if the man-made environment, through its production process, expresses or reinforces the social construction of genders. And, if the social construction of genders is reproduced or reinforced within the man-made environment as a lived experience. The third part includes the presentation of case studies in which the mediating links between human behaviour and man-made environment are investigated. The critique of these case studies which follows is based on the above double hypothesis.

The objective of this seminar is to develop the awarertess and familiarisation of the students with the social construction of genders and its possible reproduction or reinforcement through the man-made environment.

CD5

Women, Computers, and the Construction Industry

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SUMMARY

This paper consists of a brief explanation of the low number of women in the construction industry. Following this it will look at the role of computers in the industry and how this affects the women working there. Finally, suggestions will be made of ways in which women can be employed to use computers for technical work in the industry.

SOME EXPLANATIONS OF THE LOW NUMBER OF WOMEN IN THE UK CONSTRUCTION INDUSTRY

The low number of women in technical positions in the construction industry has caused some concern over the last few years. This has led to calls for greater employment in the industry of women with technical skills. Various general explanations for the low proportion of women employed in technical positions within the construction industry have been put forward. Although the construction industry is a major employer, women have rarely been seen working there. This is because women have increasingly been channeled into work which involves caring or into work in the service sector. Since the Second World War women have been most prominent in only a few occupations. Today, the largest percentages of women are employed in clerical and sales occupations. The second largest group of employment for women is in catering, cleaning and hairdressing. The third largest group *is* as professionals in health, education and welfare. The sex-segregation of occupations has been much researched by historians, sociologists and economists. One frequently cited explanation points to the role of caring for their families and the sick that woman have traditionally performed. This role has naturally prepared them for careers in nursing or domestic work, for example. Another popular explanation points to the exclusion of women from certain occupational areas. The first explanation says that women are inclined to apply for a restricted variety of work; the second says that even if they had applied for other jobs, they would not get them anyway. At any rate, women are still in a minority in most areas of technical work. They are often reluctant to consider professional careers in engineering and technology or as technicians, skilled or semi-skilled machinists in engineering companies. Researchers have considered many explanations for the low numbers of women in technical careers. The main explanations are:

1.A large proportion of girls do not take science or mathematics courses at school. [1] This means that they lack the technical background required to go into scientific or technological careers.

1. When advising girls, some careers services often overlook technical careers. Some careers advisers do not know about the variety of careers available in technical industries like the construction industry.
2. The lack of precedents may deter girls from embarking on a career in technology. [2] Girls are less likely to know of any women technologists and therefore have no role models to inspire them.
3. Women who gain science qualifications at school may be deterred from a career in engineering or technology because it is perceived as atypical of women. Women in such work often have to cope with being the only ones amongst many men. [3] Similarly, a reluctance to be in this position causes some women who may have taken further engineering or technology courses to opt for alternative courses where the percentage of women is higher.[4]
4. Many women who work leave their employment for a period of time to have families. Their return is often dependent on the companies providing facilities for childcare arrangements, part-time work, job sharing or
5. Career breaks. Within construction these are often not available. [5] Those women who want to return to their previous jobs can find that lack of contact with their profession during a break leads to their knowledge becoming outdated. [6]

Many of these general explanations can be validly applied to women working in the construction industry. However, the construction industry in particular has difficulty in recruiting and retaining women. Within the construction industry, as with most technical industries, women are subjected to vertical segregation. That is, they are usually found in the lower echelons of the company. They are found in secretarial positions, administration, personnel and in sales. A woman in the position of engineer is rare and still rarer is a woman as site manager, contracts manager or company director. Insofar as the poor position of women in the construction industry stems from a reluctance to take jobs there, specific reasons for this reluctance are:

A. Women who want to work part-time would be at a disadvantage in the construction industry. This is because the construction industry does not usually provide facilities for flexible or part-time working. As larger employers in other industries begin to offer facilities such as career breaks, flexible or part-time working and creche facilities the construction industry will be forced to respond. So it is likely that this explanation will have less validity in the future.
B. Contracting is one of the main areas of construction. Much of the work involved in contracting requires a high level of mobility. Given the tradition of family responsibilities falling disproportionably on women, some women with children may to be unwilling to work in this way. This means that they are unable to return to their previous jobs.

For both these reasons the construction industry has been unable to take advantage of the increase in married women who work. Yet married women, with or without children, have been attracted to other industries. This has been a significant factor in changing employment patterns in the post-war period. Many of these married women have returned to work on a part-time basis. In order to increase married women's participation in the construction industry, working conditions would need to reflect the dual role that women often have to perform. That is, domestic and family responsibilities would need to be taken into account. The construction industry faces a dilemma: on the one hand it wants to increase the number of women-within construction, and on the other it wants to avoid the disruption and expense it thinks would follow the introduction of working practices that would benefit women. So far it has taken negligible steps towards introducing comprehensive working packages. [7] These packages would make it easier for women returners and those who want to look after their pre-school children to continue in their present jobs.

THE IMPACT OF COMPUTERS ON THE CONSTRUCTION INDUSTRY

The construction industry has become computerised. In consultancies detailed designs, drawings and specifications are all performed with the aid of computer packages. Computers have decreased work on tendering and contract management. On construction sites computers are increasingly being used to link up with head office. Site finances, personnel information, ordering and time management are all carried out by computer in the confines of the site. Operation Site managers were often recruited from those who performed traditional site tasks such as labouring, carpentry, and scaffolding. However, modern site managers more frequently need a background in computers and management techniques than in these traditional areas. There are now jobs on site which can be done solely by people using computers, eliminating the need for physical strength. On site sophisticated computer controlled machinery is being used to lift and dig. Tunnelling equipment is programmed and operated; the need for manual digging eliminated. It is now possible for women with a technical background to work on site as managers or manual workers without having to be physically strong.

Computers promised to ease workloads and simplify processes. This they have effectively done in the construction industry. Computer operators and programme designers are more common in the construction industry, easing and improving working practices. However the construction industry should try to avoid making the same mistake as the data processing industry. Initially in the data processing industry men and women had the same opportunities. It was a new profession and needed skills which had not been developed. [8] But usually, it has been men who have moved forward in this industry. Women occupy the low grade positions of data entry rather than decision making and programming.

The construction industry is in a relatively early stage of computerisation. Computers are widely used but computer software is consistently being renewed and updated. Training within companies becomes more important to keep up with developments. This means that the industry needs to train its staff constantly to keep up with these improvements. The construction industry has a vested interest in improving its computer systems as new working practices based on an electronic exchange of design data could cut building cost significantly [9] In the interests of efficiency, women should be encouraged away from data entry to design. If women learn to work with design packages, the construction industry will benefit from the greater pool of talent that would be lost if only men were employed in this field. If the construction industry were to develop a flexible career system this might allow women to move from the non-technical computing jobs such as data entry to the more technical ones involving decision making. Once flexibility was established, recruiting costs would be reduced.

WOMEN AND COMPUTERS

It may be thought that the construction industry is unable to recruit large numbers of women to work in the field of computing. Explanations 1-4 above imply that even the adoption of different working packages would not make much difference. After all, the problem the construction industry would face seems rooted too deeply for different working practices to overcome.

Computer studies at school do not attract many girls. In mixed schools, girls are often deterred from science and science related subjects because they are unwilling to compete with boys. Peer pressure and a willingness to conform can mean that science subjects are neglected. (In single-sexed schools, girls are more confident about their ability to study science). Girls are also put off science and computing by parents who feel these subjects are unsuitable for females. This is not to suggest that a scientific background is necessary for a career in computing. But many girls believe that it is so,
lacking this background, they do not consider this career. Computing is generally perceived as a complex and technical subject. This perception is strengthened by the location of computers in the science blocks of schools [10]

Women in Construction: Why are there so few female Construction Managers?

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Start: October 1987
Finish: October 1992

Purpose: PhD by part-time mode, registered at The School of Architecture and Building Engineering, University of Bath

Aim: To establish why there are only a few women occupied as building professionals in the British construction industry.

Objectives: 1. To investigate whether there is a relationship between perceived images of the construct ion industry and to identify any differences in that perception according to sex.

2. To investigate whether there is a relationship [and, if so, what it is] between perceived image of the construction industry and recruitment levels of men and women to positions as building professionals.

Main Hypotheses: 1. The image of the construct ion industry militates against the entry of women.
2. Knowledge of the Construction industry discourages the entry of women.

Synopsis: This research defines the construction industry as separate from the engineering industry. Initial work was necessary to develop an occupational classification system for the construction industry.

The population being sampled is defined in two dimensions. One dimension is industrial, containing a near and a far comparitor with construction; namely engineering (near) and banking and finance (far). The other dimension is the education-work continuum, going from school, through higher education to employment.

Population Model			
	science	humanities/arts	Mix
school students [16-18]	*	*	*
Undergraduates	construction *	Engineering *	Bank & finance *
Graduates	*	*	*

A structured interview on 23 male and female participants was carried out and analysed. This lead to questionnaire being designed and pilotted for a larger survey of the population planned to yield 450 responses. This survey is ongoing. Each cell is planned to yield 25 male and 25 female responses. Interim findings are carried in papers listed at the end of this short document. There may be a difference in the image held by males and females of the construction industry. Courses at higher education 1 eve 1 may be gate keepers to the industry and may promote and maintain the construction industry's male culture. Gender inclusive curriculum and industry may improve the proportion of female entrants but may also increase the attractiveness of the industry to a wider selection of males.

Adjunct work: Practical action research on Insight type courses has been carried out and evaluated in conjunction with the public and private careers service abnd industry, supported by the Construction Industry training Board. Further information can be obtained from some of the publication slisted below.

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CD7

Participation of Women in the Hong Kong Construction Industry

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SUMMARY

The paper examines the traditional role of women in Chinese society and the social factors relating to their increased participation in the workforce. Female's low participation rate in the construction industry is seen as partly due to the result of stereotypic view in gender roles which is an all - important factor affecting women's choice of educational subjects and working career.

TRADITIONAL PERCEPTION OF WOMEN'S ROLE IN CHINESE SOCIETY

Traditionally a woman's role is in house-keeping, child-bearing and rearing, and her domain is within the boundary of her home. Women in the early days of Hong Kong still could not escape from the overall framework of their domestic role and only worked as unpaid labour in small family businesses, or other paid domestic service. Then came the embryonic industrialisation of Hong Kong in the late forties. Communism took over China in 1949 and mass influx of people from the mainland followed. The overall size of Hong Kong's labour force and GDP both grew rapidly from 1948 to 1979, i.e. at an annual average growth rate in real terms of GDP of around 8% (1). Women participation in the workforce also showed a sharp increase, and brought about a breakthrough in the confinement to the reproductive sphere. Women accounted for 37% of the total workforce in 1986. Overall between 1961 and 1986 the proportion of women in the workforce increased from 36.8% (1961) to 42.8% (1971) to 51.2% (1986). (2)

SOCIAL FACTORS RELATING TO WOMEN PARTICIPATION IN THE WORKFORCE

At least three important social factors relate to women participation in the workforce, i.e. the marriage pattern and family structure, fertility rates, and educational attainment.

Fig 1 Percentage fema1e of married women

Age	20-24	25-29
Year		
1961	51.4%	85%
1981	70%	28.7%
1986	21%	61.7%

Source: westwood (4)

Figure tabulated by author

Generally, women have been getting married later. The median age of first marriage for the female was 23.6 in 1978 and 25.6 in 1987. (3). Although the percentage of married women is dropping, marriage rates in 1987 were acutely higher than m 1978, therefore the figures do not reflect marriage becoming unpopular, rather, women want to continue their independence and to pursue their full time employment longer. The family structure is also tending towards the "nuclear family" with a total number of 4 members or less.

Women are also tending to have children later and total fertility rates per woman are now at less than 2 compared with 5.17 in 1961 and "fertility was found to vary inversely with income", and educational attainment for that matter. (5). Smaller families and later births and marriages may indeed help to freed the women to enter and sustain their participation in the workforce.

Another social factor is educational attainment. This has a bearing upon occupational positions, options and rewards. Currently there are six tertiary institutions funded by the Government, one of which will not start its students-intake until 1991. Male students remain dominant in engineering, science and architectural courses while female students dominate the arts and social sciences and their numbers are also increasing in law studies and business administration. Although there are still segregation in course enrollment, there is a growing tendency of equalisation of education level of male and female in the workforce.

	HKU	cu	HKP	BP	CP
1986	33.4	54.1	26.38	52.86	39.45
1987	34.1	53.3	28.71	51.97	41.82
1988	35.6	52.7	30.13	49.01	34.99
1989	41.8	50.9	32.26	50.56	36.61
1990	43.5	51.8	34.48	53.49	36.68

Fig 2 Percentage of female first year students

HKU=University of Hong Kong

CU=Chinese University of Hong Kong HKP=Hong Kong Polytechnic BP=Baptist Co11ege

CP=City Polytechnic of Hong Kong

Source: Individual institutions. Percentages calcu1uted by author

Furthermore, based on the Hong Kong Statistics, about 23.6% of women with a tertiary education

Were working in 1971 and this had risen to 71.7% by 1986 (6). It could well mean that the modem educated women need more self-satisfaction than keeping the household could provide.

SEGREGATION BY INDUSTRIES AND OCCUPATIONS

Both the utilities industry and construction industry are heavily male-dominated with over 90% of the workers being male. From the figures of the Hong Kong Statistics, the proportion of the overall working population in the construction industry has been running steadily at between 3 and 5% for most of the seventies and eighties. Since 1986, male to female workforce distribution in this industry has been steady at approximately 96% and 4% respectively. One favourite argument is that it is the nature of the required work on site that has necessitated a male dominance and that the work is considered too physically demanding and dangerous for women. However, women participation in this industry does not stem from the physical side of construction alone, and many could contribute their expertise in the professional, managerial and administrative aspects.

Interesting enough, according to the Hong Kong Statistics, the ratio of male to female in the 'Professional, technical and related workers' category has been relatively high at around 6:4, although female participation in this category has never risen above 10% of the total female workforce. The majority of the female workforce is in the category of 'Production and related workers, transport equipment operators and labourers' (around 40% in the eighties) and the only category with a female dominance is the 'Clerical and related workers' where over 50% are female. The category where women are clearly under-represented is the 'Administrative and managerial workers' with less than 2% of the working women throughout the sixties to eighties. The high ratio in the professional category is perhaps due to the inclusion of nurses and teachers, i.e. the traditional female occupations.

The four major professional institutions concerning the construction industry, ie. HKIA, HKIS, HKIE, CIOB, (7) do not have readily available statistics on gender. On request, they could only give approximate figures. In April 1991, HKIA quoted female members to be 115 out of 1000, HKIE quoted 20-30 out of 4000. HKIS replied that their membership list made no reference to gender and therefore was unable to give an indication; CIOB (Hong Kong Branch) is recently conducting a membership survey and they will have the statistics later this year. On this issue the column "ASTRAGAL" in a recent Architect's Journal had the following to say: "Do most women have better things to do than seek unemployment and frustration by becoming architects, or are nasty men conspiring to stop women entering the profession?" (8)

In general, the awareness of discrimination in Hong Kong is not strong. "There may exist apathy or ignorance about discrimination. There is likely to be a degree of acceptance, even legitimating of inequalities. There may even be a perception that you can 'make it' in Hong Kong whoever you are: whatever your gender." (9).

WOMEN'S EARNINGS AND WORKING MOTHERS

Hong Kong is a major international commercial and financial centre with an average growth in GDP of 9.9% from 1961 to 1981 and 6% from 1981 to 1986, and the predicted rate is 3% plus for

1991. (10) the basic sexual divisions of labour are evident as shown previously. There currently exists no equal employment, equal pay or anti-sex discrimination legislation in Hong Kong. Employers frequently specify sex preferences on job advertisements and this reflects society's stereotypic views on gender roles. The mean monthly earnings of a male and female with over 15 years of education are $10973 and $7011 respectively in 1986 (11). Compare to this, a professional in the construction field (architect, engineer, surveyor, town planner) in 1986 had a starting monthly salary of $13000 to $14000 in the Civil Service where pay parity of the sexes has been provided since the mid seventies. But it was only until 1981 that the Government introduced equal eligibility for fringe benefits for married men and women. However, the wage of the female site labourers in the private sector is around 18% less than their male counterparts, according to Government's Census and Statistics Department

All along, it is assumed that the care for young children is the responsibility of the family especially the mother. The working mother is then expected to take the pressure of the dual role. Those in the middle income group or above could hire domestic help (mainly from the Philippines and Thailand but the lower income group would have to rely on their in-laws or relatives or other childcare facilities which are in very short supply. Others have to leave the workforce because of an inadequate supply of such facilities. Ironically, it is also the lower income group which might require the female to work to supplement the family income. Given this difficulty and the long working hours and dangerous work nature on site, the lack of female participation in physical construction work is understandable. However, most working women still concede to the pressure of the dual role and this is likely to generate strain, especially for the educated career women on the climb. In a Dole check survey (12), the two main factors considered as a hindrance for women advancing into management positions are that the women are less dedicated in pursing their career than men and there are too few women with sufficient experience. Moreover, Lai's survey (13) showed that both sexes in the sample rejected the idea that men should give up work and look after the family while the women earn the income, and women tend to accept their dual role and did not think husbands should do more at home.

TERTIARY EDUCATION IN THE CONSTRUCTION RELATED DISCIPLINES

Fig. 2 had given an indication on female enrollment in tertiary education. The percentage of whole population attaining a degree for female has risen from 0.3% in 1961 to 0.7% in 1971 to 1.1 % in 1986. (14). The number of tertiary places available is also increasing. This is part of the measures taken by Government to counteract the Brain Drain problem, a terminology the Hong Kong people have given to the phenomenon of mass emigration from Hong Kong before China's takeover in 1997. This has drawn away most of the professionals and middle to top management personnel. The Government has plans to increase the first year intake in first degree courses from 7250 in 1990/1 to 15000 in 1994/5. The choice of their courses in tertiary education bears a relationship to gender stereotype and this leads onto occupation segregation after graduation. Cheung and others remarked that "gender stereotypic roles are fostered not only through the conservative cultural forces of the family, but also through the supposedly westernized educational system". (15) They pointed out the gender stereotypes in textbooks, the parents' stereotypic views concerning their children's future career and finally the gender differences begin to emerge in choice of subjects. It seems that the social attitudes towards gender-based occupations are deep-rooted. Similarly Westwood referred to the fact that "many women do not perceive a managerial role for themselves at all and will not therefore take any steps to prepare themselves for such a role".(16). Room for thought for breeding future female project managers in the construction industry!

Fig 3 Proportion of female first year students in first degree courses

Sources: Individual department’s percentages calculated by author

	University of Hong Kong				Hong Kong Polytechnic						CP
	Ar	CE	QS	SU	LM	QS	BS	BTM	CE	BSE	Bdg
1986	15/47	1/94	5/17						5/51	2/40	3/42
1987	16/43	0/86	6/17					6/41	1/62	0/40	3/41
1988	19/53	1/98		8/30	10/32	10/34	4/35	6/40	1/60	0/40	4/44
1989	25/33	4/87		7/31	12/37	5/34	1/31	5/38	0/62	2/40	1/46
1990	19/60	4/98		12/37	11/35	10/34	7/36	8/36	3/64	8/50	1/47
%	36.76	2.15	32.35	27.23	31.70	24.51	10.30	16.25	3.55	5.20	5.57

CP=City P01ytechnic; Ar=architecture; CE=civi1 engineering; QS= Quantity surveying; SU=surveying; LM=1and management; BS=bui1ding surveying; BTM= bui1ding techn010gy & management; BSE=bui1ding services engineering; Bdg= bui1ding.

At present, three out of six government funded tertiary institutions currently offer construction related first degree courses. Some of these courses only began in 1987 and 88. The three surveying courses at HKP has an average of 22.17% compared to HKU's 27.23%. There is a tendency that architecture and surveying courses fare better than the others. The low percentage in engineering courses is also attributable to the requirement of a relatively strong mathematical background and female students have been encouraged to develop in the arts.

CONCLUSION

Education attainment is an important part of human capital and also one of the three social factors relating to women participation in the workforce. Couple with low fertility reates and late marriage age, women have a better chance to enter and sustain her participation in the workforce. Construction industry is traditionally male-dominated, and gender role stereotype plays an underlying effect in the segregation of labour force participation in the industries. Such stereotypic views are fostered by the family, school and society. Although the physical nature of construction work is deemed unsuitable for the female, there still exist other opportunities in management aspects. However, in general, women participation in the "Management and Administration" category is also appallingly low. So is there discrimination? Women themselves generally do not show great awareness of it, it is found that they themselves also possess these stereotypic views to an extent; for instance, most will strive with their dual role without contemplating that husbands should help with housework. Therefore availability of hired domestic help is seen as a blessing to the higher income group.

Since education attainment could allow the female to enter a higher echelon in the workforce, how are they faring in tertiary education? There is a growing tendency for equalisation of education level for both sexes, but the choice of their subjects is affected by the same stereotypic views. Architecture and Surveying courses admit more female students than the Engineering and Building courses, though the percentages are still small. Recently due to the rapid expansion in tertiary education, a lot more places are available than a decade ago. Though the female percentage is still low, absolute numbers could rise, especially two other Government funded tertiary institutions are going to offer architecture and engineering courses in future. Lack of local professional institutions' interest on gender statistics is a pity, but this is in the same general line of thought that gender issues are not taken seriously, and general awareness of it is low.

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Prospective, A Strategy for the Engineer

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1. Faire de la prospective, c'est reflechir sur l'avenir pour eclairer l'action presentee

La prospective se relie tout naturellement a la strategie. Elle va aider les équipes de dirigeants a voir et a rechercher les horizons lontains de leur developpement, les diverses voies possibles pour les atteindre.

Aujourd'hui face au x mutations il manque une dimension: la mobilisation collective face aux menaces et aux opportunités de l' environnement et aut our des objectifs de la strategie.

La prospective et l' évaluation sont de plus enplus necessaires a la decision economique: c'est en construisant une vision cohérente du futur que l'on permet a chacun de situer son action, de definir un contexte balise, ses prop res objectifs et sa pro pre identite.

2. En chinois, le mot "crise" est constitue de deux ideogrammes : l'un signifiant "danger", l'autre "opportunite".

Tendances lourdes et jeu des acteurs : la chute des emplois, la montee du chomage...

Les femmes saisiront les opportunités, adapterontleur stratégie et feront preuve de souplesse.

"II n'est pas de vent favorable pour celui qui ne sait od il va " Sénéque.

L' adaptation se fera au prix de multiples transformations structurelles: sept tendances probables permettent d' avancer avec une quasi certitude un certain nombre de caracteristiques de l' ingenieur cadre et manager en l'an 2000.

* DES EXIGENCES: MOBILITE ET EXPERIENCE INTERNATIONALE
* UN RECRUTEMENT ELARGI (concurrence avec des nationaux)
* DE NOUVEAUX RAPPORTS DE FORCE ENTRE CADRES (distinction plus nette entre cadre animateur et cadre specialisè)
*L'ATTRACTION DES PME
* DES DIRIGEANTS MOINS MATERIALISTES QU'AUJOURD'HUI
* DIRIGER C'EST COMMUNIQUER
* LE MANAGER: UN ANIMATEUR PLUS QU'UN MENEUR

3. Deux scenarios sont possibles : celui des blocages issus du prolongement des tendances actuelles et celui des ouvertures a de nouvelles formes d'experiences d'organisation. La realite future sera une combinaison des deux, voire leur coexistence.

En conclusion les futurs managers seront probablement des femmes et des hommes ayant ete con frontes aux realites du"terrain", problèmes techniques certes mais surtout humains. II appartient aux ingenieurs cadres et managers de decider s'ils veulent is subir ou maitriser cette realite.

Dans ce Monde qui bouge et qui est le nôtre, je vous invite á faire vôtre cette valeur essentielle :

"COMPRENDRE SANS COMPLEXE L'EVOLUTION DE L'ENVIRONNEMENT POUR S ADAPTER EN PERMANENCE ET GAGNER."

British Airways Engineering

Judith Schwarz

British Airways, London Heathrow, England

British Airways Engineering is big business; the aircraft fleet must be maintained in a safe, airworthy, reliable and presentable condition both inside and out. The aircraft need to be presented for service on time at an economic cost ensuring total safety and making them available for high utilisation.

BA employs approximately 50,000 of which there are approximately 10,000 within Engineering. 5.3% of these employees are female. We often consider industry to be heavy maintenance, yet of the 10,000 Engineers 6,000 are employed directly in maintenance, the rest are involved in such areas as Technical Support, planning (short and long term) training, quality, materials management, etc.

I would like to explore BA Engineering, to show the opportunities it offers for women in engineering as one of the largest transportation service industries.

I would like to share my industry and take a look general) holds for me in experiences, achievement and progression within the at the vast opportunties BA (and engineering in the future.

CD10

Barriers to be Broken

C. John Baumber

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SUMMARY

History shows that change is always painful, is resisted and can only be declared as having been made when certain barriers are broken. Defining the barriers which prevent women from being able to progress in their careers, will in itself help create and increase the rate of change in attitude required.

THE BARRIER OF ACCEPTANCE

Any business or enterprise has its own culture and ethos. The overall style is often created around the personality characteristics of the senior person, together with the influences of the key players. For those working within the operation, "it is a case of change by persuasion, accepting the scene, or seeking another more compatible environment elsewhere. Whilst this gives a preference to stability and status-quo, it is just such a situation which harbours the factors that exclude women from making progress on an equal footing.

In a business that does not accept women in managerial, technical or advisory roles, whilst the present incumbents are comfortably in charge, the environment is hostile without being legally discriminatory. Breaking into the organisation requires dedicated and robust enthusiasm. Women find themselves competing against the odds. Once in, the attention of the establishment will be focussed on justifying the previous held view that women are not acceptable. This means that it is impossible to compete on an equal base. The freedom to be fallible is not an option and thus the successful barrier-breaker has to be considerably more skilled and diplomatic than her male counterpart.

THE BARRIER OF NEEDS

Life's realities are no more than our own perceptions. Many operations fail to serve their customers by thinking they know what is needed. They become aggrieved when customers have the affrontory to say they do not like what is being delivered to them! Where there is choice, customers can take their custom elsewhere. When however employers become prescriptive of what they think women need in employment, or what they think women want to get out of being employed, even the best laid minefields look easier to navigate!

Each woman has differing motivational triggers, demands from challenges and desires to contribute. That these are not in some way fundamentally different to those of men, is a perception that many males can not readily accept. The perception is generally held, particularly in manual working environments and traditional working class social areas, that women who go out to work do so either to supplement the main source of male-earned income, or to keep themselves occupied.

Getting acceptance that women desire to perform, to make a contribution, to direct and shape outcomes, means breaking the barrier of a closed mind. Of all the barriers to overcome, the barrier of a closed mind is the most difficult. Normal logic is of little help and this particular issue revolves not only around the culture of an enterprise but pervades the very fabric of the social scene. Some men are threatened by the thought of women wanting to satisfy a need of fulfillment and value outside the home. A feeling that appears to have no social strata limitations!

THE BARRIER OF BEHAVIOUR

In our endeavours to satisfy our needs, our actions are carried out in a particular way and those actions themselves create behaviour response in others. Groups of people react in ways that can be mentally as well as physically threatening. The shop floor environment in many male-dominated industries has a group behaviour pattern which is not always welcoming. Very often female visitors will be the recipients of catcalls, wolf whistles and less than complimentary remarks. The men react in this way, not because as individuals they believe it right, but because each accepts that this is the way the group is expected to behave and therefore conform to the pattern.

The introduction of women into such a group requires a critical mass of around 30% to reduce noticeably the disposition to

Hostile reaction. It is fascinating to note that in predominantly female working locations, the same reaction has not been observed when male visitors are present. Such environments that were 100% female can have 30% men introduced and the "jeering" behaviour does not even start to emerge.

Office behaviour patterns are often somewhat more covert manifest themselves as traditional role model expectancies.

A woman answering a telephone in a business is often assumed to be a secretary and the conversation takes on a certain dominance. Realisation that this may not be the case results in excuses being made and the conversation being curtailed. The caller may be embarrassed; the receiver rarely embarrassed but often offended. Care for one's fellows does not mean taking on board all the "domestic" duties. Equally it does not require the loss of simple courtesies (its polite to open the door for anyone 1)

Although these behavioural issues may appear trivial, the issue here is that behaviour is often a demonstration of attitudes.

THE BARRIER OF ATTITUDES

We are all judged not only by what we say but also by what we do. We can declare the acceptable view, but our behaviour will lay bare our attitude.

A pre-disposition to accepting women into any position or career is required by an organisation if it is to succeed. The demographic changes will leave some businesses in the lurch as women will not want to work in them. The choice will be the women's as to who will be the beneficiary of their talents.

Because the human is capable of acting, true attitudes can be disquised and the barrier is therefore sometimes hidden. Fighting a battle when you can see the enemy is not easy; when they are invisible calls for special awareness. Attitudes to women in positions of responsibility fall into three main categories.

The first is one of total acceptance and this environment allows access but still has some of the other barriers to be overcome.

The second is one of steadfast refusal to accept that women have a place at all. This, it is suggested is not a major concern as these enterprises will die through not being open to reality.

The third category is a more subtle attitude barrier issue. The

Attitude is one of acceptance for women to be in a position of responsibility …… "as long as she works for me and I do not have to work for a woman!"

BARRIERS OF LONELINESS

As more and more women achieve careers in their chosen sphere, this issue becomes less of a concern. Anyone in a strange environment will feel lonely at some time. Chief Executives, Senior Military Commanders, all experience a sense of isolation; this is not reserved to one gender. The ability to cope with loneliness is not new. The way in which all the barriers need to be broken requires determination, self belief and ability, coupled with the conviction that you will win.

The process of opening frontiers and the methods of breaking barriers have some universal traits.

BREAKING THE BARRIERS

The first to cross--new frontiers are the EXPLORERS. Often on their own, they are the ones who find, identify and define the barriers. Each has a strong, self contained and adventurous personality, not too pre-occupied with creature comforts.

Closely following are the PIONEERS. They too are individuals, independant, self reliant, and among the first to try life the other side of the barrier.

Then come the GOLD DIGGERS. They hear the good news, come and take the pickings but leave nothing behind. However, they are the opportunists who whet the appetites of others by making visible the benefits.

Following the plundering by the Gold Diggers, the CONTROLLER enters the field. The opportunities are exploited by organised, structured methodical development. Role models can begin to establish themselves.

Finally the SETTLER arrives on the scene, building existing orderly system and establishes the continuum.

We are currently at the PIONEER stage. In order to get the role models established, the process will need some support to allow women into the world of Science & Engineering NOW, and to encourage more to try the professions and become SETTLERS!

C John Baumber. April 1991

The Women in Technology (WIT) Project: Ten years of Positive Action for Women Technologist Returners (1981-1991).

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"I felt like a woman with a future", wrote a WIT student after the latest Return to Technology weekend for the Open University's Women in Technology project. For 10 years now the project has borne out this optimism both for the women themselves, and for the providing and funding bodies. The achievements speak for themselves, in terms of the numbers of women who have studied (over 600) and returned to paid employment; the expansion and diversification of the project: and the development of a specialist, women-only staff team.

Background

Women in Technology started in 1982, from a convergence of the research interests of Dr G Chivers of Loughborough University, and Ailsa Swarbrick of the Open University's Yorkshire Region, which both defined an unfilled gap in the career structure of women engineers, and suggested a means to over come it. In 1980 the Finniston Committee reported that "less than 1/2 per cent of the current stocks of engineers are women". The late 1910s had seen increasing efforts made to recruit young women at both technician and professional levels. But although women engineers who left paid work for domestic reasons rarely returned to engineering later, little attention had been paid to retention. Meanwhile, although many women were improving their qualifications through home-based OU study while at home with young families, very few studied technology. The vast majority of students on all OU technology courses were men, updating or improving existing qualifications while at work, and often sponsored by their employers.

The Project: Aims

The aims of the first model of the WIT project were to enable women with previous qualifications and work experience in engineering or technology to prepare for a return to their profession; to make them aware of the OU Associate programme for retraining; to help enquirers make the right choices by a strong emphasis on advice and counselling; and to promote confidence and skills in career planning. There were doubts voiced at the planning stage: - whether there were in fact any women engineers who wanted to return (one sceptic though we'd be lucky to get twelve!); whether it was possible to find them; and whether it would be worth the effort. By 1984, it was clear these doubts were groundless. 118 women had been through the scheme in three years. Their qualifications mainly ranged from HNC/HND to PhD, including all the branches of engineering, applied science and mathematics, with a significant minority who already had professional institutional status. They had worked for a wide range of well-known industrial employers, public companies or utilities, local authorities, and institutions of higher education or research; and they had worked on average for 6-1 years before their discontinuities began.

In labour market terms they were an investment worth recouping. They were also women eager to use again their professional abilities.

The Project: Content

Direct funding first from the Manpower Services Commission, and then its successor the Training Agency for publicity, project staff, and student costs has been of crucial importance. Non-means-tested bursaries have covered all course and residential school fees (with travelling expenses) for selected technology, science and computing courses studied as an Associate Student. The cost of such a package would normally be beyond the means of women with no earned income of their own, who tend to give a low priority to their personal claims on the family income. Changes in the Training Agency have meant that from 1990 women have also had a small training allowance.

Equally important, the funding has enabled Women in Technology to operate as a semi-autonomous positive-action project within the Open University. WIT recognised that as a minority group in a male-dominated faculty, its students would have special needs which must be met. The two main strategies have been to set up the all-women project office, based in the OU's Yorkshire Region; and to provide a residential Return to Study in Technology course at Loughborough University's Centre for Extension Studies. The aim is to give them enough confidence before and enough distance support during their studies to enable them to succeed
in the male technolgical environment.

The project staff organises and distributes the special WIT publicity through women's information networks. as well as the usual channels. Women technologists provide telephone advice and counselling for enquirers and applicants with referrals to the home region's project adviser if necessary. They continue to monitor progress through assessment listings and personal calls; and encourage a distance self help network and group attendance at summer school. This continuing support is in addition to that available to all OU students from their home regions, and undoubtedly contributes to the rate of high success and low drop-out in study.

All WIT students are required to attend the specially designed weekend which prepares them for OU study, encourages them to revalue their abilities, and advises on career-planning. The programme is a mixture of workshops. discussions and short talks. Women who have been through the scheme successfully describe their experiences, contributing to the rapid growth of self-confidence in the new students observed at every weekend so far held. Students arrive exhausted after organising family or household maintenance for their absence, but quickly regain their self-esteem - "I'd forgotten there were other women like me!", "Nice to admit having a degree in Engineering Science", and "I thought I was completely inadequate but now I can face the world again."

The Project: Expansion

WIT began with a staff of part-time coordinator and administrative secretary, one option for women technologist returners, and 38 bursaries for 1982. In 1984, with 56 bursary awards, the maximum three-year period as a pilot project came to an end. This co-incided with the WISE campaigns of 1984 concerned to promote equality of opportunity in education, training and employment. The funding body now agreed to expand the project by up to 30 extra bursaries for a second two-year option (which became Option 1), to widen access to technology for women without previous experience of work or study in that area. These women first studied the Technology foundation course, followed by a higher-level mare specialised course. Two women technologists had been appointed as advisers, to cope with the increase in student numbers, and the more complex range of enquiries. In 1987 a third technology adviser

And a vocational guidance counsellor joined the team. A short voluntary work-placement scheme began in late 1989.

Outcomes: Study

The course and employment progress of the WIT women have been monitored for up to five years after their course completion. Educational and vocational counselling have always been provided for enquirers and applicants, as well as for women given awards. WIT staff consider carefully the choice of course for each applicant. Discussion by phone and letter may result in a change of course if mutually agreed. The low withdrawal and high employment success rate indicates that resulting course choice is appropriate for most women. The course drop-out rate is lower amongst Option 2 women than Option 1 women, who do not have prior technological qualifications. A minority find the technical content of the courses too difficult. Progress analysis has revealed that for some courses, a strong background in maths is essential. Educational counselling at application now stresses this. However out of the 10/15% who withdraw, the majority do so either because of personal or family crises (illness, death, moving house) or because they have obtained work. It still tends to be women who give up steps to their awn career progression, to care for ill family members.

Outcomes: Employment

For every annual cohort of women, over 80% have eventually found jobs, (about 55% in full-time, 45% in part-time employment. During the ten years of the scheme the rate at which the women obtain work has increased. It took five years for 80% of women in the first (1982) cohort to be in employment; 80% of women in the sixth (1987) cohort were employed within a year of course completion. A growing emphasis on vocational counselling within the project has been important here. External factors have also contributed, such as more urgent pressure from the Training Agency and an improvement (until recently) in the general employment situation.

A recent innovation within WIT is the 6-8 week work placement. The majority of women have not pursued this: many had already obtained jobs, or preferred to focus on applying for jobs, or were unable to do (unpaid) placements because of the prohibitive cost of child-care, or lack of provision. For those who have completed a placement, it has been a resounding success. Employers have provided interesting projects and given good support to the women.

But personal circumstances still have a key effect on return to employment. For example, Molly had been one of a very small group who had studied a high-level microprocessor engineering package in 1982. After four years at home, and with two young children, she achieved an excellent result. However family moves because of her husband's job meant disruption of support and children's networks; and relocation from one rural area to another would have meant long journeys to relevant work. It was not until over six years after her WIT studies that Molly went back to professional employment, as a computer/programmer analyst for a company within walking distance! Her employer was interested not only in her previous experience in the chemical and energy industries, and her updating with WIT, but also in her activities in the voluntary sector during those six years. Here she had gained wider experiences and held positions of greater public responsibility than ever before.

Women respond differently, too, to the competing demands of family and profession. Catherine confidently returned to civil engineering with a regional authority after completing her structures course. She found the work enjoyable and colleagues helpful. But after two years of patching together care arrangements for her two young sons, she left for Further Education. She sees new, career opportunities now opening up. Yvonne solved the major issue of child-care by employing a nanny. She

Gained a distinction on her VIT course, and a new baby at the same time. There were no local part-time jobs, so she stayed at home for over a year before returning as a full-time chemical engineer.

Outcomes: Confidence

The aims of VIT include promoting confidence. Comments from the women indicate the experience of the majority - an increased confidence in themselves. "The WIT course was invaluable in building up my self confidence and knowledge- <Programmer>."The year I took my WIT course was a turning point....my whole outlook became more positive" <School Laboratory Technician>. Even when a woman engineer has worked hard at maintaining some of her skills in other relevant work, the move back to engineering can still seem daunting. Louisa had left full-time work as a microwave engineer 12 years before. During her 'career-break' she had produced and brought up two children. She had also worked part-time for her old employer, done scientific legal work, abstracting, and college lecturing. After her WIT course, she had continued at college for two years until taking the plunge back into microwave engineering. "The greatest value of the WIT course was the confidence it gave me to return to engineering after a 12 year break- she said. Since then she has moved from part-time to full-time work, and been promoted.

Outcomes: Career Change

Another aim of WIT is to make women aware of the Open University as a means of retraining. The follow-up of WIT women show that many continue to study in the OU while working, to enhance career progress. Some, especially from Option I, make a major career change. For example, Shirley entered WIT in 1985 with a Diploma in Drama. She had managed a touring theatre company for seven years and had then been unemployed for nine years. After her two courses she obtained a full-time job in technical sales, continuing to study with the au while in employment. She used these credits to obtain entrance to the second year of a structural engineering degree at a conventional university, and is now in her third year. Karen had not fulfilled the entrance requirements for teacher training twelve years before, and had worked in the civil service instead. Once her youngest child had started school she reviewed her plans. After following the OU technology foundation course with a design course she found work in an architectural and leisure practice, while studying to improve her maths. She is now happily studying for a degree at a local university that will enable her to teach in a school technology department.

Conclusion

The WIT scheme has continually responded to changes in Training Agency regulations, and revised policy and practice in line with reviews - most recently with regard to equal opportunities for ethnic minority women. The major limitations on the success of the scheme result, not from the women or the WIT scheme itself, but from the lack of long-term or larger-scale funding. Two main barriers remain to WIT women utilising fully their technological skills for the benefit of themselves and the economy. First noted in 1984, they continue to be the lack of flexible working arrangements offered by employers, together with a widespread inadequacy of child-care provision. Only if both these barriers are addressed comprehensively and at a national level, will WIT women be able to develop the family relationships they want with the employment of which they are capable.

Five major reports on the project (1984, 1986, 1987, 1989 and 1990) are available from the VIT Project Office, The Open University, Fairfax House, Merrion Street, Leeds LS1 8JU.

Review of the Women in Engineering and Science Situation in the United Kingdom, and Initiatives to Improve the Position

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SUMMARY

Compared with other countries, the United Kingdom has reasonably acceptable numbers of women scientists, especially in the biological and chemical sciences. However the numbers in physics and especially in engineering have been extremely low, until recent years. A wide range of initiatives has been Introduced to improve the situation. These have been partially effective, but much remains to be done.

HISTORICAL BACKGROUND

In the UK the situation in regard to women in science, while by no means satisfactory, has been broadly comparable with the situation in other Western countries. As usual, the biological sciences have considerable appeal for girls, and in terms of school studies girls are at least as involved as boys up to the minimum school leaving age of 16 years. Indeed, there is broad gender balance up to "A" level (the 'Advanced' level examinations taken at age 18 years prior to entry to higher education).Beyond this level attrition sets in in terms of high level qualifications for women, and even in the biological sciences the proportion of women achieving post-graduate qualifications is lower than for men. Many young women with "A" level biology tend to take up nursing or 'paramedical' careers rather than entering higher education, others become technicians.'

The physical sciences are considerably less popular at school level. Chemistry is, l'1avever, a good deal more attractive than physics, and this is reflected in the numbers of young women taking up degree courses or other higher/further education studies in chemistry or related fields. Sane 30% of chemistry graduates are women. The situation is much worse for physics. This is not a popular subject for boys or girls at school level. However, boys will tend to keep going with physics because of career considerations. Most girls will drop the study of physics at the first opportunity. The educational system has allowed early specialisation in the past, with 13-14 year olds being allowed to choose a limited range of subjects to continue studying from a large number. This option to choose away from physics at

Such a young age is certainly one of the main reasons why so few girls and women have entered technological careers. Not only do we find few young women taking up degree studies in physics, but the numbers entering engineering degree courses (and sub-degree courses) has been very low since most of these courses require physics qualifications from school level (typically" A" level physics for degree courses).

For this reason and others the UK has had an extremely low proportion of women engineers, with only about 1 in 1,000 female members of most professional engineering institutions. Until 20 years ago the percentage of women engineering students at undergraduate level was around 1%. This figure has hardly varied over the previous 25 years from the end of the Second World War. Figures for women technician engineers were even lower.

Even given the low numbers of girls studying physics at school the numbers of women engineering students has been exceptionally low in Britain. It seems that women students of science have been much more attracted to careers in medicine, science and teaching. Doubtless, part of the reason for the unattractiveness of engineering has been due to misunderstandings about what, ' engineering' meant. Even middle class parents have often taken 'engineering' to mean work at semi-skilled, craft or possibly technician level. The word is used in Britain to refer to, for example, car mechanics, television or washing machine maintenance and repair staff or welders. There has been a long standing image of the engineer as a big-built man in a blue boiler suit with a spanner in one hand and an oily rag in the other. In films he is typically shown in the engine room of a ship taking orders from a smart uniformed officer with an upper-middle class voice, and replying with a Cockney or Scottish accent. These problems of image are not easy to cambat, and a great deal of effort has gone into publicity to explain the role of the professional engineer in today's society. A further problem has been the relatively low status of professional engineering compared with other professions in the UK. Doubtless, this is partly the outcome of the 'image' problem just described. Additionally, Britain has struggled with an anti-industry bias amongst influential members of the Establishment and generally amongst the middle-class for over 100 years. Thus, medical doctors, lawyers and financiers have considerably higher status and higher pay than engineers, and parents encourage their talented daughters into these fields.

INITIATIVES TO ll1PROIJE THE SITUATIOO

The dearth of talented people in industry is one of the reasons for its ongoing decline in the UK, and the past 10 years has seen an emphasis on stressing the importance of manufacturing industry to young people. The continued cuts in the public services have certainly reduced the attractiveness of education, the health service, the civil service and local government, areas where able women have mainly sought careers. These developments of themselves are partially responsible for the improvement in the proportion of girls taking forward technically related studies and seeking careers in industry. However, there have been many initiatives over the past 15 years to encourage girls and women into technological study areas, and to support them while studying. Space does not permit accounts of individual projects here. I have myself been involved in a number of pilot projects which have proved successful and have in sane cases been taken forward on a national basis. Fran studies in many countries it is my view that the UK has seen a greater variety of imaginative initiatives related to women in engineering and technology than any other except possibly the USA. This has been possible because of the extremely pluralist nature of British society. For example the education system is extremely diverse, with a wide variety of state and private schools, the state schools being controlled by

Many local authorities with widely varying political viewpoints, and similar diversity within further and higher education. Similarly, there are many professional engineering institutions, governmental and semi -governmental bodies and charities with concerns related to women and technology.

The diversity of effort is well illustrated by the lists of initiatives: undertaken during 1984, which was designated by the Government as WISE (Women into Science and Engineering) year. Such initiatives typically involve or include: - brochures and posters, exhibitions and career days, visits to industry or to the engineering departments of higher and further education colleges, competitions for schools or individuals involving technology projects, special study scholarships, industrial work placements specifically for women and so on.

EFFORTS TO ACHIEVE DEEP SEATED CHANGE

As time has gone on so the emphasis on more profound changes has increased. It is now widely recognised that the education and training systems and institutions of the UK have involved deep seated sexism. While this has been true for all studies, it is not surprising that male chauvanism has been especially demonstrated in technological fields. Educational institutions have increasingly recognised this and have acted to change the situation via staff development programnes, re-design of the curriculum to better reflect the interests of women, special efforts to recruit women teaching staff, and generally to 'feminise' their agenda. While there have sometimes been attempts to oppose such changes, most men in powerful positions accept that change is. Desirable even if they make little attempt to help! At the very least there is a wish to recruit and retain good numbers of able students, and if this can be done by attracting more women students so be it.

In general terms employment prospects for women physical scientists and engineers are bright. While there may still be sane employment fields (such as steel making or coal mining) which are difficult for women technologists to enter, and sane employers with negative attitudes, most employers are very pleased to recruit women technologists and engineers. Sane industrial employers are developing their own initiatives to recruit and retain women engineers, and a good number contribute generously in financial terms to such initiatives.

THE CURRENT POSITION

As a result of all these efforts the percentage of women studying engineering and technology at degree level has risen to sane 15%, with a slightly higher proportion in the universities compared with the polytechnics. As in other countries, there is considerable variation in the attractiveness of particular fields, with chemical engineering being particularly favoured, civil engineering also being quite attractive, while mechanical and electrical engineering are much less popular. This can lead to institutions having 30% of their chemical engineering students being women, while only 6-7% of their electrical engineers are women. Undoubtedly, the most disturbing statistics in the whole field are those relating to women studying computing. Twenty years ago girls and women were well represented in the computing field, with over 25% of computer science degree students being female. Now the figure is down to 12% for single discipline computer science degrees. A1though the situation is better for broader information science and a technology course, this situation is very disturbing, given the importance of computing in today’s society. Many of the most significant initiatives and networks at present are related to increasing the involvement of women in computing and IT at the higher levels.

The Government has recently introduced a National Curriculum to be followed by all state schools which will reduce early specialisation and place m::>re emphasis on applied topics and practical skills.

ORGANISATION AND NEIWORKS

Organisations that should be mentioned because of their commitment and success in regard to women in technology initiatives over the years are The Women is Engineering Society, The Engineering Industry Training Board, The Engineering Council, and The Open. University, the Equal Opportunities Commission, and the Association for Science Education. Amongst industrial concerns the British Petroleum Company, feature strongly amongst organisations that have supported a wide range of initiatives to encourage girls to study physical sciences and technology.

A number of networks have grown up to further the cause of women in technology including WIC (Women in Computing), WIT (Women in Technology and WITEC. (Women into Technology and Enterprise in the European Community) WITEC is a European wide umbrella organisation, with its HQ at Sheffield University. It links networks and organisations concerned with gender issues in technology and industry and with supporting women studying and working in technology and enterprise fields.

WITEC is supported by funding from the European Community' s COMEIT Progranme and has partners in most EC and EFTA States.

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Women Technicians and Scientists in Mexico. Their Education, Training and Employment

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The Mexican Republica is formed by 32 states; in a surface of about 2 million square kilometers; it has a population of a little more than 80 million inhabitants. In general we estimate that in the Mexican Republic:

"Women are not encouraged to enter the technical and scientific superior studies. Working women students do not receive any help 0 incentives to continue their studies. If two technique, science 0 even humanities students happen to get married, generally the woman does not finish her degree. No precise data are available about the technical or executive positions technical and scientist women hold.

Acording to the data furnished UB by the **National Association *of* Universities and Superior Studies Institutes (ANUIES),** We have:

GRADUATES IN 1989:

In Public Institutios: 93 107 and in Private Institutions: 22 300

THOSE ENTER [NG FOR THE FIRST AND SECOND TIMES (1990):

In Public [institutions: 541 409 men and :348 963 women and in Private Institutions: 101 979 men and 85 840 wom6n.

Professional Education of Women in Pakistan: Present Status and Trends

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SUMMARY: This paper deals with the importance of professional education of women, problems faced by them and job opportunities. The recommendations made to enhance their enrolment in scientific and technological fields are: increased number of female institutions, proper education counselling, scholarships and better job prospects.

Professional education is the knowledge acquired with distinct skill in some dedicated field. A first assumption by all planners and policy makers is that professional education is a powerful tool in promoting social and economic development. The complete utilization of ALL human resources in developing countries, like ours, is a very obvious and common sense approach to doing development well. The approach to the study of women's role and status in development context is not to be viewed as an end in itself but rather as a means to promoting more effective development overall.

Education is human knowledge applied to human needs. It is not gender related but affects all people and all needs from the most humble to the most sophisticated [1]. To ignore 50% of the world human resources by focusing the use and transfer of technology and other development efforts on men only is an omission that is highly detrimental to the future of whole society.

Integration of highly educated women in development process has become a national and international theme. In developing countries, trained manpower often leaves their country for better job prospects. In contrast women being bound to their families can not leave their country easily, so this gap can be filled by educating women. Moreover, Hi-tech projects in developing countries are not under-taken for the fear of being hampered by the non-availability of manpower. By focusing attention on 50% of the unused population, these obstacles can be overcome. Also the attitude of society towards acquisition of technology would certainly upraise if more women are attracted in professional fields [2].

A cursory look at Table I will reveal that the percentage of Women's participation from initial to higher levels of education is extremely low [5].

TABLE I. NUMBER OF STUDENT IN EDUCATIONAL INSTITUTIONS BY KIND/ LEVEL AND SEX (YEAR 1987-88)

Level of Education	Total in thousand	Female in thousand
Primary	7368	2558
Middle	2004	545
Secondary	690	186
Bachelor of science &Engg.	19.287	1.356
Master	6.41	0.318
Ph.D	0.075	0.016

The feeble enrolment of female students can be attributed to the following causes:

(a) Lack of realization about the importance of female education
(b) Scarcity of female institutions in rural areas.
(c) Infra-structure of society which prevents women folk to acquire education.
(d) Meagre per capita income.

The situation gets even worst for the professional and higher science education, where there is a sharp drop out in number of girls studying science as shown in Table II [6]

TABLE II. FACULTY WISE ENROLMENT OF UNIVERSITIES (YEAR 1985-86).

Faculties	Bachelor		Master		M.Phil		Ph.D	
	T	F	T	F	T	F	T	F
Faculty of science	5159	1244	6037	1513	131	20	75	16
Faculty of Pharm	1495	430	112	26	-	-	7	-
Faculty of Engg.	14128	466	374	-	-	-	-	-

Likewise the number of women graduating from professional colleges is not even 20% of the total number of graduates as is obvious from table III (5).

TABLE III. ENROLMENT IN PROFESSIONAL COLLEGES (YEAR 1985-86)

Educational institution	Total	Male	Female
Professional colleges	64955	51652	13303

To enhance the enrolment of women in scientific and professional disciplines, new provisions are being taken into account while formulating education and national science and technology policy. Fifth and Sixth five years

Plans recommend opening of post graduate colleges for women and provision of hostel and transport facilities. Women's University which was a traditional demand has also been established.

POPULAR PROFESSIONS AMONG PAKISTANI WOMEN.

Although scientific and professional disciplines are wide open for women, some particular fields have become more attractive, the reasons being social and cultural setup of the society. Following are the popular professions adopted by Pakistani women.

TEACHING

For girls having degree in science disciplines, the choice of professions is very limited, teaching is one of them. According to Bureau of statistics, total number of female science teachers in science colleges and universities comes out to be 1708.

MEDICINE

Pakistan has 22 Medical Colleges, 2 are exclusively for girls, other colleges have quota system for admission. The number of teachers in medical colleges during 1983-84 was 2114 out of which 221 were female. The total enrolment in these colleges was 29,494 out of which 9165 were girl students. The statistics of female doctors registered with Pakistan Medical & Dental Council is given in Table IV [71.

TABLE IV. PROVINCE WISE STATISTICS OF FEMALE DOCTORS.

Province	Punjab	Sind	NWFP	Baluchistan	Total
Lady Doctors	3494	3944	651	208	8297

ENGINEERING

Engineering profession has generally been considered an exclusive field for men. This concept, however, is changing rapidly with emerging opportunities for women to join specially in the field of architecture, Civil, Electronics Chemical & Mechanical Engineering. Up till now 354 women engineers have been registered with Pakistan Engineering Council.

COMPUTER SCIENCE.

With the fast increasing role of computers in industry, computer related education has become the crying need of our age. With their patience, adherence and sophistication, female computer operators are more in demand. In last decade computer science has become a very popular- field among women. Unfortunately no statistical data of women having degree in computer science is available separately.

JOB OPPORTUNITIES.

For full absorption of educated women: in industry, Pakistan Government has taken a number of constitutional and legislative measures to eliminate. Discrimination against women in employment. But in actual practice, large gaps remain to be filled. No complete statistical data of highly educated/professional women employed. is available but the information gathered from different sources reveals that they even do not constitute 2% of total male professionals. The steps taken by Government to enhance women's activities in practical fields are very

Encouraging like government hostels, transport facility, maternity leave, transfer consideration's and special facilities of child care. Inspite of all these facilities, following factors are responsible for the invisibility of women outside their homes:

1. Social and cultural taboos.
2. Age limit in government organizations
3. Early marriage.
4. Numerous myths regarding inferior intellect of women for scientific work.

IMPACT ON SOCIETY

Old traditions and misconceptions are slowly wiping out from the society and new ways and means are becoming open to those who were neglected for a long time. Realizations about women's work, their participation, their problems and programmes to improve their social and economical conditions have now been accepted on large scales. A number of women organizations such as WOMEN'S DIVISION, PROFESSIONAL AND BUSINESS WOMEN CLUB, WOMEN'S ACTION FORUM, APWA etc. are working from community to international level to motivate women's activities [3]. Many individuals and sub organizations have endorsed promotional activities to correct the distorted image of women and their work in society. Whether and to what extents society is affected,
is difficult to determine, but some important factors are:

1) Educated women, being aware of their capabilities have knocked . down traditional barriers, previously set in their path [4] .
2) Economical benefits, enjoyed by working women families lead men oriented society to change its dependence solely on men.
3) Family problems along with job put constant tension on working women. At times they have to decide between their profession or family.
4) If a complete survey could be inducted, it would have revealed that children of working women are always faced with special problems peculair to their group.

CONCLUSION AND RECOMMENDATIONS.

The overall situation of educated women is still unsatisfactory and requires special attention. To enhance female participation in S & T fields, following recommendations are made:

1) Number of female institutions should be increased.
2) New professions should be made attractive to women.
3) Job opportunities for women in S&T fields should be increased.
4) Proper education conselling should be provided.
5) Proper encouragement to women participants in educational fields should be provided in the form of scholarships.

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Women in Engineering in Canada

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In 1990, fewer than four per cent of professional engineers in Canada were female. Nationally, women represent about 15 per cent of undergraduate engineering students, while law, business and medicine have reached gender equality. The highest level of enrolment of women was in the field of chemical engineering (30%), followed by geological, civil, industrial and agricultural (near 20%). Enrolment in a Master's degree was 10% and 6.1% for the doctorate. There were 2.2% women faculty. The main underlying reason for the under-representation of women in this field is the lack of awareness on the suitability of engineering careers for women and on the particular contributions they can make.

The process of preparing young women to become engineers begins at birth. Despite the increasing numbers of women in non-traditional careers in the workplace, societal attitudes and pressures still channel women into traditional roles. For the women who do choose the field of engineering, many still face systemic barriers affecting their career progression. Some working and learning environments do not nurture females and some women report they have dropped out of the profession because of isolation, lack of respect and lack of support.

The Canadian Committee for Women in Engineering (CCWIE) has held six regional public forums where 160 briefs were presented. Over 35 private briefs were received, many describing the experiences of women working and studying as engineers. The CCWE also commissioned research into effective practices to recruit, retain and advance the careers of women engineers, which involved seven faculties of engineering and six workplaces across Canada.

The CCWE reviewed the briefs, refined and prioritized the recommendations and will now develop action plans. Four main sectors were targeted: pre-university and engineering education, workplaces and the Professional Associations. The draft recommendations discussed here concern education issues.

EDUCATORS IN THE PRE-UNIVERSITY SECTOR SHOULD PREPARE GIRLS FOR ENGINEERING CAREERS BY THE FOLLOWING ACTIONS:

- Enhance the mathematics and science curriculum by
  - including references to women's scientific achievements;
  - incorporating teaching and evaluation styles which recognize feminine talents and perspectives;
  - Increasing the emphasis on science at the elementary school; - including applied science topics in the curriculum.
- Ensure girls have opportunities to develop self-confidence and competence by:
- creating separate laboratory groups for female students;
- ensuring boys and girls in equal numbers pursue mathematics and science throughout their high school years;
- developing extracurricular science/mathematics activities/clubs that would allow young girls to meet role models, have more freedom to experiment, and discover that science can be fun; and
- initiating a work-experience program for high school students

- Ensure girls interact with more female role models by:

- initiating and promoting visits to schools by female engineers, female engineering students and professors;
- encouraging and supporting career development for female science and mathematics teachers; and
- Ensure girls have equal and unbiased access to career information and guidance by:
- providing guidance counsellors and teachers with up-to-date information on workplace skills and the success of women in non-traditional careers;
- Ensuring that counsellors understand and support the concept of changes in gender roles.

TO ENHANCE THE RECRUITMENT OF FEMALE UNDERGRADUATE AND GRADUATE STUDENTS, ENGINEERING FACULTIES SHOULD:

- Initiate specific efforts to recruit and retain women in engineering programs until at least 35 per cent of the new students at all Canadian engineering schools are women.
- Offer workshops for guidance counsellors and teachers to make them aware of new engineering programs and career options open to students who pursue mathematics and science.
- Support and give credit for visits/presentations to elementary and secondary schools by students and faculty.
- Create and expand summer science and engineering camps for elementary school children.
- Ensure that qualified students are aware of scholarships and that qualified women are encouraged to apply.
- Hire/appoint an individual to advise the dean about issues of concern to women students.
- Evaluate the success of recruitment and retention programs by polling all first-year students about why they chose engineering, and interviewing all students who drop out of engineering.
- Recruit and encourage qualified female students to pursue graduate studies by offering challenging and well-paid research projects, instituting co-operative work/study programs and instituting part-time graduate programs;
- Ensuring that students are aware of the range of funding available for graduate studies and supporting graduate students/research assistants on parental leave.

- Encourage mature students, including those with nontraditional backgrounds, to enter engineering programs by offering introductory, transition, and/or qualifying courses and adopting flexible admission policies, including transfer of credits from other educational institutions; instituting part-time studies and sponsoring special scholarships and bursaries for part-time learners; and establishing and marketing awards programs for individuals returning to university following a break.

TO RETAIN STUDENTS, FACULTIES SHOULD:

- Create an environment in the engineering faculty that is free of sexism, racism and homophobia by adopting and enforcing a written code of behaviour that would govern the acts of engineering students and adopting and enforcing a policy of gender-inclusive language;

- Establishing a gender-balanced editorial board and adopting a formal editorial policy for student engineering publications; and ensuring that all students and faculty are familiar with the university sexual harassm3nt policies and that individual with sexual harassment complaints can approach university sexual harassment officers/committee in confidence.

- Reinforce positive efforts to create a better environment and a more positive image of engineering students by reinforcing and formally recognizing student activities such as student government, volunteer work, charity fundraising and other community activities; and recognizing male and female role models who behave in a non-sexist fashion and use gender inclusive language and examples in class.

- Provide mentors/resource persons for students by recruiting mentors for first-year students from among third- and fourth year students, recruiting mentors for senior students from among faculty, engineers in industry and professional associations and matching female mentors with female students who would prefer a woman as a mentor.

- Provide comprehensive support for students by ensuring services such as tutorial services, orientation sessions, conferences, seminars, and counselling are made known and available to female engineering students; nominating qualified women for scholarships and awards; offering hands-on activities to first year students so that they will be confident in their abilities to do engineering laboratories; ensuring libraries, computer and other laboratories are open, secure and safe on weekends and evenings; creating opportunities/space for rap sessions for men and women to discuss issues of concern.

- Ensure the engineering curriculum is relevant to current societal realities and needs by incorporating material in existing courses or creating new courses to make students aware of human rights in the workplace and to train them in people skills and assertive communications; including in the engineering curriculum references to women who have made contributions to engineering and science; creating a compulsory second or third-year engineering course to explore the impact of science and technology on society so that engineering students will be made conscious of the impact of their decisions and designs on society; and creating innovative ways in which engineering and arts students and faculty can interact so that engineering students develop an understanding of the arts and arts students are more comfortable with technology.

- Develop co-op programs where they do not already exist, and ensure women students benefit from these programs.
- Investigate the academic workload and average graduation period for engineering students.

RECRUITMENT AND RETENTION OF FEMALE FACULTY

Faculties of Engineering should develop, implement and report progress annually, plans to increase the proportion of female faculty. Universities are responsible for creating an attractive. Environment for women with career interests in teaching, research and administration. Faculties should:

- Increase the proportion of female faculty in engineering by establishing reasonable targets, adopting equity measures if necessary as part of the hiring plan; provide funding for female students to pursue graduate studies; establish co-operative programs that would allow qualified female engineers from industry and government to teach on a limited-term or part-time basis and to give lectures and presentations.
- Ensure all faculty understand the logic of employment equity measures and the benefits women faculty brings to the teaching of engineering; instituting gender awareness/sexual harassment orientation programs for all teaching and administrative staff.
- Support and encourage women faculty by: adopting clear policies prohibiting sexual harassment, and incorporating procedures for lodging, assessing and resolving complaints, and for reporting on resolutions; provide day care at cost or a day-care referral system; ensure maternity and paternity leaves do not interfere with progression or the acquisition of tenure and promotion; guarantee pay equity; offer part-time faculty positions; provide mentors for new faculty; compile, distribute and keep up-to-date a list of all women engineering faculty at Canadian universities so that women faculty can network with each other.
- Adjust tenure and promotion criteria by recognizing the impact of family responsibilities; giving credit for participation in recruitment/mentoring programs; and injecting flexibility into the tenure and promotion system and their time frames.

CONCLUSION

All stakeholders have a responsibility to create an awareness among parents and the public regarding the role of women in engineering. The engineering profession and its image will be enhanced by greater participation of women. It may become a more caring and balanced profession that considers the impact of engineering designs and projects on society, the environment and the health of individuals. In an increasingly diverse workplace, women engineers will contribute to development and the image of the profession by bringing complementary talents and skills to the workplace. The economic well-being of Canada and the development of its technological base depend upon the recruitment of the best engineers. If the pool of potential engineers originates from only 50 per cent of the population, excellence and standards in the profession will be lower than would be the case if the entire population were represented. It is imperative that the engineering profession change its image to one that is more dynamic, human and visible. This change of image is the responsibility of all stakeholders, as individuals and as representatives of the profession. Women must have an equal opportunity to pursue careers in engineering, and must be respected in the university and the working environments as well as by all professionals in the field.

Some Factors Hindering Women Scientists in Their Success

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SUMMARY: this paper gives a statistical description of the general situation of Chinese women in their education and being engaged in science and technology in the last ten years of reform and opening to the outside world. It deals mainly with problems of the women in scientific and technological circles in their work and life.

With the reform and the opening to the outside world as well as social progress in China, there is a higher requirement on working women. Many working women actively participate in various kinds of spare-time study and vocational training to increase their educational standards and enhance work and management skills. More females have received higher education since 1978. The proportion of female students between 15 and 19 of age increased by 23.34 percent in 1987, a 8.24 percent jump from 1982 [1]. The total of the female students in universities and colleges was more than 640,000 in 1987, three times as much as that in 1978 [2], consisting one-third of the whole students in universities and colleges.

According to the State Statistical Bureau, China had a total of more than 4.44 million female scientists and technologists by the end of 1986, accounting for 31. 7

Percent of the country's total, an increase of 37.3 percent over 1978 [3]. There are 1,456 female scientific and technological personnel who were awarded various science prizes by the State in the last ten years. The old generation of female scientists and technologists has made outstanding contributions to the advancement of science and technology. A large number of young female scientists have also sprung up. In 1987, the State Science and Technology Commission approved [5] young and middle-aged female scientists and technologists who had made outstanding contributions as State-level experts. Up to 1988, China had 63 female experts at the State level [4]. They have played a major role in the progress of science and technology, and have contributed to the commercialization and industrialization of high and new technology products.

However, it is not easy for the female scientific and technological personnel to make achievements in their scientific research. It is not easy especially to obtain outstanding achievements. The reason for it is two-sided. In subjective respect, a part of women are still affected by the feudal idea of male supremacy. They have cultivated the female inferiority complex themselves. Passive obedience and dependency mentality still exist in their minds. All these undoubtedly hinder the development of their career and wisdom. In objective respect, in some work units there are feudal ideas such as regarding men as superior to women. In addition, some units worry about the interruption of work by women getting married and bearing child, especially under the condition of implementation of the optimum organization of workers. For example, when enrolling students or workers, many organizations and institutions prefer men, even though men and women are at the same level of ability. And there are higher requirements on women so as to exclude them, For instance, some women graduate students got better results than men in taking an entrance examination to a certain research institute, but the institute still didn't want to enroll the women. At last, only two females were enrolled.

As to the employment of woman graduates from universities, discrimination phenomena are serious, such as returning them to their universities or simply

Refusing to accept them, regardless of whether they are assigned by the State or seeking a job by themselves. Undoubtedly these exert pressure on women ideologically and psychologically. In addition, a cause that shouldn't be neglected is that the women's household chores interfere with their scientific research to a large extent.

A investigation from the organizations concerned showed that the female Scientists and technologists have to spend 2 to 4 hours shopping and cooking every day. About 15.7 percent of them have to do all of housework and the rest have to do a part or the most part [5J. At present, the socialization level of housework in our country is quite low. Many household chores -- strenuous and boring -- must be done by women themselves. Most woman scientists and technologists are unwilling to lag behind in their work. and must make every effort to that end. For example. Taking UP advanced studies in their spare time. So some of them are in poor health because of the heavy burdens. Under these circumstances, woman scientists and technologists have to make different choices to resolve the contradictions between their work and daily life. A few of them have to take good care of their families, giving up their own goal. Most of woman scientists and technologists give considerations to both work and family life. Some of them who are devoted to their careers have to. Lo some extent. Sacrifice the interests of their families, however. They often attend to one thing and lose sight of another and it is hard to make success in both their careers and family life. Only through economic and social development can various kinds of services such as good nursery. medical services and catering trade, etc., be provided to women engaged in science and technology, thus extricating them from their' strenuous housework.

At present, some housework have been socialized, but it is far from meeting the demands of the masses of scientific and technological personnel. For example. The "neighbourhood service centres for women and children" have been set up by some scientific research institutions to solve scientists' (specially woman scientists')

Troubles at home. Some nurseries for babies under 1.5 years old have been set UP, and also "pre-school education classes" have been organized teaching children how to draw, dance and recite. These classes are favourable to the development of the children and to their parents as well. In addition these service centres are preparing to provide other services and to set up various kinds of service branches. Though a lot of difficulties exist, such as funds, houses etc., this work has been started under the support of departments concerned, and some initial results have been got.

In any case, to achieve the same success as men, woman scientific and technological personnel have to pay a higher price, and bear a heavier load and psychological pressure. Therefore, a better social environment is needed to create more woman scientists and technologists.

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The Role of Women in the Development of Science and Technology in Mexico

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SUMMARY. Women's participation reached the 24.3% of the total scientists in Mexico. This proportion changes depending on the education level, area of knowledge, and the regions in the country. Results show the necessity of increase and create new programs and investigations about the obstacles in the access to education and scientific work that Mexican women find.

This work deals with the characteristics of women's participation in scientific and technological activities in Mexico, with the aim to obtain images of their present situation and to propitiate the discussion about the role of women in the development of science and technology in the country. Participation of women in science education and research activities was studied. Student enrolment records were analysed by academic level, starting from higher education (see table 1), as well as data collected from national institutions of education, science and technology.

TABLE 1. STRUCTURE OF FORMAL EDUCATION IN MEXICO
POST DOCTORAL STUDIES AND RESEARCH
DOCTORATE DEGREE STUDIES (2-5 years)
MASTERS DEGREE STUDIES (2-4 years)
HIGHER EDUCATION (UNIVERSITY AND PROFFESIONAL STUDIES) (4-6 years)
BACHELOR DEGREE (2-3 years)
SECONDARY SCHOOL LEVEL (3 years)
PRIMARY SCHOOL LEVEL (6 years)
PREPRIMARY SCHOOL LEVEL (3 years)

In Mexico, university population is the origin of human resources for postgraduate courses and research. In universities and higher education centers, the greatest percentage of students has been represented by men, but during the last years, this proportion has been changed. In the 1969 to 1985 period, higher education enrolment growed 4.19 times, men population in a rate of 3.3 and women in 9.4 [1].

The proportion of students at higher education level in Mexico is indicated in figure 1; it shows the growth of women students as percentage of total population in the last 15 years. (1-A). The Universidad Nacional Aut6noma de Mexico (UNAM) is considered one of the most important institutions of higher education and research in the country (the greater student registration; 60-90% of the scientific activity; second place between the institutions that share the federal government budget in science and technology), for all this reasons, the incorporation of women was studied. Data collected showed that in 1980, 65% of the total scholar population was constituted by men and 35% by women, in 1990, this proportion is 56% and 44% respectively (1-B). Women's choice of different areas of science education can be seen from figure 1-C, in some disciplines, such as biology, chemistry and medicine, women's participation achieve equal values in comparison to men; in social and human sciences, like education, psychology and communication, there is a great percentage of women, however, there is still a reduced number of women in areas that have impact on the production, and define the economic relationships in the country and in the world (physics, engineering, mining and agronomy).

The next steps in scientific education are the masters and doctorate degree studies. When the number of women holding postgraduate scholarships granted by the Consejo Nacional de Ciencia y Tecnologia (Conacyt: a national organism that grants the majority of scholarships), is analysed, it is observed that in the years of 1971 to 1982, represented 23% of the total, and in1989, it increases to 33.3%. In the same way, the students with master and doctorate degrees, from the two institutions that have the greater number of graduate students per year, shows that in the last decade, it has ocurred an increase of 10% in the presence of women [2]. In 1984, the Sistema Nacional de Investigadores (SNI) was created whith the purpose to propiciate research, granting scholarships and support according to academic formation and productivity of scientists from higher education and research institutions in Mexico. The evaluation of its members shows that 20% are women, and from 1984 to 1990, the number of men and women scientists grows in a different way, there is no homogeneous distribution by areas of knowledge, and as the level goes further, female presence is reduced [3] (figure 2).

The participation of Mexican women scientists in 2 important research institutions of the country was evaluated. Results showed the number of women scientists in the 29 schools and centers that constitute the research system of the Instituto Politecnico Nacional (IPN), represented 26% of the total, and the percentage of women scientists in the research system of the UNAM in scientific areas, reach 30%.

The presence of women in higher stages of the scientific profession and at .policy making levels is very small. It is observed that management and planning places for women, only obtain 2% of the total [2].

FIGURE 1. PROPORTION OF STUDENTS AT HIGHER EDUCATION LEVEL IN MEXICO

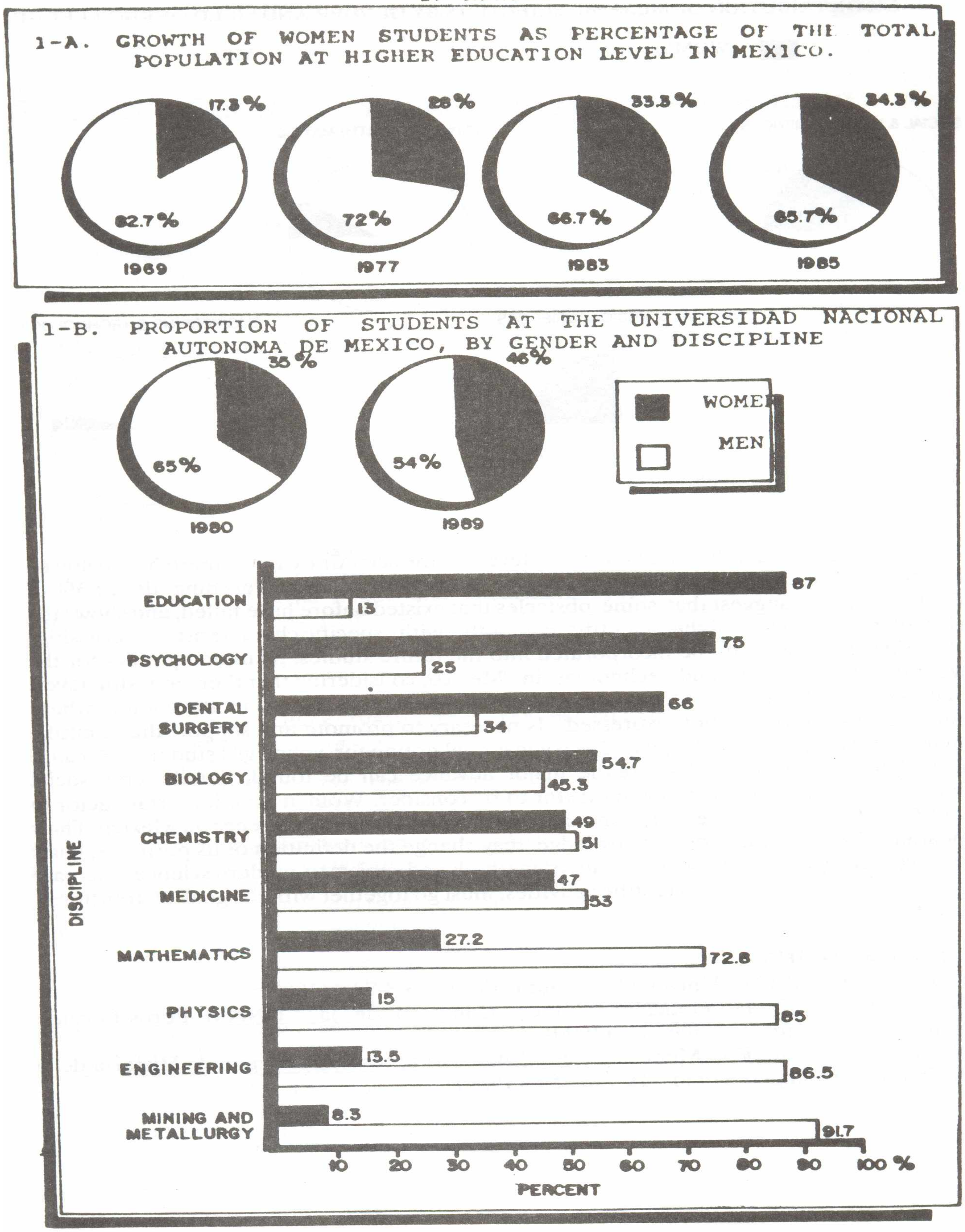
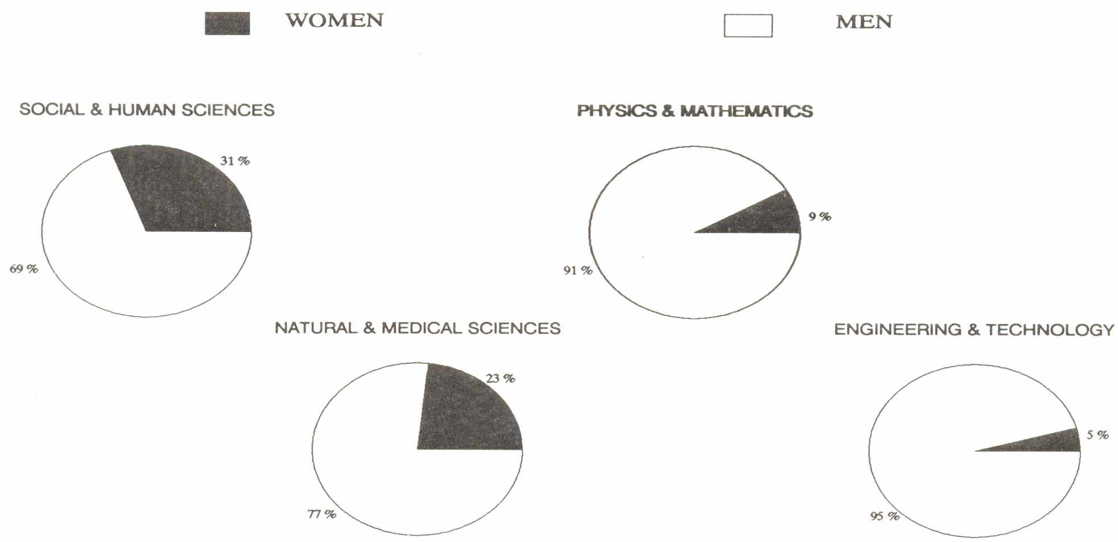


FIGURE 2. DISTRIBUTION OF MEXICAN SCIENTISTS BY GENDER AND FIELD OF KNOWLEDGE



The studied decade, shows that in each level of the scientific career, there had been an increase of women. Gradual incorporation of women to science, reaching the 24.3% of the total scientists, suggest that some obstacles that existed' before have failed, and shows the arrival of a new sector at the scientific community with specific characteristics, necessities and claims that have to be incorporated into the future studies, plans and politics for the development of science and technology in Mexico, considering that there are still levels of academic and scientific education, areas of knowledge and regions in the country where women participation is not expressed. Is necessary to promote and support the scientific activity in all areas of knowledge and as a vocational option for young girl students. Because it is in higher education level where the major advance can be found, family and social encouragement may be an important factor to be consider. Woman is an important actor in scientific activities that gives a new indicator of the development of science in Mexico. Their appearance in the production of knowledge may change the definition of its purposes, goals and judgments, giving new focus in analisys, methods and subjects to modern science. Increase opportunities of women in scientific activities, must go together with the goal of transforming science.

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Scientific Career of Women Physicists in Poland

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SUMMARY

The professional activization of women in Poland in the recent decades has led to the intensive intellectual development of the part of women. We observe a large popularity of the exact and natural sciences with the studying women. Unfortunately the number of women in the research teams, manager groups in business suddenly decreases due to both social and psychological factors.

INTRODUCTION

If we assume, after Mark Twain, that the permanent, inflexible practicing of mind is an important, valuable, and fundamental essence of human life, we easily notice the situation of women in the present world is "schizofrenic". Most of the societies give the women a chance of education and recognition of the strength of their intellect, and simultaneously still uneasily accept the women's career based on the intensive intellectual work, especially in the exact sciences and engineering professions. This means the women do not take part in creation of culture proportionately to their talents. After all, "the modern natural sciences, especially physics and biology are the most positive products born by the culture of the 20th century", as said the German physicist, Professor Weisskopf on receiving an award for the popularization of the modern physics in 1989.

This sociological point of view has been a basis for an analysis of the professional activity, position and achievements of the women in Poland, presented in this paper. Some statistical data as well as the own observations of the author during the work as an university teacher of physics have been also taken into consideration. The sociological and psychological factors have been discussed, that determine the large popularity of mathematics, physics and chemistry with the women during studies (about 50% of the amount of students of these faculties) and the sudden decrease of women's activity at the higher levels of the scientific career. A few names of the Polish women scientists have been presented.

PROFESSIONAL ACTIVIZATION OF WOMEN IN POLAND IN THE LAST FIFTY YEARS

In Poland, we used to refer any economical, demographical or historical analyses to the World War II, as an event that drastically changed the life of Poles. The enormous destructions, the large emigration of the highly-educated people, and 20% of Illiterates generated the necessity of the hard effort, also in the education field. The transformation of the country from the agricultural to the industrial one caused moving of millions of people from villages to towns. The increasing demand for the labour - force activized the women to the gainful work outside home. One should appreciate the policy of the government towards education of women as well as people from the peasant and worker classes (free of cost schools and universities, scholarships).

Finally, because the communist system has occured absolutely not effective in economy, the Polish society is rather poor but relatively well educated. As somebody said, "the communists educated their own grave-diggers".

As a result of this trend, 53% of the Polish women completed the secondary schools and universities [1]. In 1984, Poland was first in the world in the statistics of the studying women (55% of the total number of students, with 150 students per 10000 inhabitants; the total population in Poland amounts about 38 millions). Moreover, at present, about 46% of the Polish women are professional active [1]. The detailed data concerning women's employment in Poland are collected in table 1 [2].

Table 1. Employment of women in Poland in the last ten years [thousands]

Women& Men				Women			
		Total	Graduated	Total		graduated	
Total	1980	11634	938	5044	43%	421	45%
	1985	11206	1058	5008	45%	508	48%
	1988	10717	1037	4921	46%	515	50%
Industry		3957	184	1472	37%	48	26%
Building		906	80	166	18%	22	27%
Agriculture		666	29	171	26%	9	31%
Transportation		785	27	185	24%	8	29%
Communication		153	4	90	58%	1	25%
Trade		1148	44	800	70%	26	59%
Science& technics		114	35	54	47%	17	31%
Education		911	344	732	79%	239	69%
Medicine & social care		775	106	632	82%	69	65%
Administration		217	65	139	64%	30	46%
Culture & art		89	18	53	60%	10	55%
Tourism		103	8	57	55%	3	38%

We see that the women are indespensable in a trade (70%), education (79%) as well as in medicine and social care (82%). They reached also a strong position in the science and technics (47%). But. we knows well that women are not fully appreciated. Their salaries amount only 70% of the men's income. The women usually stay at the second plan ("a woman - permanent deputy"). We can find only 30% of the women managers, 12% vice-directors, and only 4.5% directors of departments in the State administration. The representation of women in the authorities is also not sufficient. At present, we have only 13.5% of women in the parliament (women did not vote for women). It is a paradox of history that now, when we built the new democratic system in Poland, we observe a dengenerous increase of the neotraditionalism and clericalism, leading to the

Reduction of women's rights in the majesty of low (e.g. diminishing of the social provision for the child-care and the recent aggresive campaign for the criminalization of abortion).

WOMEN IN NATURAL SCIENCES AND ENGINEERING PROFESSIONS

The considerable professional activity of the Polish women in the recent decades has led to the changes of motives of undertaking the work by women. Besides the married women working with the aim of being a co-supporter of the family, a group of women intellectually oriented and taking part in the cultural, economical, and scientific life of the society has appeared. It is interesting that among students of mathematics and natural sciences 60% of students are women (table 2 [3]). This fact is being in contradiction with the popular meaning that the woman mind is not suitable for the exact and scientific thinking.

Table 2. Students according the group of specialization in 1989/90 [thousands]

Total	378.4	Women 51.3%
Technics	84.6	17.4%
Agriculture	22.5	43.5%
Economy	38.5	55.5%
Low	23.8	50.0%
Humanities	106.1	75.0%
Mathematics& natural sciences	36.4	60.0%
Medicine	37.5	62.2%
Art	6.2	48.6%
Theology	8.2	27.5%

Unfortunately, the amount of women in the research teams at universities, suddenly decreases, disproportionately to the real achievements of women during studies. Most of women choose the teacher career at school. Also the scientific career of women is not so effective as of men, especially at the senior levels at universities. The higher level, the lower percent of women receiving the university degrees (table 3 [3]).

Table 3. Scientific degrees given in 1981-1989 in Poland

	Years	1981-1958	1986-1989	1988	2989
Doctor	Total	13527	9310	2020	2440
	Women	32%	28%	30%	29%
Assistant	Total	2615	2583	653	755
Professor	Women	20%	21%	21%	21%
Professor	Total	2020	2611	614	910
	Women	16%	15%	17%	16%

The reasons of this trend are only sociological and psychological. The most obvious one is not proportional charging by the family duties of women and men (in circumstances of a very high birth-rate of 19%0 in 1955 and 10.2%0 in 1983; in Great Britain 1.0%0).Moreover, the observations of students allow to confirm a psychological fact, That woman do not associate so strongly their personal success with profession as men do, and much more easily resign a competition in the case of failure. Also we can notice something like a fear of success. In the traditional society a woman is appreciated for her empathy, beauty and readiness to compromises [4]. Whereas the scientific and engineering professions require the independent thinking, strong focusing of mind on abstractions and often work in isolation from the surroundings. So a price of the scientific career for women is often very high. Fortunately some women do not treat seriously the traditional point of view and work in the science by standards of their mind.

The most famous Polish woman scientist was Maria Sklodowska-Curie (1867-1934), the Nobel Prize winner in 1903 and 1911 in physics and chemistry. Her works, together with her husband, Pierre Curie are fundamental in radioactivity. Her biography is a wonderful example of the human independence in thinking and creative acting. Many other Polish women have their share in a development of the exact and natural sciences. There are some names of the women scientists, professors working at present: Boguslawa Jezowska- Trzebiatowska (physical chemistry, works on electronic structure and theory of the coordination compounds, spectroscopy, and radiational chemistry), Wilhelmina Iwanowska (astronomy, research of star populations), Bogna Klaner (physics of organic semiconductors), Krystyna M. Maluszynska (physics of high energy particles), Maria H. Checinska (physics of semiconductors and infrared detectors),Czeslawa Troszkiewicz (organic chemistry), Ewa Skrzypczak (experimental physics, an active member of the board of the European Physical Society), Anna T. Szaynok (physics of semiconductors), Cecylia Wesolowska (physics), Maria Steslicka (theory of solid state), Ewa Dobierzewska-Mozrzymas (physics of thin metal films), Hanna Meczynska (chemistry and physics of semiconductors), Aleksandra Kopystynska (optics and physics of lasers).

CONCLUSIONS

This short discussion of the professional situation of the Polish women has provided that many of them still work below their intellectual possibilities. The future should bring a considerable wider activization of women for the explicit articulation of their affairs in the democratic society. Let us hope that the equal chance, independent on sex, for a free choice of profession and a style of life, in accordance with talent and interest will be really accepted by the modern society and treated as one of the fundamental human rights.

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D6

Great Contributions of Chinese Women Scientists and Engineers

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SUMMARY

Women in China have been playing an important role in economy construction. This paper gives some statistics numbers of proportion of female students and women scientists to all staff. Chinese women scientists and engineers are working hard and are contributing their creativity to many technology aspects.

Women in China have a very important role. There is a famous words in China that is "Women are half heaven". Indeed, Chinese women possess the noble qualities and a lot of advantage, which are hard work, bravery, intelligence, polite and so on. They dedicate their life to sublime cause for China's modernization and service to the people everywhere in government,management,business,industry, science research Engineering,technology,education etc. The proportion of women staffs to total is 43.7%. [1]

They are really fair for education and profession. In various school, the proportions of female students to all students per year are shown in Fig.1A. These proportions in University and institute per year are shown in Fig.1B. It is growing year by year. [1]

The total of scientists and engineers in natural science aspect in China has 9.6615 million person. The women scientists and engineers in natural science aspects are 301.06 million people which ratio to total in 31.16% is shown in Fig.2A. There are 812.4 thousand women engineers have employed in industry and 91.5 thousand women scientists have employed in academic. The proposition of several kinds of scientific and engineers are shown in Fig.2B.

All women scientists and engineers work to be continued after having a family and still work after becoming mother.

Fig.1

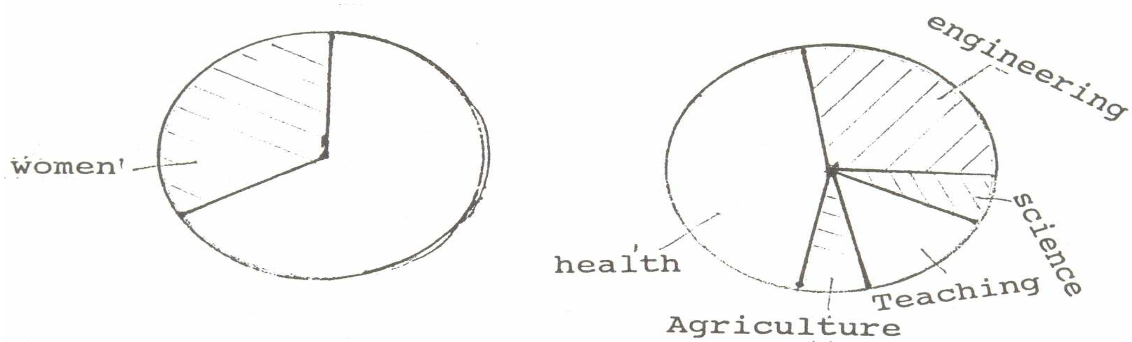

Fig.2

These baby may get good care in nursery and kindergarten when they are 3 month to 7 years old. From 3 month to 3 years old, they can live with teacher and other children in day and live in home with their parents. Of course a few children can live in home with grandmother and grandfather. When they are 3 years old to 7 years old, some children live in keder-garden in whole day because their parents always keep busy or go to other place for some working, but some parents have other resone to do that, for example, the education in kinder garden is better than in the home, there child can get good hegiene habit have more reasonable foodsÁÂhave more knowledge, and talent.

The primary schools accepte their children, between 7 years old to 11 years old, they study the courses of school defined by the nation education committe. After 11 year old, these children start accepting the education of mild school and then go to university, or other place.

The number of kinder garden and primary school are shown in Fig.3. Mother has the vacation of 90 days, may work after 3 month. She have the time to feed her child. twice a day, which a time keeps half hours, The time from home to working place if they need and

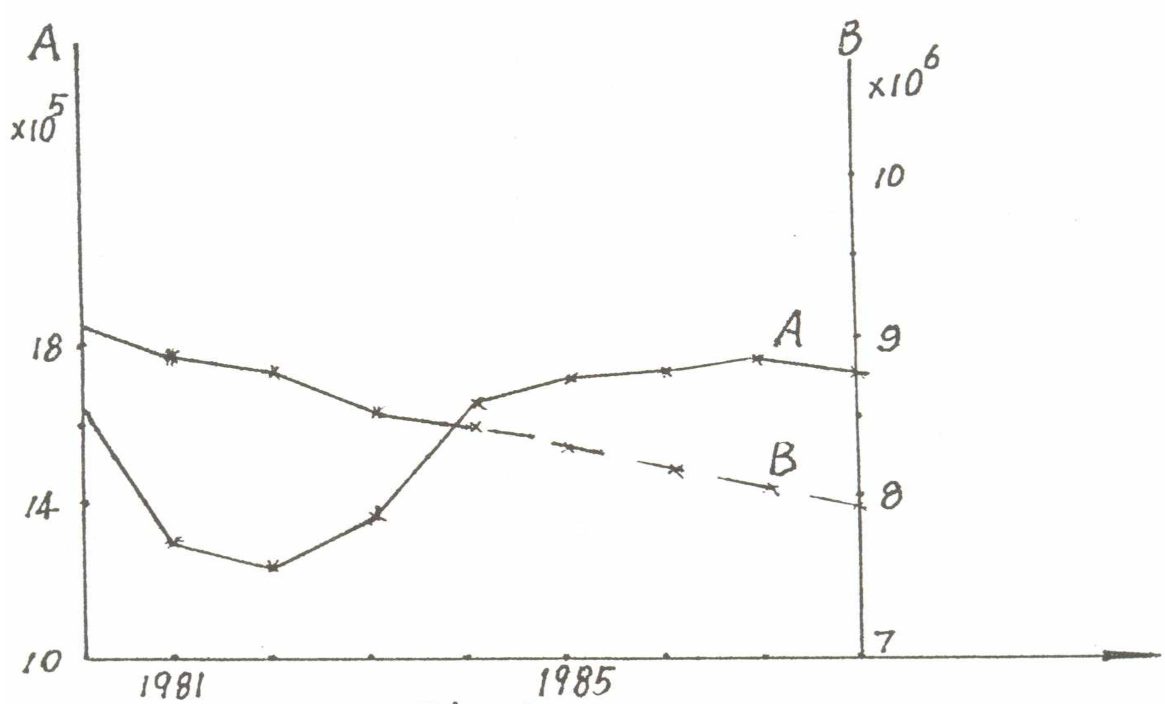

Fig.3

Their salary can be ensure. The nation state has publicated the rule named "women labour protect rule", defined that do not to allow decrese salary or release labour contract during women pregnancy maternity leave, suckle gestation. [2]

Women scientist and engineer are top of women, just like a splendid pearl. They give their country and people to great contribution. The proportion of women scientist and Engineer to all women staff is 4.43%. The proportion of women manager to all women staff is 1.1%. About 31.5 per cent of all natural scientists are women, which 45.6 per cent have high level education. By each year, these percentages are shown in Fig.4.

Chinese ecnomy is growing fast and fast. The index of gross national product since 1980 to 1989 is shown in Fig.5 [3].

The fruits of Research on science and technology are 100277 terms with the national prize. There are 1664 terms of the invention with the national prize. Fig.6 and fig.7 show these fruits and inventions per year. [3] These achievements always include contributions by Chinese women scientists and engineers.

They have creativity to produce excellent results and create the wealth of society on every technology aspect and always keep busy. Especially, they who work on high tech research must make effort to expense much more labour. Therefore they always keep high level and success; also they are encouraged and respected by Chinese people.

Acknowledgement: this work was partially suported by the National Natural Science Foundation of China.

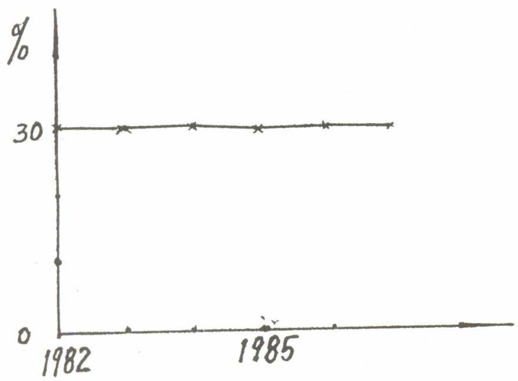

Fig.4

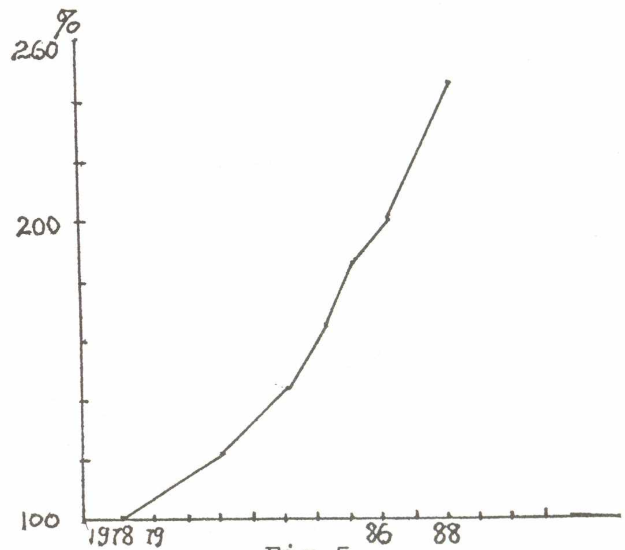

Fig.5

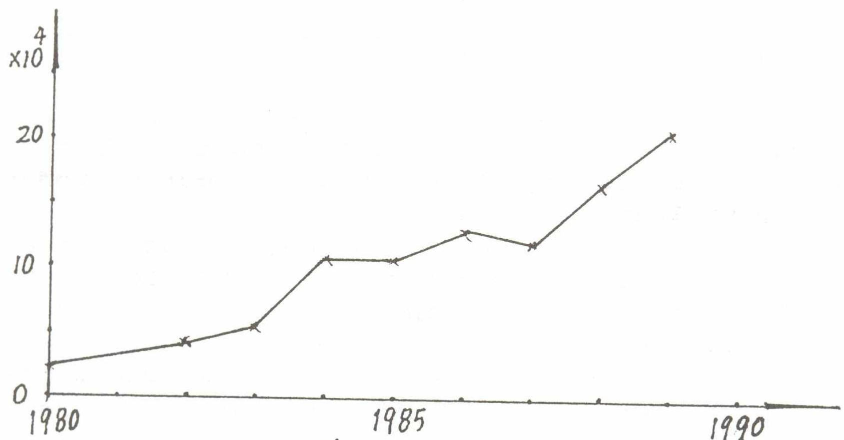

Fig.6

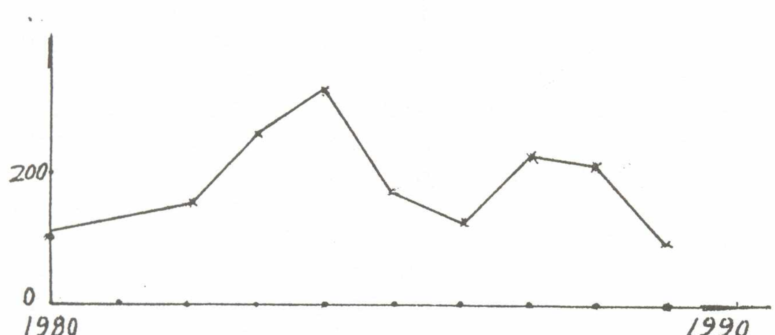

Fig.7

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A Woman in the Engineering Profession and Education

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The paper deals with:

1. The social position of a woman engineer: a comparison of conditions in developed versus developing countries, in Christian versus Islamic countries

2. The position of the female staff members of the Faculty of Engineering, University of Maiduguri, Nigeria and of the University of Zimbabwe, Harare a comparison of the contract and living conditions for women

3. The position of female students of Engineering, their chances to get a qualified job and their overall position in the society.

D8

Women in Chemical Engineering Studies

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SUMMARY

The students of the two courses of the Chemical Engineering speciality have been questioned by means of a Likert type test in order to elucidate the causes of the presence of different number of male and female students in this speciality. From the answers of the male and female students analyzed no relevant differences are found among the two groups.

INTRODUCTION

An important feature of the scientific and technical studies, around the 'world, is the difference between the number of male and female students in the courses. This evidence is also given in the studies of Chemical Engineering in Tarragona. This town, placed at the north east of Spain, is the center of a zone that have the bigger number of chemical industries (Basf, Bayer, Dow, Erkimia, Hoechst, Repsol, Shell, etc.) in the south of Europe.

The Chemical Engineering studies at the University of Barcelona at Tarragona are constituted by the two last courses of the Chemical studies, that has a duration of five academic courses. The number of women enroled in the first course of Chemical studies is roughly the same of man, but in the last two courses, the number of women is always lower than the 30 % of the total number of students. .

From this evidence, an study to determine the causes of the difference between the number of male and female students was undertaken. The student of the two last course of Chemical Engineering speciality was questioned with an open questionnaire about the reasons that they attribute the lower number of women in the specialty [1].

1. The Chemical Engineering speciality is the less attractive
2. I study Chemical Engineering to maintain my opinion against everybody
3. The studies of Chemical Engineering has the greatest difficulty
4. I like to work at the laboratory
5. I choose to study Chemical Engineering because of the number of chemical industries in the surroundings of Tarragona
6. I have the forbearance needed to work in the chemical and analytical laboratory
7. I have little possibilities to advance in my career in chemical industries
8. My parents are surprised because I study Chemical Engineering
9. I consider me to be able to order a group of workers
10. There are to much mathematics and calculus in the Chemical Engineering speciality
11. I study Chemical Engineering because I shall earn many money
12. My friends are surprised because I study Chemical Engineering
13. I should like more Chemical Engineering if their are not Mathematics

Table 1 Items of the test (The items have been translated from the original Catalan, the language in which the test was administered).

QUESTIONNAIRE

Afterwards, a Likert type test, Table 1, was elaborated with items arisen from the causes found in the bibliography [2] and from the answers given by the students of the speciality to the preceding questionnaire. This test has 13 items with five possibilities of answer by item, from the complete agreement with the item (1 point) to the complete disagreement with the item (5 points). The neutral opinion was scored with 3 points. The test was administered to the students of the speciality of Chemical Engineering of Tarragona.

GENERAL RESULTS

The mean score of each item and its standard deviation are presented in the Table 2 for the female (N = 12) and male (N = 19) students of the 4th course considered in this study.

The analysis of the answers of the students of 4th course show that women scored higher than men and are in more agreement with the statements in the items 1, 4, 5, 6, 10 and 11, while men scored higher in the items 3, 7, 8, 12 and 13. In the other items the scores for the both groups are similar. Significant differences appear only in the items 7 and 8, where woman scored lower and are near the neutral score. Women think that they could advance in their career in the chemical industries (item 7), but their score is

Item	Women			Men
	mean	s.d.	mean	s.d .
1	4.33	0.49	3.95	1.08
2	4.75	0.87	4.74	0.45
3	2.67	0.78	3.10	1.05
4	3.08	1.16	2.53	1.02
5	2.83	0.72	2.63	1.01
6	3.58	1.08	3.21	1.08
7	3.50	0.90	4.10	0.46*
8	3.67	1.43	4.32	0.58**
9	2.08	0.52	2.00	0.82
10	3.92	0.90	3.63	1.16
11	3.17	0.72	3.00	0.94
12	3.42	1.00	3.89	1.05
13	4.08	1.16	4.21	0.98

Table 2 Average scores and standard deviations of the test items for the woman and man students of the 4^{th} course (* $p < 0.02$, ** $P < 0.09$).

Near the neutral opinion. Also, the woman opinion shows more variability (greater standard deviation).

Item 8 shows that the students think that their parents are not surprised that their sons and daughters study Chemical Engineering although this opinion is weaker in the woman group and, furthermore, the variation of the opinions is greater in this group as is deduced from the higher value of the standard deviation.

The mean score and its standard deviation for each item is presented in Table 3 for the students of the last course (5th) of Chemical Engineering. The scores are presented for the woman group (N = 8) and for the man group (N=21).

The analysis of the answers given by the students shows that the woman group shows higher scores in the items 2, 5 and 6, while the man group scores higher in the items 1, 7, 8, 9, 10, 11 and 12. In the other items the scores for the both groups are similar. Significative differences appear only in the item 8 as in the students of 4th course and has disappeared the significative difference in the item 9.

Comparing the female answers to the item 9, the students think that they are able to command a group of male workers in a chemical industry. This statement is lower scored by the students of the 5th course which was doing a practical work as a complement of their formation during they summer holidays. It must be noted that all women has worked in the

Item	Women		Men	
	mean	s.d.	mean	s.d.
1	4.25	1.03	4.38	0.86
2	4.87	0.35	4.71	0.56
3	3.25	0.71	3.33	0.86
4	3.12	1.12	3.05	1.20
5	3.37	0.91	2.86	0.96
6	3.37	1.06	3.19	1.17
7	3.87	0.64	4.09	1.09
8	3.75	0.46	4.43	0.93*
9	1.62	0.74	1.95	0.74
10	3.62	1.19	3.81	1.08
11	3.00	0.76	3.24	0.83
12	2.75	1.16	3.62	1.32
13	4.00	1.07	4.09	0.89

Table 3 Average scores and standard deviations of the test items for the woman and man students of the 5^{th} course (* $p < 0.06$).

Industrial surroundings of Tarragona and any female student takes a chemical job in a foreign country by means of the IASTE organization proposal.

The female students of Chemical Engineering in Tarragona, according to they answers to the test that was administered, think that their abilities are the same that they counterparts, they show a similar perception about the reality present or future, whether in their present studies or in their future work, that the male students. Therefore, the causes that bring about the lower number of women in Chemical Engineering have not to be searched between the women who follow this speciality [3].

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Women in Engineering: A Study of the Professional Orientation of Women in Various Societies

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SUMMARY This paper suggests the changes in pre-university education which will result in an increase of number of women in the engineering profession. The recommended changes are based on the comparison between the educational systems of the Western and Eastern European countries. Emphases are made on the change of attitudes, the universal secondary education and the industrial attachment programmes.

INTRODUCTION

In the world today, about 600 million women are working, constituting a third of the aggregate labour force. Although it is accepted that men and women have equal capacity, the division of labour by sex in most parts of the world remains one of the most pressing issues. While in Eastern Europe 42% of students in engineering are women, this figure is only about 10% in Western Europe and less than 1% in West Africa. There is no doubt that these numbers are in many ways a reflection of the degree of political, economical and social emancipations of women in their societies.

The first and very important issue is the right to equality. In USSR, the constitution states that women and men have equal rights, while in Britain, France and other Western European countries, the equality is being granted in pieces, which creates loop-holes for sex discrimination. In West Africa, the Common Equality Law is restricted by the existence of Moslem and Customary laws. The second, equally important issue is the right to work. In USSR, this right is protected by the constitution as an inalienable right of all people. This law was adopted as an international law by the UN General Assembly during the UN Decade for women in December 1979. However, few countries have amended their legal systems in accordance with this law. The above-mentioned differences in the legal rights in various societies are having a considerable impact on the professional orientation of women. While the political, economical and sociological changes are very slow and not within the power of the educationist, it is possible to introduce some changes in the pre-university education and career guidance in order to

Increase the participation of women in engineering. The suggested changes are based on the comparison between the educational systems of the Eastern and Western European countries.

THE STARTING POINT

The girls in Western Europe are subjected to a massive brain washing at home and school. Right from the start the infants are not allowed to develop their individuality. The first toys, books, TV programmes and teaching aids are gradually preparing the boys and girls for their future roles in their societies. When the girls go to school they learn many more lessons about their place in the man's world. The textbooks in science and technology are more appealing to boys by the nature of their presentation. Furthermore, girls are not encouraged to express their preferences, creative powers, point of view, etc. When they reach the age of 13-14 years, at which they are expected to select their profession, the girls voluntarily exclude themselves from technology.

The suggested changes in education of this period of time must start early. Efforts should be made to overcome the existing assumptions about boys and girls through the mass media and adult education. Ways of control over the curriculum of nursery schools, mass media, religious and cultural influences should be explored. More efforts should be made to put an end to making the teaching profession only feminine, because there is obvious need for pupils to communicate with teachers of both sexes.

MATURE DECISION

In Western Europe girls enter the profession prematurely between the ages of 13-16 years. At this age girls undergo physical and psychological changes; they also realize the societal expectations that they have to live up to. They are torn between what they are expected to do, what they like to do, what they an~ advised to do, their academic performance at that stage, the length of the study, the cost of the study, etc. An additional fear of coping with reality surfaces from the fact that choosing engineering as a profession means going into an area dominated by men.

The solution to this problem may appear very radical, but in the final analyrsis it is rewarding. The girls need more time in order to absorb the impact of the expected responsibility and alter accordingly their values, personalities and future careers. Therefore, secondary education must be compulsory in all subjects. Broader and less specialised education will widen the scope of knowledge and therefore, the maturity of the decision at the are of 18-19. At that are the girls will be able to achieve their real potential as individuals irrespective of being born a girl (or a boy). Need less to say, the undergraduate courses will need to adapt accordingly ill order to accommodate the pre-university educational changes.

INDUSTRIAL ATTACHMENT PROGRAMME

The existing professional guidance in Western Europe often misleads the girls by the career officers, who themselves believe that engineering is not a suitable profession for women. Those career officers, who believe that girls should be advised to consider engineering as a profession have their' h;-U1ds tied by the influence of the family, mass media and existing

Conceptions. The career guidance is a compound problem which depends a lot on the slow change in attitude of the society. However, it is possible to make the technology attractive to girls by introducing a regular anticipation of students in the industries as a part of their secondary education. At the completion of school, the students will get an initial professional qualification. Throughout the industrial attachment programme, girls will have equal exposure and participation in technology. Visit to various industries and inviting women engineers for orientation advice will indeed help to achieve n successful] professional guidance.

CONCLUSTON

The professional orientation of women in the western and developing world needs fast and radical changes in the pre-university education. More efforts should be made towards the change of attitudes and concepts of societies. Thus, more women will participate in engineering profession.

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D10

A Career in Chemical Engineering –
A Viable Option for Women

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The Paper will survey admission statistics relating to Teesside Polytechnic Department of Chemical Engineering. It will look at data covering the past decade and correlate statistics relating to girls entering the Degree and END in Chemical Engineering, in terms of their qualifications on entry and final performance and compare these with mean data for the total student cohort of the Department.

Three case studies will be presented outlining the Careers of three female graduates in Chemical Engineering.

Finally, the Career progression of the only two female Academics in the School of Science and Technology will be outlined.

D11

Changes of Soviet Women's Role in Science and Technology during the Perestroika

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In the report, the status of soviet women working (or studying) in science and technology is concerned, for example, in the Moscow Aviation Institute.

After the Second World War, technological education was prestige, emancipation succeeded in USSR, so a lot of women began to work in science and engineering, acquired high qualifications, but seldom reached significant positions, the reasons for which are presented in the report.

Now, during economic depression, providing even the min1mum family needs (according to tradition it is solely a woman's affair in Russia) takes the majority of a woman's time, disarranging their work. Women are the first candidates for discharge. Under progressive inflation, science financing is reduced, so women are not satisf1ed with their wages and are looking for new jobs. These and other reasons lead to the impossibility for them to apply their qualifications (even h1gh ones). As to women's future in science and technology, young girls, seeing the failures of their mothers, do not cons1der the job of engineer or scientist to have prestige

In the effort to improve this situation, the organising of Joint work of Soviet and foreign research and educational1nstitutes in the first place to draw together skilled women scientists, engineers and faculties and girl students is suggested. MAI, where experts in most of technology branches are working together could be one of the partners in such a collaboration. This would help women from different countries to learn of the work and knowledge about the life of their colleagues.

Are all Australia's Engineers Women?

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1.0 SUMMARY

This paper takes a look at the sort of science and engineering practised in Australia. It reports on number of women engineers, and comments on some of the current projects to determine issues of relevance to women profession.

2.0 INTRODUCTION

This is a personal view. By that I mean that this is a subjective paper, a record of situations seen from my perspective as a senior electronics design engineer in a large manufacturing company. I do not have any statistics, but I have been able to speak to many people who are interested in the progress of women in engineering, and there are many projects underway which, if fruitful, may produce quantitative information over the next few years, which may be presented at the next ICWES.

2.1 AUSTRALIA

When I informed friends in July 1987 that I was leaving Britain for Australia, I was bombarded with information about the place, some of it true, some imaginary, and some hearsay. Many people were concerned about whether I would be able to use my electronic design experience, among other things. Well, I have been able to use and further develop my skills in electronics design, so no one need have worried! But let me describe a little about the country that is now my home.

Australia is a continent/country, with roughly the same land area as the United States, but a population of only 17 million. "In shape, Australia resembles a ragged square, but the real Australia where people live and work is a ribbon", according to Blainey [1], where the "ribbon" tends to be the coast, where most of the cities are located. The capital cities of the six states account for over half the population.

This spread of the populace (in a few large cities, smaller towns and rural areas with vast distances between the centres of population) has some effect on the type of science and engineering practised, and also the way it is practised.

2.2 APPLICATIONS OF TECHNOLOGY

Primary industry plays an important part in the economics of Australia. Wheat, wool, beef, cotton, and lamb are significant exports, and thus veterinary and agricultural sciences are areas where much basic and applied research is done.

Then, because Australia is a "new" country (a large number of settlers came 200 years ago, and continuing immigration is a major factor in increasing the population), construction is a principal industry. There are homes to be built, as well as office blocks, roads and bridges. You may have heard of two major edifices in Sydney - the Harbour Bridge, and the Opera House .

Two industries affected by the vast distances between centres of population in Australia are transportation, and communications. Included in transportation are the railways, and airlines. Airplanes are commonly used for travelling between state capitals for business (e.g. from Sydney to Melbourne or Adelaide). A flight of 1-2 hours replaces a 7-15 hour drive! In telecommunications, consideration has to be given to using line transmission methods (copper cable or optical fibre), or radio/microwave, or satellite, for telephony, data communications or broadcast (TV) signals.

The urban centres (towns and cities) support the day-to-day activities of large commercial centres the world over - banking, commerce, accounting, retail, etc, so the normal infrastructure of roads, water supply, electricity is required to support this.

Finally, the local universities and other research institutions are noted employers of scientists and engineers, with research being undertaken on topics of global interest (such as cancer cells, or in-vitro fertilisation), or industry specific (such as optical fibre systems for telecommunications).

With that overview of areas of application of technologists in Australia, we can now see how women fare in these areas.

3.0 EMPLOYMENT OF WOMEN TECHNOLOGISTS

It is not really possible to generalise about the status of women engineers and scientists in Australia, as the situation differs between the two groups. Also, as this is a personal view, I can only really talk with experience about engineers. So we say that scientists tend to be employed in research institutions. These could be in universities, hospitals, or in government sponsored or private institutions. It is my understanding that in many cases women may make up more that 50% of the employees in such a laboratory, but they seldom head such a department.

For engineers; though, women usually make up far less that 10% of the total in any department, if they are present at all! This has been seen as cause for concern, and actions are being taken to identify why this is so.

3.1 WOMEN ENGINEERS

An investigation into engineering culminated in the production of the Williams Report in 1988 [2]. This recommended that women make up 20% of those in engineering courses by 1997. This was seen as a necessary goal Australia to increase its pool of practising professional engineers to more than 1% of the labour market by the year 2000. In 1990, however, women made up only 8% of engineering students, and 2% of practising engineers, and it does not appear as if the 20% figure will be reached by 1997.

There are a number of initiatives that are being undertaken to promote engineering as a suitable career for women, and a few of them are discussed in the next section.

3.1.1 Encouragement for schoolgirls

i) The Institution of Engineers Australia (IEA), one of the two major engineering institutions, has a separate division in each State. In Sydney, a "Women in Engineering" project has been run from the University of Technology for the past 4 years. This project arranges for practising women engineers to visit schools, and explain their work to the pupils, through talks and activities.

ii) Another project, at the University of Adelaide, has recently completed its second of three years. At the end of the first year it concluded [3] that there was a dearth of information about Engineering in secondary schools, and a serious lack of informed teachers; it also found that girls embarking on Engineering studies were influenced most by relatives and friends. The project then recommended "that a comprehensive package of information be compiled and used on a trial basis during 1990 in a pilot group of schools." The target group was to include girls aged 11-17, careers teachers, maths/science teachers, parents, peer groups and employers. This was done [4] and the teachers' response was most favourable, indicating that the information package produced supplied schools with the types of information they required.

The project is continuing in its third year, to make available three information packages to students in age groups 10-12, 13-15, and 16-17. These packages are to be distributed to all schools in South Australia.

3.1.2 Encouragement for students and practising engineers

i) Some of the divisions of the IEA run a women's group which consists of the women members of that division, student as well as professional engineers. These groups meet at regular intervals for social activities, and act as mentors and a support network for each other.

ii) The IEA in April 1991 set up a committee of called the "National Women in Engineering Committee". This reports to be Council of the Institution, and pr9vides a means whereby the women members of the institution can be represented on council. The committee consists of ten women, representing all States of Australia, of whom four currently are engineers.

iii) The Institution of Radio and Electronic Engineers Australia, (IREE), is also planning an initiative to see what can be done to enhance the status and prospects of women engineers.

3.1.3 Informing employers and the general public

i) The IEA instituted the Engineering 2000 Awards in 1990, which in recognition of organisations which have made significant progress in the advancement of women in engineering. These are national awards which are open to organisations in the public and private sectors, including industry, government departments and educational institutions. In its first year, there were twenty-nine entries, and eleven prizes were awarded. One of these was for an engineering student who found the course so daunting that she eventually gave up engineering, but not before writing her thesis on the topic of why women give up engineering.

ii) A group of Human Resources consultants have recently put forward a proposal for a grant to undertake a survey of the prospects of women technologists in industry. In particular, they will be looking for barriers to promotion, and advising on" training requirements for women. The results of the survey will be presented to industry for action.

4.0 CONCLUSIONS

Clearly there is recognition of the fact that more women could be undertaking technological careers in Australia, and people are asking themselves why this is not happening. positive action is now taking place in the general community to promote engineering as a suitable area for women to take up careers.

So, not all of Australia's engineers are women. But we can at least hope that by the time ICWES10 comes around, most of the initiatives reported on here will have produced quantifiable results, and that the number of women engineers will be near the 20% target of the Williams report.

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The Working Conditions for Women Researchers in National Institutes in Japan

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We are women researchers who work in the Laboratories of the Ministry of International Trade and Industry in Tsukuba (Sc1ence) cit¥, Japan. Here in Tsukuba there are 50 national research 1nstitutes belonging to nine ministries. The M.I.T~I. has nine laboratories in Tsukuba, in which 2,000 researches are working. Among them, the number of women researchers is 600, only 3% of the total in 1986 and 76, just 3.8%, in 1990.

We studies their working conditions, including their positions, their chances for developing their studies, and their roles in the laboratory "and the home in 1986 in order to find out why women researchers are so few.

The questionnaires were very detailed and the answers were compared with those from from men researchers. In spite of the legal rule that salary payments should be equal for women and men, the positions of women were lower than men in all the categories. The contribution of husbands to the house-keeping and child care was less than 20%.

This inquiry has been used for improving the working conditions and for increasing women employees by women researchers themselves. They could increase the number of women researchers in every year at least

D14

Current Statistical Data for Women Engineers and Scientists in the United States of America

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INTRODUCTION

In the United States, students enter the engineering profession by earning at a minimum a bachelor's degree: in the sciences a master's degree or a doctorate. There are other methods, but space here precludes their discussion.

ENGINEERING STUDIES

Based on 1990 data, women received over 15% of all bachelor degrees, out of a total of over 10,000 engineering degrees conferred. As a comparison, in 1975 878 women graduated in engineering and 62 in 1955. 14.3% of master's degrees in engineering were granted women in 1990 and 9.1% Ph.Ds. As a base for the future, there were 94,346 first-year full time engineering students in 1990, of whom 16,674 were women (17.7%). There were 338,842 full-time undergraduates in engineering, with 55,915 female (16.5%), and 16,611 (14.1%) in full or part-time graduate study for engineering. Thus the overall percentage for new female engineers entering the market appears to be stable at the 15% mark for the immediate future. It is also noted in the literature that women are more likely to be studying part-time at the graduate level. This indicates that they are employed, and are taking advantage of company funded tuition programs: as most PhD programs have a residency requirement, it can be deduced that most of the women in part-time programs are unlikely to continue onto the doctorate level.

The distribution of women students is not uniform, over 40% of the MS and PE recipients were women attending sixteen schools. The average University had less than ten women receiving engineering graduate degrees in 1990.

It is worth noting that women of colour receive BS degrees at a far greater percentage in their minority group than as women as a whole. In 1989, 31% of BS degrees awarded in engineering to Africa-Americans went to women - double the percentage for all women. These data should be compared to the data for overall math achievement in high schools for black students, which show that this group's scores lag several years behind those for whites.

Overall, the data for women studying engineering are relatively positive. However, the leap to parity (50/50) representation is as yet unattainable. The barriers to this goal are those related to culture, societial pressures, and teenage

Females lower self-worth, compared to males of the same age.

SCIENCE STUDIES

For the purpose of this discussion and to conserve space, I shall treat the sciences under two headings - the life sciences: biological, social sciences and psycology: and the math based sciences: physics, mathematics, chemistry, astronomy, and geology.

In the life sciences, women are well established. Women now earn half the biological BS degrees, and one-third of the PhDs in these fields. They continue to increase their representation in the social and behavioral sciences.

In the physical sciences, however, there is a wide range of representation. In chemistry, they represent about 40% BS graduates, but for physics they are 15% of the total, numbering about 300, (1989 data). All the physical sciences have experienced a severe drop in total numbers since 1985. In mathematics and computer science, women in 1988 earned more than 40% of all BS degrees in math, and 32.5% for the latter field. That women have earned at least a fourth of all math BS degrees since 1951, and 40% or more since 1973, counters the myth that women lack math ability. For both headings, female representation at the PhD level is very much lower than for the BS level.

Overall, women are less than one third of the total graduate enrollment for the math based fields, 42% of the biological, 45% social sciences and 62% in the behavoural sciences.

EMPLOYMENT OF WOMEN SCIENTISTS AND ENGINEERS

Against a background of increases in jobs in the Sci/Eng sector (employment in the Sciences has increased by 100% and 75% for engineers from 1980 to 1988) we see that the employment of women in Sci/Eng increased by only 2%, to 13% overall, and only 1% of all women workers are in-Sci/Eng, compared to 6% of men. Women are concentrated in the sciences, 26% of all scientists are female, compared to 4% of all engineers. In 1988 it is estimated that Sci/Eng jobs will increase by 34% by the year 2000.

As in the statistics for students, women are not spread evenly across all disciplines of Sci/Eng. The majority of women scientists are in psychology, life and social sciences, with only 13% in the math based sciences. In engineering, they are 3% of all mechanical and electrical engineers, and 8% of chemical. Similar trends show in a comparison of doctorial women and men in Sci/Eng. Over four fifths of the women scientists with PhDs are in the life sciences, whereas men are concentrated in the physical sciences. Similarly, engineering doctoral women tend to be in electrical/electronics materials, whereas men are more likely to be in the electrical/electronics engineering fields.

Looking at the data for unemployment in 1986, women in Sci/Eng were twice as likely to be unemployed as men. When the 1989-91 unemployment data are available, these differences will remain, and possibly will have worsened. The unemployment rate for women Sci/Eng is comparable for all women in the professions. As unemployment rates are related to field, the disproportionate higher rate of unemployed women scientists is partially accounted for by the reduction in number of jobs available in the life and social sciences over the past five years.

It is impossible at this time to accurately estimate future

Trends of hiring in Sci/Eng during the current recession. Some fields will be stronger than others, and we do know that highly skilled workers will be needed in the future. Opportunities will be available for women entering the Sci/Eng fields. As the majority of women engineers are much younger than their male counterparts, they should be more flexible and accept retraining as new fields open.

LEVELS OF EMPLOYMENT

From the salary and employment data, after the first year of employment women start to drop behind men in both salary and rank, in almost all types of employment in Sci/Eng. The considerably lower numbers of tenure and tenure track positions available for women PhDs than for comparable men means few role models for women in Universities and high ranking research institutions.

The average age for women engineers peaks around age 30, then drops off fairly sharply, whereas for men it is more or less level fram age 30 through retirment age. Thus, the majority of women engineers are concentrated in the lower levels of management and academia. A very few are making it to the top, and are highly respected by their colleages. Until these few become a significant number, however, there will not be great changes in how women are viewed overall in the Sci/Eng community. For example, in the life and social sciences, there are fewer differences in position, tenure and salary between women and men. But in the mathematical sciences, and engineering, the gap between women and men, whether measured by position or salary, is still large. The salary gap between women and men with PhDs in the mathematical sciences is $9000/ year.

Betty Vetter [1] suggests that the shattering of the glass ceiling needs another decade before these gaps disappear. From my reading of the current references on this topic, it may be longer, unless there are several changes. First that more girls choose the mathematical sciences or engineering as their career path, and manage to shake off the sociological barriers. That more women go on to graduate study, and obtain the necessary funding for the extended period of study. Lastly, that the projections for employment needs for Sci/Eng's for the year 2000, are real. The 1990 data show that there will be significant shortages of qualified white males in the technical fields, particularly at the advanced degree levels, opening up opportunities for women. Girls should not be deterred by the present economic downturn, which appears to make jobs in the Sci/Eng fields less attractive. Teaching at the middle and upper school ages needs to be more creative and less book/rote learning. There are some fantastic programs in existance, but they are not consistently available across the country.

About 40% of the PhDs granted in the USA in Sci/Eng go to foreign nationals, the large majority of whom are male, many of whom have cultural backgrounds that make them less receptive than white males, to women as colleagues. Many of the research fellowships tend to go to men leaving less desirable positions available for the women students.

Some of the other barriers such as child care, flexible working schedules, extended time off from work to cope with family crises are easily overcome by employers, if they wish to attract women -- a few corporations have taken the lead in this respect, and shown that such programs are feasible and cost effective.

PROGRAMS TO ENCOURAGE WOMEN TO ENTER SCIENCE AND ENGINEERING

There are numerous programs across the country to encourage girls to study science related subjects at school. Some are for all students, such as the Junior Engineering Technical Society and the Explorers Science Committee programs. There are summer intern programs for High School through bachelor's degree aimed at helping women and the under represented minorities to complete their studies. Corporations, either sponsor one of the existing programs, or create their own. Some programs are run by educational societies such as the Society of Women Engineers, Women in Science and Engineering, etc. Most of these programs show great dedication and creativity.

The Federal Government says it is concerned and wishes to encourage girls to be directed into the Sci/Eng fields, but does very little to actually implement, or assist others to achieve this goal. Similarly, in the employment field, the President last year vetoed a bill which would have allowed careers of elderly relatives or children to take extended time off without pay. Talk is fine, but as has been shown with the recent limiting of opportunities for women and minorities by the Supreme Court, legislation can be changed, money cut from programs, for example, funds available for student loans, is being severely reduced. Research money available for graduate students is also much more limited, than in the past.

CONCLUSION

Based on the data and current trends, there is still much to achieve before women are on parity with men in all fields of science and engineering in the work place. The reasons for this lack of parity, are still the same they were ten years ago, but are amplified by the current cut-backs in available funds and opportunities, as well as a more conservative outlook by the general public. Let us hope that the pendulum will start to swing back the other way, very soon.

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Italian Women in Scientific and Technical Research

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Generally, we all know that the object and the applications of great scientific discoveries and the lives of men who made these discoveries have been dealt with a lot. But we usually know little or nothing about women who devoted themselves to culture and science; the hopes and the bitterness, the sacrifices and the anxieties of research, the successes and the defeats of women who led the way for the difficult development of civilisation by means of their beneficial work are often put in the shade by numerous male names in the history of science. Besides, we can say that nearly in every time and in every place, women have been treated less favour ably than men, even though from ancient civilisations up to today, women have undergone a great evolution both in the social field and in expressing their own personalities, and in the politico-judicial arena.

In the patriarchal civilisations, the only function of women was to secure family descent, and only in Rome could they enjoy a greater freedom, receiving a more complete intellectual education, even if it was always imbued with principles of cautious prudence. They passed from the teaching of the 'litterator' (guide for primary schools) to the teaching of the 'praeceptores' to study Latin and Greek literature, but their salient occupations were always the household duties, the children and the female works (we remember for these activities the figures of Calpurnia, Cornelia, Proba Falconia and Sulpizia Teofila).

Women get a new characterisation with the renewal of the culture peculiar to Humanism and the Renaissance; besides prayer and Holy doctrine, they also read Plato and Cicerone, Sallustio and Livio. The union of things sacred and profane acquired a more deeprooted and nour ished harmony in t-he Humanist women than in men, giving rise to those virtues of balance that distinguished the wonderful female figures of the Italian courts (Vittoria Colonna, Giulia Gonzaga, Veronica Cambara). The authors who extolled a religious female education, without rejecting for this reason other cultures, showed traces of the influence of Humanism

The work, "Della istituzione delle donne secondo i tre stati, che cadono nella vita humana", by L. Dolce, published in Venice in 1545, is one of the results of this age. Meanwhile, the female world did not remain inert but began to stir itself, and the question about the education of women was discussed all through the eighteenth century. In Naples, in Padua and in other towns, the interest about the importance of this question was kept alive, mostly solved in favour of female education and exactly at the "Academia dei Ricoverati" in Padua, on 16th June, 1723, took place the public discussion about the new, and for the those times, unusual problem: "if women can be admitted to the study of sciences and noble arts" - which culminated in the anti-feminist libel in "II Giornale dei Letterati" by Volpi; it provoked an "Apologia in favore degli studi delle donne" by the Sienese Aretafila Savini de Rossi in December of the same year.

In 1740, G. Niccol6 Bandiera published in Venice the "Trattato degli studi delle donne", so that in Italy, the argument did not only regard the aristocracy but involved the middle-class too; the female education was meant not only as an ornamental and literary culture but also as a scientific one.

The first modern treatise of obstetrics by the French Louise Boursier, written in 1608, gave rise for the first time to the problem about the woman of science who practised a profession in competition with her male colleagues, and gave a stimulus to the others who loved science and worked for it and incited to challenge the establishment.

In Italy, the first obstetrics teacher was Maria dalle Donne who taught at the "Regia Universitá" of Bologna at the end of the eighteenth century. By means of her activities she was able to redeem women in a profession they had practised for ages, but secretly, using an alternative medicine made of medicinal herbs, and often mistaken for witchcraft. The female scientific interest did not regard medicine only, science in which women had been present since Greek ancient times in the figures of Hygeia and Panacea (The goddess who seemed to witness the medical activity practised by women) but also other exact sciences, usually attributed to men, such as physics, engineering and mathematics.

A 'star' of the eighteenth century who excelled at applied sciences was Maria Gaetana Angesi (1718-1799), one of the most renowned women in her time who left her native Milan for Bologna to propose her dissertation on the electric fluid to the senatus academicus of the University of Bologna. Her thesis on the one hand provoked astonishment among the senatus members (European famous men) because a woman had devoted herself to science, and on the other hand, roused interest for her new theories about the universe, the celestial bodies, animal and plant life.

In a pamphlet of 1753 dedicated by an anonymous author to the Cardinal Prospero Lambertini "magnificent patron of the arts and the applied sciences", it is briefly told the life of this lady who was very useful to science progress and who could, for the first time in history, discuss about electricity and the science of spirits by stating: "it is time to be convinced that love for the arts and sciences is not at all in contrast with the female sex".

Later on, Maria was asked to collaborate on a set of scientific experiments to obtain field discharges in glass pipes filled with low-pressure gas, realising that results of great importance would have been obtained from the study of these phenomena (in fact, after a century and a half it will happen with the discovery of X-rays). Maria Gaetana at twenty published her first book written with the mind of a woman of science and the culture of an artist that is the consequence of a poetic meditation on the great mysteries of the universe. After ten years she published the "Istituzioni Analitiche", subsequently translated into English and French that made her famous. Later on, the Cardinal Lambertini became Pope with the name of Benedict XIV, offered her a professorship at the University of Bologna; at that time she was 34 years old, but she retired into private life after the first lesson attended by the young Lazzaro Spallanzani and the fifteen-year old Luigi Galvani. After some years, invited to examine some of the famous Lagrange studies, she refused by answering that she did not deserve such tokens of someone else's esteem.

Owing to the innovative ideas of the French Revolution, the nineteenth century acted as interpreter to the renewal stimulus in all fields, and the cultural and political world dealt with the problems of the book and the reading ability diffusion in areas with a rough degree of learning.

During this period, an upward movement of the female culture began, and the principle of "women who educate women" developed in a surprising way in school organisation; women took the first decisive step in society as educators and teachers, a principle that will be ratified by the Casati Law of 1859 about the female masses education. In 1877, owing to the emancipation of women, they were given not only a general education but also a professional one within a co-educational system with male colleagues and Italy was one of the first countries to adopt this kind of education. Thus in 1877, a degree was given to a woman for the first time.

The beginning of the twentieth century saw the spreading of culture helped by the presence and the bibliographic work of Clara Cavalieri, a learned librarian who conceived the plan of "small free libraries" for youths, a plan that was approved between 1905 and 1906 in the 'Italian Kingdom. The librarian professional association that resulted from it caused the spreading of culture and science in both sexes without any inequality.

In the present century the Italian female scientific panorama has become richer and richer with the presence of illustrious female names who work in the field of research. We shall end this work by introducing the most outstanding contemporary female scientist: Rita Levi Montalcini, Nobel Prize winner for Medicine in 1986 and one of the researchers of the National Research Council (CNR), the greatest organisation of Italian research.

Her book "Elogio dell' Imperfezione", published in 1987, tells the story of her life of sacrifices to science, her desire to play an active role in it to meet with demands of an internal aspiration that has been the constant stimulus of all her life. After having taken a degree in medicine in Turin (during which time, she wrote in her book, the women matriculated in this faculty were only 7), She had to leave university because of the racial laws, however, she kept working increasingly in a fortuitous laboratory set at home where she laid the basis of her future researches. In the United states she continued her studies on the nervous system and particularly the research on the genetic or environmental growth factors. The NGF (nerve growth factor), for whose identification Professor Montalcini shared the Nobel Prize with the biochemist Stanley Cohen, has extended the research to other growth factors and other discoveries.

Between 1960 and 1970 she changed the small Neurobiology Centre of the National Research Council into an official organ of the body named the Cellular Biology Laboratory (LBC) which included three other departments: molecular biology, mechanisms of gene expression and immunology.

The element that distinguishes her life now is only "the fascinating vicissitudes of a woman in science" as can be seen in her autobiography. All her life has been a crescendo of exciting activities and entirely devoted to science. Nowadays, the scientist that five years ago was awarded the Nobel Prize for Medicine is required everywhere and gathers prizes and laurels. This year she won the "12 Apostoli" prize that till now had been won by writers and journalists. In Verona, last May, she was given an "honoris causa" degree in Medicine by the Rector of the University of Trieste, during the celebration of the twenty-fifth year of the Faculty of Medicine of that University, founded in 1965, which marks, with names known worldwide, the basic steps of the history of the Faculty.

The dichotomy of science and woman has been eventually overcome. Nowadays in Italy there are favourable opinions to the presence of women in the scientific field; furthermore, the progress is so powerful that the role played by women in science has demolished the discrimination and the barriers that have existed for centuries towards them.

On the contrary, apologetic writings about these female activities can be found in may places. An example is the book by Gianni Bonadonna "Donne in Medicine", published by Rizzoli, the history of the protagonists of a science in which they have always been working, even if in the shade of Esculapio. Moreover, to witness their constant activity, has been awarded the "Curie 2000", a prize of AIDDA (Association of Women Managers and Entrepreneurs) in recognition of the activity of women in the field of scientific research.

Last, but not least, the contribution and character of women of different ages and achievements are recognised and confirmed in the historical and social background in which they lived as exceptional protagonists.

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The Asociacion Mexicana de Mujeres en la Ciencia: A Descriptive Study

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It is important to identify more factors that serve as barriers to the full participation of women scientists at high levels of their professions, and to develop strategies to facilitate their scientific work and advancement. With these ideas in mind, after a continuous effort begun in 1984 by a group of graduate students from the Centro de Investigacibn y Estudios Avanzados del lPN, the Asociacibn Mexicana de Mujeres en la Ciencia (AMMEC, Mexican Association of Women in Science) was formed in 1987. AMMEC's general goals are to promote and support women in science. Currently we are working on nine specific projects.

AMMEC started with 35 members, mainly students (80%), and has grown to 90 registered members (64% are established researchers). Most of them (65%) are currently working in biology, while 25% are distributed among the following areas: mathematics, astronomy, astrophysics, women's studies, and history and philosophy of science. Our members are working or studying in 17 institutes, research centres and universities in Mexico City; 8 universities or research centres in 7 states, and some are currently working in the USA and the UK.

AMMEC published its first bulletin in January, 1990. It is being sent to 700 researchers at the main scientific institutes all over Mexico, 100 Mexican students and 60 postdoctoral students and researchers in the USA. AMMEC was the first scientific women's association promoting the work of women scientists in Mexico, and presently is working in collaboration with other Mexican women scientific groups, such as the recently formed Grupo Femenimo de Educacibn Matem~tica. We would like to contribute to the development of- a communication network of women scientists in the world by establishing contact with scientific organisations with similar goals.