PROCEEDINGS OF THE

SECOND INTERNATIONAL CONFERENCE

OF WOMEN ENGINEERS AND SCIENTISTS

Cambridge, England, I - 9 July, 1967

Volume I

GENERAL

1967

W E S

VOLUME 1 - CONTENTS

Conference sponsored by

The Women's Engineering Society
25 Foubert's Place
London, W.I., England

Conference supported by

Le Cerole d'Etudes des Femmes Ingenieurs de
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Society of Women Engineers (New York)
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Belgium	Miss Paula Talpaert
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Hong Kong	Dr. Doris Edna Gray
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Italy	Miss Anna Enriohetta Amour
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U.S.A	Miss Isabelle French, President, S.W.E., 1964-66.

The Conference is deeply grateful to the overseas Conference representatives, and to the many members of The Women's Engineering Society, and their friends, without whose freely-given help this Conference would not have been possible.

ACKNOWLEDGMENTS

The Conference is greatly indebted to the following organisations and institutions which have given generous support:

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Other organisations

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Council of Engineering Institutions
The Electrical Association for Women
Electricity Council
First International Conference of
Women Engineers and Scientists
The Royal Society
University of Cambridge Engineering
Department
International Federation of Business and Professional Women

The Conference is also indebted to all those organisations and institutions which arranged visits and tours for the delegates.

CONFERENCE PROGRAMME

<u>Saturday 1 July 1961</u>

Afternoon	)	Delegates assemble and register
Evening	)	

<u>Sunday 2 July 1961</u>

Morning	Delegates assemble and register
Afternoon	Delegates assemble and register Guided tours of Cambridge University Colleges
Evening	Bringing of Greetings

<u>Monday 3 July 1961</u>

Morning	Opening Ceremony Enough for Everyone - The Application of Technology to World Food Problems - Opening Address
Afternoon	Enough for Everyone The Application of Technology - The Use of Power in Agriculture
Evening	Reception by the City of Cambridge

<u>Tuesday 4 July 1961</u>

Morning	The Application of Technology - Increasing Food Production
Afternoon	Technical Visits
Evening	Reception by the Council of Engineering Institutional and Cambridge University Engineering Department

Wednesday 5 July 1967

Morning	The Application of Technology - Future Trends Technical Films
Afternoon	The Application of Technology - Preservation The Application of Technology - Distribution Technical Films
Evening	Conference Reception and Banquet

Thursday 6 July 1967

Morning) Afternoon)	All-day Visits Travelling Exhibition "Technology Today"
Evening	Morris dancing demonstrations by the Cambridge Morris Men Discussion on the possibility of further international co-operation between women engineers and scientists

Friday 7 July 1967

Morning) Afternoon)	The Woman Professional Engineer
Evening	Party given by The Women's Engineering Society

Saturday 8 July 1967

Morning) Afternoon)	Visits to Woburn Abbey, Grantchester or Sawston Guided tour of Cambridge University Colleges Organ Recital in King's College Chapel by David Willcocks

Sunday 9 July 1961 Morning	Departure for post conference tour of Irish Republic

BRINGING OF GREETINGS **2 JULY 1967**

In the Chair: Mrs. Isabel H. Hardwich (U.K.)

Greetings and messages of goodwill on behalf of women engineers and scientists of many countries were brought to the Conference by the delegates named below. Good wishes were also received from numerous absent friends.

Mrs. Anna M. Janovicz	Austria
Miss Paula Talpaert	Belgium
Miss Sophia Machado Portella	Brazil
Dr. M. E. Dormer Ellis	Canada
Miss Premala Sivaprakasapillai	Ceylon
Mrs. Jirina Vejvodova	Czeohoslovakia
Mrs. Saima Komulainen	Finland
Mrs. Adrienne R. Weill	France
Mrs. Jlse Knott-ter Meer	Germany
Mrs. Letitia E. Obeng	Ghana
Dr. Doris Edna Gray	Hong Kong
Mrs. Zsuzsanna SzentgyőrgyJ.	Hungary
Mrs. Ila Ghose	India
Mrs. Mahin Rahmani	Iran
Miss Nathiro Qusto	Iraq
Mrs. Katherine E. Walshe	Irish Republic

Miss Anna Enrichetta Amour	Italy
Miss Dorothy U. Mizoguchi	Japan
Miss Eva Ricketts	Kenya
Mrs. Angelina Perez Lopez	Mexico
Mrs. E. Jesse	Netherlands
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Mrs. Ragnhild Wallin	Sweden
Miss Berta Rahm	Switzerland
Mrs. P. Saengbangpla	Thailand
Miss. Bilge őzgűner	Turkey
Miss Miriam Muwanga	Uganda
Miss Frances E. Jones	U.K.
Miss Isabelle F. Frenoh	U.S.A.
Miss Luisa Chebataroff	Uruguay

"

International Organisations

Mrs. Lorna E. Scarisbrick	International Council of Women
Mrs. C.E.Arregger	International Federation of University Women
Miss B. Rahm	International Union of Women Architects
Mrs. Lucie M. Gui11erau1t-Dane1	Open Door International
Mr. W. Ryland Hill	UNESCO

OPENING CEREMONY 3 JULY 1967

In the Chair: Miss J. Cicely Thompson (U.K.)

Welcome by the Chairman

Welcome by the President of The Women's Engineering Society,
Miss R. Winslade

Opening Speech Mrs. Lillian M. Gilbreth (U.S.A.)

Opening Speech Mr. A. L. Armitage, Vice-Chancellor of the University of Cambridge

Mrs. Lillian M. Gilbreth

Mrs. Gilbreth is world renowned for her pioneering work in the field of time and motion study and industrial management, as President of Gilbreth, Inc. (industrial engineering and management consultants), and as international consultant and lecturer on these subjects.She has received the Washington Medal, the Gantt Medal and numerous other awards and honours including over 20 Honorary Degrees. Mrs. Gilbreth is not only a member of the Women's Engineering Society, and also a member of the Society of Women Engineers in the U.S.A. who sponsored the First International Conference in 1964, but she was the keynote speaker at the opening of that Conference.

Mr. A. L. Armitage

Mr. A. L. Armitage, Vice-Chancellor of the University of Cambridge, President of Queens' College and University Lecturer in Law is nevertheless no stranger to the industrial scene. He has been member and Chairman of Wages Councils and member of the Chairman's Panel of the Industrial Court, and he is also Justice of the Peace and Deputy Chairman of Quarter Sessions.

Miss R. Winslade

Miss Winslade is a member of the Society of Instrument Technology and was formerly Joint Manager of the Electronics Division of Research and Control Instruments Ltd in the Philips Group of Companies. She is now Assistant Secretary at the Council of Engineering Institutions.

Welcome by the Chairman

Mr. Vice-Chancellor, Mr. Mayor, Mayoress, Mrs. Gilbreth, Madam President, ladies and gentlemen, I am delighted to welcome you all to the official opening of the Second International Conference of Women Engineers and Scientists.

For its lecture sessions the Conference is divided between two themes: first, The Application of Technology to World Food Problems and secondly The Woman Professional Engineer. The first of these themes presents a challenge to every engineer and scientist. A very wide range of engineering and scientific disciplines can and do contribute to the solution of food problems, but a great deal more could be done if the will and knowledge were more widespread. Engineers, however, in particular, are generally in short supply and there are few women professional engineers. The second theme looks at their position today and their future.

The Conference is sponsored by the Women's Engineering Society whose President, Miss R. Winslade will welcome you on their behalf.

Welcome by the President of the Women's Engineering Society,

Miss R. Winslade

Mr. Vice-Chancellor, Mr. Mayor, Mrs. Gilbreth, ladies and gentlemen, on behalf of the Women's Engineering Society I welcome you here to this Second International Conference of Women Engineers and Scientists. I hope that you all have a wonderful time in this one week that you are in Cambridge and that you will find much in the programme that will interest you both technically and on the social side. I would like to read you some messages we have received and to seek your approval to send a message of thanks to our Patron, H.M. Queen Elizabeth The Queen Mother from this Conference.

(The President then read messages received from the President of the Society of Women Engineers (U.S.A.), women engineers in the U.A.R., and the message received from H.M. Queen Elizabeth The Queen Mother, with her reply.)

Opening Speech

Mrs. Lillian M. Gilbreth (U.S.A)

It is a great privilege to be asked to speak to you at this time - as we once more gather together from allover the world. The world needs the contribution that women engineers and scientists are able to make, and we, in turn, need to be needed.

Women have achieved an impressive standing over the years because of their ability to recognize basic problems and to analyze and solve them. The war-time record of the women of Great Britain demonstrated this very clearly. Many of us met together three years ago at the First International Conference of Women Engineers and Scientists and we took part in far-ranging discussions that gave us at least a glimpse of the breadth and depth of women' s involvement in world-wide problem solving.

The world needs the skill that we can contribute and we need to know that we are needed. It is a universal need. People of all ages, all walk, of life, and every country on earth need to be needed. Life becomes exciting and worthwhile when, our skills are applied to needed tasks. Even a tiny baby needs to feel needed. His very development depends upon it. His response to the living attention showered upon him, and the delight it gives those around him, is his first taste of success in life. It helps his whole personality to blossom.

One of the critical turning points of modern life is the time when we reach so-called “retirement age”. Then, quite arbitrarily, our work may be out short at a specified calendar date, without regard to our work capacity, state of health, or desire to continue in our chosen field. When this time arrives, even one who has conscientiously tried to plan a rewarding retirement schedule may find that adjustment to a newway of life is complicated by a lurking, subconscious feeling that one is no longer really needed - a feeling that never oompletely disappears unless and until a new need is found to demand one' s highest Skill.

The needs are there, just waiting to be found - all sorts of volunteer activity, participation in civic affairs - there are boundless opportunities to give of ourselves and our experience, in order to meet the needs of others. Unfortunately, some people never quite manage to find a spot where they feel truly needed and when this happens the result is all too often quite literally fatal. Women as a rule can manage retirement more gracefully than men because, running parallel to their professional lives, they have usually been filling the needs of their homes and their families, their children and grandchildren, and these needs remain when the pressure of other duties slackens. This can be a wonderful time of life for a man or a woman, as competition slips into the background and we are able to give ourselves fully to projects we find satisfying and truly worthwhile.

We need to be needed, but we must not selfishly hoard the satisfaction this can bring. Others need to be needed too. In an International gathering such as this one, it is all too easy for the person full of enthusiasm for some particular project to overlook the fact that others, coming from a totally different background, will also have important contributions to make, and that their need to be needed is just as great as anyone's. So, in these happy surroundings let us all give, and all accept, and all share the abundance of good things we have brought together from far and wide. Then we can take home with us, not only inspiration and new ideas, but the deep down knowledge that we are needed, and that we met the need.

Opening Speech — **Mr. A. L. Armitage Vice-Chancellor of the University of Cambridge**

Madam President, Dr. Gilbreth, ladies & gentlemen, I consider it a very great privilege as Vice-Chancellor to take part in the opening of this the Second International Conference of Women Engineers and Scientists. I see Ma'am that the First International Conference was held in New York in 1964 and now this Second International Conference is to be held in Cambridge. May I say unreservedly that the University of Cambridge considers it a great honour that you have chosen this University as the place for this important international gathering. It is a nice compliment to us as an important centre of international scientific study and we welcome you with pleasure and with thanks. Dr. Gilbreth has the great advantage over me in conducting this joint opening ceremony, which I am very honoured to do with her, in that, of course, she was present at the First International Conference and addressed you there, but I am very happy to follow her and to endorse what she has said.

From the point of view of the University we are very pleased that whilst you are here, in addition to your important Conference Sessions, you will see our Laboratories and our Colleges and the changes and developments which are taking place in Cambridge science and in Cambridge as a scientific University. It is true to say that we have in Cambridge, for centuries, believed in science and technology as appropriate subjects for University study, and we believe, though for not quite as long a period, that it is appropriate for women to study these subjects. We have always had a high proportion of our students reading science and this long before the modern pleas for such high proportions.

One of the first of the five Regius Professorships founded by Henry VIII in 1540, was the Regius Professor of Physic but even these Professorships are not the oldest teaching posts in the University. The probability is that the oldest teaching post in the University dates from 1501 when Roger Collingwood, Fellow of Queens' College, and the author of Arithmetica Experimentalis, began to receive a stipend of 2 marks a year from the University. From then on in the University accounts there is a regular series of successors in that office, indicating the establishment of professional salaried teaching in mathematics from 1501 onwards.

Moreover science was clearly recognised as a matter of very good general education in the University for, and I apologise for mentioning two Fellows of Queens' in this context but you will realise and forgive me for a certain amount of bias in this connection, it was said of Sir Thomas Smith, Fellow at Queens' and first Regius Professor of Law, appointed in 1542, that he was, “an accomplished physician, mathematician, astronomer, architect, historian and orator ” and at least four of these qualifications are scientific.

The Sadleirian Professor of Mathematics since 1669 is the seventh most senior professor, in date of foundation, in the University. He is followed by the Professor of Chemistry, who is the eighth, the Plumian Professor of Astronomy and Experimental Philosophy, the ninth, the Professor of Anatomy in 1707, the tenth.

There were, however, in some of our earlier scientific chairs provisions which would hardly commend themselves to/this Conference. For in the case of the Woodwardian Professorship of Geology, founded in 1728, the founder provided “that none be chose but bachelors and that the office should be immediately vacated by marriage less the care of the wife and children should take the lecturer too much from study and the care of the lecture”. I have, perhaps, said enough of our history to indicate a long, strongly held, scientific tradition through four centuries and more, and I should perhaps turn to modern times where Cambridge is synonymous with science in the United Kingdom. It would be invidious for me to mention names because you will be familiar with the great scientific names from this University in this century and the present, and the important research which is going on, but I think I can mention with pleasure and pride the seven Nobel prize winners in residence, as well as over 100 Fellows of the Royal Society and I can, perhaps, appropriately indicate to you certain developments which are occurring in science in Cambridge and which might be an appropriate background to you holding this Conference here

First is this, that we have, practically speaking, nearly doubled the number of undergraduates reading science subjects since the war and we have now nearly 4,000 science undergraduates in residence, together with 1,000 graduate and advanced course students. That total of 5,000 is the size of many Universities so we certainly provide a scientific University of 5,000 even though it is only 50% of our total number of students.

Secondly, we have in the last three years completed some very important reforms of the Natural Sciences Tripos, modernising the whole organisation of our courses and subjects, and, at the same time, the Engineering Tripos has itself been completely re-organised, to form an Engineering Sciences Tripos including instruction on materials, aerodynamics and so forth followed by the necessary specialization.

Thirdly, we have had a long term study of our scientific needs for all the science departments in an important report known as the Deer Report from the name of the Master of Trinity Hall, who was Chairman of that Committee. This is a most important planning document for the University forecasting the situation in five, ten, fifteen and twenty years ahead.

Since the war, too, we have completely rebuilt a large number of our scientific laboratories. We have completely rebuilt those for engineering, chemistry veterinary studies, and chemical engineering, and at the same time we have added important new buildings to physics, biochemistry, mathematics (pure and applied), physiology, psychology and genetics. All that at a cost, so far as the science buildings alone are concerned, of some £7 million. At the same time, we have another £5 million worth of scientific buildings in course of construction the new medical buildings on the new hospital site, the new zoology buildings, the mathematical laboratory, metallurgy, the Scott Polar research institute, theoretical astronomy and geophysics. We have a future programme of another £5 million to build a new Cavendish Laboratory for physics, a new biochemistry laboratory and a new pharmacology laboratory. When this is completed, which we hope it will be by 1971, provided we can raise the necessary finance, we shall have virtually replaced our scientific buildings with completely modern and up to date laboratories. I think too, as figures sometimes imprint scales in peoples minds, that if I can take just one illustration from one Department - which will appeal to you - the Department of Engineering, of the increase in sophistication and specialization in teaching and research. If you take the annual recurrent expenditure of the Department of Engineering, from University sources alone, it has risen from nearly £70,000 in 1946-47 just after the war, to £570,000 in 1965-66. That is the scale of the progress and of the cost. And in addition to the strong scientific tradition of the older colleges, we have now been reinforced by the building of a completely new college with a strong scientific bias in its foundation: namely Churchill College, where you are having so many of your meetings. This has been built for over 500 students and is a college with a very high proportion of its members reading mathematics, engineering and natural science.

I think I can say from that very brief outline, that we intend to keep our position in science and technology and to go forward in all our developments, planning and thinking. But you will say, “What of the women in all this?”. I can reply that there are over 300 women students studying science here and that that number is increasing. That of the three heads of the women’ s colleges, Dr. Cartwright, Mistress of Girton, who is here with us today, and Miss Murray, President of New Hall, are both scientists and if you include social sciences, as I see in one half of your programme you do, the Head of Newnham College is also a social, scientist. We want more women reading science, because, although we have no difficulty in filling our scientific and technology places, nevertheless on the national scene there are vacancies in the University places in science and technology, and it is vital that more girls are encouraged to read science. This is one reason why we are pleased to have your world wide Conference here in Cambridge. It is not only important for its own sake, for its participants and for the important papers that you have in your programme, but it is a matter of great importance in scientific education generally, and for that reason too we welcome you. I end as I began by welcoming you to Cambridge and by wishing your Conference every success, from every point of view and so, with Dr. Gilbreth, I have the great honour and great pleasure in Opening this most important Conference.

BANQUET **5 JULY 1967**

In the Chair : Miss R. Winslade, President of
The Women's Engineering Society

Toasts

The Queen

Proposed by The Chairman

The City of Cambridge

Proposed by Mrs. K. Walshe, B.E., A.M.I.C.E.I.

Response by Alderman E. A. Gill, Mayor of Cambridge

The University of Cambridge

Proposed by Miss V. S. Prabhavalkar, A.M.I.S.E.

Response by Dr. M. L. Cartwright, F.R.S.
Mistress of Girton College, Cambridge

Women Engineers and Scientists

Proposed by Sir Charles Wheeler, K.B.E.
Chairman of Associated Electrical Industries Limited

Response by Dr. Beatrice Hioks

Our Guests

Proposed by Mrs. M. Maple, M.I.E.E.

Response by Dr. K. G. Denbigh, F.R.S.
Principal of Queen Elizabeth College, London

Plate 1 - BRINGING OF GREETINGS.
Miss.D.E. AJAKAIYA (NIGERIA) and Mrs.I.H.HARDWICH (U.K.)

Plate 2 - DELEGATES AT THE BRINGING OF GREETINGS

Plate 3 - DELEGATES ARRIVING AT THE UNIVERSITY CHEMICAL LABORATORY

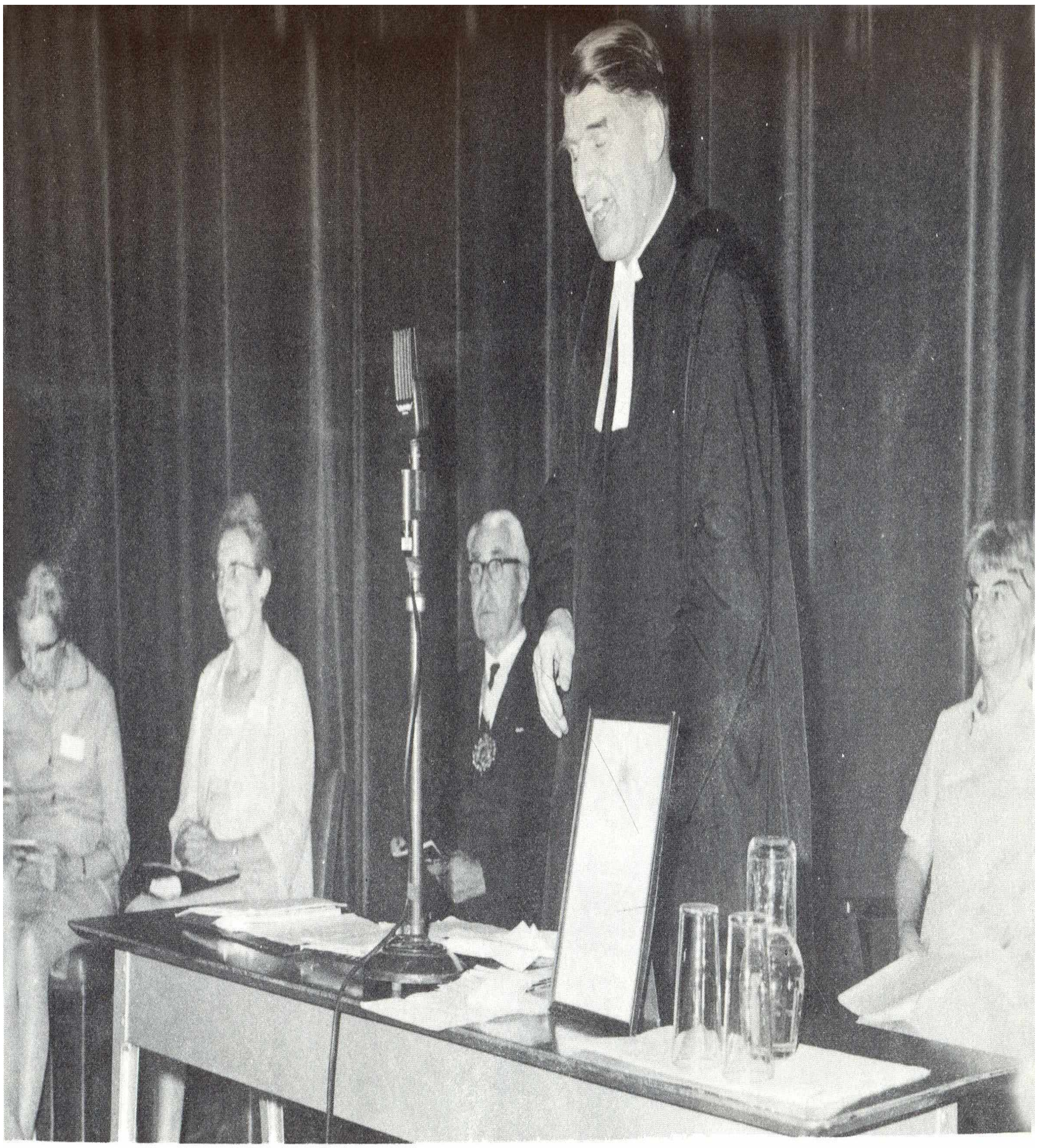


Plate 4 - Mr.A.L.ARMITAGE (U.K.) SPEAKING AT THE OPENING CEREMONY
L.to R. Dr.M.L.CARTWRIGHT (U.K.), Miss.D.F.HOLLINGSWORTH (U.K.),
Ald.E.A.GILL (U.K.), Mr.A.L.ARMITAGE (U.K.), Miss.J.C.THOMPSON (U.K.)

Plate 6 - Mrs.T.SUZUKI and Miss.A.YAMASHITA (JAPAN) DURING A TECHNOLOGICAL SESSION.

Plate 7 - AN INFORMAL DISCUSSION BETWEEN SESSIONS
L. to R. Miss. B. A. KRENZER, Miss. M. P. GAUVEY, Lt. Col. G. STURIALE (U.S.A.)

Plate 8 - DISPLAY OF FISH PROCESSING FROM JAPAN.
Miss.J.ANSCOMBE (U.K.) and Mrs.I.GHOSE (INDIA)

Plate 9 - An international group at a technological session.
L.to R.(front) - Mrs.L.M.GUILLERAULT-DANEL &
Mrs. M.BRYLINSKI (FRANCE), Mrs.H.SZUTORISZ-HOMONNAY
(SWITZERLAND); (Back): Mrs.M.R.BAURICHTER, Mrs.A.W.FLETCHER

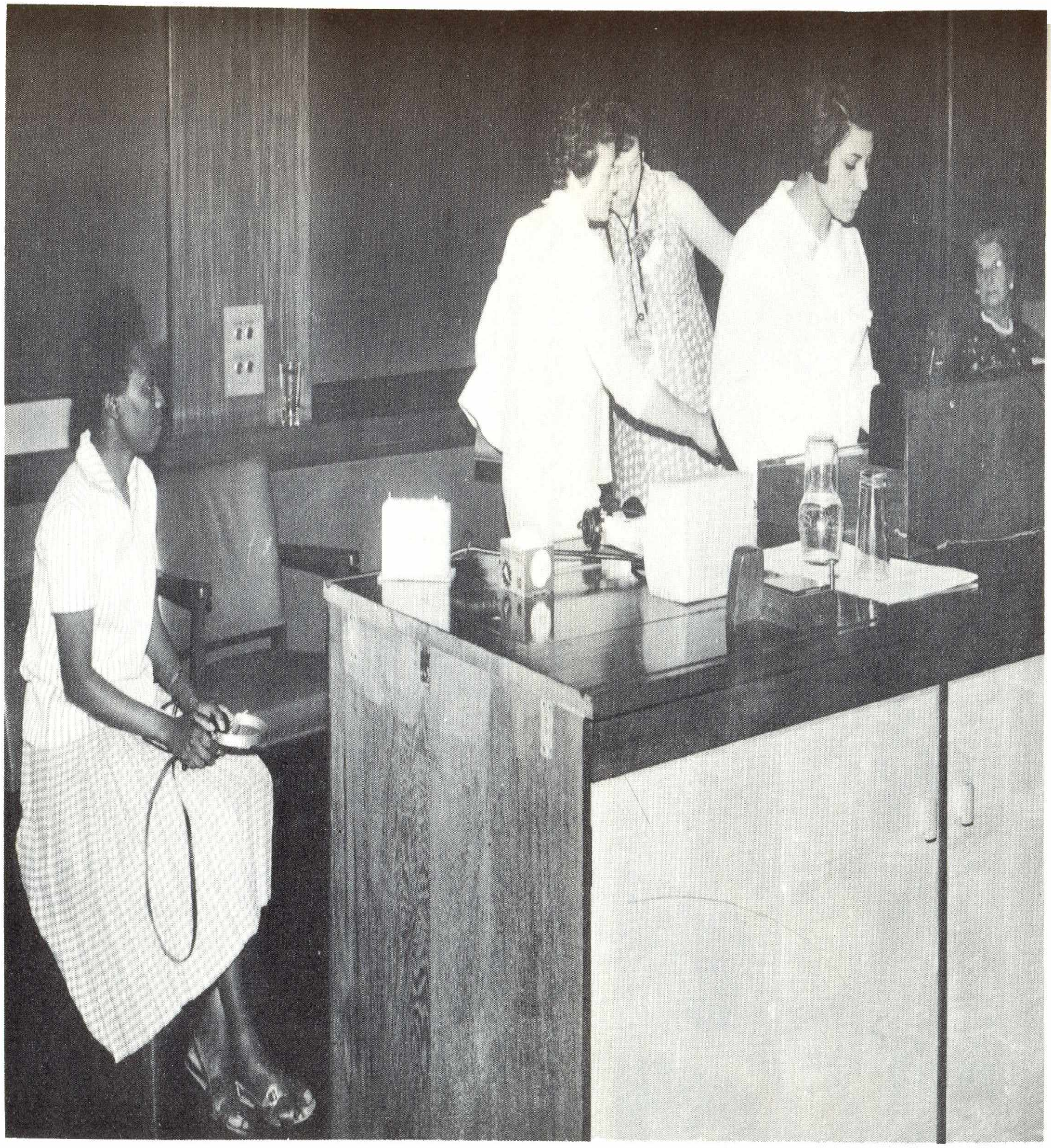
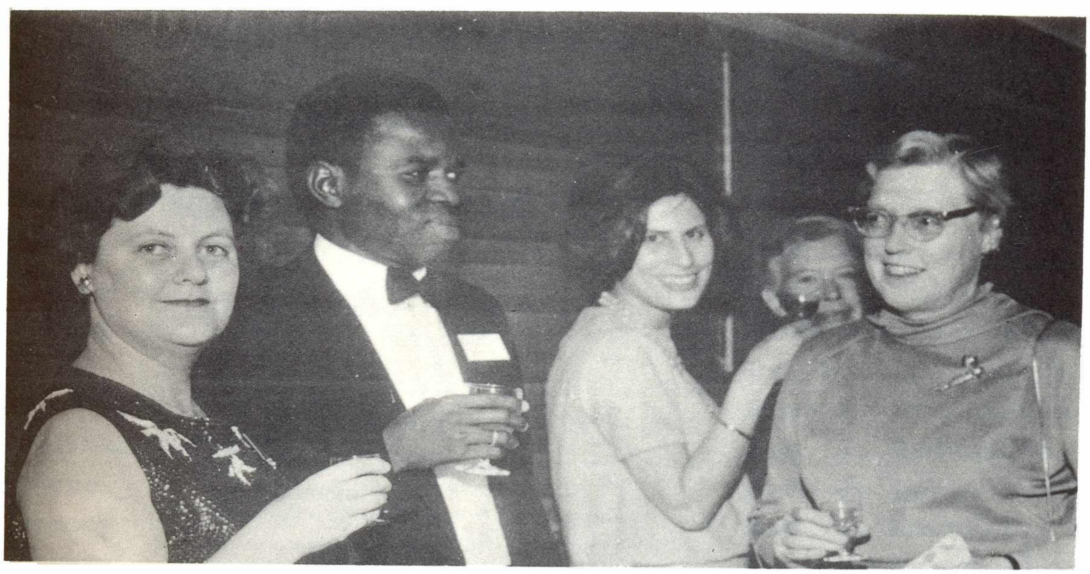


Plate 10 - Mrs. M. RAHMANI (IRAN) ABOUT TO OPEN A SESSION.
L. to R. Miss.M.MUWANGA (UGANDA), Miss.K.STINSON (U.S.A.)
Miss.R.WINSLADE (U.K.), Mrs.M.RAHMINI (IRAN),
Mrs.C.E.ARREGGER (U.K.)

DELEGATES FROM GHANA, AUSTRIA, BELGIUM, SWEDEN & TURKEY



DELEGATES FROM CANADA, SIERRA LEONE, NETHERLANDS
SWITZERLAND AND U.S.A.

Plate 11 - Two international groups at the Conference Reception

DISCUSSION ON THE POSSIBILITY OF FURTHER INTERNATIONAL

COOPERATION BETWEEN WOMEN ENGINEERS AND SCIENTISTS

Minutes of a meeting held at 21.00 hours on 6 July 1967 at Fitzwilliam College, Cambridge

In the Chair: Miss J.C. Thompson, Chairman, Conference Executive Committee.

Present:

Representatives of Supporting Societies

La Cercle d' Études des Femmes Ingenieurs de l'Association des fran9aises diplomées de l'Université	Mrs. M. Bry1inski
Associazione Italiana Donna Ingegneri e Architetti	Miss A.E. Amour Miss P. Ferrero
Society of Japanese Women Scientists	Miss K. Saruhashi Miss M. Tanaka
Society of Women Engineers (New York)	Miss L.I. Pickup Mrs. O. Salembier
Women's Engineering Society (London)	Miss R. Winslade Mrs. I.H. Hardwich

One delegate from each country

Austria	Mrs. A.M. Janovicz
Belgium	Miss P. Talpaert
Brazil	Miss S.M. Porte1la
Canada	Dr. M.E. Dormer Ellis
Ceylon	Miss P. Sivaprakasapillai
Czechoslovakia	Mrs. J. Vejvodova
France	Mrs. J. David
Germany	Mrs. J. Knott-ter Meer
Hungary	Mrs. Z. Szentgyorgyi

India	Mrs. I. Ghose
Iran	Mrs. M. Rahmani
Irish Republic	Mrs. K.E. Walshe
Japan	Miss D.U. Mizoguchi
Kenya	Miss E. Ricketts
Mexico	Mrs. A. Peréz Lopéz
Netherlands	Mrs. E. Jesse
Nigeria	Miss E. Adegbohungbe
Poland	Mrs. U. Angielska
Portugal	Mrs. A.V. de Seabra
South Africa	Miss P. Harding
Sweden	Mrs. R. Wallin
Switzerland	Mrs. J. Juillard
Thailand	Mrs. P. Saengbangpla
Turkey	Mrs. B. Őzgűner
Uganda	Miss M. Muwanga
U.S.A.	Miss I.F. French
Uruguay	Miss L. Chebatarott

Officially appointed representatives of international Organisations

Open Door International	Mrs. L.M. Guillerault- Danel
UNESCO	Mr. W. Ryland Hill

People who had expressed great personal interest

Dr. B.A. Hicks   Miss B. Rahm   Miss L.M. Maltby

In attendance:

The Conference Executive Committee:-

Miss E.H. Blount
Mrs. M.Neal
Mrs. I. Rischowski
Miss R. Winslade
Mrs. I.H. Hardwich (Honorary Secretary)

I Apologies for absence

Apologies for absence had been received from Mrs. L.E. Obeng (Ghana), Mrs. N. Abacumkin-Agnantopoulou (Greece), Dr. D.E. Gray (Hong Kong), Mrs. U.R. Ahmed (Pakistan), Mr. B.B. Ibrahim (Sierra Leone), Mrs. A. el-Hefny (U.A.R.), Mrs. L.E. Scarisbrick (International Council of Women).

II Preamble

The Chairman welcomed the delegates and explained that the Executive Committee had been moved to call the meeting by the world-wide enthusiasm for international cooperation between women engineers and scientists which had been displayed in the correspondence they had received. The Committee had already circulated some brief resolutions but they did not want delegates to be bound by these. They felt this meeting should “plant an acorn and let an oak tree grow”.

III General Discussion

A lengthy and involved discussion ensued. Delegates helped each other with informal Translations and the following points emerged:-

A Continuity of Conferences

1. There was a unanimous desire for the continuation of International Conferences of Women Engineers and Scientists.

2. The Conference Agenda could be on the lines of the First and Second Conferences or it could be a discussion on and, preferably, a solution of some specific problem experienced by women engineers and scientists.

3. The duration of the Conference should vary with the agenda.
4. An international secretariat to organise the Conference was desirable but was prohibitive in cost. Each Conference would build upon its predecessors and self-help and enthusiastic volunteers could provide the necessary workers. However, it would be extremely difficult to organise a Conference if there were no already existent host organisation. This did not have to be a women's organisation.

5. A Conference Representative in each country was desirable. She should organise her own voluntary supporting and fund-raising sub-committee.
6. Three years was a reasonable gap between Conferences. A spacing of five years would tend to break up newly-made contacts.
   An attempt should be made to hold the Conference outside the University terms and yet during a cheap travel period.
7. The Conference venue should move around the world.
8. Conference participation should be truly world-wide and a great effort should be made to secure the attendance of delegates from all countries.
9. UNESCO might be able to offer financial assistance.

B <u>Other activities</u>

1. A bulletin to disseminate information on women engineers and scientists was highly desirable although it would probably cost a great deal.

2. A centre to help keep the contact between supporting organisations was highly desirable but probably prohibitive in cost.

IV <u>Third Conference</u>

It was agreed that the Third Conference should preferably be held in 1970. Each delegate present was anxious to do her utmost to assist in the preparations for the Conference and it was suggested that each should contact the representative of her country at UNESCO in the hope that that organisation might provide financial assistance to the Third Conference.

For a wide variety of reasons, no one present was prepared to offer to sponsor the 1970 Conference without further consultation with her home-country organisation, so a small international committee was entrusted with the task of ensuring the continuity of the conferences. It was granted the power to co-opt further members and its basic membership was Ebun Adegbohungbe (Africa), Dorothy Mizoguchi(Asia), Bilge Ozguner (Europe), Angelina Perez Lopez (Latin America), Mahin Rahmani (Middle East), SWE President (North America) and Isabel Hardwich (Chairman).

It was agreed that delegates to the Second Conference should be invited to make a small contribution to a fund to finance the work of this committee.

V Any Other Business

1. To maintain contacts, Jlse Knott-ter Meer invited delegates to attend the meeting of the VDI in Germany in September 1967 at which one session would be devoted to women in engineering and Berta Rahm invited delegates to join with the International Union of Women Architects at their Second Conference to be held in Budapest in 1968.
2 Several delegates and groups of delegates thought they would be prepared to sponsor a conference in 1973.

3. The Chairman said the Executive Committee would send goodwill messages to absent friends in UAR and USSR.

There being no further business, the Chairman thanked the delegates for attending, hoped she would meet them all again in 1970 and declared the meeting closed.

I.H. Hardwich
Honorary Secretary,
Conference Executive Committee

Meat Research Institute and Low Temperature Research Station,
Agricultural Research Council

Spillers Ltd. Technological Research Station and
Central Laboratory

Tollemache and Cobbold Breweries Ltd., Cambridge and
Hutchings and Harding Ltd. Sawston

Simplex Dairy Equipment Co. Ltd.,Sawston

Wicken Fen Nature Reserve

Cavendish Laboratory, University of Cambridge

Engineering Department Laboratory, University of Cambridge

Radio telescope, University of Cambridge

Pye Telecommunications Ltd.

CIBA (ARL) Ltd.,Duxford

CONFERENCE VISITS **6 July 1967**

Fisheries Research Laboratories, Lowestoft, Suffolk
Ickworth, Bury st. Edmunds, Suffolk

Allis Chalmers Ltd. Stamford, Linoolnshire
Burghley House, Stamford, Lincolnshire

Lincolnshire Canneries Ltd._King' s Lynn, Norfolk
Sandringham Estate and Holkham Hall, near King's Lynn, Norfolk

Ross Foods Ltd. Greenfield, Ampthill, Bedfordshire
Hatfield House, Hatfield, Hertfordshire

St. Albans, Hertfordshire
Ovaltine Dairy Farm, Abbots Langley, Hertfordshire

Wyndmere Farm, Steeple Morden, Royston, Hertfordshire
Hatfield House, Hatfield, Hertfordshire

Sizewell Nuclear Power Station, near Ipswich, Suffolk
Melford Hall, Long Melford, Suffolk

Eleotrolux Ltd.,Luton, Bedfordshire
Luton Hoo, Luton Bedfordshire

Harlow New Town, Essex
Lunoh at AEI, Harlow

Hatfield House, Hatfield, Hertfordshire
Kayser Bondor Ltd.,Baldook, Hertfordshire

London. Luncheon at the House of Commons
Tea party given by the Electrical Association for Women

CLOSE OF CONFERENCE **7 JULY 1967**

Miss R. Wins1ade, President of The Women's Engineering Society

I am going to do two things, first to go through a list of people I would like to thank for their help and then to finish with a quotation from the paper by Mrs. Jo Webb. Let me first of all thank our speakers, both those who attended in person and those who read papers in the absence of authors. Then our Chairmen, who have been moat patient and very careful to keep our programme to its very strict, rather crowded time limit. Without our firm Chairmen, we should still be discussing the papers from half-way through the week. I would then like to say thank you very much indeed to those younger members of The Women's Engineering Society who have all this week, most unobstrusively, but very efficiently, handled the discussion sessions by running up and down with miorophones so that everybody could be heard.

Mr. Fuller, the projeotionist, started this week with rather a tough time, primarily, I think, due to a little difficulty of language, as we had not taken our interpreter to him when we took some of our overseas speakers to meet him. Nevertheless he coped very well and, very patiently and all thank him. In the matter of interpreters, I am sure that everybody here realises that a great deal of the success of our discussion periods has been due to the very efficient, careful and rapid translation we have had on our four channels; but, of course, the interpreters would not have been very useful to us without the equipment and I would like to thank the two young men who came along and spent the whole weekend installing the equipment for simultaneous translation. Then a special thank you to Mr. Bason and his staff here at the Chemical Laboratory. I think all of you must have been very impressed with the facilities that have been put at your disposal this week, in this building, both from the point of view of your lecture facilities, your morning coffee and afternoon tea, the facilities out in the hall to enable you to continue your registration to meet each other, to look at the pictures, to have displays of materials and so forth. Also the use of the second small lecture theatre where on Wednesday this week there were some very exiting films. In the case of the films, we have to thank certain members of The Women's Engineering Society, who have spent many months collecting these films together. Then, of course, we have also had the British Red Cross in attendance. I hope they have not had to do too much work, but from the organisational point of view we have felt much relieved to know that they were there. I hope that I have covered the whole list of those who have contributed to our success in this building this week. If I have not, please take it that whoever you are the omission is quite unintentional.

It looks as though I am not going to be able to quote from Jo Webb's paper straight away because somebody is waving a hand at me which I think means she wants to say something urgent.

Miss L. Pickup (U.S.A.)

Madam President, delegates, I propose a standing ovation for The Women's Engineering Society of the United Kingdom.

Miss R. Winslade (U .K)

Thank you very much indeed. I know that all the organisers and the members of the Society will be very grateful for your kind thanks. I would like to say that although at the beginning, last Saturday, we were all a bit afraid and wondering how things would go on, today I notice that everybody on the committee is smiling broadly which means that either things have gone well or they think that it will soon be over.

We have talked this week on two major subjects. That of 'Enough for Everyone where we tried to relate the many problems of food shortages, food surpluses, application of science and engineering to this, and of the interrelation of science, technology and sociology. I think that all of you will agree that in the first part of this week these three strands were very firmly woven together. We have, today, tried to discuss woman's role in the world of engineering, perhaps we could have done with an extra day on this, I think we were just beginning to get warmed up. But these two subjects, the one at the beginning of the week and the subject we had today are very much interwoven and I think that this quotation from Jo Webb's paper is rather important. It is :

> "We have called ours a scientific culture by virtue of its application of a scientific method even while our many anxieties and social problems have led to annoying disillusionment with science. Yet the great majority of people, even in the most technologically advanced societies, in their thinking and in their motivation, are as yet nearly untouched by the spirit or understanding of science. This state of affairs can, I think, be traced directly to education, education by indoctrination and still lacking the spirit of seeking the whys, the wherefores through experiment and hypothesis. Today we must face continuous change, our children must be educated for an unknown future. We need not only a well rounded knowledge of the various disciplines of thought but also a very real conception of the actual world in which we live."

This, I think, is the operative phrase in what I have said - we need not only a well rounded knowledge of the various disciplines of thought but a1so a very real conception of the actual world in which we live. I think that from this week we will all go home with a better idea of some of the problems of the actual world in which we live. Let us hope that we can get closer to them spiritually and practically in the future.

CONFERENCE RESIDENCES

Churchill College (Headquarters)

Fitzwilliam College

Girton College

New Hall

University Arms Hotel

LECTURE THEATRES

University of Cambridge Chemical Laboratory

CONFERENCE PARTICIPANTS

CONFERENCE GUESTS

DELEGATES

DELEGATES’ GUESTS

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Occupation
Organisations represented

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Mrs. M.F. Brown	Chairman, Cambridge Branch, The Electrical Association for Women
***Mr. and *Mrs. H. Butler**	Directors, Harold Butler Ltd.
Dr. Mary L. Cartwright	Mistress, Girton College, Cambridge.
Miss Ruth Cohen	Principal, Newnham College, Cambridge
Prof. P.V. Danckwerts	The Council of engineering Institutions.
Mr. Michael Deaves	"Cambridge News".
Dr. J.M. Dodds	Director, rower Group Research Laboratory, A.E.I. Ltd.
Mr. John .W. Elven	Town Clerk, City of Cambridge.
***Brig. J .R.G. Finch**	Secretary, The Council of Engineering Institutions
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Mr. S.A. Ghalib	Managing Director, The Nuclear Power Group, Ltd.
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Miss Sheila Menzies	Acting Steward, Girton College.
Mr. D.J. Mothersill	Managing Director, Eyre and Spottiswoode Ltd.
Prof. Sir Nevill Mott	Head, Department of Physics, University of Cambridge.
Mrs. Corrie Otter	"Mid-Anglian Magazine".
Mr. O.J .B. Prince-White	Central Office of Information in Cambridge

*Miss Anne G. Shaw — Managing Director, The Anne Shaw Organisation Ltd.

Sir Charles and Lady Wheeler Chairman, A.E.I. Ltd. and his lady.

and

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INTERNATIONAL FEDERATION OF UNIVERSITY WOMEN

[x]Mrs. C.E. Arregger (U.K.)

INTERNATIONAL UNION OF WOMEN ARCHITECTS

Miss B. Rahm (Switzerland)

OPEN DOOR INTERNATIONAL

[C]Mrs. L.M. Guillerault-Danel (France)

UNESCO

Mr. W.R. Hill (U.S.A.)

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The Women's Engineering Society founded in June 1919, is the oldest society of women engineers in the world with members in Africa, America, Asia, Australia and Europe, as well as in the United Kingdom. All branches of professional engineering and allied fields are represented within the Society.

The two most important aims of the Society are to promote the study and practice of engineering among women, and to enable technical women to meet and correspond and to exchange ideas.

The Society has four branches; in London, Manchester, the Midlands and South Wales, and each of these branches has a regular programme of meetings and works visits. An annual conference held alternately in London and the provinces allows members of all branches to meet at least once in the year. The conference, which usually lasts three days, includes technical papers given by eminent engineers or educationalists of both sexes, works visits, and at least one social function. The town in which the conference is held always extends a warm welcome and, outside London, a civic reception is a feature of the conference.

The Electrical Association for Women and the British Women pilots Association both owe their being to the 'Women's Engineering Society. The former, which has many thousands of members, has as its prime purpose that of teaching women to make the best use of electricity in the home and it is considered in England to be doing a most important job.

The British Women pilots Association is a young but growing society with, we believe, an exciting future.

The Society's quarterly magazine "The Woman Engineer" has an editor and business manager both of whom give their services entirely free.

Most of the work of the W.E.S. is done on a voluntary basis by its members who give talks to schools and careers conventions, represent the Society on other organizations and, through Council and the committees, keep the Society active, dynamic and in the public eye. It was typical that about 20% of members were involved in some way in the organization of the International Conference.

PROCEEDINGS OF THE
SECOND INTERNATIONAL CONFERENCE
OF WOMEN ENGINEERS AND SCIENTISTS

Cambridge, England, 1 - 9 July, 1967

Volume 2

ENOUGH FOR EVERYONE - THE APPLICATION OF TECHNOLOGY

TO WORLD FOOD PROBLEMS

1967

WES

VOLUME 2 - CONTENTS

Enough for Everyone - The Application of Technology to World Food Problems: Papers presented on 3, 4 and 5 July 1961.

Papers are grouped into sessions, preceded by a list of titles and followed by the discussion (abridged).

Enough for Everyone - The Application of Technology to World Food Problems

3 July 1967

In the Chair **Cicely Thompson (UK)**

Opening Address:

Nutritional goals in a world context

Dorothy F. Hollingsworth (UK)

Discussion

Vote of thanks **Miriam Muwanga (Uganda)**

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NUTRITIONAL GOALS IN A WORLD CONTEXT

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Summary. The growth of thought on the application of nutritional. knowledge to the problem of feeding populations is traced. Experience in the United Kingdom since the beginning of this century is used to illustrate certain general principles. The growth of international action in matters of food is followed from the concept in the 'thirties of the "marriage of health and agriculture" of the League of Nations to that of the Indicative World Plan of the Food and Agriculture Organization of the United Nations in the sixties.

Nutritional Goals in a World Context

by **Dorothy F. Hollingsworth**

"If every just man that now pines with want
Had but a moderate and beseeming share
Of that which lewdly-pamper'd Luxury
Now heaps upon som few with vast excess
Natures full blessings would be well dispenc't
In unsuperfluous eeven proportion,
And she no whit encomber'd with her store, ….."

So spoke Milton's Lady over three hundred years ago in her argument with Comus about gluttony, and her words are true today. The concept of "a moderate and beseeming share" might be taken as a text to our scientific efforts to determine the nutritional requirements of persons and to translate these into the food requirements of nations. To help each person to get such a share is the Goal that those working in pure and applied nutrition and food science have set themselves.

Advances in the application of knowledge on food and nutrition have often come about because of national or international disaster, and the present time is no exception to this generalisation. We might consider, first, some experiences during this century in Britain. At the beginning of the century a few social workers, notable among whom were Seebohm Rowntree of York and Charles Booth in London, were struggling to make known facts about the poor living conditions and poverty of large sections of the population, but no great notice was taken of their efforts until the Director General of the Army Medical Service showed that the Inspector of Recruiting was having the greatest difficulty in obtaining sufficient men of satisfactory physique for service in the Boer war. This led to the formation of the Inter Departmental Committee on Physical Deterioration which made a comprehensive survey, including close questioning of 68 widely experienced witnesses, into the possible causes of the poor physique and ill-health of the labouring population of the towns of Britain. The Committee reported in 1904 (Inter-Departmental Committee on Physical Deterioration, 1904). They found much wrong with conditions of life in the towns and, although there were divergences of view about the prevalence of under-feeding, opinion was unanimous that the use of unsuitable food was widespread in the towns. The report stated that "The greater cheapness of many articles of consumption - meat for instance - has brought them much more largely within the reach of the poor but there has been no corresponding increase of knowledge as to the economic expenditure of money on wholesome food; indeed, the general consensus of opinion collected from every variety of witness points to the conclusion that in no branch of domestic life is the English housewife so deplorably destitute of the necessary equipment". This criticism directed public attention to the need for making more and better provision for teaching cookery in schools. It gave fresh impetus to the study of actual food budgets, and of the management of different incomes, particularly expenditure on foods. It directed attention to the problems of catering and marketing and to the planning of meals balanced to meet the nutritional needs of families. It led to the consideration of the special educational needs of girls and to the creation of a post of Chief Women Inspector of schools. This was filled early in 1905 by the first woman of be appointed His Majesty's inspector of schools, and, shortly afterwards, twelve other women were appointed H. M. inspectors, five of them holding qualifications in domestic subjects and experience of teaching them. One of the first tasks allotted to those with qualifications in domestic subjects was to investigate the methods of teaching cookery in the elementary schools and centres and in the training schools in England and Wales (Sillitoe, 1933). Many witnesses expressed the view that it was cruel to impose education on undernourished children and another important outcome of the Committee's report was legislation giving Education Authorities power to provide meals for school children (Provision of Meals Act, 1906.)

Concurrently, it was being established by Pekelharing in the Netherlands, Stepp in Germany, Gowland Hopkins in England, Holst and Frőhlich in Norway that foods contain not only carbohydrates, proteins, fats and mineral salts but small quantities of organic compounds, at first called accessory food factors, later vitamins, that are essential for life and health. The 1914-18 war broke out before the importance of this advance in scientific knowledge was fully recognised. However, late in 1916 a committee of physiologists appointed by the Royal Society to advise on physiological matters relating to the war published as a confidential document the first estimate of the food resources and requirements of the United Kingdom (later published as “The Food Supply of the United Kingdom". Royal Society Committee, 1917). This committee, bearing in mind current scientific work on the cause of scurvy and beri-beri, warned the government that there would be risk if imports of fresh fruits were stopped, as was proposed, that the health of the people would be harmed as a result of lack of "essential subtle principles". The committee concluded that sufficient food was available to feed the people adequately, but warned that food prices were rising, and that this was an indication of approaching scarcity, which would need careful watching if equitable distribution of food was to be maintained. The conclusion of the committee on this subject is valid today and is worthwhile quoting:

> "The Committee, as physiologists, desire to lay stress on the fact that in buying food the labouring population buying energy – the power to do work. Increased cost of food …. means increased cost of production. If the rising prices curtail for any class of the community its accustomed supply of food, its output of work will, of necessity, be reduced”.

During the early months of 1917 the food situation deteriorated and the Royal Society Committee urged the government to apply known scientific principles to the management of the food supply. This was eventually done, but perhaps the most important contribution of government policy at that time was to keep food prices steady and to provide employment, for the first time, for the whole population. The achievement of food control in Britain in the First World War was to ensure that avai1able food was fairly distributed at prices people could afford. In an official report on the Cost of Living in1918 (Working Classes Cost of Living Committee, 1918) it was stated that:

> …… "Our figures indicate that the families of unskilled workmen were slightly better fed at the later date (in June 1918 than in June 1914), in spite of the rise in the cost of food. This conclusion is more than confirmed by the reports we have obtained from the Medical Officers to Education Authorities in the great cities. From London it is officially reported, after inspection of all the children entering school, 'that the percentage of children found in a poorly nourished condition is considerably 1ess than half the percentage of 1913' ".

Beveridge (1928) concluded that the direct lessons from the work of the first British Ministry of Food concerned as it was with the control of livestock and with the rationing system, were small. Nevertheless, the First World War had far-reaching influence, both direct and indirect, on knowledge of the functions of food and other food problems. It was directly responsible for a great, deal or technical investigation into methods of preparation, preservation, storage and transport of foods. Emergencies had revealed how little was known about the changes that occur in foods under such treatment and it become obvious that the urgent problems which had to be solved as well as possible under the stress of war were insignificant compared with those needing attention, and that much research in food science and technology was required. On the medical side there were demands for more extensive research into the physiological functions of foods, because the medical services had been caught unawares by numerous food difficu1ties. Thus, interest became directed towards the scientific aspects of food and nutrition and the outcome was a remarkable development of experimental research, particularly in Britain and the U.S.A .At this time too, the importance began to be appreciated, of finding out what families, and individuals, actually eat. The nature of adequate nutrition was fairly well known by the 'thirties, but it took the economic depression and unemployment of those years to cause the developed countries to consider how sufficient food could be provided at a cost within the means of their own poor. At that time the needs of the rest of the world did not enter the field of discussion. It became plain that there was much disparity in food consumption between the rich and the poor of such rich nations as the United States and Britain. For example, in December 1935 an important paper, as read by Mr. E. M. H. Lloyd at a meeting of the Agricultural Economics Society in London (Lloyd, 1936). In it he analysed information relating to food consumption at different levels of income. This was the first attempt to apportion the British nation's expenditure on food between different income groups, and it showed the wide ranges between income groups in the consumption of dairy produce and fruits and vegetables - the foods which, by that time, had begun to be designated "protective". The data obtained by Mr. Lloyd were made the basis of an analysis by Sir John (now Lord) Boyd Orr (1936) of the national food consumption in terms of calories, protein, mineral salts, such as calcium and iron, and some of the vitamins. The analysis showed that only the richest had a surplus of all the constituents considered, while the diet of the poorest group was deficient in every constituent examined. This group was estimated to contain 4 $1/_2$ million people, including 20 to 25% of the nation's children.

In previous centuries malnutrition could be traced to failure of harvests. In the 'thirties the inability of the farmer to sell his produce set in motion much of the mechanism that led to the economic depression, a fact that, was recorded in epitaph to a Canadian farmer of the time:

"Here lies the body of Farmer Pete,
Who died from growing too much wheat".

It was in the interests of farmers throughout the world that governments should find some way of expanding the market for foodstuffs. Both in Britain and the United States a few trials were made to dispose of surplus milk and other foods in the form of relief to the unemployed and in the feeding of school children, but the first proposal to expand the market for food came from Australia, with its food-exporting interests. The notion of "a marriage of health and agriculture" was first enunciated by an Australian, F. L. McDougall, at that time Economic Advisor to the Australian High Commissioner in London. His idea was to use unwanted surpluses of foods to promote health - the prosperity of the farmer could be restored by raising the nutrition and standard of living of urban consumer. Increased demand both for agricultural products and industrial goods could contribute to an expanded world economy. This fitted the ideas of many people concerned in the development of new knowledge about foods and in the welfare of agriculture, and in September 1935 the Australian representative at the

League of Nations, Stanley Bruce, then Australian High Commissioner in London and later Viscount Bruce of Melbourne, raised the whole subject in Geneva. As a resu1t, the League of Nations estab1ished the Mixed Committee on the Relation of Nutrition to Health, Agriculture and Economic Policy which met between 1935 and 1937 and published a series of reports on nutritional problems, which can still be read with profit today. Indeed they formed the basis of later food and nutrition policies, even though this important international committee thought almost entirely in terms of malnutrition in advanced countries. Of 322 pages in the committee's principal report (1937) on "The Relation of Nutrition to Health, Agriculture and Economic Policy" only six were devoted to the problems of Asia and the "colonial areas" - and this was only 30 years ago with this background the outbreak of war in Europe in 1939 found the belligerent countries well fitted to apply these new concepts of food and nutrition to the task of feeding their populations under the stress of war. Walters in his history of the League of Nations (Walters, 1952) notes that "the scientific standards of diets drawn up by the League were first used by Germany, then by other governments, as a basis for their rationing systems". In Britain the aim was not only to maintain but to improve the nutritional value of the diet, and in this the British government was outstandingly successful.

The world food movement started by the League report, which had great international success, took root, particularly in the United States of America, and at the height of the war the same people who were responsible for the League discussions on health, agriculture and economic policy, began to consider what could be done about world feeding after the war. Again, F. L. McDougall appears to have been a key figure. By that time he was in Washington as Australian representative in negotiations for international wheat agreements and, while these were in progress, a small group of people, mostly from the U.S. Department of Agriculture, met McDougall to discuss international food problems. Sir John Boyd Orr was also in Washington at about that time. "The McDougall memorandum" was produced, which outlined proposals for establishing an international organisation concerned with food and agriculture as soon as the war ended. A copy of the memorandum fell into the hands of Mrs. Eleanor Roosevelt, with the result that she invited McDougall to lunch in September 1942. There can be little doubt that this lunchtime conversation had something to do with President Roosevelt's invitation to the allied governments to send representatives to a conference on food and agriculture at Hot Springs, Virginia in May 1943. It is recorded by Gove Hambidge (1955), later one of the earliest members of the staff of FAO that "The delegates of 45 countries who attended ……had a sense of participation in a world event of unusual significance". The delegates, many of them technical, discussed the world food problem with a new urgency and drive that was itself partly an effect of the war. The excitement and sense of dedication that attended the Hot Springs Conference was well described by one of the British delegates, Mr. J. P. R. (now Sir John) Maud, on his return to London in a brilliant address to the staff of the Ministry of Food. He spoke in unforgettable terms to the John Donne text "Any man's death diminishes me, because I am involved in Mandkind; and therefore never-send to know for whom the bell tolls; It tolls for thee".

The delegates agreed that "There never has been enough food for the health of all the people. This is justified neither by ignorance nor by the harshness of nature. Production of food must be greatly expanded; we now have knowledge of the means by which this can be done. It requires imagination and firm will on the part of each government and people to make use of that knowledge". They agreed that "The first cause of hunger and malnutrition is poverty. It is useless to produce more food unless men and nations provide the markets to absorb it. There must be an expansion of the whole world economy to provide the purchasing power sufficient to maintain an adequate diet for all". They agreed that "The primary responsibility lies with each nation for seeing that its own people have the food needed for life and health .... But each nation can fully achieve its goal only if all work together". They agreed to recommend that a permanent international organisation with a wide range of technical functions and duties, concerned with food and agriculture, be established as quickly as possible. (Final Act of the United Nations Conference on Food and Agriculture, 1943). It was decided to set up an Interim Con11'nission on Food and Agriculture. Mr. L. B. Pearson, the Minister - Counselor of the Canadian Legation in Washington (now Prime Minister of Canada) was elected Chairman and was more than any other person responsible for steering the Interim Commission through two successful years of work in Washington. One of the Panels of the Commission chaired by McDougall prepared a general report on The Work of FAO, which included the views that the development of the less advanced countries might be regarded as the major need of the decades following the war and that in an age of increasing agricultural efficiency and industrial mass production it was little less than suicidal to leave two-thirds of the world's people in a state of chronic poverty and undernourishment. They realised that the problem was to get already available knowledge put into practice on the necessary scale and they felt that the simplest beginnings should not be despised; indeed, that they should sometimes be especial11 sought. The Interim Commission prepared a draft constitution that was eventually put before delegates from 42 countries who met at Quebec in October 1945 and created the Food and Agriculture Organization of the United Nations. The Constitution was signed on 16th October, 1945. Its "Preamble" reads as follows:

> "The Nations accepting this Constitution being determined to promote the common welfare by furthering separate and collective action on their part for the purposes of

raising levels of nutrition and standards of living of the people under their respective jurisdictions,

securing improvements in the efficiency of the production and distribution of all food and agricultural products,

bettering the condition of rural populations,

and thus contributing toward an expanding world economy,

hereby establish the Food and Agriculture Organization of the United Nations... through which Members will report to one another on the measures taken and the progress achieved in the field of action set forth above".

If we might jump briefly twenty years ahead, on 1st December, 1965 the Biennial Conference of FAO, the governing body of the present 113 -member organization, amended this preamble to include in FAO's stated aims the phrase "ensuring humanity's freedom from hunger" in recognition of the accelerating urgency of the world food problem.

In Article 1 of FAO's Constitution,. it is stated that the Organization shall "collect, analyze, interpret and disseminate information relating to nutrition, food and agriculture" and where appropriate "shall recommend national and international action with respect to", inter alia "scientific, technological, social and economic research relating to nutrition, food and agriculture" and "the improvement of education and administration relating to nutrition, food and agriculture, and the spread of public knowledge of nutritional and agricultural science and practice". The prominent position accorded to nutrition is noteworthy.

In 1948 the first World Health Assembly was held in Geneva and the World Health Organisation was started in its permanent form, with a Constitution which declares the objective of the Organisation to be "the attainment by au peoples of the highest possible Level of health". In the preamble to the Constitution health is defined as "a state of complete physical, mental and social well-being and not mere1y the absence of disease or infirmity", and nutrition is singled out for special mention as an aspect of "environmental hygiene" which it is the stated function of WHO to improve. On nutritional matters FAO and WHO work jointly in pursuit of their common aims.

At the 1945 Quebec Conference, Sir John Boyd Orr was elected the first Director-General of FAO. He served until 1948. It was he who was responsible for FAO's motto "Fiat panis" - "Let there be bread". One of his first acts was to set his small staff, with the help of borrowed experts, the task of compiling the first "World Food Survey". This gave the best approximation of the time (1946) of the world food supply and of world nutritional requirements (Food and Agriculture Organization: United Nations, 1946). It was the first attempt to review food supply as a world problem. Its methods have been refined in the succeeding second Food and Agriculture Organization: United Nations, 1952) and third (Food and Agriculture Organization: United Nations, 1963) World Food Surveys, but its main findings have never been seriously assailed. It showed, as its successors have shown, that the world is divided into the “have” and “have not" nations, the first group getting something of the order of 3000 kcal per head per day and ample supplies of protein and the second group getting nearer 2000 kcal per head per day and much more meagre supplies of protein. These reports have set targets for the nutritional requirements of populations and have translated them into terms of supplies of food required for the expected populations in the short and long terms, taking account of the food patterns and possibilities in the various regions of the world. In setting such goals it is realised that nutritional goals are themselves dynamic. They will change as people change their way of life. They will probably recede the more nearly they are realised, since increased stature and body weight will lead to increased requirements for food, though increased mechanization will probably lead to decreased requirements for calories. FAO and WHO, by calling together appropriate scientifically expert groups, have made striking advances in the development of scales of nutritional requirements applicable to people living in different environments and these new scales have been used in the setting of their targets.

It is one thing to set targets. It is another to meet them. During the last ten years or so the whole concept of the world food problem has changed with the growing understanding that it has become a race between food production and population growth. The efforts, often heroic, of the developing nations to produce sufficient food are being defeated by their own rapidly growing numbers - the last year in which there was substantial increase in per caput food production in developing regions was 1958/1959. This problem has come very suddenly upon the world. We are apt to forget that in the 'thirties fears were expressed that, owing to the low birth rate, Western Europe would become depopulated and that populations in some of the less developed parts of the world were at that time only just emerging from a state in which high birth rates were necessary to secure survival against the periodic ravages of disease and famine. The min factor in this growth of population is, of course, man's achievement in combating the diseases which until recently were largely responsible for high death rates and short expectation of life in most parts of the world, though according to the Secretary of the Institute of Commonwealth Studies (Smith, 1966), “higher birth rates have also played a part …… in the more developed regions of the globe”. To quote Smith further: “Better health, longer life expectation and low death rates are obviously desirable, but they have created new problems for mankind, particularly in the developing countries where the general desire for improved conditions of living tends to be frustrated by the difficulties of generating a rate of economic growth sufficiently in excess of population growth. It should be noted, however, that by no means all the governments of developing countries view the current population growth rate with alarm. For instance, a number of African governments have recently been canvassed about their views on family planning, and three of these governments - those of Tanzania, Sierra Leone and Somalia - came back with the comment that they would like to see a higher birth rate in their countries, though fertility is in fact very high in almost all of Tropical Africa. To balance this zeal, it must be stated that the majority of the African governments questioned did not adopt a pro-natal policy, and some, including Kenya, have actively expressed an appreciation of the need for a lower population growth rate".

The gravity of the implications of the rapidly rising world population in relation to food supply was brought to the attention of the U.N. Population Commission in March 1965 and to the world Population Conference in August 1965. In Hay 1966 FAO made a statement (reported in Food and Agriculture Organization: United Nations, 1966a on "Family Life Planning" which does not minimize the extreme complexity of the situation. It points out that the next 25 to 30 years are likely to be the most critical for the developing countries, because the trends of population growth are unlikely to change substantially during these years, and that "it is by no means certain that disaster can be forestalled and avoided. The situation calls for the adoption of population stabilisation and a social policy of urgent priority". The FAO emphasis is on "Planning Family Life" rather than “Family Planning, emphasizing first the importance of planning for the whole family life. This 'Work is part of the home economics programme in FAO and is a co-operative effort in home economics, nutrition and agricultural extension work. This and similar statements represent a very important development and they are accompanied by others, perhaps more subtle. It has long been understood that it is no good teaching families how to improve the nutritional value of their diets unless they have the means to buy the necessary foods or to grow them. It has much more recently become known that more than purely scientific knowledge is required to influence food habits even if economic problems are not present. The importance is being appreciated of the social scientist and the anthropologist in determining, for example, the patterns of food distribution and food preferences within family groups for particular societies or the tide available for food preparation or the role of women in determining food choice. It is one thing, and a most essential first step, for administrators, economists, nutritionists, agriculturalists to plan for increased supplies of protein at prices within the means of all the people, for the most effective way of increasing the protein intake of children is to improve the protein supply of the family. But it is quite another thing to get the improvement through to the child in the village or in the urban slum. To get this done requires patient work with individual mothers to find out what they themselves want. A striking example comes from a rural area in a. Latin American country. Classes offered in cooking and nutrition had failed to attract the poorer members of the community who most needed to recognize and to be able to prepare nourishing food. They told the social anthropologist who was assisting in the project that what they really wanted was to learn "how to do addition, how to tell the time by the clock, how to make dresses, and how to read and write”. When literacy classes were started these were well attended and it was through them that interest in improved diets was at last successfully stimulated. Or to take a different example, people may show little *or* no interest in producing foods for home use if', in their view, their greatest need is for a larger cash income - such a fact could be discovered and provided for early on in a programme by a social scientist. Appreciation of such facts has led to the development during the past 10 to 15 years of what have come to be called "applied nutrition programmes”, of which more than 60 have been undertaken in some 35 countries. (Food and Agriculture Organization: United Nations, 1966b). In outline these programmes "have been composed of the following elements:

"1. Co-ordination of relevent concepts, policies and activities of the ministries, or departments, of public health, education and agriculture, as well as other national bodies whether public or private, the ultimate aim being to help the population learn to produce and to eat a more nourishing and better balanced diet.

"2. Studying, testing and popularizing, suitable educational methods and techniques; determining, in the agricultural field, which nutritionally needed foods it is possible to produce locally or to market at reasonable prices, and then popularizing them as well as perfecting simple agricultural techniques for improving their production.

"3. Training the personnel needed to start and carry out the program.

"4. Obtaining the active collaboration of the communities affected by the program, and, in the execution phase, contacting different members of the family in their own occupational centers or the places where they normally are accessible in groups. (e.g. the school, the health center, the agricultural center or co-operative, social centers or clubs, etc.); if necessary, such centers may also be set up under the program".

Their broad objectives are considered to be:

"1. To establish dietary practices essential for sound growth and development of children and for the maintenance of health of all members of' the family and the community to "which they belong.

"2. Concurrently to improve levels of family living and local patterns of food production, distribution and consumption".

It is difficult to mount such formidable programmes and the Joint FAO/WHO Report discusses in considerable detail such matters as the difficulties of co-ordination at all levels and the lack of suitably trained staff. British experience suggests that such difficulties can be overcome if the need is recognized to be urgent. The British wartime food and nutrition policy, started early in the Second World War was, in effect, a highly successful applied nutrition programme. After the war, when it became apparent that the public health had been maintained and in many respects improved in spite of the material, social and personal disruptions of war, the success of the policy was widely acknowledged. Indeed in 1947 the Lasker Awards Committee of the American Public Health Association recommended "awards for scientific and administrative achievements to the British Ministries of Food and Health and to the four great leaders in this historic enterprise, Lord Woolton, Sir Jack Drummond, Sir Wilson Jameson, and Sir John Boyd Orr", expressing the opinion that "this has been one of the greatest demonstrations in public health administration that the world has ever seen".

The steps the Ministries of Food and Health /took to promote their policies were essentially those advocated in the Joint FAO/WHO Report. They were able to build on available scientific and social knowledge but when the emergency arose, to quote again from the Lasker Award Citation, "A separate ministry of Food was established with wide executive powers over the production and rationing of foods, the purchase of foods from abroad and the education of the public in the proper use of available foods. By the effective employment of its great powers, the Ministry of Food, in consultation with the Ministry of Health and with the advice (on all matters which might affect the health of the people), of a standing committee under the Chairmanship of the Chief Medical Officer, succeeded to a remarkable degree in providing a diet for all the workers of the country in conformity with their physiological requirement, irrespective of income" - to which one might add that such a diet was provided not only for workers, but for expectant mothers and young children, school children and adolescents. The actual measures taken are irrelevant to present considerations of the world food problem, and I have described them elsewhere (Hollingsworth, 1958). The only point I wish to draw from this wartime experience is to emphasise the importance of sound scientific advice in an enterprise of this kind. The Ministry of Food had a Scientific Adviser's Division which to quote from the official history of the Ministry of Food (Hammond, 1951) was "an indispensable condition of the influence of the health authorities being continually effective"- "for only thus can they be kept in touch with circumstances". The influence of the Ministry of Food in applied nutrition was wide and it was centred on the Scientific Adviser, Sir Jack Drummond, and his Division. They worked within an executive department, aware of its day-to-day problems, but they were in touch with outside scientific opinion and they were able to marry the two.

Since the end of the war there have been changes in emphasis to the food programme, but its essence remains. Those who work in applied nutrition in Britain today are conscious of the success of the wartime policy - many of us indeed were part of it - and we are jealous of our heritage. Present and future policies are based on past strength

It was easier to put an applied nutrition programme into effect in a wartime Britain than it would be in a developing country today. To mention two obvious differences, there was no real shortage of food and there were considerable numbers of trained people in Britain. The Joint FAO/WHO report discusses at considerable length the lack of suitably trained people in the developing countries and the urgent need for international advisers, concluding that "the future of applied nutrition programs is .....heavily dependent upon training international and national personnel of suitable calibre". This is an important report for both factually and conceptually it breaks new ground. It preaches the need to make haste slowly, going back to lithe simplest beginnings" envisaged by FAO's founders; it teaches the importance of the grass roots. It demonstrates daunting difficulties. But to see a problem clearly is often to be half way to its solution.

Against this growing awareness of the real need of people, two important and imaginative developments in FAD may be viewed. The first, the launching by the Director-General, Dr. B. R. Sen, in July 1960 of his Freedom from Hunger Campaign. This is essentially a reaffirmation of the fundamental objectives of FAD, but it is based on a new" concept of action. The campaign, which was conceived to capture the feeling of the world against poverty and hunger, aims not merely at rapid, temporary relief, but rather at lasting remedy. It has paid particular attention to mobilizing people in the underdeveloped countries, who are often resigned to poverty, disease and ignorance, to work themselves out of their cycle of food shortages and malnutrition and this is imperative, since no amount of external aid can substitute for a greater and more effective effort by the needy countries themselves. Secondly, the campaign aims to mobilize people and organizations who can offer technical knowledge and initiative, development finance in such forms as capital, fellow/ships, and modern equipment, and human co-operation which developing countries need if they are to help themselves. It has already led to a multitude of activities in the economically and industrially developed countries on behalf of the others.

The other important new development is the Indicative World Plan for agricultural development, whose underlying objective is to assemble a collection of extrapolations of the predictable tendencies likely to influence the balance between food and population in the years ahead. This work has just started and it looms large in the present programme of FAO Headquarters staff. On 19th October, 1966, The Times (of London) published exclusively a summary of the Plan's first progress report. The following points are taken from The Times summary. The plan spans the two decades from 1965 to 1985 and its aims are to establish a rough measure or the problems that are likely to arise and to devise a strategy for overcoming them. It can "make member governments aware of the vast scale of the problem that they face, and by pointing out what needs to be done, shift the responsibility for failure firmly on to the political shoulders where it belongs". The food problem cannot be considered in isolation, but is essentially a by-product of the problem of overall economic development.

The two most important factors affecting what the world will eat in 20 years time are the population numbers and income. "Between 1965 and 1985 the world population should increase from 3,400 million to some 5,000 million. This means 1,000 million more mouths to feed, of which 1,000 million will be in the developing countries, and 400 million in China and other communist countries in Asia. At the end of the period the 'rich' -countries (north America, Europe, the Soviet Union, Australia, New Zealand, South Africa and Japan) will account for only a quarter of the world's population. But the real jolt to the consciences of the' rich' lies in the shift in income levels. Even if the plan's rapid or 'target' economic growth rates were achieved per capita gross domestic product in developing countries would rise on average from $133 in 1965 to only $255 in 1985, compared with an increase from $1,300 to $3,000 in the rich countries ……Thus even the most optimistic objectives of the plan would leave a massive gulf between the income levels in developed and developing countries".

Because "even the most clear-sighted planner cannot forecast how far the world conscience will wake up, or how far developing countries will really try to help themselves" the future has been viewed taking a series of different possibilities into account. Assuming an optimistic or “target” rate of economic growth and agricultural production and if food supplies were to increase by 115% between 1965 and 1985, calorie shortage should be about solved in 20 years time, though protein malnutrition would still present serious problems. Assuming, on the other hand, no improvement in recent trends in development, there would be a slight increase in per caput food supplies (equivalent to 160 kcal per head per day) over the next 20 years and the average calorie value of daily food supplies per person in all developing countries would be about 2,400, but no impact would be made on the problem of protein malnutrition. It seems fairly clear, whether an optimistic or a gloomy view of economic growth is taken, that developing countries will not be able to meet the whole of their future requirement for food out of their own increased production and that imports on an increasing scale will be needed. These will have to be paid for. Thus the plan has singled out the importance of finding ways in which underdeveloped countries will be able to pay for imports of food out of their own resources.

Food aid to developing countries must continue to increase for some time, but it offers no permanent solution, though in passing it should be noted that the United States Government bas played an important part in the recent developments and that its Public Law 480 (passed in 1954, ended in 1966) baa been the major instant of food aid to the developing countries. Past help has run down the United States grain stocks to their lowest level for ten years, but the new Food for Freedom Act introduces a radically new approach to food aid. The intention is that such aid will in the future no longer be dependent on existing surpluses aid measures have been taken to increase the U.S. grain acreage in 1966/67 and in 1967/68 for the first time for many years, increased in wheat, rice and soybean production being arranged, specifically to meet food aid commitments. The other important development is that it is intended that future aid will be conditional on efforts by recipient countries to improve their own agriculture. Increased production, both agricultural and 1ndustrial,in the developed countries, must be the long-term solution. How this can be done rapidly and on a massive scale is the key problem. Intensification of food production means a massive increase in purchased farm inputs, such as fertilizers, pesticides and animal feed; in investments, such as irrigation, mechanization, storage facilities and processing plants; and the development of efficient extension services, credit and marketing facilities. In some countries, it means also far-reaching institutional changes, such as land reform. To make the most effective impact the scarce resources, both in capital and trained workers, should be concentrated in selected areas with big potential. With such a concentration of effort it has been found possible in the past to increase agricultural production by a steady 8 or so per cent a year over limited areas. An essential part at such a strategy is to build up industries to process farm output.

In the 'fifties the establishment of heavy industries in low income countries was often thought to be the only route to development, but agriculture's failure to keep in step led to repeated failure. There must be close interplay between different sectors, of the economy rather than the creation of an island of modern technology in the middle of a traditional economy. The Indicative World Plan is therefore emphasising the need for closely integrated expansion of agriculture and applied industries with each putting pressure on the other towards faster growth. At one end of the scale this means the production of fertilizers and small farm equipment and at the other the refrigeration of meat and the development of modern flour-milling. Only in such a way is there hope not only of feeding people but of employing the 20 millions who will be added each year to the labour force towards the end of the next two decades.

The two detailed regional studies that are nearly ready for the Near East and East Africa, express agricultural requirements in quantitative terms. For example, in East Africa the use of fertilizers should be more than trebled in the 20 years and in the Near East it must multiply six and a half times if the proposed targets of food production are to be reached, while the number of tractors, which increased from about 3,000 in 1950 to 34,000 in 1963, should exceed 300,000 by 1985. It is reported that these regional studies indicate that it should be possible for Near East countries to supply those of East Africa with cheap fertilizers, while surplus food production in East Africa, particularly of meat and maize, could help to meet the Near East's growing food deficit.

But even under the plan's most optimistic assumptions, there may be no reduction in protein malnutrition over the next 20 years. To quote The Times "This springs from a phenomenon that few agricultural planners have so far realised". As incomes rise, more people can afford meat and fish and increasingly neglect cheap sources of vegetable protein, such as beans and peas. Thus improvements in diets brought about by eating more meat may be cancelled by eating less vegetable protein. It is pointed out that in most developing countries no interest has been taken in increasing production of protein-rich crops and that in India the output of beans and peas has hardly increased for the last 12 years and the supply per head has actually fallen.

An important recent development is the publication of a report on protein supplies by the Advisory Committee on the Application of Science and Technology to Development of the United Nations Economic and Social Council. The title of the report is "Feeding the expanding world population: recommendations for international action to avert the impending protein crisis". In this report it is recognised that the most important aspect of the world food problem is the supply of protein foods, and that this is reaching a critical stage. The report urges the United Nations family of agencies to take immediate action aimed at closing the present gap between the world protein needs and protein supplies and at preventing even more world wide protein deficiency in future generations than at present exists in the developing world.

The report makes important and detailed recommendations on promoting the production of protein foods by conventional agricultural and fisheries methods, and on reducing wastage (at present serious and extensive, amounting to some 25% of the food supplies in the developing countries). It makes recommendations on developing unusual sources of protein, on searching for even newer ones, and on the use of synthetic amino acids to improve the quality of proteins in cereals and other plant materials. It also proposes support for methods of promoting and distributing protein foods in developing countries, and with the further development of facilities for training and research in the appropriate subjects in various parts of the developing world. Finally, it proposes that Governments should review their systems of legislation and regulations so that there will be no unnecessary obstacles to the promotion of new protein foods. The report reviews the financial measures necessary for such a programme and concludes that the technical knowledge and resources can be utilised before it is too late to improve the balance between population and food supply, but points out that this is not happening at present and will not happen spontaneously. To quote from the conclusion of the report: "It can come about through decisive international action on the part of the United Nations family to stimulate and assist Governments to adopt the necessary measures and to persuade multilateral, bilateral and non-governmental foundations and organizations to co-operate in essential programmes - the material and human resources required to avert the impending protein crisis are very large but well within the possibilities of the presently industrialized countries to support <u>without</u> impairing their own continuing development. On the contrary, such an effort will return long-range benefits to them and to the world as a whole far greater than the costs involved. Indeed, the cost estimates suggested for United Nations activity in attempting to close the protein gap are only a small portion of the total foreign aid of the industrialized countries, but will yield particularly high returns for the benefit of mankind in the developing world".

We should also note that the world food panel of the Scientific Advisory Committee of the President of the United states issued a warning on the 17th June 1967 that a world food crisis of staggering proportion could occur by 1985 and could be prevented only by a "massive long-range innovative effort unprecedented in human history" if it were to be started immediately. The Committee emphasised that to avert famine and violent upheaval the rich nations must drastically increase aid to poor nations for food and population control programmes.

In considering nutritional goals in the present world context this is the overwhelming conclusion one reaches. Although more research is always necessary to solve the problems of a particular time and place, sufficient scientific and technical knowledge is already available to feed the world adequately. What is needed is the will to do this.

The Chairman of the First Session of the FAO Conference, Mr. L.B. Pearson of Canada, wrote in his introduction to the first <u>Conference Report:.</u>

> "The first of the new, permanent United Nations agencies is now launched. There are few precedents for it to follow; it is

> something new in international history. There have been functional international agencies with more circumscribed objectives and tasks, but FAO is the first which sets out with so bold an aim as that of helping nations to achieve freedom from want. Never before have the nations got together for such a purpose".

That was 20 years ago. The difficulties have turned out to be more daunting than the founding fathers anticipated. The Indicative World Plan aims to confront all the difficulties and to show what must be done in the next 20 years if disaster is not to befall us all. The fact that it has started is about the most hopeful facet of the world food scene today. But its hope will be fulfilled only if it leads to appropriate action.

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Nutritional Goals in a World Context

DISCUSSION

J. C. Thompson (U.K.)

Miss Hollingsworth, could you elaborate a little bit more on what we as women engineers and women scientists can do to solve this very grave and serious problem.

D. F. Hollingsworth (U.K.)

Madam Chairman, I find it very hard to answer that question, because it all depends on what jobs you are doing. If you are working in a meat refrigerating factory then you can obviously help to make equipment to refrigerate meat, alternatively if you are working in a milling factory you can do a similar thing. If you happen to be working in a developing country, it seems to-me that the most important thing to do is to try and prevent waste. Try to build a new kind of store which perhaps has a concrete floor instead of a mud floor to prevent rodents eating up the grain or build something which is up on stilts so that they cannot get up, as they do in Scandinavian countries. There are all sorts of simple things which can be done, but very important, I think, is to develop the food processing industry, not sophisticated food processing but something which fits in with the traditional food habits of the country concerned, but which applies modern engineering and scientific principles so that the job can be done better and under more controlled conditions in the future than it has been in the past. I give one simple example. I was up in Leeds University at the beginning of this year, in their Department of Food Science and there was a lady from Korea studying their traditional food which is called kimshi, which is rather like sauerkraut. She was busy in the Department of Food Science making this food by traditional methods which she knew how to do, and finding out the science of it, so that she could go back home and, I suppose, put it into practice. I think the idea was that she should perhaps start a kimshi factory so that the people would not have to go on making it in their own homes. You see this is happening allover the world, women no longer want to spend all their day grinding up corn or maize or pounding rice to get the food supplies for the family, they want to be able to buy something in a shop and to have more time to do other things. . However, if you start milling rice in a big industrial mill instead of in a little home pounding mill, much of the vitamin B1 content is lost and it is recorded that people in the rice eating countries are beginning to develop more beri-beri now than they did before, because they are using factory produced rice. This does not matter in a country like ours where we have a great variety of foods, but it does matter in a country like Thailand which is highly dependent on rice. Summing up, the answer would seem to be that what you can do depends on the circumstances.

M. D. Lum (U.S.A.)

I wish to comment on the statement you made on page 15 where you said that the aid from the U.S. in the grain surplus has gone down critically. I am not an expert in food production or nutrition, I am a research scientist, but speak as a private individual who happens to own 200 acres in Ohio. Last fall, for the first time, the Agricultural Department requested that we increase our wheat crop. It is my personal belief that the emphasis towards a solution of this problem should be less on direct aid from the U.S. which, I think, will not last much longer put more on science and technology whereby a small number of people can grow food for a very large number proportionally.

D. F. Hollingsworth (U.K.)

I am glad to have confirmation that the facts in my paper are correct that Americans have been asked to increase grain production specifically for aid purposes. I am interested in the speaker's comment that the ultimate solution is intensive agriculture in developing countries. This may be the long-term solution, but I am not absolutely convinced-that it is the short term solution, because it brings with it such intensity of human misery. It is alright if you are short of labour to have intensive agricultural production, but if you are not short of labour, what are you going to do with all the people who were employed in agriculture? The condition in Calcutta for example, partly brought about by people flocking into the towns from the country districts, is the most shocking story of human misery, of people lying about on the pavements as there is no place for them to go and so on. Any policy of intensification of agriculture is most desirable in a country where labour is short, and certainly is the most efficient way of producing food, but it is not the most efficient way of using people if labour is not short. It is the employment of people that is going to exercise the minds of the countries where the populations are increasing so rapidly, and this must be taken into account.

F. E. Rowland (U.K.)

I am an electrical and agricultural engineer and I have been employed in the application of electricity to agriculture and horticulture for 40 year.. I have decided to devote the rest of my life to this problem of feeding the hungry millions. May I express the privilege and honour I feel at being present at your Conference and being permitted to take part in the discussion. As a man, I feel that women have a particular contribution they can bring to technical problems such as feeding people, and that is their compassion and sensitivity. I feel that they do not want to compete with men in technology but that they should bring their own particular characteristics and gifts to bear on our joint discussions.

D. M. Holladay (U.S.A.)

I wonder that if in those countries where they have sacred animals there is any indication that instead of using their resources to feed the animals they will let the animals feed the people?

D. F. Hollingsworth (U.K.)

I am afraid I cannot answer that question, it must be answered by an Indian.

K. Chandrasekhar (India)

As far as India is concerned the cow is considered sacred. Other animals, for example sheep and game, are edible so it is only a small percentage which is sacred, and I do not think it is such a big problem as it is presented outside my country. I would now like to make a point. As an endocrinologist I have been studying the problem of increasing population. The problem of controlling population through the hormone treatment has been going on for some time, but it takes a long time to learn what exactly happens to the human system and particularly what complicated psychological problems develop. This needs immediate attention. In my country it has affected many women and it is an increasing trouble, we may be producing lunatics or psychological specimens rather than controlling the population!

P. B. Berger (U.S.A.)

I would like to ask Miss Hollingsworth two questions. Do you think it is a feasible long range goal that every nation in the world can be self-sustaining in food production? Secondly, have you not said that in both the long and the short range, the largest part of the problem of the world's malnutrition is political rather than technological.

D. F. Hollingsworth (U.K.)

If I could answer the second question first: my personal view is that it is political and economic. The whole business of sending food from one place to another enters into world trade and it does seem to me that the economic and financial aspects create almost insuperable difficulties. If it was an ideal world and nobody had to buy anything from anybody else and prices need not be controlled, I think sufficient food could be produced now to feed everybody, indeed, if you added it all up together and divided by the number of people in the world there is sufficient food. Eminent scientists in the United States have done this for protein and have calculated that there is sufficient. The problem is one of distribution. Now your other question is: "Do I think the long term aim should be for all countries to be self-supporting" - No I do not think it should be. Part of the first interim report on the indicative world plan has shown by a study of East Africa and the Middle East how the two economies could in fact help each other. Fertilizers could be produced in one place and sent in ordinary economic exchange for something else. East Africa can produce a lot of food, the middle East can produce a lot of fertilizer. I think it is reasonable to expect that there will be world trade and that each country should be able to produce within its means. Take for example this country, it would be extremely difficult for this country to produce all its food, we import about half of it.

B. M. Williams (U.S.A.)

In regard to D. Holladay's question about the sacred cows of India there is an article in a recent Natural Science Magazine which indicates that it is not purely a question of religion, it is a question of agricultural economies. The people in the countryside use cows - cows produce dung which is a very important fuel, they produce milk which is important and if the cows are allowed to live out their natural lives the meat and hides are used. It is a complete use of the animal.

L. E. Obeng (Ghana)

I would like to go back to the earlier part of the discussion. As somebody from a developing country who is at the receiving end of powdered milk and grain and wheats from the U.S. I am interested in what a lady earlier on said. I am also very interested in the comment made by the speaker about getting machines to produce more food but then probably not using the people. I think this is -a very serious problem if we put them out of their jobs, what are they to do? They go down to the towns in the hope of finding more work to do. We may succeed in providing more food but then what do we do with the people. I think that this is some sort of vicious circle and I doubt very much whether it can be tackled in a very simple way. In the long run if we come to make certain recommendations here as our contribution towards solving the problems which face us and providing enough food for everybody, I think we have to rope in the politicians, as we will have to rope in everybody else. If it is possible to site industries, particularly in the developing countries, in the forests and villages where these people can stay when they have been knocked off the fields as a result of mechanisation, perhaps we might be farther along the way to providing what we need to do by way of getting more food.

L. M. Maltby (U.S.A.)

I would like to ask Miss Hollingsworth how she believes that the professional societies such as societies of Women Engineers, Home Economists and Nutritional societies can get together. There seems little communication between the various types of professional societies and I wondered if FAO had ever worked out a method whereby the nationals of a country who are nutritionists or scientists or engineers or sociologists or economists could get together and work on their own problems which they understand better.

D. F. Hollingsworth (U.K.)

I am sorry I do not really know the answer to this question. I am not an expert on all the things that FAO has considered, as I work for the British Government and am now and again at FAO meetings. I have not heard it discussed at international food meetings how the various technical groups in individual countries can be brought together. My answer would be that it would depend on every country, and the individuals concerned, co-operation of all kinds does in the end depend on the people concerned, whether they will get together and discuss.

Vote of Thanks - Miriam Muwanga (Uganda)

Madam Chairman, Ladies & Gentlemen, you will all agree with me I am sure, that Miss Hollingsworth has given a very interesting and very useful account of nutritional problems and the effort made to solve these problems on a world wide scale. Of course, many of us today tend to take things for granted especially when we happen to have a bit of everything. We never realise that there are certain people working very hard behind the scenes to ensure that there is enough for everyone and that whatever we we eat is health-giving. Therefore, Miss Hollingsworth's speech has been very enlightening indeed, and for this she deserves our most sincere thanks.

Enough for Everyone **3 July 1961**

In the Chair **Premala Sivaprakasapillai (Ceylon)**

Développement économique de l 'Uruguay de point de vue de la production des aliments
Luisa Chebataroff (Uruguay)

The food problems in Brazil **S. M. Portella (Brazil)**

Importance of fishery in food problems **K. Saruhashi (Japan)**

Discussion

Premala Sivaprakasapillai

Premala Sivaprakasapillai studied Engineering at the Faculty of Engineering, University of Ceylon and after graduating worked as an Instructor there for one year. She then worked in the Public Works Department for a few months before leaving for Oxford on a Ceylon Government SoholarShip and is now reading Structures at the University of Oxford.

DÉVELOPPEMENT ÉCONOMIQUE DE L' URUGUAY DU POINT DE VUE DE LA PRODUCTION DES ALIMENTS.

Par **Luisa Chebataroff**: Ingénieur Civil et Maitresse d' Enseignement Primaire.

Mlle. **Luisa Chebataroff :** reçoit son titre d'Ingénieur Civil en 1949; entre à la Direction des Ponts et Chaussees du Ministere de Travaux Publics en 1950, comme Ingénieur de Projets de la Section Etudes et Projets; est nommée Chef de Section en 1955 réalisant au début son travail comme Chef de la Section Services et Annexes du Département Oeuvres occupant actuellement la place de Chef de la Section Administracion et Coûts du Departement Conservation et Maintient: assiste en 1956 comme déléguée de la Societé d'Ingénieurs de 1 'Uruguay à la Convention Panaméricaine d'Ingénieurs realisee au Mexique. posséde en outre le titre de Maitresse de l'Enseignement Primaire.

Résumé La plupart du marche interne des aliments à l'Uruguay est fourni par la production nationalle. Les caractéres physiques du territoire uruguayen l'ont predestiné devenir essentiellement éleveur. L'agriculture extensive s'est aussi bien developée. Cependant, ni le climat ni la fertilité de son sol l'ont favorisé. Cette situation pourra être ameliorée avec un évolution de l'exploitation agricole vers la ferme, qui établit un lien plus étroit entre l'élevage et l'agriculture. Il n'y a pas dans Ie monde un pays qu'égale la consommation de viande par habitant à l'Uruguay. La diète uruguayenne se caractérise par un excés de calories. L'Uruguay est, aprés l'Argentine, Ie pays latinoaméricain avec la plus grande disponibilité de en production par personne pour l'agriculture ou l'élevage. Les fertilisantes forment I' apport le plus important pour la productivité des terres agricoles et fermieres. Stimulés par la poli tique actuelle de sub sides pour l'agriculture et de facilités pour l'importation, la consommation de fertilisantes s'est augmentée depuis des derniéres années. Chez nous, le poisson est un produit qui substitue, mais ne rernplace pas la consommation de viande. La plupart de la rishesse ichtiologique a l'Uruguay corresponde a l'Ocean Atlantique et au Rio de la Plata.

DÉVELOPPEMENT ÉCONOMIQUE DE L' URUGUAY DU POINT DE VUE DE LA PRODUCTION D' ALIMENTS

Par **Luisa Chebataroff.**

A.Generalites

Le territoire de 1 'Uruguay, situé au S.E. de l'Amerique, a ses côtes sur l'océan Atlantique et sur le Río de la lata, ample estuaire fluvial navigable. Il est compris entre les parallèlea 30º et 35º de latitude sud, et les méridiens 53º et 58º de longitude ouest. Sa dimensión en ces deuz sens ne dépasse pas les 550 km. de longueur.

La surface de 187.000 km2., abrite 2.600.000 habitants. Son climat est temperé, son sol de doux relief, possède un bon reseau hydro graphique, des abondants pâturages, des côtes amples et abordables avec des très belles plages, d'une etendue de 300 km.

Il manque de bois, comme aussi de minéraux métalliques et de combusti bles naturels, et son limat est variable dans sa benignité.

L'Uruguay fut rarement peuplé de tribus guaranis jusque â 1516, aûfut colonisé par les espagno1s et aussi par des portugais. Les deniers 100 ana, il fut visé par un- grand comant d'inmigrants italiens et in géneral européeus.

Grâce au fondateur de notre nation, José Artigas, notre pays est libre et independant depuis 1825, et république unitaire en 1830.

Les caractéres physiques du territoire uruguayen l'ont predestiné a devenir essentie11ement é1éveur.

L'agriculture extensive s'est aussi bien developpée aux meilleures de ses 16.000.000 d'hectares laborables. Cependant, ni Ie climat ni 1a ferti1ité de son sol l'ont favorisé.

Cette situation pourra être amelioreé avec un évolution de l'exploitation agricole vers la ferme, qu'etablit un lien plus étroit entre l'évage et l'agriculture. Tout en acroissent ainsila production de bêtai1 et laitiére, et les industries rura1es. Cette évolution est déjà notee au Bud d'Uruguay.

Les combustibles naturels sont trés rarest : le charbon existant ne peut pas s'exploiter en des conditions economiques oar il se limite à des petlts glsements. On ne connaît pas des dépôts de petrole et l'explitation forestale es nulle dû à la faute de bois.

Les sources d'énergie sont: la thermique (a base de charbon et autes combustibles importés), et l'éléctrique (produite par des générateurs mûs á vapeur, à moteurs-diesel, on a la force hydraulique).

La pecha obtient quelques ressources, mais insuffisantes. Elle se réalise principalement à l Atlantique , au Rio de la Plata et au fleuva Uruguay. Les côtes du pays occuppent une des premiéres places plans Ie monde par sa richesse ictiologique, encore trés peu exploitée.

Par rapport au <u>développement industriel</u>, il a été trés rapide aux derniéres années, magré la faute de produi ts énérgétiques (houille, pétrole, gaz naturel) de métaux, de bois, et parfois de capitaux et de main d'oeuvre technique suffisants.

L'utilisation hydroéléctrique du Rio Negro (barrages del Rincón de Bonete at Rincón de Baigorria) pourraient aidee l'implantatión et le , développement industriel. Il n'y pas actuellement de déficit energétique, mais les besoius futurs doivent être envisagés immédiatement avec deux nouveaux barrages à Salto Grande (avec l 'Argentine) et Palmar.

La protection des industries par l'Etat et l'abondance des matiéres pré miéres comme, la viande, les fruits, les óléagineuses, eto. ont facilité le développement industriel interne, malgré la concurrence d' autres marchés de pauples dont le "standard de vie est beaucoup plus bas que le nôtre.

La Base de Notre Economie

Les facteurs de base de la production seraient :

1. L'aport de capitaux et du travail de l'homme.

2. La climat que malgré sa variabilité dans des limites modérés ne presente pas les rigueurs d'un climat continental.

3. Les ressources naturelles basiques dont. le sol cultivable, lea pâturages, et l'eau - suffisante por l'habitation urbaine l'elevage, l'agriculture, l'induatrie et la pêche.

Toutes oettes caractérist1ques font de l'Uruguay un pays essentielle ment éleveur.

L'élevage fournit du 85% au 90% de la production exportable et il contibue dans une place trés importante à l'alimentation de la population. L'Uruguay est placé entre les nations où l 'onmange le plus de, viande.

Dans le parentages cités, il faut comprendre la laine, dont l exportatión occuppe une des prémières places dans le marché mondial.
L'élevage a assuré; la stabilité économique du pays, mais pas toujours il a incidé pour ameliorer le bien-être de ses habi tanta.

B La Consommation Des Aliments

Le plupart du marché interne des aliments à l 'Uruguay est fourniex par la production nationale. La disponibilité de terrains at lea condition écologique propres á chaque région du pays, font possible la production locale de la totalité des denrées alimentaires d origine animale et de la plupart de celles d'origine agricole.

Seulement l'Uruguay doit importer des aliments d'origine tropicale (café, cacao, bananas, ananas, etc.) et quelques autres de production nationale dont le suministre pose de moment des problemes de ravitaillement temporaire (la pomme de terre), ou pour lesquels le manque de capacité dé l’ industrie dé ja installée exige des compléments pour régler Ie marché , parfois inégal (sucre).

Dans 1959 / 61 (trois années) on importe 600 des 3.100 calories disponibles par personne et par jour: à peu prés le 20% total de calories s'originérent aux produits importées. La moitié de ces calories correspondait au sucre importé

Par rapport aux protéines, seulement 7 (sept) sur 150 (cent cinquante) grammes par jour disponibles par personne.

Mesurés en termes de monnaie, l'importation atteint seulement le 9.8% un dixiéme - des denrées alimentaires. Cela vent dire que l'Uruguay a besoin seulement de calories à bon marché, bien que le sucre et le céréales - qui en forment les chapitrés plus notables de ces importations, constituent les sources d'énérgie les moins chéres.

La diéte uruguayenne se caractérise par un excès de calories. Si l'on tient compte des divers facteurs déterminants des besoins caloriques d'une communanté, on calcule que pour l'Uruguay, ces besoins - exprimées au niveau du marcher au détail - suffiraient avec 2.770 calories - jour - personne.

D'autre part, Ie calcul triennal pour 1959/61, au niveau du même marché au détail, fait voir que la réalite de la distribution par personne et par jour atteint les 3.100 calories au quelque plus.

Il y aurait, done, un excès s calorique à la diète premédiale d' à peu près un 13% (treize pour cent).

Des récentes enquêtes d'organismes spécialisés (I.C.N.N.D. Uruguay), arrivent aux mêmes résultats.

La blé et les viandes sont les premieres fonts energetiques. La ble-ind1viduellement considere - est Ie produit Ie plus important.

Quelque plus de mille calories, à peu prés un tiers du total par jour, son pourvues par an, par 100 kilogramme de cette céréale.

D'autre part, à peu près 730 calories, - c'est à dire, le 23% de celles que chaque jour on achête au détail - ont son origine à l'elevage. Il n'y a pas dans Ie monde un pays qu'égale la consommation de viande par habitant à l'Uruguay. A la périodecitée, 1959 / 61 la distribution "per capita" atteignit 114 kg. par au.

D'autres sources importantes sont Ie sucre et le lait, avec 387 et 364 da calories par jour.

Les oeufs, la pêche, les légumes, et les fruits font en moindre part la diéte de l 'uruguayen. La faible con sommation du poisson se doit à manque d'habitude mais, surtout, au développement insufisante de la pêche comme du systéme de sa distribution.

Du point de vue du contenu en protéines, le diéte uruguayenne doit être qualifiée excellente. Les disponibilitées par jour et par habitant, à niveau de vente au détail, sont de 105 grammes de proteinés, 77 desquelles sont d'origine animale.

Si le minimun requis - pour le pays - est selon les spécialistes, de 70 gr. par jour, la situation de 1 'habi tant de 1 'Uruguay, est – en ce cas - exceptionnelle, car seulement à Nouvelle Zèlande on aurait une consommatipn supérieure de protéines animales.

La situation de l' Uruguay est comparable - a cet avis - a celle des Etats-Unis.

Des résultats aussi favorables, quant à la qualité nutritive de la diitê, on peut constater en détérminant le pourcentage total des calories derivées des principales sources d'hydrates de carbone, c à -d. les céréales, les racines féculentes et le sucre.

Malgre la situation plus que suffisante enregistrée par le bilau alimentaire de l 'uruguayen, des récents études - comme l'enqûête de l'I.C.N.N.D. - Uruguay - on mis en evidence certains aspects déficitaires à la diète. En ce sens, on marque l'insuffisance des vitamines A et C, thiamine et riboflavine, causaée - en general - par la manque de diversification de la diète au pays.

C. Un Analyse de la Demande des Produits Alimentaires

La disponibilité totale des produits de l'agriculture et de l'élevage vient de la production nationale et des produits importés. La demande interne a enregistré un expansion continuelle jusqu'au 80%.

La production rurale parvient au consommateur en sa forme naturelle où elle souffre d'abord un procès de transformation ou d'elaboratión. C' est à dire, qu' il peut être sujet d'une demande directe ou indirecte. Cette demande, par example, en 1961, a été la suivante:

Produits:	Demande pour cent: (directe)	(indirecte)	ELEVAGE:	(directe)	(indirecte)
AGRICULTURE:					
céréales,	-	100	viande,	33.3	66.7
oléagineuses,	4.4	95.6	lait,	40.1	59.9
racines,	88.2	11.8	oeufs,	100	-
légumes sèches;	100	-	laine,	57	43
sacar1.gene s,	-	100	autres,	87.8	12.2
raisin p.vin,	-	100			
légumes vertes,	100	-	sub-total,	52.6%	47.4%
fruits,	100	-			
stimulants,	31.2	68.8			-
autres,	-	100			
sub-total	23.3%	76.7%	TOTAL GRAL:	41.7%	58.3%

On observe qu' en 1961, le 4.2% de la demande totale des produits agricoles a êté directe, et le 58% restant a êté soumis à un procès préalable d'éleboration, avant de parvenir aux consommateurs. La demande de ces produits represénte un 23% du total agricole. Au contraire, dans le secteur de l'élevage, la demande directe arrive au 53%, dû partiellement à le consomation de lait et de viande aux establissements agricoles, et à la consommation de lait sans pasteuriser à l'interieur du pays.

Le pourcentage si éleve de 1a production agrico1e soumise à n'importe quel procès d'élaboration, assigne au secteur une importance économique aditionnelle. Un secteur très important de l'industrie du pays est ainsi dedié a 1a transformation des produits agrico1es.

Cadre :

Coéfficients d'importation pour 1e ravitaillement.
(Produits a1imentaires à niveau de vente au detail)

PRODUITS :	MOYENNE (total)	ANNUELLE 1959 / 61 (importés)	COEFF. D' IMPORT. (pour cent)
Céréales,	219.2	36.8	16.8
Racines,	65.8	22	33.4
Sucre,	124	92.1	74.3
Légumes sèches,	10.7	5.1	47.7
Viande,	755.7	-	-
Oeufs,	77.9	-	-
Poisson,	10.2	0.3	2.9
Lait,	339.9	0.2	-
Huiles, graisses,	128.5	13.8	10.3
TOTAL:	1.885.8	184.1	9.8

Cadre:

Disponibilités d'A1iments, par Personne et par jour:
(Exprimés en ca1ories, protétines et graisses. Vente au détail)

PRODUITS:	CALORIES (nombre):			PROTÉINES (grammes):		
	1950/62:	1959/61:	differ:	1950 /62 :	1959/61.	differ:
Céréales,	1.035	1.138	103	30.2	32.7	2.5
Viandes ,	792	729	63	46.8	43.6	3.2
Oeufs,	31	30	1	2.4	2.3	0.1
Poissons,	4	4		0.5	0.6	0.1
Lai t ,	302	364	62	16.6	20	3.4
Graisses, huiles,	217	237	20			
	3.026	3.133	107	102.3	105.1	2.8
Ce total contient 1es va1eurs suivantes:						
Racines	112	127	15	2	2.5	0.5
suctes	399	38	12			
Leg sèches	25	19	6	1.5	1.2	0.3
Leg. vertes, fruits	109	98	11	2.3	2.2	0.1

Pourcent de calories òbtennes de céréales, racines et tubercules et sucre:

	51.1	52.7	
Protéines d'origine végetale:	36	38.8	2.8
Proteines d'origine animale:	66.2	66.6	0.4

L'on observe que la composition de la diète a subi des petits changements les derniers dix ans, sans presque altérer sa structure et son niveau.

Une seule variation importante: la réduction de la disponibilité de la viande de boeuf et celle de mouton, compensée par des plus grandes disponibilités de lait.

D'autres changements désirables ne se sont pas produits, et l'on pent noter à cet avis, une rigidité assez accentuée des habitudes alimentaires.

La consommation du poission, que - sans doute - pourrait contribuer à diversifier la diète et à liberer la viande pour l'exportation, s' est placée à un niveau insignifiant.

D'autre part, la consommation de légumes, de fruits et d'oeufs demeure constante.

D.Posibilites du sol de L'Uruguay

Elevage et agriculture.

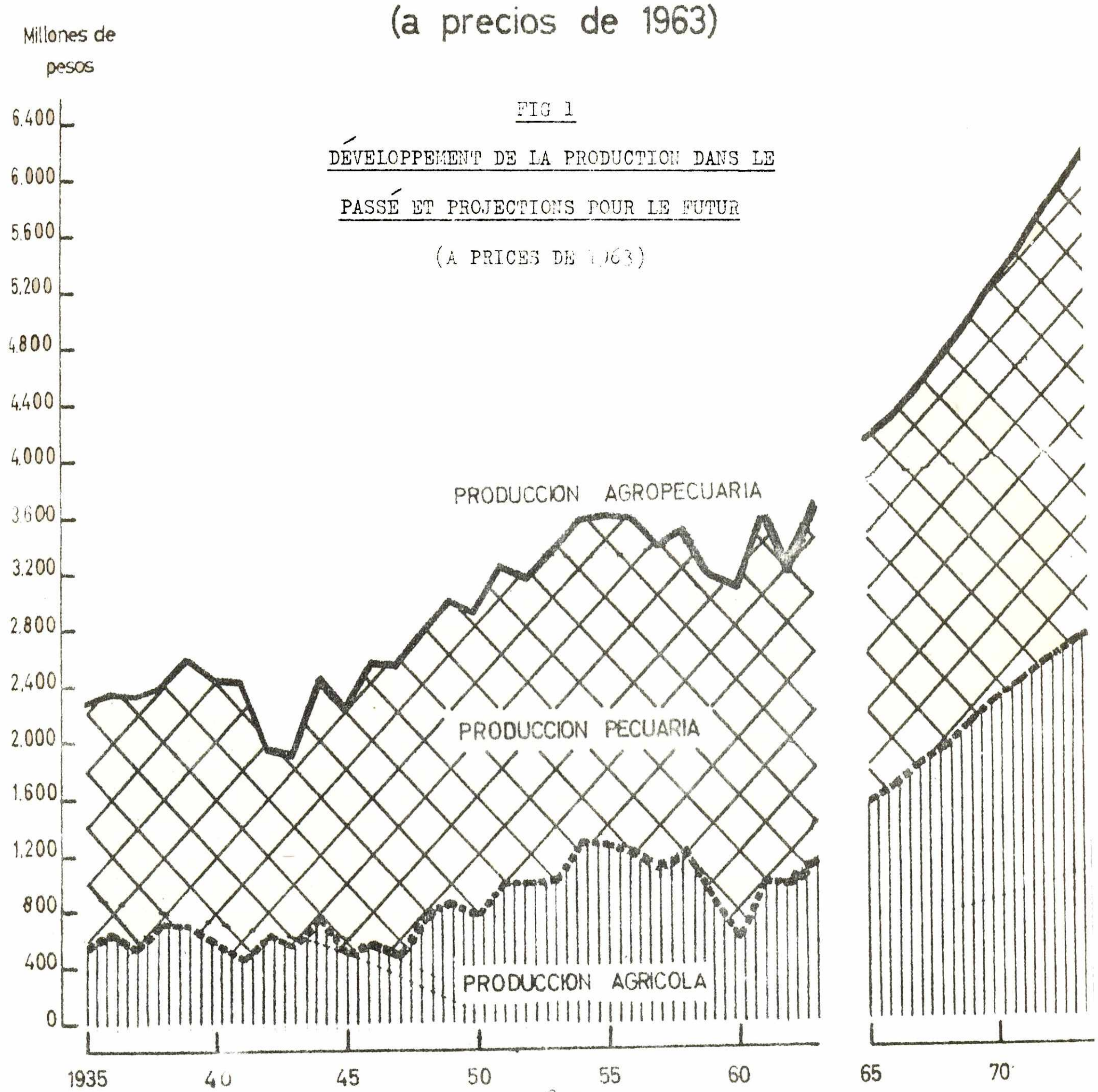
L'Uruguay est sans doute une contrée privilegiée par rapport à la disponibilité du sol, aela ne se voit pas chez autres nations de l'Amerique Latine.

Presque tout le territoire nationel a des possibilités d'usage agricole on éleveur et en les faits el est en train de s'utiliser. Des conditions topographiques et geographiques favorables que facilitent les communications et les transports, s'ajoutent a ces possibilités.

Cette situation privilegiée devient plus évidente si l'on considère qu' à l'Amérique Latine, seulement 1[e] 24% (vingt quatre pour cent) de la surface territoriale est consituée par du sol labourable, des prairies ou des pâturages. D'autre point de vue, l'Uruguay est après l'Argentine - le pays latinoaméricain avec la plus grande disponibilité de terre en production par personna, pour l'agriculture ou l'élevage.

Desarrollo de la producción agropecuaria en el pasado y proyecciones para el próximo decenio.

(a precios de 1963)



Les terres pour l' élevage sont en train d' être soumises a un usage extensif, presque exclusif de boeufs et moutons d'une trés bonne qualité, sur des pâturages naturels. On cultive une partie du terrain (500.000 Há.) pour des fourragéres annuelles, pour résoudre partiellement les crises stationnelles de fourrage, et les prairies artificielles au les naturelles ameliorees atteignent les 200.000 hectares.

La plupart de ce dernier effort s'est réalisé aux trois dernierés années, avec la participation active du "Plan Agropeouario".

Ces amélioremmente - d'accord au sol et a d'autres oonditions - consisten à la sustitution de la prairie naturelle par une artificielle, en particulier aux sols appelés cultivables, commo à la fertilisation - avec des phosphates - des prairies naturelles, sans compter avec d'autres solutions mixtes.

En synthèse, on doit noter la sous - utilisation des terres d' élevage, et les possibilités – déjà prouvées - d'en faire un meilleur usage et plus intensif

En outre, les sols du pays sont mal utilisés, ce qui provoque la parte de sa fertilité naturelle, associée parfois avec sa destruction partielle - au même totale - par l'érosión. Les terres uruguayennes sauffrent les effets de l'érasion, soit dans le régime de l'élevage comme quand elles sont cultivées.

A tous ces facteurs physiques déterminant l'érosion du sol, on doit ajouter son mal usage. Aux zones d'élevage, l'excés de pâturage das prairies naturelles provo que une réduction de la capacité d'infiltration. Aux zones agricoles, où les agents érosifs ont agi avec le plus d'intensité, on ne voit pas toujours cultiver parmi des systhemés conservationistes, mais avec une prédominance de la monoculture.

Pour tout cela, les 3 a 3.8 millions d'hectares que l' on pourrait destiner annuellement à l'agriculture, n'ont pas une ample possibilité d'usage. C'est ainsi que por les céréales d'hiver (blé, avoine, seigle, orge, alpiste at lin), on n'a qu a 1.4 a 1.6 millions d' hectares.

On doit ajouter entre 600 et 700.000 hectares aptes por le mais, le tournosol et le sorgh; 300.000 hectares aveo un plus ample usage, car - a part les usages cités - on peut y ajouter des racines et des tubercules, telles que la betterave `a sucre, et de 450 a 600.000 hectares avec une capacité d'usage plus limitée, car elles seraient aptes seulement pour le sorgho et le tournesol.

L'on devra noter que les rendements a l' Uruguay, dans le plupart des cultures, son très infèrieurs a ceux que ‘ on obtient chez autres nations. La fluctuation du rendement de blé - par exemple - aux derniers périodes triennaux, est comprise entre les 720 et les 770 kg par hectare, autant qu'aux Etats-Unis l'oscillation est entre les 1.600 et les 1.730.

Ces bas rendements obtenus son dûs à 1 existence d 'un niveau tech nique insuffisant, à une manqué d'intiegration entre l'agriculture et l' élevage, et mêma à des problémes de tenance partiale ou totale de le terre.

Existence de Boeufs a Viande et de Moutons (an 1963).
Surfaces destinées à boeufs (à viande) et moutons:
(en milliers d'hectares)

Prairies artificielles permanentes,		87
Prairies a "zapata" ou "pelletées",		5
Champs naturels fertilisés,		15
Fourragères annuelles,		285
Champs naturels ,		12.974
	Total:	13.356

Eristences bovines (en milliers de têtes)

Prairies artificielles permanentes,		116
Prairies a "zapata" ou "pelletées",		6
Champs naturels fertilisés,		14
Champs naturels,		7.993
	Total:	8. 219

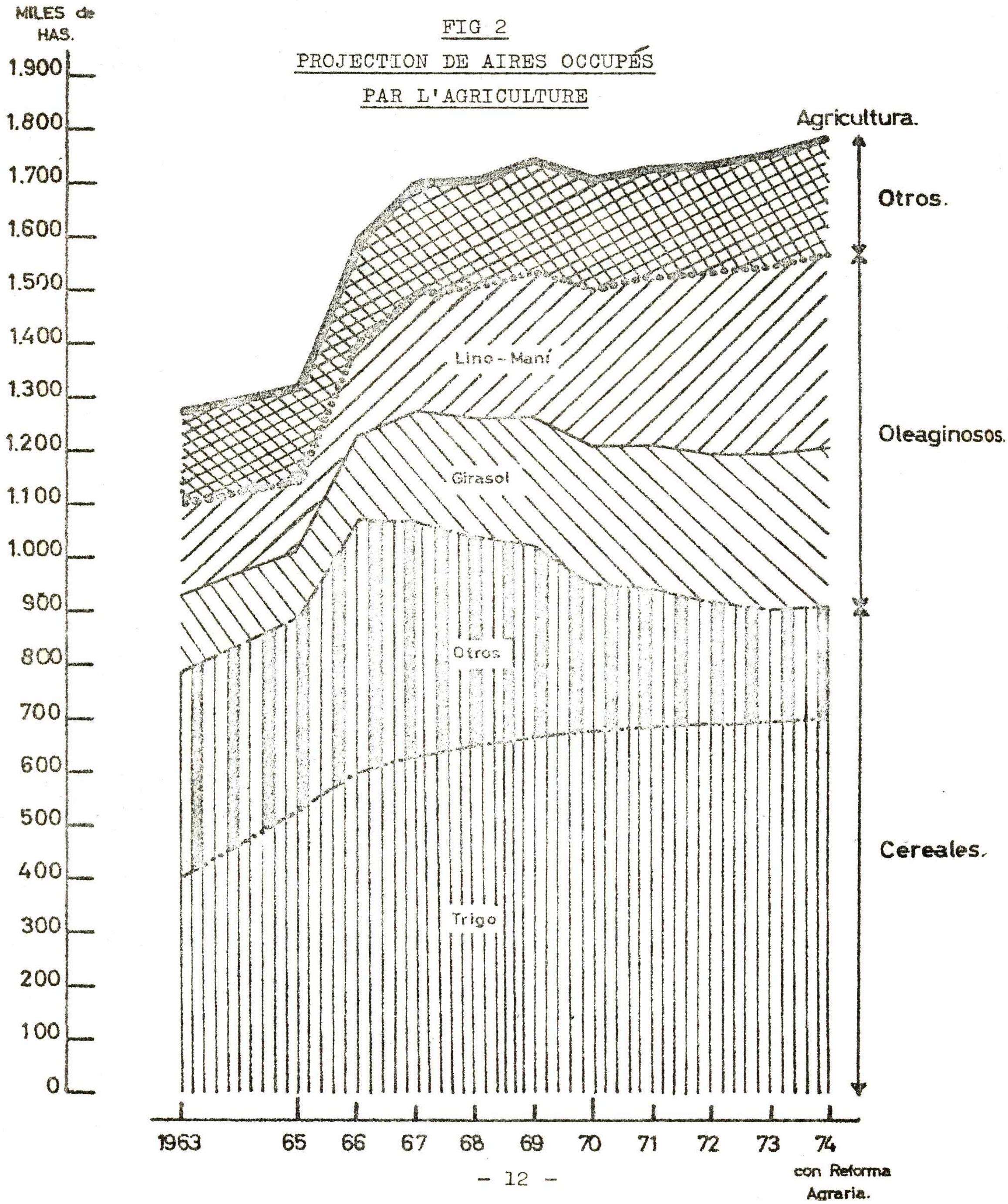
Existences ovines (en milliers de têtes)

Prairies artificielles permanentes,	331
Prairies a "zapata" ou "pelletées",	16
Champs naturels fertilisés,	35
Champs naturels,	21.449
	21.831

Proyeccion de areas ocupadas por la agricultura.

FIG 2

PROJECTION DE AIRES OCCUPÉS PAR L'AGRICULTURE



La Production de Lait et son Rendement par Vache

Production (million de litres),	758
Total de vaches (milliers de têtes),	553
En traite " " "	334
Sĕeche s " " "	219
Participation pourcentuelle,	100%
En traite ,	60%
Sèches,	40%
Production par vache (lt. p. an.)	1.370
Production par vache en tait (lt. p. an.)	2.270

Le capacité de l'industrie laitière est la plupart engagée dans des programmes de développement déjà initiés, et l'on estime que elle serà; en plein réegime, seulement en cas d'une reforme des structures agrairea.

L'effet combiné dlune plus grande dotation par hectare, comme d'une aussi plus gran de production par animal, permettrait d'augmenter la production de vi an de de boeuf, par hectare de prairie naturelle, à presque 2, 3 et 4 fois, selon l'améliorемment y incorporé: soit la, fertilisation du champ naturel , la prairie à "zap." ou "pell" ou la prairie artificielle permanente, respectivement.

Les restants produits agricoles – c' est à dire - viande de pore et de volaille, oeufs, miel et cire, sont seulement réferés aux prévisions de la demande interne, 5i bien ils pourraient se développer avec l' obtention parall le de nouveaux marchés.
La production pecuaire en milliers de tonnes est (1963) la auivante:

Viande de boeuf (en pied)	649.5
Viande de mouton " "	112.2
Viande de pore " "	25
Viande de volaille " "	5.5
Lait, en millions de litres,	758
Oeup, en millions,	358
Miel, en tonnes,	481

E. La Production De Cereales

Quand des changements technologiques appropriés seront adoptés, l' Uruguay pourra augmenter la production de céréales.

D'autre point de vue, l'ampliation intense des prairies cultivées, requiert et devient favorable au eveloppement de le semence, de cereales, et d'oleagineuses, pour qu'une adéquate explotation agricole puisse se réaliser.

Le demande interne de céréales comprend:

1. La consommation humaine de farines et d'autres derivés alimentaires.
2. La consommation de bière.
3. L'usage des céréales puur l'alimentation de bêtail.
4. La demande pour la fabrication d'amidon.
5. L'usage de semences.

Les céréales ont une forte participation à la diète nationale. Si l' on établit en 3.000 calories par jour le consommation totale "per capita", presque 1.000 correspondent aux céréales. Excepté le riz, on ne prévoit pas une consommation additionalle de céréales par habitant.A cause de cela, la plupart des besoins sont déterminées par la croissance de la population. La biére est une boisson couramment consommée à 1 'Uruguay.

Avec l'étab1issement des prairies artificie11es et des concentrés bases au sorgho, on en devra substituer part de 1a demande de céréales (en spécial, de mais, seigle commun et avoine) pour l'a1imentation du bêtai1 laitier.

La demande interne de cereales en 1963
(en mil1iers de tonnes).

	blé:	orge p.bière:	maìs :	riz :
Consommation a1imentaire,	302.2	13.4	5.9	49.2
Amidon,	1.6	-	2.2	-
Alimentation du bêtail,	25.5	-	191.0	-
Samenees,	39.7	3.0	1.7	3.9
Restes,	7.5	0.3	6.2	-
TOTAL,	376.5	16.7	207.0	53.1

La Blé

La culture du blé s'est loca1isée au litoral et au sud du pays. Les ,act els rendements pour'le blé sont faibles, car ils atteignent à 920 k. par hectare (1961 / 63). Pour 1'augmenter on a adopté a des amé1iore-menta technologiques comme larotation avec des prairies de légumineuses et par l'application de fertilisants appropriés et un plus grand usage de semenoes certifiées.

On y développe les traitements sanitaires pour le contrôle des insectes et on y applique avec la plus gran de amplitude les herbicides pour celui des mauvaises herbes. Du même mode l' on doit intensifier la lutte contre les oiseaux que consituent une plaie d 'importance.

Le Mais

Cependant que le mais se cultive part out le pays, sur les plus divers sols, son exploitation se localise au sud. Aux sols avec une potentielle aptitude pour des sémences d'ête, l' on estime aux 360.000 hectares calles aptes pour le mais.

Les conditions écologiques du pays sont peu favorables pour ce type de culture, ce que fait convenable d'étudier et promouvoir la diffusion d'autres espéces de grains plus résistants, en espécial le sorgho, avec lesquels l'on pourrait obtenir des plus grands rendement s au moindre coût.

Il conviendra, alors: substituer l'emploi de graines courantes par des hybrides d'ine haute qualité agronomique comme d 'une grande capacité de production; développer l'usage de fertilisants, et alterner les sémences avec des prairies artificielles.

Le Riz

Le riz se cultive aux terrains de caracteristiques similaires appropriées. Le pays possede des conditions favorables de climat comme de sol. Les rendements - quoique possibles de s'éléverrésultant satisfiants.

Les Oleagineuses

L'Uruguay posséde des terres nettement aptes pour les cul tures du tournesol, de l'arachide, comme du lin, soit pour satisfaire la demande interne, soit pour obtenir des excédents exportables.

Les conditions ecologiques sont favorables. Le demande interne se doit d'abord à celle d'huile comestible et d'huile de lin, à le demande de sémences at de tartes et "expellers".

La industrie de l'huile laisse comme de sous - produits - selon le méthode d'extraction que l'on utilise - de lafarine ou des "expellers", qui servent à l'alimentation du bêtail, Le demande interne d'oléagineuses ou de ses sous-produits, en 1963, était de 22 milliers de tonnes, dont les surfaces ensemencées furent lea suivantes:

Tournesol :	140.000	Héctares	11%	de la surface agricole
Arachide:	9.000	"	0.7 %	" " " "
Lin:	160.000	"	12.5 %	" " "
Total:	309.000	"	24.2 %	" ,, "

En général, les rendements que l' on a obtenu avex les oléagineuses son tres bas, quoique les conditions écologiques du pays soient favorables. L'on attend que les améliorements techniques se tourneront vite à acroître les rendements et à développer la productivité

Une condition indispensable pour ce dernier développement est donnée par l'intégration agricole-fermière, de maniere de que la culture des oléagineuses puisse former part d'une rotation avec des prairies artificielles destinées au pâturage.

Les Saccharigenes

Aux trois années 1961 / 63, la consommation totale de sucre blanc est arrivé a une moyenne annuelle de 96.000 tonnes, ce que correspond a une consommation individuelle de 37 kilos par habitant. Le 60% de l'offre locale a été fourni avec du sucre provenant de matieres premières importées. La production interne est limitée par la capacité industrielle des sucreries existentes.

Le pays est en condition de se auto-ravitailler avec la production de canne à sucre et de betterave sucrière, aussitôt que la capacité des moulins a sucre au des betteraveries soit suffisante.

F. Les Fertilisants

Les fertilisants forment l'apport le plus important pour la productivité des terres agricoles et fermiéres. En 1963 on a fertlisé 108.000 héctares d'agriculture et 85.000 hectares pour l'élevage.

La consommation de fertilisants, exprimée en poids total et en unités d'azote, phosphore et potase, est la suivante:

1. consomm totale de fertilisants (1963),	117.650
2. azote (N),	9.606
3.Phosphore(P),	22. 659
4. Potase (K),	4.300
5. Total,	34.565
6. relation moyenne: N = 1; P = 2.4; K = 0.9	

Stimulés par la politique actuelle de subsides pour l'agriculteur et de facilités pour l'importantion, la consommation des fertilisants s' est augmentée depuis les derniéres années.

On envisage un développement encore plus grand, à mesure que le pays disposera d' une plus grande information par rapport à la réponse aux fertilisants dans les diverses cultures et prairies à chacune des zones d'usage et manipulation, de sols, parvenant des travaux d' investigation et d' experimentation.

Face à des telles perspectives, il faut créer l'instrument legal permanent pour protéger avec amplutude aux consommateurs de fertilisants et - par consequent – aux intérets mêmes de la production agraire nationale.

La protection du consommateur est - en grande mesure - indispensable, par les difficultés qu'il rencontre pour vérifier la qualité et 1égitimité du produit qu'il acquiert.

Las normas relatives aux garanties du benéfice des consommeteurs ont une double finalité. D' abordo on doit assurer que les produits qu' on achêtera correspondent en réa1ité aux specification conténues à la carte de marque ou á la propaganda. En deuxiéme place, que le produit remplira les conditions minimes d'efficacité pour son application economique au développement végétal.

Avec la solution adopteée, les services de fiscalisation seront con centrés dans un systhême d'inspection destine a prouver que les per sonnes aui vendent las fertilisants accomplissent les condition êtablies par la loi : que les récipients contiement les etiquettes exigees; que les récipients et que les produits en vente crresponderont aux formules, gre pourcentage d'élements nutritifs, etc., déclarés en vue de son enregistrement, a la dite occasion.

Le montant de fertilisants actuellement ecployé à 1 'Uruguay, est à tout avis insufficient, quoique on est en train de developper son usage. En réalite, le progés est plus notable si l' on tient compte sinon du Poids mais de la richesse du fertilisant.

Il deviant intéressant de noter qu' à quelques cultures se trouve assez généraliée la fertilisation, à d'autres, - en la practique - ne s' y utilisent pas.En effet, à. la plupart des cultures intensives, tells que 1a pomme de terre, la betterave, la canne à sucre, les cultures horticoles on fruitieres, etc. l' on note un usage élévé de fertilisants.

Au contraire, chez l'agriculture extensive du pays, en 1961 en fertlisa à peine le 1.7% de la surface semée de mals, le 3% de celle de riz 134.7% du blé, le 6.6% de reste des céréales et le 0.6% des surfaces destinées aux oléagineuses. Ce fait est aussi plus grave si l' on considère que la plupart de l'agriculture du pays se trouve divorcée, de l' élevage, ce que veut dire que les terres soumises à des cultures annuelles ne sont pas incorporées a aucun procès de rotation avec des ., légumineuses que pourraient resti tuer au sol une part de sa fertilité extraite annuellement par les cultures unilatérales.

L'emploi de fertilisants est encore moindre aux terrains destinés à l'élevage. Avec les fertilisants on améliora à peine le 0.6% les 152 millions d'hectares occuppéea par l'élevage. Avec la politique actuelle des subsides, le prix des fertilisants se trouve à une position avantageuse. L'explication de son emploi si réduit pourrait se trouver à la faute d'insuffisance de services d'extension, aux limitées connaissances techniques existentes.

On expose - ci dessous - le cadre de l'emploi de fertilisants pendant l'année agricole 1961 / 62:

Culture:	Surf.Cult. :	Surf.Fertilisee :	Pour Cent
Agricole:	(en milliers	d' hectares)	Fert .S /TOT
Blé,	435.9	20.6	4.7
Mais ,	267.3	4.6	1.7
Riz,	17.8	0.5	3.0
Autres céréales	140.0	9.3	6.6
Oléagineuses	291.0	1.7	0.6
Betterave,	15.7	15.7	100%
Pomme de terre,	19.4	16.0	82.1
Canne à sucre,	4.7	4.7	100%
Horticulture,	4.4	20.1	100%
Elevage:			
Pres naturels			
et artificiels,	15.126.0	89.9	0.6

G. L'Industrie de la pêche

(Extrait des travaux des prof. J. Chebataroff et J. Soriano)

Evidemment les ressources disponibles de la pêche ne sont pas exp1itees a. l'Uruguay. Chez nous, Ie poisson est un produit qui substitue, mais ne remplace pas, la consommation de vi an de , (qu!excéde les 90 kg. "per capita" alors que le poisson ne dépasse pas les 2 ou 3 kg.) ce qui donne un marché saturable. La population de l'intérieur du pays consomme una très rèduite quantité de poisson, parfois nulle, et il existe trés peu d ' intérêt à l'alevinage artificiel.

La plupart de la richesse içhtiologique à l’ Uruguay correspond à l’ océan Atlantique et au Rio de la Plata. Elle est moindre aux fleuves et rivières intérieurs, sans dédaigner ses possibilités, car le pêche fluviale et lacustrepeut devenir d’ une importance locale appréciable.

Si l’ on voudrait incrémenter l’ industrie de la pêche, l’ on devrait recourir à tout l'espace océanique sur la Plateforme Continentale tout au long des côtes atlantique et du Plata, en une bande de 160 à 200 m. de profondeur moyenne. Les ressources marines se trouveraient sur cette plateforme, et aussi au fond ou el existent la flore et la fauna "bentoniques". Si l'on ajoute la pêche en altitude, l'Uruguay pourrait obtenir des ressources alimentaires et industrielles de la mer, jusqu’ à un montant de plusieurs dizaines de mille de tonnes annuellement. Mais, la verité c'est que la pêche aux actuelles conditions, seulement obtient des produits oscillant entre les 6.000 et 8.000 tonnes par an, toujours en ajoutant à la pêche par l'institut officiel (SOYP) celles realisée par les particuliers.

La production de l'Uruguay, d'après les chiffres pourvues par la C.I.D.E., par rapport à la pêche, serait (entre 1957 et 1961) la suivante:

Années:	Pêche privée:	Pêche SOYP (contrat):	Pêche SOYP (propre):
1957	2.660 tonnes	2.510 tonnes	1.720 tonnes
1958	2.600 "	960 "	1.850 "
1959	1.600 "	1.660 "	2.590 "
1960	3.180 “	4.340 "	950 "
1961	4.200 "	4.310 "	670 "

L'intervention de l'Etat à la pêche surpasse le 60% du total, quoique cette proportion est fluctuante. La pêche propre du SOYP (Servicie Oceanografico Y de Pesca) est descendue du 25% en 1957 au 9% en 1961.

D’ autre part, le petit rendement de la production est fondé a une réduite demande de la population, habituée à la consommation de la viande de boeuf ou de mouton, comme aussi par une peu éfficace organisation du commerce et de l'industrie de la pêche. Le dit valeur d'au plus 3 kilos de poisson par habitat et par an, forme un évident contraste avec - par exemple - le Chili, avec ses 45 Kg.

Quant à l'alévinage, malgré quelques essais avec peu de succés, n' existe pas dans le pays.

Le probléme de la pêche à l'Uruguay dépend, d'abord, du peu d' importance du marché consommateur interne, associé a l'absence d' une politique cohérente pour la pêche nationale.

Le champ de l'induatrialisation n'est pas, en outre, si promisoire comma les possibilités de capture, et pour le moment l'on doit abbandonner l'idée d'un marché international pour la conserve, à laquelle ont seulement accès des pays grands produoteurs de peu de types trés bien dèfinis par la tradition et dont le preparation compétitive exige une matiere première adquàte.

Le type de ressources biologiques disponibles, limite aussi les possibilités d'implantation d'usines importantes pour la farina et l'huile soit par le prix surhaussédes matieres premières, soit par le manque de disponibilité de grands bancs de poissons d'espéces sans consommation humaine. A cet avis, il aerait seulement convenable la couverture des besoins locales que l'on verrait satisfaire avec la réduction de résidus de l'industrialisation.

La pêche se réalise avec des filets de trainage en fond, des mailles d'enoerlement de l'échosonde pour détecter la pêche, etc. L'on y disposê de 40 barques, en général mineures avec une centaine de pêcheurs stables.

<u>Les textse consultes sont les suivants :</u>

Uruguay en America. De Jorge chebataroff
Tierra uruguaya. De Jorge Chebataroff
Proyectes de Leyes de PROMOCION AGROPECUARIA del Ministerio de
Canaderia y Agricultura.
Plan Naoional de Desarrollo Eoonom10o y Sooial del CIDE (Comision Interministerial de Desarrollo). La pesca en e1 Uruguay. De J. Soriano.

THE FOOD PROBLEMS IN BRAZIL

By **S.M. Portella**

Sophia Machado Portella, took her Master Degree in Industrial Engineering at the University of Brazil and Electronic Engineering at Marconi's College, Chelmsford, England. Since 1953 was appointed Professor of Electronics at the School of Engineering of the University of Brazil and also works at the National Bank for Economic Development where she actually is Assessor of the Administrative Council.

Summary An analysis of the population growth in Brazil, based on Malthus predictions is made and suggestions on measures to be taken in the country, one of the largest in the world, are presented. It is stated that Brazilian people are actually underfed, and assistance given by the National Bank for Economic Development forecasts that when the underdevelopment period is overcome, Brazil will be in position to meet the challenge of the demographic explosion.

THE FOOD PROBLEMS IN BRAZIL

By **S.M. Pertella**

Making an amazing and admirable forecast in 1802, Thomas Robert Malthus, in his "An Essay on the Principle of Population as it Affects the Future Improvement of Society"', established the law of subsistence of mankind, drawing attention to the difficulties that would be encountered in the year 2000 if measures were not taken.

Malthus put forth the following principle.

> "The means of subsistence increase in an arithmetic ratio while population increases in a geometric ratio".

It may be inferred from the foregoing that the per capita share of subsistence means will normally decline, and offsetting measures should be urgently taken so that mankind is not destroyed bydeath from famine.

This short paper will be limited-to studies on the Brazilian problems and to the concerns of Brazilian administrators and economists, and particularly of the economic staff of the National Bank for Economic Development in respect of those problems.

The table below shows the populational growth in Brazil and the forecast for the year 2000.

YEAR	Population in Million Inhabitants	Percentual Yearly Growth
1500	1	_
1600	1.2	.18
1700	2	.51
1800	3.5	.56
1825	4.8	1.3
1850	7.1	1.6
1875	10.0	1.4
1900	18.2	2.4

1915 1930 1940 1950 1960 1965	23.0 33.0 40.0 52.0 71.0 81.5	1.6(*) 2.4 2.0(*) 2.4- 3.5
1970 1982 2000	95.9 150.0 275.0	3.5 3.5 3.5

(*) Dis_crepancies due to migrations at different intervals.

The growth rate of Brazilian population has been a steady 3.5% in recent years, which makes it possible to anticipate a population of 275 million in the year 2000.

It is known that save in cases of war and epidemics, both umpredictable, the aforementioned populational growth is praotica1ly impossible to check.

The solution to the famine problem can ob1y be obtained by increasing food production.

As Brazil is one of the largest countries in the world, with an area of 8,511,965 km^2, its populational density is very low at present, being of approximately 17 inhabitants per km^2 and 80 inhabitants per km^2 near the coast In the year 2000 there will be 33 inhabitants per square kilometer approximately.

The country is now in a transition period, since it was primarily agricultural at the beginning. But with migration towards the cities, Brazil is becoming industrialized. In 1940 there were 50 cities with more than 20,000 people, and in 1960 that figure rose to 172. The cities with more than 100,000 inhabitants rose from 14 in 1950 to 31 in 1960. Urban concentration with the problems of transport, housing and food, is demanding a more rapid and easy transportation of agricultural products.

It should be noted here that Brazil's vast extension, with immense uncultivated areas, may be considered as a potential reserve, since that fertile land, once tilled, is due to become a producer of toad in coming years.

The Brazilian Institute for Land Reform, which handles agricultural problems in the country, has published a study on the demand for food products. The table appearing in the said study is transcribed below.

PER CAPITA CONSUMPTION (KILOGRAMS PER INHABITANT PER DAY)

	Total Consumption 1963	Forecast			
		1970		1975	
		Actual Demand	Internal Supply	Actual Demand	Internal Supply
Grains, roots and tubercles	20,320	39,220	38,960	50,210	47, 950
Proteic Animal Products	11,090	13,500	13,320	15,940	15,720
	41,350	7,530	8,070	9,930	10,480
Fruits					
Animal Fate and	650	710	710	780	780
Oils	440	537		793	1,560
Vegetable Oils	2,740	2,650	525	3,100	4,100
Sugar	5.69	1,500		1,800	4, 200
Coffee (Export)			3,500		
			4,050		

Exception made of fruits, sugar and coffee, the demand for the above products is higher than their supply. Unfortunately, food production. Is not enough to meet the needs of the population.

According to estimates made by the United Nations in 1960, the death index in Brazil, of 20.6 per 1,000 inhabitants, is one of the highest in Latin America. Such a situation is even worse in rural areas, for which no statistical data are available.

I regret to say that the main cause of such a high death rate is <u>subnutrition</u>, that cuts down resistance against diseases. Each Brazilian consumes an average of only 1470 calories, while, the minimum daily requirements by individual are estimated at 3000 calories. When we see that only 10% of Brazilians live to the age of 50 we can only ascribe to subnutrition the cause of such a Short life span.

The average daily diet of a poor Brazilian is made up of 50 grams of proteins (20 grams being of animal origin), rice, beans and flour in a higher proportion than milk and meat.

The wrong diet of the people is due to the following main causes

a) inadequate production of vegetable foodstuff and fruits;

b) wrong choice (taste) as regards the quality and the quantity of food;

c) shortage of certain products in the markets;

d) lack of support to producers;

e) difficult t transport of food in view of the country's vast area;

f) little efficient and old production systems;

g) lack of entrepots, warehouses and conditions for regularizing and preserving products.

A factor which substantially contributes to the bad diet and mainly to the reduced consumption of vegetables is education our ancestors fed on roots and grains rather than vegetables and fruits, as the early agriculturer was led to this type of culture (corn, manioo, etc) in view of the smaller amount of labor it involved.

The present Minister of Health, by means of instructive propaganda, has been attempting to convince the people that a good balanced diet contributes to the longevity and health of the population, at the same time that it reduces premature death rate.

The lack of proteins in the diet of poorer classes bring about diseases in children, as evidenced by hospital records.

As meat is insufficient, I will now make an analysis of its production, together with other animal food products.

FOOD INDUSTRY

Annual Growth Rate

Period	Total	Animal Food	Meat	Animal Fats	Milk and milk Products
1960	3.9	-1.3	-5.8	2.5	0.9
1961	8.1	9.7	13.2	8.5	3.6
1962	3.3	5.7	-2.4	5.3	15.8
1963	-4.9	-3.0	-0.8	2.5	-7.9

Source: Getulio Vargas Foundation

It can be seen that the expansion of these products have not kept pace with the aforementioned increase in population, mainly in large cities.

The Government has been adopting measures designed to remedy the shortage of meat. The National Bank, for Economic Development had already extended its assistance to slaughterhouses and cold storage plants in the interior of the country, but so far a full solution to the problem has not been possible.

The balance in the amount of meat distributed in the different seasons of the year requires stockpiling in order that the market can be supplied with the product in the period between crops.

The South and the interior of the country have abundant meat. The cattle is raised free, and in certain months of the year it is rounded up in corrals where beef animals are separated. When the slaughterhouse is near the farm, the cattle, after prepared and washed, is slaughtered by means of a coup in the bulb.

If the slaughterhouse is far from the farm, the cattle is carried by train (in cattle cars) or by foot. In certain areas the herds sometimes move for weeks, and when they finally reach their destination the cattle is thin and worn out. They must then be fattned during a few weeks, which greatly adds to the price of the product.

The total utilization of the animal is made in more modern well equipped slaughterhouses. In the farms a selection is also made of more economical breeds, such as Devon, Heresford, Aberdeen, Angus and Poliangus, that require a shorter fattening period. Pastures are well cared for and substantially contribute to the good quality of the meat. But the number of pastures and slaughterhouses as also or entrepots, cold-storage space and transportation facilities is far from sufficient to meet the needs of the country.

The vast fields, the rich nature, the climate are very favorable to cattle raising, and once the required investments are made in the meat sector, we can be sure that the population will be supplied with the proteins they now lack, and there will still be meat left for export. An investment in a well organized industry, with transport facilities, entrepots, cold-sotrage plants, farms for cattle breeding by modern methods, can only benefit the country in particular and the world in general. Thus, Brazil, where prospects for the expansion of cattle raising are favorable, is in a privileged position to be the future supplier of the world. Since we are dealing with protein-rich food, mention should be made here of the importance of fish in the diet of the Brazilian people. The extensive coast of Brazil, that is also served by long and voluminous rivers, contains a very rich fauna, producing food that is highly appreciated by the people. Fish fat is rich in vitamin A, B and D. As fish are easily obtained the product is generally eaten fresh.

However, preserves demand great care, since the country's tropical climate favors deterioration of the product. Entrepots and cold-Sbrage facilities for the preservation of fish, and canned fish industrialization are not yet sufficiently developed.

The growth rate of the production of fish preserves bas been satisfactory, but its increase might also contribute to improve the diet of the population

1960 -	8.2
1961 -	5.5
1962 -	35.8
1963 -	5.0

Populations of the inland are early consumers of fisn from its voluminous rivers, such as the Amazon, the Tocantins, the S.Franoisco and others, including their tributaries, as the river fish meat is tasteful, healthy and clean.

The fishing industry is closely connected to that of salt extraction. Natural deposits located mainly in the Northeast and in the State of Rio de Janeiro were recently favored by investments under BNDE loans for the mechanization of salt extraction. But production is also deficient in this sector, since the Fabrica Nacional de Alkalis, which produces barrila, is a large consumer of salt practically absorbing the entire output.

Another food that could and should be consumed in large scale by Brazilian population is milk and dairy products, including cheese. However, the insufficiency of that food, the production of which has not been following populational increase rate, still represents a serious problem.

Milk in natura is still distributed in bottles, which substantially add to the price of the product, since the distribution, transport, return and cleaning of containers (subject to breaking) considerably burden its cost.

The establishment of a waterproof-bag industry would find a market that has so far remained untapped in Brazil.

Powdered milk has been replacing crude milk and its production went up from 1% of the total in 1940 to 4% in 1950 and was as high as 28% of the total distributed milk in 1963. The F.A.O., acting through the A.I.D., bas been extending its assistance to this sector by distributing powdered milk in the poorer areas of the country, thus contributing to improve the health of children in those areas.

As to cheese and other milk by-products, their production is also far behind ideal conditions.

A brief analysis will be made of sugar cane. The favorable conditions offered by Brazilian soil led the Portuguese to set up mills immediately upon their arrival on the new land. In the 18th Century, the European market purchased sugar from Brazil but the utilization of beet sugar has recently replaced cane sugar. Sugar cane culture in Brazil suffered much when the European market was lost.

The Alcohol and Sugar Institute, which controls sugar production in the country, checks the good quality of the product, that is crystallized and purified according to modern methods in well equipped plants. Sugar production reached 654,471 tons in 1963 and 457,714 in 1965. Past experience shows that our soil is good for cane culture and with some investment effort to expand the mechanization of cane and juice extraction, production could be rendered moreprofitable and attractive.

We will also briefly mention winegrowing, as wine is on its way to become a National beverage. In South Brazil its production is plentiful and of good quality. Laboratories have been set up where chemical analyses are made of the samples collected in winegrowing farms.

We must also refer to bread, a food that is highly appreciated by manking, and whose raw material - wheat - is not produced in efficient quantity in the country. Wheat imported from the United States, Russia and Argentina is a burden upon the balance of payments, and in 1965 Brazil imported 170,000 tons of wheat. For consumption control wheat is mixed with other flours, but the ideal thing would be to plant wheat in the South and provide transportation facilities and silos so as to render wheat flour distribution more regular and satisfactory for consumption.

Wheat imports are compensated for by the exporting of coffee.

Although Brazil is the largest coffee producer in the world, coffee had its origin in East Africa, in the vicinities of Kafa. Later taken to Arabia, transplanted to Egypt and Turkey and spread over Europe in the 18th Century, it finally reached Brazil through the French Guyana

The great coffee culture of the world is to be found in Brazil, that supplies practically 92% of world consumption, having exported 633,408 tons in 1965. Synthetic coffee, recently offered as a substitute, does not have the same qualities of the vegetable product, even though it did find a market as a result of its lower cost.

There is a kind of "infusion" in Brazil - Mate - that could also be appreciated as a beverage appropriate publicity were made of its advantages and taste.

Fruits, mainly citric fruits and bananas, are part of the usual diet of Brazilians; the only problem is preservation, since they ripen very quickly. The regular distribution of water is an essential if a region is to become inhabited. The problem of water distribution in the territory is very serious and has been one of the greatest concerns of municipalities.

In extending its assistance to municipalities for the establishment of hydro-electric plants, the National Bank for Economic Development has been contributing to the advancement of the country since 1953.

Water consumption in Brazil varies from 70 to 170 liters per inhabitant per day and in tropical regions it ranges from 60 to 160 liters per day.

150 liters per day is the figure adopted in the calculations of water supply projects. In large cities, there are pipelines as long as 16 kms, with stations, and, houses are provided with. watermeters, the basis for forecasts being 250 liters per inhabitant per day. The per capita cost of setting up a system is estimated at US$23.00.

Projects for small towns, where watermeters are not adopted, provide for the construction of tubular wells without pipelines, consumption being figured at 150 liters per inhabitant, at an estimated per capita cost or US$ 10.00. Rural communities, in greater number, are supplied by means of artesian wells or dams, at an estimated per capita cost of US$5.50. This sector offers no great attractive for investments, as such a service always operates at a deficit.

In a country which was said to be essentially agricultural, only 2% of its land has been cultivated, and one third of that is utilized for the production of food. The predominant factor is the rather irregular distribution of income, causing an imbalance in wealth. Hence the lag of certain regions as respects their land development. The agriculture's productivity and the productivity of cultivated land give a low yield, as 10 million workers are required to cultivate 20 million hectares of land in Brazil, while in the United states 8 million men can cultivate 190 million hectares, that is an area ten times larger.

According to the Chinese economist Pei-Kang Chang "industrial development cannot command 1andeconomy reform'". Such a phenomenon

is evidenced when we see that from 1948 to 1958 the per capita gross national product rose by 29% and agricultural and cattle raising production by 15%. Reacting against this imbalance the BNDE has been granting indirect assistance to agriculture.
Sectors

Sectors	BNDE cooperation			
	In Local Currency Million Cr$		Provision of Guarantee US$ equivalent	
	1964	1965	1964	1965
Transportation	-	16,000	-	5,799
Electric Power	4,755.0	34,000.00	39,878	-
Agriculture & Supplementary Sectors	70,100.7	136,577.0	116,655	260,734

The production of large trucks by Fabrica Nacional de Motores, under BNDE assistance, provided a solution as regards the transport of foodstuff, since railways in addition to offering slow transport, demanded a highly costly reequipment.

Crop marketing was a matter of concern to the Government, mainly in 1965 when warehouses and silo networks were built. The indirect assistance granted to iron and steel, metallurgical and mechanic industries also contributed to the necessary mechanization of agriculture.

When the Land Statute was enacted, the Agricultural and Industrial Fund (FUNAI) was established.

I only briefly referred to the development of the hydro-electric sector, because it is closely connected with the regularization of the hydrographic system and basic services for the setting up of 1ndustries

The industrialization of foodstuff, which lags far behind requirements as a result of the low effective utilization or the equipment (15 to 20%) suffers from its loss of capacity, consequently adding to production costs.

The causes of such a loss are the following,:

a) difficulties in obtaining raw material, distance, transport facilities, warehousing, etc.

b) irregular demand, requiring expensive stockpiling.

c) shortage of working capital.

These factors also affect the quality of the product.

The action of middlemen, although necessary, also affects prices. The efforts made by a controlling agency have been yielding no results, and that is why direct sales by producers might offer a solution to the problem. But this could only be done if agricultures were given assistance for developing their farming.

Transcribed in the next page is a- table showing the composition of the cost of main food products in 1963.

A brief comment must be made on food warehousing problems, Brazil's climate covers tropical as well as semi-tropical regions, the temperature being warm and humid. Products are more perishable and must be prepared for preservation. The early drying, salting and other processes are being put aside and the present trend is towards the employment of other industrial processes such as liofilization – good drying under special pressure and temperature, causing dehydration through the direct passage of water from the liquid to the gaseous state. The product remains undamaged and its organolitic properties are not affected. However, the adoption of such a process requires expensive equipment of a high operating cost. It also requires special waterproof and sterilized packing.

In recent years the manufacture of canned food and fruit preserves has developed satisfactorily, and the resulting product presents quality which conforms to procedures adopted in more advanced countries.

But there is still much to be done, for, we repeat, Brazil can easily produce enough for its own consumption and for export.

That is why the BNDE, in assisting metallurgical and mechanical industries, has indirectly contributed towards the expansion of these products, since 50% of domestic canned food plants have been set up with locally manufactured machinery. In 1960 90% of the equipment was imported, which shows the country's rapid industrialization;

STRUCTURE OF INDUSTRIALIZED FOODSTUFF

% Composition of Costs (1963)

ITEM		Processing Toasting Milling	Masses- & Biscuits	Animal Slaughter& Preserves	Pasteurization & Dairy	Fish Preserves	Fruit and Vegetable Preserves	Vegetable Oils & Fats
Production Cost	71.5	64.1	68.2	79.2	81.6	72.8	70.2	69.5
Raw Material	53.0	45.0	47.8	68.5	65.1	41.5	37.7	53.0
Labor	4.5	3.3	6.4	4.9	3.9	12.2	5.2	2.8
tPacking	8.1	6.7	7.7	3.3	6.1	19.5	23.6	9.0
Iwixed Expenses	5.9	9.1	6.3	2.5	6.5	5.0	3.7	4.7
Administrative &Sales Expenses	21.2	25.3	24.1	17.6	15.4	23.7	23.6	19.4
Profit	7.3	10.6	7.7	3.2	3.0	3.5	6.2	11.1
Value of the Proc.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Ina addition to equipment, pipes, steel joints, valves, conveyors, heat exchangers, evaporators, mills, grain separators, baggers, canners are also locally produced, and before long we will be manufacturing automatic controls.

A serious obstacle - inflation - has been blocking the way to progress. This economic distortion is a terrible burden upon the country's population and is reflected mainly in the high prices of foodstuff. A well guided and balanced economic development is therefore essential.

Inadequate land structure, bad utilization of our natural resources, low agricultural productivity, obsolete agrarian structure, all these shortcomings must be urgently coped with.

Furthermore, new systems and organizations must be set up so as to raise the attractiveness of the agricultural sector.

The following conclusions can be drawn from this short analysis:

a) although extensive and in full development process, Brazil is still far from providing good food to its people;

b) an obsolete land structure is the main cause of subnutrition;

c) an empirical and disorderly utilization of the soil and inadequate transport and warehousing facilities also add to difficulties in supply;

d) the population has not been given sufficiente knowledge on the requisites of a good diet.

However, we feel sure that once stern measures are taken Brazil will step out of the clouds of the past and win a brilliant victory over famine.

As the French writer said:

> “La mensonge héroique est une lâcheté. Il n'y a qu'un hèroisme au monat
> c'est de voir le monde tel qu'll est, et de l'aimer.”

We also see reality, we also love our beautiful and vast country and wish to disclose to our friends the green and golden riches of South America.

IMPORTANCE OF FISHERY IN FOOD PROBLEMS

By **K. Saruhashi**, Dr. Sc.

Dr. K. Saruhashi was awarded Dr. Sc., Tokyo University in 1957. In 1962 she worked at Scripps Institution of Oceanography, University of California to make a comparative study of radioactive measurements of sea water. She was invited as a speaker at the 2nd International Conference on Water Pollution. In 1965 she gave a report at the International Conference of Cloud Physics. In 1966 she participated in 2nd International Oceanographic Congress, Moscow and was appointed Press Secretary General at 11th Pacific Science Congress. She is a chief chemist at Meteorological Research Institute, Tokyo. She was awarded a prize by Minister of Transportation for her accomplishment in 1964.

Summary The total catch of fishes in the world at present is 5 X 10^7 tons in a year in which Japan shares about 7 x 10^6 tons. Japanese people eat 15 grams of fish protein per capita per day. Japanese takes only one third of necessary protein from animal foods in which 60 % is supplied by marine products. If fish 5 meat is replaced by cow meat, Japan has to get newly 1.2 x 10^5 square kilometers of land for pastures which is equivalent to the area twice as large as the whole arable land in this country. To improve the standard of living, every country in which diet of people depends on sea food has to investigate scientific means for conservations, protection and culture of fishes as well as the expansion of arable land to raise more animal foods. The latter needs the water resources which will sometimes be limiting factors for food production.

Importance of fishery in food problems

K. Saruhashi

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The industry of Japan has developed very fast in recent years and the gross national production is expanding year by year.For example, at present, the annual production of steel manufacturing is the third in the world following those in USA and USSR.

However, Japan has still many difficult problems: to be solved.One of them is the food problem on which I want to make some remarks in relation to the great importance of fisheries for Japanese people.

At present, Japan has the population of nearly one hundred million which is approximately a half of those of USA and USSR. Despite a larger population, her land is very small.The total sum of surface area of the land consisting in four major islands, is only three hundred and seventy thousands square kilometers, which is almost the same as that of the State of California, USA.

Most of the land is covered by mountains and thick layers of volcanic ash and the surface area of the arable land is not more than sixty thousands square kilometers which is only 16 % of the total land area.Most of the crop from the arable land is rice, of which amount of production is about l3 million tons annually.

Because of the shortage of land and the long history of the rice depending agriculture in Japan the production of animal foods is very small.The amounts of the annual productions of beef and milk are respectively only 250 thousand tons and 3 million ki1o litres in 1965.

Reflecting those unbalanced situations in food production, most of Japanese have to depend mainly on plant foods for their diets.

The percentage of the amount of consumption of protein by Japanese is as follows.

Table 1 Consumption of protein by Japanese people (g /day,man)

Plant	46
Fish	14
Meat etc.	10
Total	70

It is to be noticed that the percentage of the animal protein is only 34 % of the total, in which about 60 % is supplied by marine foods.

Japanese fishermen are harvesting about seven million tons of fishes in a year which is close to one seventh of the total crop of fishes in the world.Owing to the large fishery, Japanese can take some 14 g per day per capita of the animal protein as shown in the above table.

I would like here to give some considerations on the great significance and the importance of fisheries for Japanese people in future.

According to Bradley (1962), necessary amounts of water for food, production are one ton and 20 tons respectively for cereal water and cow meat of each one kilograms. These are the amounts of which are lost to the air by transpiration through the plant bodies of wheat or alfalfa to raise each one kg of cereal and cow meat.

If we replace fish protein of 14 g per day per man by animal protein of cow meat or other land animal foods, we have to have fifty, five billion tons of water in a year. On the other hand, the total amount of water now available for the whole agriculture in Japan is about sixty billion tons per year. Therefore the above figure of fifty five billion tons of water is almost the same as the total amount of water for the whole agriculture. In other words, it requires the expansion or new cultivation of the meadows as large as the present total arable land in this country.

The population and food problems are the most important problems in Japan and also in other Asian and African countries. For example, in twenty years, the population of Japan will increase to about one hundred and twenty million. If we want to improve the diet by increasing the percentage of the animal protein, including the fish protein of 15 g per day per captia, to about 50 % of the total protein, we have to import some 3.5 million tons of meat in a year, unless we cultivate newly a few to several tens of thousands kilometers of the land for pasturage. Needless to say, this is the very difficult task when we consider the geographical situation of the land of Japan.

Accordingly in future, the fisheries will be more and more important for Japanese people than the present time. When we think about the poor diet of Asian and African people, it is necessary and urgent that we have to raise more animal protein from the oceans.

There are many augments about the productivities of fishes in the ocean. Some of them think that the present amount of fish catches already exceeds the annual production. According to others, however, the annual harvest of fishes can be increased to ten times the present amount. Therefore, it is important for us to estimate the exact amount of the annual productivity and the amount of the standing crops of fishes in the world oceans. On this point, we have much anticipation for the results of studies in the International Biological Project (IBP) which are now going on under the corporation of scientists in many countries.

It is also important to protect the standing crop of fishes as much as possible and to develop new techniques to increase the annual production of some useful species of fishes. To achieve these aims, it is necessary to study the oceans from various aspects in order to elucidate the ecology of marine organisms as a whole.

I stated here mainly on the importance of fisheries for Japanese people, but this is not only for Japanese but also for many nations which have the same difficulties on the food problems of their people. I hope, my friends and collegues from Europe, America, Australia, New Zealand etc. who are not suffering from the food problems so much, should also understand the difficult food situations in many countries in other areas of the world and encourage the scientific effort to raise more foods from the marine environments to improve the future living standards of the people of the whole world.

DISCUSSION

D. M. McNulty (U.S.A.)

I would like to ask the Japanese delegate have they had any success with the experimental growth of algae as a food supplement for the Asian people.

K. Saruhashi (Japan)

The shortage of animal protein is solved partly by algae, but algae is a small amount of the food available from the ocean.

D. U. Mizoguchi (Japan)

May I add a little more to the algae question. We eat lots of algae and we have some cultivation of algae being made on the coast of Japan. We eat mostly brown algae but we dry green algae and make up into a sort of sheet which can be stored for some time and whose artificial cultivation is now being tried. Most of the algae we get naturally.

D.M. McNulty (U.S.A.)

I read an article about experimental algae and I do not know whether it is protein for animals or protein for humans.

K. Saruhashi (Japan)

It is protein food for human beings. Also it contains iodine and supplies iodine for people who eat a lot of starchy foods.

K. Chandrasekhar (India)

The Japanese paper mentioned the IBP programme. I am very interested in this because I have a scheme under the IBP programme and so I would like to know what exactly is the Japanese contribution towards this IBP.

K. Saruhashi (Japan)

IBP is under the sponsorship of UNESCO. I do not know about IBP exactly. It just began last year or the year before last.

K. Chandrasekhar (India)

I just want to know what exactly Japan is contributing towards the increasing food production through the IBP.

K. Saruhashi (Japan)

The IBP includes both basic and applied research to increasing the food production. This research is in itself a contribution to food production.

D. U. Mizoguohi (Japan)

May I complement that: Japan is making a research investigation of the marine product resources in the Pacific area. Not a direct production but a research investigation of the amount of natural resources that can be obtained from the Pacific area.

A. Azmaz (Turkey)

My question is for the Japanese delegate. Considering the fact that Japan has accomplished much on land reform and remembering the point that was made by Miss Hollingsworth this morning that land reform has a great effect on food production, I would like to know the relationship between the accomplishment of land reform and food production in Japan.

D. U. Mizoguchi (Japan)

None of the Japanese delegates are agricultural experts or civil engineers. We do have land reform also land reclamation. Land reclamation for food production or for industrialisation, but Miss Susuki says that by land reclamation we are killing the fish industry. So we cannot have both. We must have either land reclamation for increased industrial production or increase of natural products without land reclamation.

I. Ghose (India)

I would like to know whether there is any limit of the exploration of food products or should we put more stress on population control.

S. M. portella (Brazil)

The extent of our country is so big that we need to expand our population to get enough workmen to do all this work. So our problem is not one of population control, our problem is to educate so that our big land becomes productive.

A. M. Janovioz (Austria)

Could Miss Portella or Miss Chebataroff give us any information about their neighboring country Argentina. Formerly this was one of the most important agricultural and meat producing exporting countries. Now, meat production has diminished to such an extent that they themselves have had to introduce one or two days a week without meat. As we all agree that food production must be increased this is an astonishing development.

S. M. portella (Brazil)

Food production must be increased and mainly meat production as you say. But as it is a vast country there is the problem of transportation.

From the country to the big cities takes about 6 days by train.

A. M. Janowicz (Austria)

I do not think the means of transportation have deteriorated in recent years but formerly in Argentina there was much more production and exportation of meat.

S. M. portella (Brazil)

I have not got the Brazilian map with me but if you see the distance from the inside of the country to the sea it is much greater than Argentina. Argentina is near the sea so we must have railroads - railroads are difficult, so now we are making roads to bring the meat but even so it is expensive. You have heard of Brazilia which is towards the centre of the country, it was built there because the Brazilian Government is trying to bring population to the middle of the country. At present all development is near the sea area, round the coast.

L. Chebataroff (Uruguay)

I do not know whether the Uruguayan problem is similar to that in Argentina but on Saturdays and Sundays we are not able to buy meat. Production was going up year after year but at the same time we had a population increase and there came a time when the increased food-stuff was being absorbed by the population, and our exports which were principally wool, cereals and meat started to decrease. We do not have any oil sources, nor coa1 or much in the way of mineral sources, although we do have hydro-eleotric power. We have to export, one of the basic items of export being meat, so the Government has attempted to limit the consumption of meat within the country. We have to do a great deal in the way of educating our people so that they will substitute fish for meat. I do not know whether this is the same problem as the one they have in Argentina. We have a country which is all ready to produce and the problem is really in developing the technical facilities. We need minerals and fuel, the rest we have.

A. M. Janowicz (Austria)

We have been living in Argentina for two years and, as far as I am informed, the problem is political owing to the agricultural workers being told that they have to go to the cities to become industrial workers to improve their standard of living and get higher wages of the country has become isolated from labour. I am informed that this is one of the reasons for the decrease in agricultural output in Argentina.

S. M. Portella (Brazil)

That answers one question for me also. In Brazil the same thing happens. There is emigration from the country to the big cities because of the high wages paid.

S. R. Berbynuk (Canada)

I should like to pose a question to each of the three panelists: How much effort is being made, and in what manner, in making the people themselves aware of the food problems.

S. M. portella (Brazil)

The effort is very big in Brazil. The Brazilian Government helps by education, distributing machinery and helping with investments all through the country. Secondly there is help from the U.S.A. by the Bank of International Development which lends money to help our peoples other countries are also helping us as well as UNESCO, and the United Nations. Even countries like Germany and Japan are investing in Brazil, building factories e.g. automobile industry. We are now self-sufficient in car production. So the effort is ours, but other countries are helping.

K. Saruhashi (Japan)

I think all engineers and scientists in the whole world who are not suffering from the food problem should try to understand the difficulties in many countries. Secondly there needs to be more scientific and technological effort to raise more food from the oceans. I do emphasise this as about 70% of the world's surface is covered by ocean.

L. Chebataroff (Uruguay)

The education of the farmer is a very important aspect but, as one of our colleagues was saying, there is this exodus from the rural areas towards the towns of people looking for better openings in life. My country is attempting to resolve this problem. We have to do something in order to keep people on the land. We have to deal both with large estate farming and very tiny farms. Over the last few years we have been doing an intensive campaign as regards the education of the farmer for using the proper crops, using certified seeds, adapting the crops to the ground, not necessarily the kind of crop the farmer thinks will do well. We have a series of subsidies which we are applying to the land and so long as there is a promise of increased yield the farmer is interested. Erosion is one of our very serious problems and we are losing inches and inches of the top soil simply due to ignorance. It is not an easy problem to solve, all kinds of actions are being taken, people are bound by tradition, and there is a great deal of disinterest at a political level, although there has been some considerable agrarian reform. We have high hopes that with time we will be able to overcome these problems as they have been overcome in other countries. There is an interesting aspect in my country that the schools bring the parents together and give them some form of instruction though this is, of course, very elementary. We have agronomic engineers who give courses and classes so we are trying to reach the farmer in this way. The problem with Uruguay is not the problem of food stuffs it is mainly a question of transport, getting the appropriate machinery, it is really a more far reaching problem.

The Application of Technology - The Use of Power in Agriculture

3 July 1967

In the Chair **Jirina Vejvodová (Czechoslovakia)**

The application of hydraulic technology to world food production
Harold A. Lehmann (USA)

(presented by Ann W. Fletcher (USA))

Ways by which electricity can increase agricultural productivity
A. E. Amour (Italy)

Irrigation and the High Dam in UAR **A. el-Hefny (UAR)**
(presented by E. Laverick (UK))

Discussion

Jirina Vejvodová

Jirina Vejvodová graduated at Charles University, Prague in Applied Physics. After some years of research work for which she received a scholarship, she was appointed lecturer and later, after receiving the PhD degree, senior lecturer at the Department of Electronics and Vacuum Physics, Charles University. In 1966 she was appointed Reader in Electronics in the same Department and in 1967 she was elected vice-dean of the Faculty of Mathematics and Physics, Charles University in Prague. Her field of interest is electron physics, especially theory of electron and ion beams.

THE APPLICATION OF HYDRAULIC TECHNOLOGY TO WORLD FOOD PRODUCTION

By **Harold A. Lehmann**, Manager Engineering Services
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Farmingdale, L.I., N.Y.

Mr. Lehmann has been in hydraulics and related fields for over seventeen years; holds ME from Wayne State University; previously was Staff Engineer, J.I. Case, Inc. and before that was section supervisor, hydraulic section, research and product engineering, Tractor and Implement Division, Ford Motor Co., responsible for design, development, and production release of hydraulic systems and components for agricultural tractors; also was assistant group engineer, hydraulics and landing gear group, General Dynamics, Inc.; he is a member of the American Society of Agricultural Engineers; is a member and past chairman of the ASAE's PM 51 Committee; is a member of the Racine-Kenosha Chapter of the Fluid Power Society; and serves on several hydraulic committees of the Farm and Industrial Equipment Institute (F.L.E.I.).

SUMMARY The paper points out the important roll and the vast coverage of hydraulics on farm equipment. From the initial preparation of the fields to the final harvesting of the crops, hydraulic systems and components are lending muscle and speed to facilitate food production. Hydraulic power is making many back breaking chores easier. Through the use of hydraulic power, man and machines have been able to multiply acreage output per man many fold.

World population explosion necessitates continuing research and development in this field.

THE APPLICATION OF HYDRAULIC TECHNOLOGY TO WORLD FOOD PRODUCTION

By **H. A. Lehmann**

One technology that is a major contributor to world food production is hydraulics. Hydraulic power plays a very prevalent roll on the majority of the tillage and harvesting implements in agriculture. Hydraulic applications range from the very simplest circuit as a hand pump and cylinder (Fig. 1 & 2) for positioning a wagon unloading auger to the more complex and sophisticated circuit of hydrostatics (Fig. 29) for propelling a combine harvester.

Starting from the initial preparation of the soil, the two way or turn over plows (Figs. 5 & 6) are hydraulically controlled for rotating the plow bottoms at the head lands.

The plow's depth and draft is controlled automatically by draft-o-matic control. This hydraulic device (Fig. 17) automatically lifts or lowers the plow because of soil changes as it is being drawn through the field. Figure 1 shows a two way, 36 inch, disc plow that uses four double acting cylinders.

This same draft-o-matic lift is used for controlling, fitting, and planting implements such as the disk harrows, planters and cultivators.

The wagons (Figs. 3 & 4) for transporting the produce from the field to processing plants are unloaded with hydraulic cylinders.

For highway beautification and field preparation prior to plowing, the rotary field cutter shown in figure 8 is a very usefu1 tool.

Figures 9 & 10 show two hydraulic motors as used on a portable elevator for transporting produce into barns or other storage areas; Figure 11 shows a hydraulic mower application. Services on this device include a motor for activating the cutter knives and a cylinder for controlling rising and lowering of the cutter head.

The largest number of applications of hydraulics on agricultural implements other than tractors is on the combine; Figures 12 & 13 show two views of the combine. Combine services include power steering, vari-speed control aDd. reel speed control. Under study in many companies is the use of hydrostatics as the driving means.An optional feature available is an automatic sensing and. header control hydraulic circuit.

The automatic header sensing is very attractive to operators for reducing operator fatigue. Secondly, automatic control is faster and more consistent than physical operator response, providing the sensing mechanism is properly designed.

The primary reason for the interest in hydrostatics for combine drive is the fine speed control obtainable. The transition in speed range from low to high is smooth and stepless. The vehicle moves up and over levies at a constant speed. It does not gain speed on the descend causing the header to dig into the ground as on conventional drives. Thus the drive prevents the header from gathering more grain than it can digest. This would cause clogging and consequent down time.

Figure 15 shows a diagramatic schematic of a combine hydraulic system. Power is provided by a gear pump having a priority flow divider and two discharge ports - one directing oil priority to the power steering circuit - the other directing oil to the control valve for control of the header and vari-drive control cylinder. Thus the steering circuit receives oil first, it the pump is delivering.

Figure 16 shows a typical pump and flow divider package. As stated above, the priority flow divider delivers oil first to the power steering system and sector to the other services.

On J. I. Case machines, 2-1/2 gallons are delivered to the power steering system and the remainder, or 7-1/2 gallons,. to the main control valve. Pump speed is usually stepped up to provide adequate oil volume for the main valve services at all working ground speeds.

Two types of power steering are used on Case Combines. One is a linkage follow-up system or booster type. The other is a hydrostatic type with no mechanical connection between steering linkage and steering mechanism.

Figure 14 shows a booster type assembly. This particular assembly is used on tractors, however, the combine application is very similar in body and principle. Figure 23 shows a typical schematic of this complete circuit. Flow is pump to valve to return and then valve to double acting cylinder. This circuit is typical and is used in many tractor and automotive applications.

Figure 19 shows the hydrostatic installation assembly with no mechanical linkage. Steering with no hydraulic power in case of failure is transmitted through operator actuation of the hand pump located at the end of the steering shaft.

Figure 20 shows a typical power steering hydrostatic pictorial diagram. The Case 530 Construction King tractor also uses this system. Flow is from the engine driven hydraulic pump to the control valve, to hand pump, to the cylinder and finally return oil to valve to reservoir.

Figure 21 shows a clear view of oil flow through the control valve and the hand pump during a right hand turn, neutral and a left hand turn.

Figure 22 shows the rotor and canmutator operation in the hand pump. The rotor delivers the oil power generated by operator through the commutator to the proper side of valve and cylinder. Initial hand pump movement causes displacement of the control valve spool into a position to deliver oil to hand pump to valve and consequently to cylinder.

In other words, the hand pump tends to boost the pressure and lead the steering. In case of engine pump failure, the operator generates hydraulic power via the hand pump.

One of the major problems in this type of steering is leakage resulting in steering wheel slip. Therefore, the components such as valve spool, rotor and commutator are select fit assemblies. All sealing surfaces that contribute to slip are very carefully controlled.

Figure 18 shows schematically the entire combine hydraulic circuit having hydrostatic steering. Compared to the booster type circuit, there is no mechanical connection between the steering column and the wheel linkage.

Figure 24 shows a combine control valve. The control valve consists of two 3-way spools, a relief valve and load checks. One three spool controls the vari-drive single acting cylinder that controls ground speed in the manually slected range gear. The other three way spool controls the two single acting header cylinders. Included in the two circuits are single load check valves pressure operated. These valves provide a more positive seal to prevent header drift or sheave position change. The valve also enables the usage of interchangeable spools rather than select fit spools. Cylinder pressure cannot be released it the engine is not running. Last, but by no means least, in this valve package is a pilot operated relief valve. And this element is quite often the heart of most hydraulic systems.

In the past few years, considerable interest has developed in automatic header sensing controls. Figure 25 is a diagramatic sketch of a possible header sensing control. This type is one of the most prominently used version of a sensing application used on combines. One drawback in the system as shown is that the hydraulic pump is constantly running under pressure.

Leaving the combine for a moment, the rotary motor as shown in figure 26 has a single vane and can travel through approximately 270° of rotation. Motors are also available in two vane assemblies. The double vane motor will have approximately one-half the angular rotation as that of the single vane motor, however, the torque output will be approximately doubled. Figure 27 shows a diagram of a typical motor application. As shown, the application is for continuous running motor, however, a vane motor maybe substituted for MF. In the agricultural industry these motors usually operate at a maximum pressure of 1500 PSI. Sealing of the hub and vanes is a critical problem. Pressure surges in the units tend to deflect the covers causing nibbling and trapping of seals it clearances and deflections are not kept to a minimum. Sharp edges and burrs on tot ring grooves and surfaces must be monitored. very carefully and continually during manufacturing. Two-way plow applications frequently require circuit relief valves to decrease the transient pressure shocks that occur in this application. Mechanical lockups will help except during initial lockup when sufficient leakage must occur for the assembly to rest against the locks.

In figure 5 we saw a two-way plow actuated by twin single acting cylinders. Sealing cylinders is considerably easier than the sealing of rotary motors; however, the motor provides the implement with uniform torque throughout its travel range. Usually in an equivalent design, because of mechanical disadvantages occurring at the cylinder extremities, the, motor requires a smaller volume ot oil to complete the operation.

Figure 7, as you will recall, shows a J. I. Case two-way disc plow. This plow has four double acting cylinders. One to swing the sector of the discs and three for control of the transport wheels. In the majority of the plow and other remote cylinder applications, the power source is the tractor hydraulic system through the use of the remote control valves.

Agricultural applications, where hydraulic power for continuous rotary motion is required, can best be provided by a pump and motor combination and a valve for motor control. Referring back, figure 27 shows a J.I.C. schematic diagram of a typical circuit to accomplish this same operation. A natural thought to accomplish this function is to use the tractor hydraulic pump and remote valve plumbed into a hydraulic motor. This presents a problem to tractor engineers, for the tractor pump is not usually designed to be subjected to this amount of continuous heavy duty. Also the hydraulic reservoirs are relatively small and heat dissipation sometimes becomes a problem.

One of the most popular pump motor combinations and one that has had many interesting papers given and written on is the Hydrostatic Transmission. Figure 28 shows a typical J.I.C. schematic diagram of a closed circuit type hydrostatic transmission. This closed-circuit type of drive takes the output of the pump flow directly into the input of the fluid motor. Crossover checks are required to provide replenishing oil during pump or motor stroke changes as well as a relief valve for the circuit. A manually controlled variable volume pump and variable motor complete the closed circuit.

Returning to our best hydraulic customer, the combine, considerable interest is currently being generated in hydrostatic propulsion of this implement. The smooth control and the infinitely variable speeds obtainable with this type of drive make the combine a perfect subject. One of the major problems confronting the engineers in designing hydrostatic drive for combines or other applications is the design of an economic package. Secondly, in combine application, the design of an economic unit having sufficient range to cover the slow speeds required for rice and other grain combining and the higher speeds for transport is a challenging exercise for the design engineer. I am speaking of travel speeds of 0.5 to 13 mph in rice combining and 0.6 to 16 mph in grain combining. One method of accomplishing this is by driving through a set or sets of range gears. This provides infinite control in each range; however, the economics of this arrangement is questionable for we have eliminated very few components and added an expensive hydraulic drive and. control package.

Another hydrostatic combination (Figure 29) has the variable pump and variable motor, where fluid motor speed is adjusted by a Combination of adjustments of pump and motor displacements. This is a more sophisticated circuit in which the motor and pump are controlled by servo-valves and a brain box.

In design of hydraulic components, for satisfied custamers, durability of the hydraulic system is one of the most important factors to consider. In the design stages considerable thought should be given the following:

1. Initial cleanliness of the components and systems. Too often contaminants are introduced at initial assembly. Because of this, seals and surfaces are damaged very easily in their operations, resulting in early failures or unsightly leakages. A clean working area and thorough cleaning of components prior to and during assembly can eliminate these problems.

2. Once cleaned, the system should be designed to prevent entrance of foreign contamination from entering the system. Sealing of ports of entry and proper reservoir design of breathers to accommodate volumetric changes due to cylinder displacements and thermo changes is essential to maintain cleanliness.

3. Reservoirs must be properly baffled to keep foaming to a minimum and induce rapid dissipation of entrained air.

4. Sufficient filtration must be provided to trap generated contaminants to retain and maintain a clean system,

5. The system relief valve if not properly chosen and properly designed can give no end of trouble. There are many versions of re1ief valves available however, generally speaking, there are four basic types. Figure 30 shows a simple ball and spring type. This valve is relatively inexpensive and is excellent for circuit relief where occasional operation is required. Where more frequent operation is required, early decay of pressure development occurs. Usually the spring starts to fatigue or take a permanent set and weaken, the seat tends to peen and early loss in pressure range occurs. To accommodate the high pressures, small high rate springs and relatively small ports are used to reduce package size. Therefore, a small depreciation in the spring force or seat peening, changes the pressure setting considerably.

Figure 31 shows schematically a pilot operated relief valve. This is an excellent valve where frequent operation is required. This type valve is used in the combine header and vari-drive circuit. Each time the header is raised and the cylinders cane to the end of their strokes, the relief valve operates. This occurs hundreds of times a day. Another outstanding feature of the valve is its ability to accommodate a wide range of flows without a large change in relief pressures. This is very important for good pump life.

Figure 32 shows the response time and relief pressure at 1 GPM flow through a pilot operated relief valve.

Figure 33 shows the same relief valve response time and relief pressure with 15 GPM flow through it. The graph shows approximately a 200 to 250 pressure change in relieving the system. The transients or initial pressure peak is approximately 2500 PSI compared to 2100 at 1 GPM and is quickly dampened out.

Figure 34 shows a malfunctioning relief valve severely chattering a condition that is very detrimental to systems and one that the designer must carefully avoid. In general, relief valves must be tailored to the Particular system where used. One relief valve may work fine in one system and give no end of trouble in a slightly modified system.

Recently at our plant, a combine would come off the line with a noisy relief valve. The same valve could be placed in another control valve on another combine and the noise would not always be evident.

After changing lines, i.e., replacing metal lines with hoses, adding clamps to reduce vibration without a satisfactory change in results, we ran a Brush Recording of several relief valves and found their characteristics to be different.

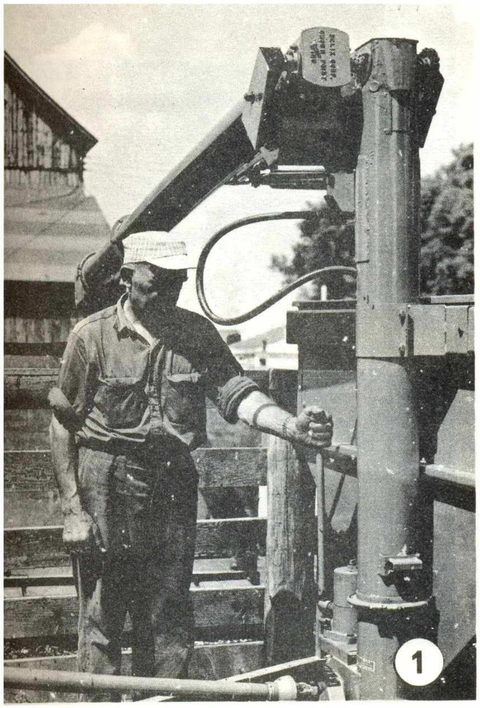
Figure 34, the malfunctioning relief valve, was noisy. Figure 35 shows the same relief valve functioning properly and quiet, modified as described below. Dimensional analysis revealed a variation in poppet to pilot seat clearance. However, the dimensions were well within print tolerance. This, of course, is not startling, for tolerances are necessary for economical manufacturing and inter-changeability. However, the analysis revealed that in this particular application the smaller diametrical clearance part made up into a noisy valve. The solution here was to selectively choose the largest manufactured clearance parts for this particular application. I am only speaking of a tolerance range of .0007 to .0015.

Projecting this information to a S-N curve, this type of action contributes to early decay in relief valves. For the endurance or cycle life of the material is being highly accelerated.

Figures 36 and 37 show schematically, the other two basic type relief valves, namely, the differential piston and guided piston type. The former is a type used with pressure ranges from 200 to 1500 PSI. The later, because of the large piston area that is exposed to pressure is generally confined to pressure systems up to 600 PSI. Spring size is the l1m1ting factor in this design.

I have deviated slightly from my original subject; however, a well designed system depends upon the engineer's careful consideration of the above details. The above information, I am sure, is not new to you; however, I feel it is always good practice to review and emphasize the above points.

Thank you.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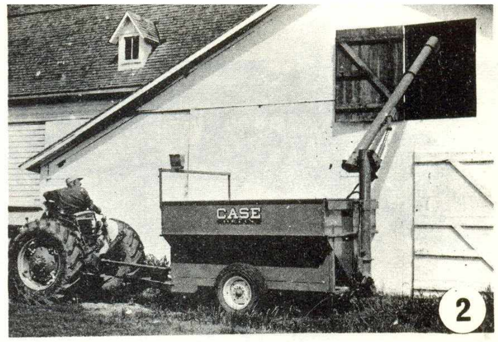
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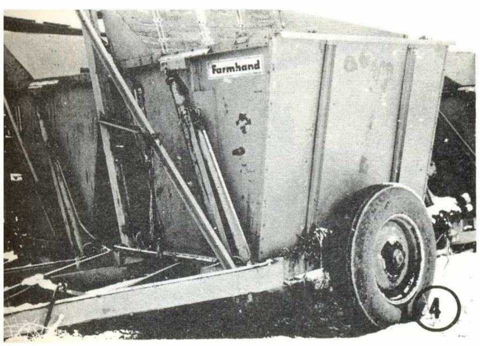
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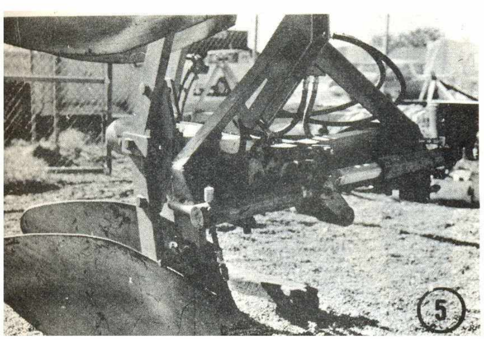
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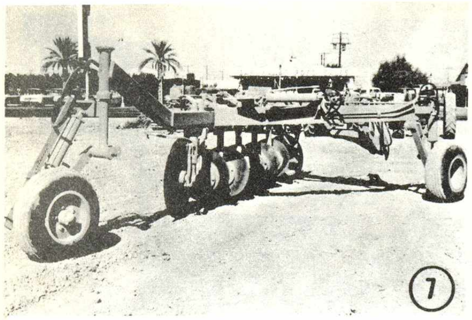

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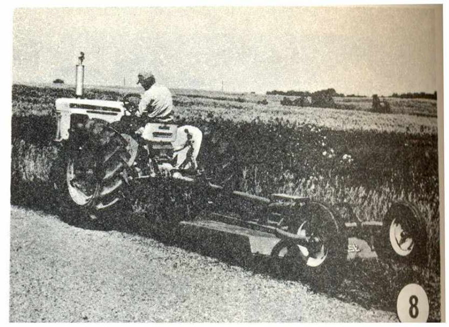

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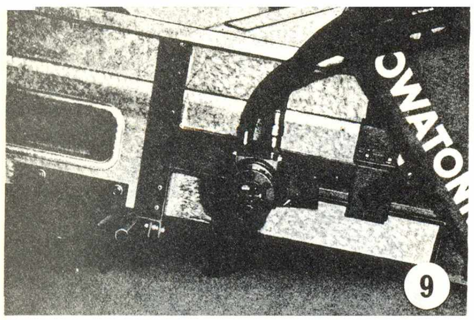

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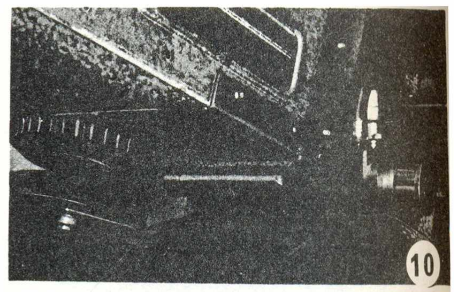

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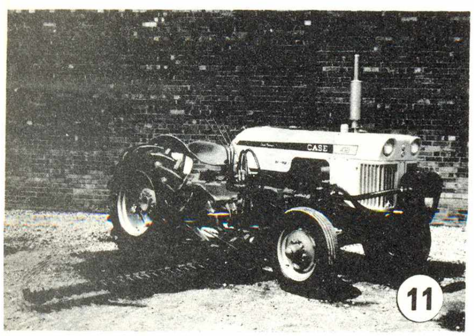

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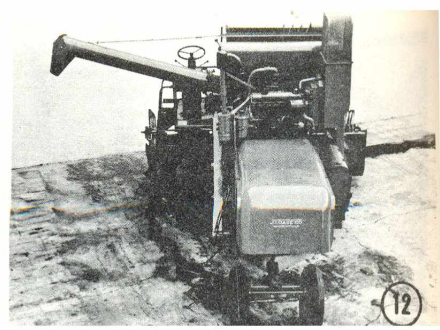

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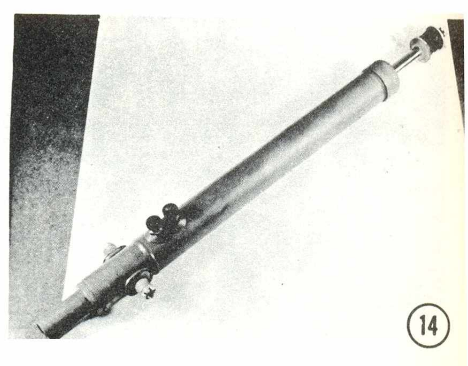

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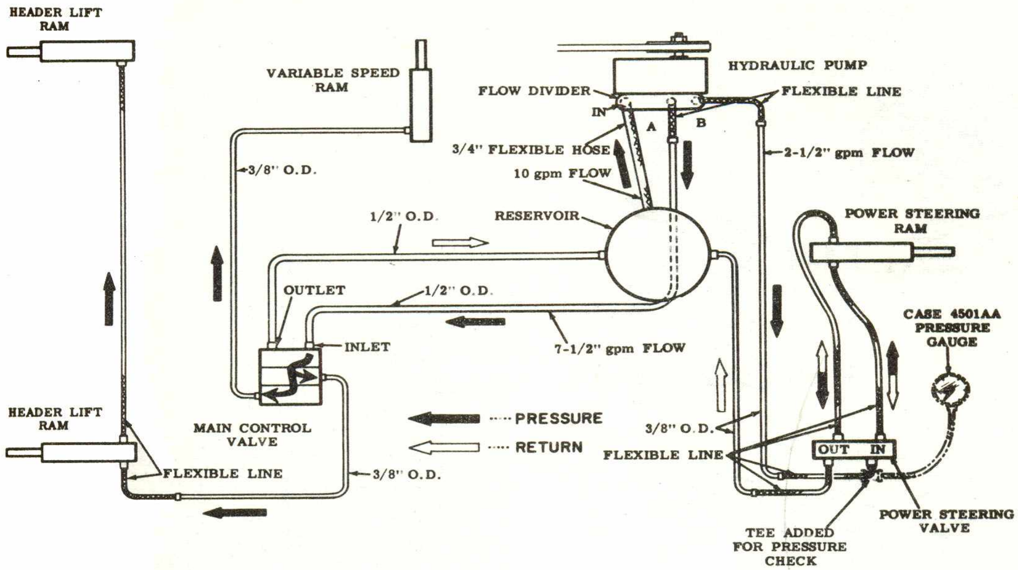

Schematic Drawing of Complete Hydraulic System

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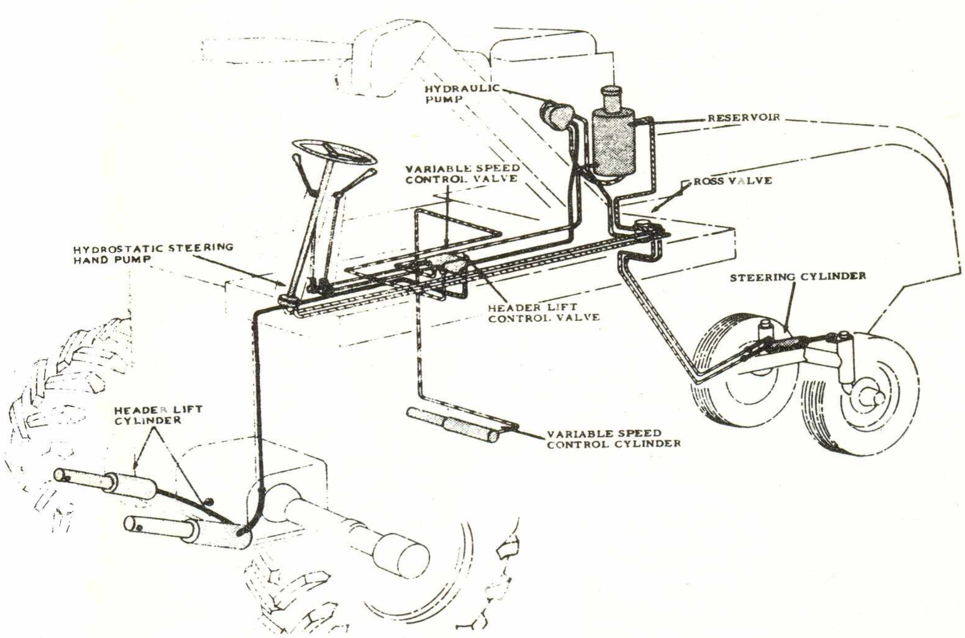

Hydraulic System

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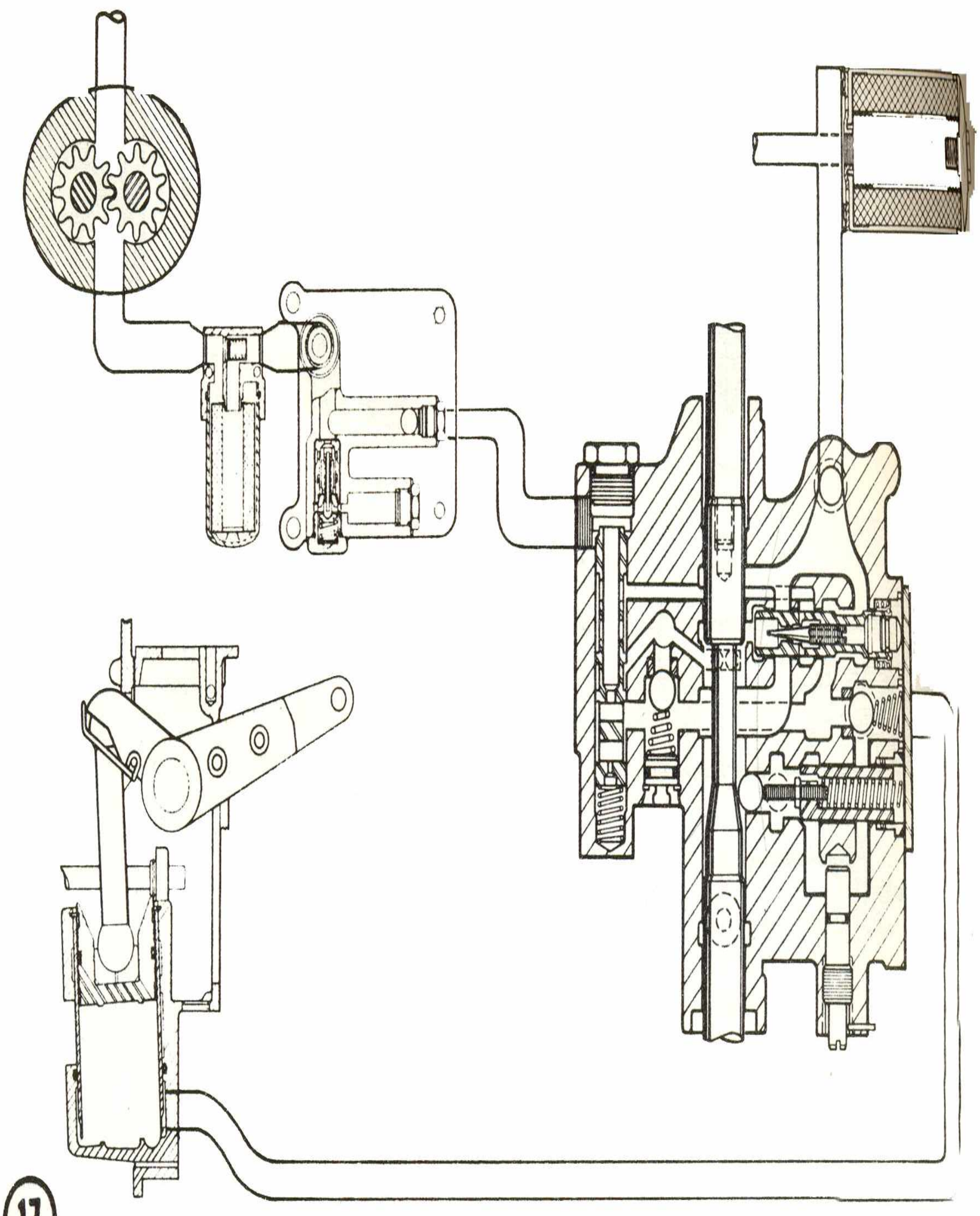

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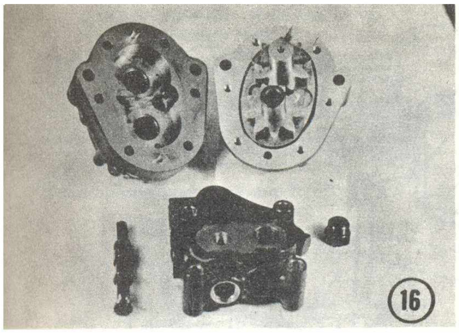

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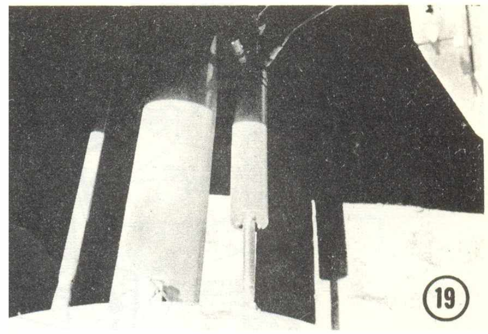

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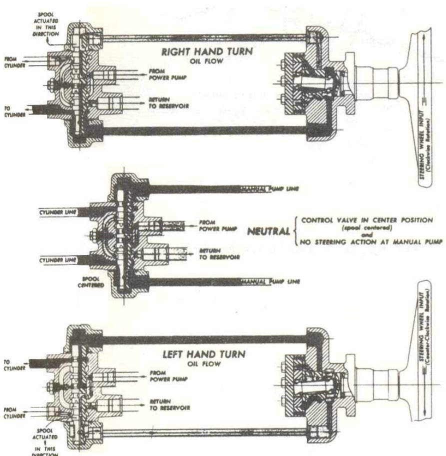


PINK High Pressure Oil Flow from Power Pump

RED Higher Pressure Oil Flow out of Manual Pump. (Slightly Higher Pressure to Actuate Valve Spool)

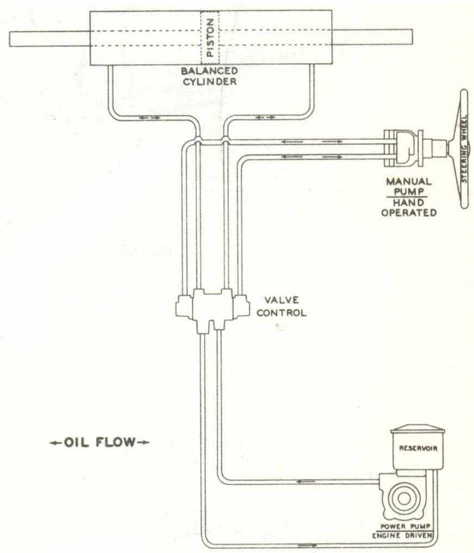
GREEN Return Oil Flow from Cylinder to Reservoir (Low Pressure)

BLUE Oil Flow from Power Pump to Control Valve and back to Reservoir while there is no Steering Action at Manual Pump. (Low Pressure)

ORANGE Static Oil—No Flow—while there is no Steering Action at Manual Pump.

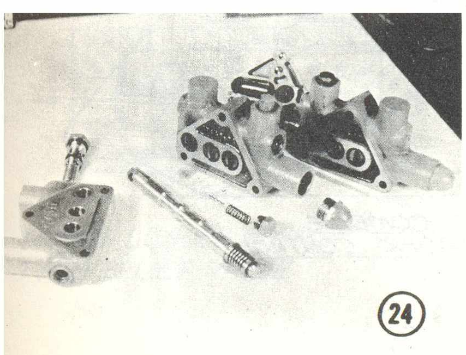
OIL FLOW ILLUSTRATION
FLOW FOR LEFT AND RIGHT TURNS and FLOW WHILE NOT STEERING
FOR POWER STEERING

21



PICTORIAL DIAGRAM OF STEERING SYSTEM

20



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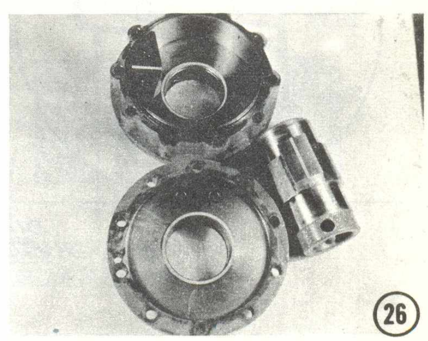

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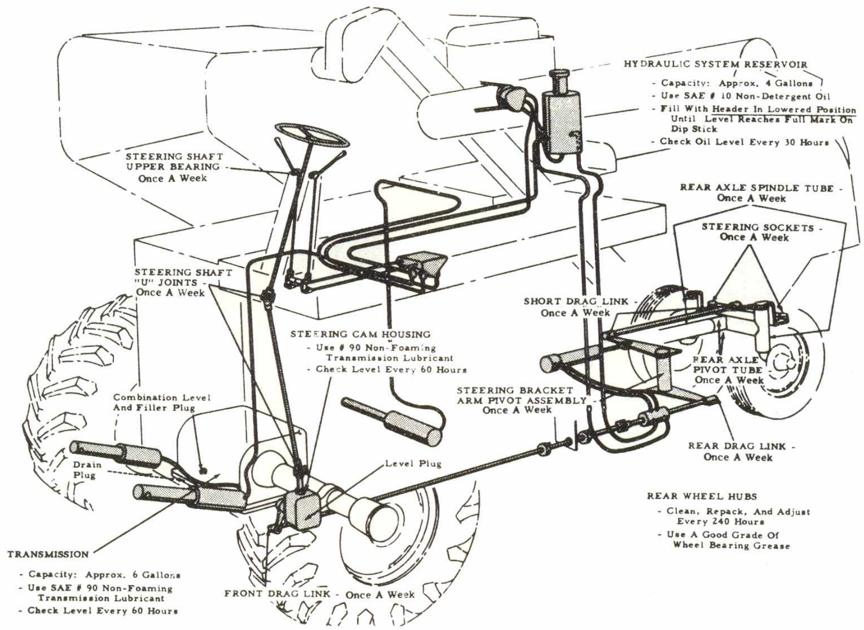


Lubrication - Transmission, Wheels, Steering, and Hydraulic System

23

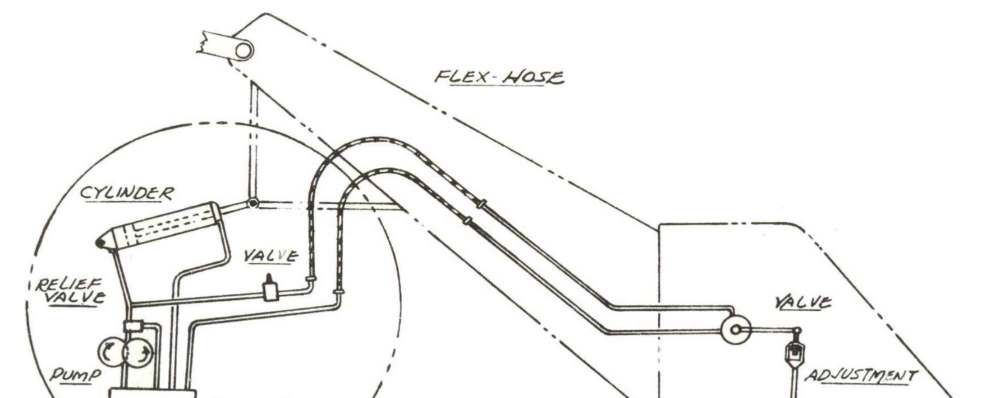


DIAGRAM OF COMBINE AUTOMATIC HEADER CONTROL

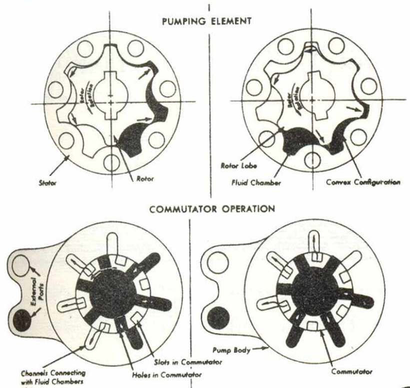
25

ILLUSTRATION OF ROTOR OPERATION and COINCIDENTAL ROTATION OF COMMUTATOR IN MANUAL PUMP

Each lobe of the rotor has a diametrically opposite lobe, therefore, when one lobe is in a chamber its opposite lobe is at the crest of the stator's convex form opposite the chamber. As the rotor is rotated each lobe in sequence is moved out of its chamber to the crest of the stator's convex form and this forces each opposite lobe in sequence into a chamber. AS A LOBE IS MOVED OUT OF A CHAMBER ITS OPPOSITE LOBE IS MOVED INTO A CHAMBER. Due to the interaction between the rotor and the stator, there are 42 fluid discharging actions in one revolution of the rotor. When the rotor is moving, fluid is always flowing out of three of the chambers while fluid is flowing into three other chambers, and one of the chambers is inactive as it changes from one of discharging fluid to one of admitting fluid.

The commutator rotates with the rotor and channels the fluid from and to the rotor and the pump ports.

Rotor, cummutator, and input shaft with steering wheel rotate together in direct 1:1 ratio.

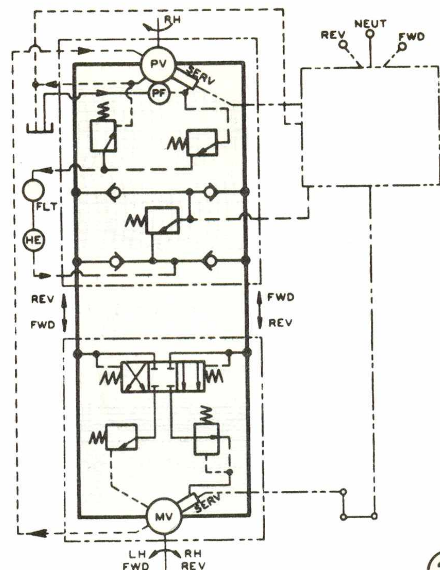


BLUE = Oil flow TO pumping element   RED = Oil flow FROM element (at higher pressure)

Note = Oil flow is opposite with opposite rotation of rotor

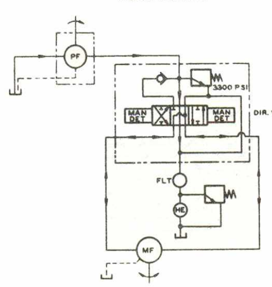
(22)

PV-MV TRANSMISSION



(29)

OPEN CIRCUIT TYPE
HYDROSTATIC DRIVE



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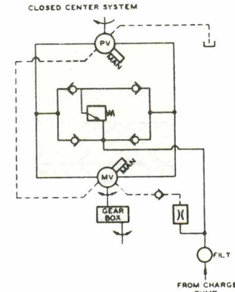
CLOSED CENTER SYSTEM



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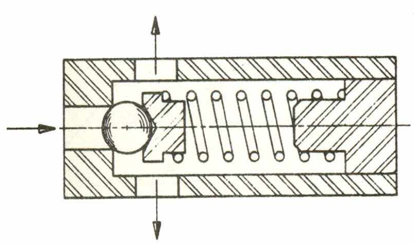
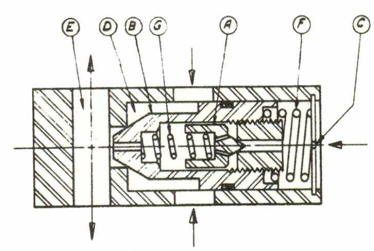


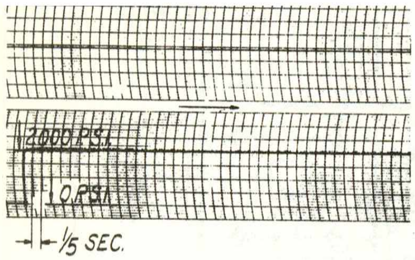
SPRING LOADED POPPET
TYPE RELIEF VALVE

(30)



PILOT TYPE
RELIEF VALVE

(31)



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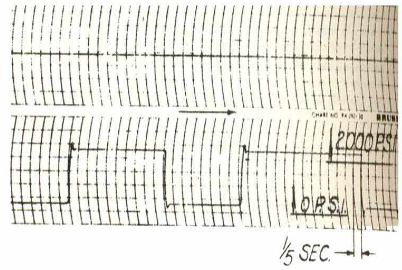

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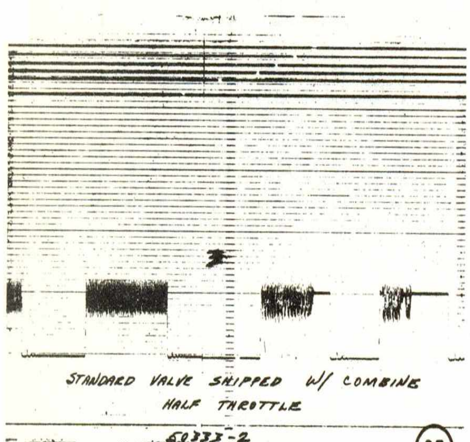

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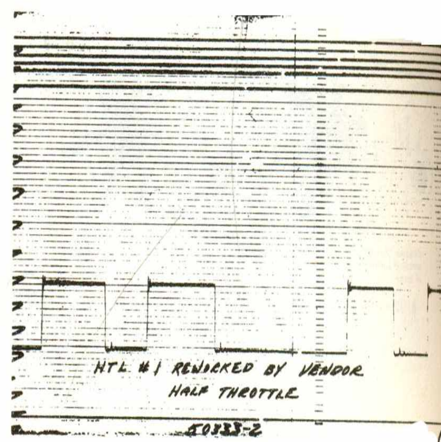

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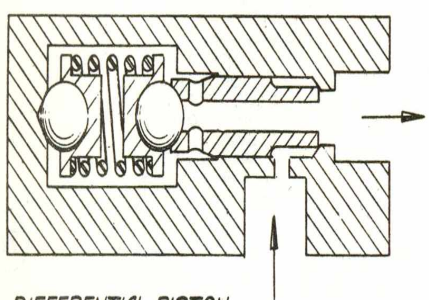
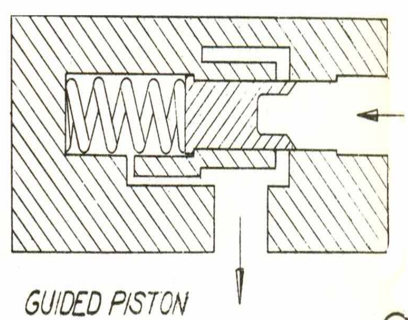


DIFFERENTIAL PISTON
TYPE RELIEF VALVE

(36)



GUIDED PISTON
TYPE RELIEF VALVE

(37)

WAYS BY WHICH ELECTRICITY CAN INCREASE AGRICULTURAL PRODUCTIVITY

By **A. E. Amour**, Dr. El. Eng., M. I. E.

A.E. Amour was conferred the Doctor's Degree in Electrical Engineering at the School of Engineering in Turin in 1933. In 1934 she joined the Società Idroelettrica Piemonte, where she was charged with Study and Statistics Office of Gruppo SIP until 1951.On leave in 1952 she got a Master's Degree in Industrial Engineering at N.Y.U. From 1953 back in SIP, now Enel, she has been charged with the Direction of a Technical Review for employees and of the Suggestions and Proposals Office.

Summary. Electricity can increase agricultural productivity as light, heat, ultraviolet and infrared radiations, as rotating power and directly in many ways here described together with a number of farm applications. The success of electricity is due to the variety and flexibility of controlling its use by means of electric and electronic controls which are the key to progress mechanization toward automated operation of the farm. Future prospective of full electrification at which are aiming the efforts of electric utilities.

WAYS BY WHICH ELECTRICITY CAN INCREASE
AGRICULTURAL PRODUCTIVITY

By A. E. Amour

Productivity , as defined by OECE terminology , is the quotient of a production by one of the factors of production that is to say the quantity of a product related to the factors which enters into the productive process: labour time capital invested or energy consumed during operating phases of the productive cycle.

In agricultural fields where men are engaged in getting a product from earth or from cattle, be it the harvest forage vegetables and fruits, or milk and pleat and eggs. productivity is measured by the quantity of product yelded by a unit of land surface or by one cattle or by one worker or by a capital invested in machinery and equipment or during the unit of time, the year according to the natural laws of our solar system which regulate the succession of seasons.

To increase the productivity means therefore to increase the quantity of harvest per sq. dekametre or to get more litres of milk from a cow, or to obtain a larger quantity of any product per unit of labour or during a season. Whereas an increase in productivity may also be obtained by a reduction of the hours of labour needed to get the same quantity of product or. “ceteris paribus,” by improving the quality of the product to get a better reward per unit of capital invested in production factors.

Under these different aspects an increase of productivity is so much sought in more industrialized countries where the average wages level and the tendency aiming at a higher standard of living, induce small holders to leave agricultural work, while the scarsity of men contributes to rise rural labour wages to values which do not allow a convenient margin of profit to capitals invested.

And the increase of agricultural productivity. intended as a greater quantity of product per unit of hind surface or per unit of cattle is even more important in those countries on the way of developing their resources. where such a large part of world population often does not have food enough because conventional ancient systems of doing the work by hand cannot provide for the needs of populations on steady increase.

Electricity utilisation in agriculture. In the agricultural field. as in other fields of production. electrical energy can be used by converting it into other kinds of energy as:

- Illuminating , ultraviolet ,infrared ,thermic radiations.

- rotating power

or directly by circulating adequate currents to the purpose of teletransmitting signals and orders, or to keep cattle within fences or to protect propriety and other uses which are the subject of experimental researches in many countries.

A complete list of the many and different agricultural applications of electricity would be a very long one to-day and to-morrow it would yet be incomplete, for the ingeniousness of technicians and manufacturers is every day at work to improve existing means of using electricity and to find new better means of accomplishing the many tasks that a farmer has to achieve before harvesting and being able to bring on the market milk, meat and fruits and any other food we need to live.

Electricity as radiant energy. Converted in radiations, electricity is used to integrate and replace the energy that the sun irradiates under various forms: light, heat, ultraviolet and infrared rays.

Light, defined as visually evaluated radiant energy, is the most common type of radiation we get from electricity. We are so much accustomed to have the light on at sunset to read, work or walk, that only when electric plants of production or distribution go temporarily out of service, we can realize how much human capacities and activities are limited by the absence of light in the rural areas, not yet reached by electric wires.

Good lighting, well diffused, to work and also for safety, to prevent obscurity dangers around a farm and to propriety protection. Electric light, essential to work during the night or inside inner rooms and cellars where sun rays do not enter, and good light for enjoying more comfort in the house and in the garden.

To plants as well, light is an essential element of life: they are phototropic, their shape and colour are influenced by light. Through the process of photosynthesis plants assimilate most of their aliment, since 95% of their substance is derived from carbon dioxide CO_2 existing in the air, and only 5% is derived from mineral substances dissolved in the soil Without light plants do not turn green, since photosynthesis produces also clorophyll, whose function is to transmit lighting energy and to allow plants nutrition and respiration.

It has to be underlined that, unlike human eyes, plants absorb more intensively light radiation when it appears fainter.

Among other factors which play a role on vegetation development are the length of day-light, that is to say the photoperiodism, which in the temperate zone varies from 8 hours in winter to 16 hours in summer, and the favourable temperature conditions.

With additional artificial lighting it is possible to reproduce the conditions best suited to plant-growth by lenghtening the winter days in temperate zones or even replacing sunlight by absolute illumination in antartic zones, where the winter period lasts -many months (as viceversa it is possible by obscurating green-houses to shorten the day-light period to cultivate for ex. chrysanthemum plants).

Actually, lighting radiations, be they emitted from the sun or from a lamp, are electromagnetic waves which bring energy in itself invisible. We just see their effect when the proper amount of energy reflected by an object reaches the eyes.

To the lighting effect of radiations is associated the thermic effect since radiant energy degrades itself in thermic energy. That is why lamps always have a heating effect.

Light's fostering effect on growth is long since known by poultry breeders who make use of artificial light to increase eggs production and chicks growth with different methods. By means of electric lamps it is possible to anticipate dawning or to prolong the light after sunset, or even, with the step-up, step-down method, to vary gradually the length of lighting periods from 24 to 10 hours per day and then from 10 to 14 hours per day, according to a predetermined program, experimentally studied to get a rapid growth of chicks and there after a higher eggs production.

Light sources. The two most diffused sources of light in the farm are the incandescent lamp and the fluorescent lamp. Incandescent lamps give a light more similar to sunlight, because it contains all wavelenghts. Its intensivity is however differently distributed, what causes a rather high thermic effect which, in the long run has an unfavourable influence on the development in height of plants. Incandescent lamps are utilised to raise flowers in dark rooms and to produce photoperiodism effects.

Fluorescent lamps give a continuous light spectrum, of different colour depending on the fluorescent layer applied on the internal surface of the tube. Its extended shape allows a more regular distribution of light in green-houses. A fluorescent lamp produces about three times more light per watt than does the incandescent lamp, and lasts three times longer. A fluorescent lamp emits less heat, also because its spectrum comprises a lesser proportion of infrared waves.

High pressure mercury vapor lamps are best suited where higher lighting levels are needed, but the intensive heat radiation makes their use often unfavourable.

High pressure mercury vapor lamps with fluorescent bulb give a high intensity of light which favours photosynthesis and the effect of long daylight. These lamps have recently been put on the market.

Good artificial lighting has to satisfy two essentials: quality, that is to say light. free from glare, will diffused and well distributed, and quantity, that is to say light intensity proper to ease visual tasks according to I. E. S. recommended illumination levels.

Ultraviolet radiations. Ultraviolet rays, not visible, have for certain wavelenghts the propriety of killing bacteria and for other the propriety of transforming in ozone a quota of atmospheric oxigen; they also stimulate the production of vitamin D. These radiations can be produced artificially duced rates during off -peak hours, while heat can be stored in water or other materials and utilized during following hours.

Rotating power. Thanks to the electricity, in the farm too man can free himself from hard labour and put at work a motor: an electric motor of 1/4 HP can successfully replace a man operating an equipment by hand, at the same speed.

Assuming that a 1/4 HP motor uses in 1 hour 0.20 kWh which, at a price of 3 cents per unit, costs 0.75 cents; allowing a 10% increase for fixed charges, the total cost is but a fraction of the minimum hourly wages for rural workers. It is therefore easily understandable that in most countries agricultural machines are driven each one by a single motor, if not by two or more motors.

When an electric current is circulated in the windings of the stator it creates a rotating magnetic field which induces the rotor shaft to turn and to drive the operating machine, either directly coupled or through gears or pulleys.

Compared to other kind of motive power, the electric motor is exceptionally well suited for farm jobs: it has low initial and operating costs, it is safe and easy to operate, little affected by external conditions, capable of withstanding temporary overloads and the abuse of its surroundings as dirt, grease, water and fumes, and of being run by automatic and remote control.

Types of motors. To give an adequate performance a motor must be able to start the load, that is to begin rotation from standstill and to accelerate up to and maintain the running speed, to drive the load properly.

If the equipment is easy to start as a fan or a centrifugal pump, the single-phase split-phase motor is the best adapted, but for machines which must be started with a part of their operating load attached, that is hard to start, as an air compressor or the vacuum pump of a milking machine, or a feed grinder, the capacitor-start induction motor and the three-phase induction (squirrel cage) motor are applied, depending on the size.

The capacitor-start induction motor is used to drive loads which do not require a motor larger than 1 HP. For larger loads up to 7 HP such as ensilage cutters, conveyors, mixers, etc., the best suited is the three-phase induction motor which is the most rugged, reliable and convenient type of motor., Its efficiency is good, the running speed is constant and in general it gives a long and satisfactory service. The direction of rotation is reversible by interchanging any two input line connections.

Unfortunately the three phase supply is not yet available in all rural zones. Often only two wires lines are installed for serving newly acquired users who are still unacquainted with the many electrical appliances.

Two wire lines of limited size din supply lighting and heating appliances and single-phase motors of small capacity, up to few kW.

The three phase converters designed to supply a three phase motor from a single-phase source are not yet in a form suitable for use by an untrained operator. Therefore the squirrel-cage three-phase motor is not as widely used on farms as it should be advisable, to extend the electrification of farm jobs and speed up the development of agricultural production on an industrial basis.

Another limitation in the utilisation of an electric motor is due to the fact that it requires a connection to a fixed socket, even though by means of an insulated cable, many meters long. For that reason, the electric motors are precluded from field services which constitute a large part of farm activities.

So electric motors are most applied in the farm to fixed machinery, or else to run movable apparatus, equipped with and independent source of electricity as storage batteries, to be charged by night, as fork-lift trucks and tractor-trailers, which offer an efficient way of handling rapidly cases and containers of products to be worked, stored and dispatched.

Electric motort's applications. Together with lighting and heating appliances, the first stage of farm electrification includes the small motor which drives the pump to get water, indispensable for domestic uses, for feeding livestock and for cleaning services in the farm.

The second stage sees the electric motor being applied to the conventional rural equipment which from thousand years were operated (and still are where electricity is not supplied) by the forces of men, or animals: feed grinders and mixers, barrel churns, corn sheller, elevators and hoists, saws and lathes in the shop, etc.

In the successive stage of electrification new machines and farm equipment are designed to utilize the rotating power of electric motors to mechanize other farm operations:

- water pumping into reservoirs or pressure tanks and distributing for irrigation purposes;
-forced air ventilation in the poultry, dairy and crop-conditioning to remove warm moist air which deteriorates products;
- seed cleaners and graders;
- vacuum pumps; dehorners, gutter cleaners clippers;
- vacuum-operated clippers, run from the milking machine vacuum line;
- power-driven brushes for grooming cattle and horses.

A list of appliances is given in appendix with the approximate power required, just to give an idea of the versatility of electric power uses and of framers opportunities to exercise his higher capacities in coordinating and controlling the work done by machines.

Electric controls. Here it may be emphasized that the success of electrification in the farm as in industry is due to the many various possibilities of measuring, regulating and controlling the performance of electric appliances and motors by means of a number of devices, which can be combined in various ways to fix the sequence of different operations, according to a predetermined programme, especially studied to get the most convenient results.

The first of all electrical control is the switch which starts and stops the flow of electricity.

A switch having contacts operated by magnetism is a relay. Its main advantage is that the switch and wires which control the current flow to the relay coil do not conduct the current to the appliance, therefore it can be placed very far from the appliance and operated by means of pushbottons to control driers, hoists, portable motors and vacuum pumps.

The manual-motor-starting switch to control a motor has in addition a built-in overload device that automatically trips the motor, by the melting of a solder, if an excessive current should flow to the motor.

For large size motors or heating or lighting loads the magnetic starting switch incorporates into one complete unit the principles of the relay coil, the overload heater strips and the pushbutton control.

Motors larger than 7 HP are usually not directly connected across the line, but through reduced-voltage starters, which apply the full voltage only after the motor has gained speed enough.

Solenoid valves operated by electricity are extensively used to control the flow of water, oil or gas, either manually or automatically.

Automatic controls are multiplying their services in farm operations to exempt the farmer from overlooking the development of a process and to let him free to attend other tasks.

Thermostats are switches whose contacts must open and close automatically in response to changes in temperature. Their contacts are operated by the action of a bellow or the expansion of a gas or the bending of a bimetallic strip. The selection of the proper type does account for the desired temperature range and the allowable variations in temperature.

Thermostats are the most widely used type of automatic control in hot-water systems, hot-beds, electric brooders, incubator, refrigeration systems, crop driers ventilating-fan, electric stock waterers, etc.

The time at which an electrical appliance must be energized or disconnected can be automatically controlled by a clock, that operates switch contacts at definite time intervals.

Other devices designed for automatic control are the float switch that operates according to some predetermined liquid level the pressure switch whose contacts are operated according to variations in liquid or gas pressure, and the limit switch which is operated mechanically by the movement of some other piece of material or machine to limit the travel of a rope chain or carriage.

The control of mechanized processes in an automated sequence are now further fostered by electronic regulating devices which combine power with versatility and compactness and can be integrated into existing systems. Their types and use are multiplying as:

- static -switching control systems,
- variable speed drive motors,
- photo-electric cells and sensors,
- timers and dimmers,
- microswitches and subminiature valves, etc.,

which can be variously combined to coordinate the program of operations.

Here we can try to describe briefly some types of automated equipment for the farm.

Cooling. Refrigeration for cooling farm products is one of the common automated applications of electricity. A refrigerant element is indefinitely subjected to a cycle of expansion, evaporation, compression and condensation to release outside the heat absorbed inside. The operation is controlled by a thermostat which starts the motor and opens a solenoid valve, and is protected by pressure switches and other devices, so to maintain the needed temperature level inside storage rooms, where eggs, milk, vegetables and fruits have to be preserved from deterioration. The power required is about 1 HP for refrigeration of 1 ton of material in chill rooms.

Preparation of food for livestock. The cost of feeding livestock can be appreciably reduced by an automatic hammer mill, which is composed of: a small hopper for controlling the flow of grain, a trap excluding stones or metal objects, an electric motor and the mill with incorporated beaters or hammers. The meal is then reduced into an homogeneous mixture, together with other ingredients, by a mixer. Combined milling and mixing outfits, comprising an automatic hammer and a vertical mixer provide an attractive packaged unit. To reduce wastes, pelleting machines can be incorporated in a combined layout with an automatic hammer mill and mixer.

Also for food preparation pressure type boilers are available, for cooking swill containing meat or bones, which can be arranged for automatic control, by means of pressure switch.

Milk production. Milking by vacuum pump has gained wide acceptance even in not large farms as the only means of saving costly labour by an electric motor which consumes 30 kWh per cow per year to drive the vacuum pump. Machine milking includes a suction line running along the cowshed and a bucket, or a pipeline system to transfer the milk into a bulk storage tank or churn. Here the milk can be rapidly cooled at below 4 °C to prevent the growth of bacteria by circulating ice-cold water, cooled to below 4 °C between each milking. Chilled water units, capable of cooling 250 litres of milk per day can be runned by 1/2 HP motor.

For large farms there are completely automatic endless belt filler and capper, and for the washing of milk bottles there are twin brush machines capable of handling thousand bottles.

The farm of the future. In Ohio Edison Co's idea, in a 20 years from now the complete electrification of the farm will succeed in developing an agricultural industry. The farmer as manager will operate a battery of computers and automated equipment, and supervise any operations center with TV cameras. Cattle and crops will be raised in high-rise buildings, with controlled atmosphere, to make-up for the decreasing availability of good farming land, and feed supplements will be grown in the growth chamber. Electric energy will operate environmental control equipment, producing, distributing and controlling heat, cold, fresh air and humidity. Electricity will pump water to storage areas on top of buildings and run thermostats and humidistats on every floor.

High-rise growth buildings may eliminate crop damage due to inclement weather.

> Commenting the farm of the future idea, it has been said that even if the productivity per man has increased five times in the last 20 years, that rate is not good enough to keep the ever increasing demands. In fact it is estimated that nearly 50% of U. S. farms feed more than 90% of people.

Farms of the future perhaps will be devoted to one specialized activity: plant growth, beef-cattle, dairy-cattle swine or poultry.

Extending farm electrification. The actual development of electrification is still far contrasting with those future plans. In 1965 28% of world population used 88% of annual energy consumption, and 57% of the people used less than 6% of the total, while two-thirds of world population are dependent on agriculture for their livelihood as peasant farmers living at bare subsistence level, and unaided by any form of mechanization.

But also in countries well advanced on the way of industrialisation, as Italy, where the degree of electrification is high (97.6%) there are still 340,000 rural houses not supplied with electricity, where agricultural work is carried on in a more or less primitive way, while in other areas of Italy agriculture is already fully mechanized.

As industry proceeds toward mechanisation and automation its profits increase and workers get more wages. This affects also agriculture which can survive and compete with industry only extending mechanisation and introducing automation to a comparable extent. So there are less farmers, but they can be far more productive than in the past and get a more rewarding profit from their work.

Rural electrification is not just a matter of stringing lines from existing systems to farms. In it fullest value it means the most complete use of electricity to increase agricultural productivity for providing the food required by the whole population.

The problem of complete electrification implies two aspects equally important: the financial charges corresponding to the investment costs of adequate distribution installations and an informative action among farmers to make them acquainted with the many ways of putting electricity at work.

At these objectives are aiming the efforts of electric utilities.

APPENDIX

ELECTRIC APPLIANCES IN THE FARM

	Capacity kW		Capacity kW
Lighting lamps 5-40 ft-c; per sq. m	10- 30	Ultraviolet per 100 chicks	0.5
Infrared lamps	0.1.0.2	Incubator " " "	0.3-0.4
Heating "	0.1.1	Brooder " " "	0.15-0.2.
Water pump	0.2-5	Egg candler	0.05-0.1
Water heater	1.2 -3	Egg washer and grader	0.2-4
Refrigerators	0.2-5	Egg cooler	0.2-0.3
Cold storage freezers	0.3-1		
Portable heater	0.5.3	Seed cleaner and sacker	0.5-2
Water tank deicer	1 - 3	Corn popper	0.4-0.6
Lawn mower	0.2-0.5	Corn, ear crushing	0.5-5
Insect electrocutors	0.05-0.2	Ear sheller	0.2.2
Sump pump	0.2-1	Grain cleaner	0.2.-0.5
Burglar, alarm	0.01-0.06	Grain dryer	5 – 15
		Crop conditioners	2 - 5
Milking vacuum pump	0.2-1	Ventilating fans	0.5-10
Milk cooler	0.2-1	Hay drying	2 – 5
Churner	0.1-0.2	Hay curing	3 -7
Cream separator	0.2-0.3	Portable hay baling	5
Utensil sterilizator	1 – 6	Ensilage cutter	5 –7
Washer (pipeline system)	0.1-0.2	Ensilage ,blower	3 - 5
Pail heater	0.1-0.2		
Gutter cleaner	0.5-1	Conveyors	0.2-1
Manure pump	0.5-2	Elevators	1.5
Bam ventilator	0.2-0.5	Hoists	5 –10
		Fork-lift truck	2 .5
Groomer	0.05-0.1		
Clippers	0.05-0.2	Fruit graders	0.2-3
Dehomers	0.1-0.3	Fruit washers	0.2-1
Sheep shearing	0.1-0.2	Waxer	0.1
Debeaker	0.2-0.5	Tiers and baggers	0.2-0.5
Feed grinder	0.5.2	Hot benches and frames per F cu. m	0.1-0.2
Feed mixer	2 - 5	Hotbeds per sq. m	0.05-0.2
Food boiler	2 - 5	Soil sterilizer " " "	0.3-0.5
Crimper-cracker	0.5-1.5		
Hammer mill	0.5-2	Sprayer	0.2-0.5
Automatic feeder	0.2-0.5	Trouble lamp	0.1-0.5
Water cooler or warmer	0.1-5	Battery charger	0.5-1
Electric fences	0.007-0.01	Soldering iron	0.01-0.5
		Tool grinder	0.2-0.5
Pig brooding	0.1.0.3	Circular saw	0.2-0.5
Germicidal lamps per 100 sq. m	0.3	Portable air compressor	0.5-1
		Concrete mixer	0.2-2

Note - Given the non-contemporaneity of farm appliances utilization, the total actual load equals 0.2.0.3 times the total capacity of all appliances installed in a farm.

IRRIGATION AND THE HIGH DAM IN U.A.R.

By **Mrs. A.El-Hefny**, B.Sc. Chem. Eng., M.Sc. Manag[t] Eng.

Mrs. A. El-Hefny is the head or productivity measurement section at the Productivity and Vocational Training Department or the Ministry of Industry in U.A.R. In 1950 she obtained her B.Sc. in Chemical Engineering at the University of Cairo. From 1951-1954 she studied social and Economic Sciences at the University of Geneva, Switzerland. In 1962 she obtained her M.Sc. in Management Engineering at the Rensselaer Polytechnic Institute, Troy N.Y., U.S.A. She started her engineering carrier in 1950 as production engineer at the Cairo Gasworks and joined the Productivity Department since 1959.

Summary Egypt's agriculture relies on the Nile, and depends mainly on irrigation for the cultivation of land. The paper gives a brief description of the development of methods of irrigation in U.A.R., showing the importance of the High Dam for its agricultural expansion. It contains a short description of the High Dam structure and the plan of execution of the project. Further the benefits of the dam for agriculture are listed, followed by some details of the most important ones: the conversion of basin irrigation to perennial irrigation and the utilization of underground water with their effect on cropping patterns.

IRRIGATION AND THE HIGH DAM IN U.A.R.

By **Mrs. A. El-Hefny**

Historical Background "Egypt is the gift of the Nile" states the famous saying of Herodotus. The Nile has from the very ancient days irrigated and fertilized Egypt's soil; served as its principal means of communication therefore the main effort of the Egyptians has been and will always be directed towards the fullest possible utilization of the life-giving waters of their river.

The Nile has its seasonal flood between July and December, with a peak in September. Cultivation was therefore first practiced in the Nile valley, and crops were grown on the moist soil after the recession of the flood waters. Later, in order to take the fullest possible advantage of the Nile water and alluvium, great banks of earth were raised, transversal to the river, dividing the land into basins. The banks served to retain the water a little longer during the flood and the basins were further irrigated by canals which brought them water from a slightly higher level upstream.

Since the nineteenth century, irrigation works are being undertaken, to increase the land under cultivation and replace basin irrigation by perennial irrigation and thus produce valuable crops that require summer water. Dams were constructed to store water, barrages to raise the water level, drains and pumps were installed for carrying off the water, and dykes for protecting the fields against the summer flood.

These dams and barrages are supplemented by an elaborate network of irrigation canals, most of which are navigable. Fields are watered either by free flow or during low flood by mechanical means such as pumps, "saqias", "shadufs" or Archimedes screw.

Underground water is also being made use of, and artesian wells are dug for irrigation purposes.

Necessity of the, High Dam The need for the project arises from the fact that the flow of the River Nile, like that of many other rivers, is fickle and unsteady, being governed by intricate climatic conditions, as yet uncontrolled by man. During a high flood, the discharge at Aswan may be as much as 1,200 million cu.m. /day and 1n a low flood it may not reach 450 million cu.m. /day.

The maximum total annual discharge may be as high as 150 billion cu.m. and as low as 40 billion cu.m. The average total annual supply during the last recorded 60 years, is about 84 billion cu.m. Considering that our present requirements of irrigation water for the existing cultivations is 52 billion cu.m. annually; that means an average of about 32 billion cu.m. are being thrown into the Mediterranean every year.

Therefore to avoid the extreme fluctuations of draught and flood, and to obtain the maximum benefits from the rivers potential resources, it was found necessary to devise measures for regulating the flow and storing all surplus water, which now runs to waste into the sea.

However, the problem of controlling the flow cannot be adequately solved by annual storage systems like the existing Aswan Dam, because the utility of such reservoirs is restricted to retaining part of the water at a certain stage of the falling river, when it is comparatively clear of silt, so as to use it in the same year to supplement the natural flow, when the river sub sides. In some low years, such reservoirs cannot be filled and the natural supply of the river in the following low season may fall below normal, with the result that the present irrigation requirements cannot be guaranteed and any further development of irrigation would run the risk of disaster in low years.

It was therefore decided that the only solution for the problem is the construction of a storage reservoir, which could deal with the whole volume of the river, and store all surplus water from one year to another. For this a very large storage capacity is required and further capacity is needed to allow for the accumulation of silt and to provide flood protection.

Hence came the idea of building a high dam on the main Nile at 1 kilometres upstream the existing Aswan Dam, for the development and utilisation of the water resources of to the best advantage.

Brief Description of the Project The project comprises the construction of a rockfill dam across the Nile, 7 kms south of the present Aswan Dam. The dam will have a total length of 3,600 m of which 520 m are through the present channel. It will be 111 m high above the Nile bed, 980 m wide at its bottom and 40 m wide at its top. Its body is composed of rockfill, sand and clay. It has an impervious core, a grout curtain extending 180 m under the core to meet the bed rock, and a horizontal upstream impervious blanket. This design was chosen as the best to suit the requirements for its safety, its dynamic stability as well as the economical use of the building materials in the vicinity.

Water will be diverted to flow through a new water passage, 1950 m long composed of two open canals interconnected with six main tunnels driven through the virgin rock under the right wing of the dam. The tunnels are equipped with control and service gates. Each tunnel has two outlet branches feading 12 turbines, each having a capacity of 175,000 kw.

The artificial lake, "Lake Nasser", formed by the dam will be one of the largest in the world, having a length of 500 kms and an average width of 10 kms.

There will be a spillway in the left wing of the dam to overflow the water which exceeds the maximum allowable level of storage.

The total reservoir capacity will be 157 billion cu.m. of which 30 billion cu.m. are allowed for the accumulation of silt over some 500 years, 37 billion cu.m. for protection against high floods, 10 billion cu.m. to account for seepage and evaporation losses. The rest of the capacity will be enough for the live storage necessary to ensure an annual net supply of 74 billion cu.m. for the UAR and the Sudan

<u>Execution of the Project</u> The execution of the project was inaugurated on the 9th of January 1960, when President Gamal Abdel Nasser blasted the first charge of explosives for the excavation of the diversion canal. Inspite of the difficulties encountered during the execution, and the extra volumes of works added especially in the items of excavation and concreting, due to more difficult natural conditions than anticipated, it was possible to finish the first stage of the project in time and the Nile was diverted to its new passage on the 14th of May 1964, as scheduled. Due to this an additional quantity of approximately 4,000 million cubic metres was stored in 1964, that was utilized in the summer crops of 1965.

The construction of the dam is proceeding gradually and the additional storage capacity increased to 6 billion cu.m. in the year 1965 and to8 billion in the year 1966. In 1967 it will be possible to store the flood water completely, if the flood will not exceed its mean value. The dam construction will be completely finished by 1968.

Three power units will be ready for operation by the end of 1967 together with one line of the two 500 kw high voltage transmission lines to Cairo. The whole transmission and distribution system will be completed by the end of 1968. The number of operating units will increase gradually at the rate of 3 units per year until the final completion of the power station in 1970

All the work of the project runs according to preplanned programmes. A close system of follow-up of the work and reporting is adopted, according to which the necessary measures are taken for immediate rectification of deviations and solving the working problems.

Economic Benefits of the Project The Aswan High Dam is considered the backbone of the national economic programme for the years 1961 - 1970.

The benefits gained will be:

1 Expanding the cultivated area by 1.3 million feddans to be newly reclamed (one Feddan – 4.200 sq.m.)
2 Conversion of 700.000 feddans from the basin irrigation system to perennial irrigation, thus multiplying their crop area.
3. Ensuring the water requirements for irrigation of the present and newly reclaimed lands, even in the years of low river supply, thus increasing their yield.
4. Protecting the country against high floods.
5. Increasing the productivity of land by improving its drainage through lowering the ground water- table.
6. Expansion in the rice crop for export.
7. Improving the navigation conditions along the Nile.
8. Estimated annual electric energy generated amounts to 10 billion K.W.M. to be used for industrial and agricultural development.

Besides, it will increase the amount of energy produced by the existing Aswan Power Plant.

The direct annual increase in the national income of the UAR due to the construction of the High Dam is estimated at 234 million pounds.

As for the Sudan, the High Dam will avail an extra quantity of irrigation water amounting to 14.5 billion cu.m. annually. This extra water will be used for agricultural expansion by three fold the present cultivated area

The conversion of basin Irrigation to Perennial Irrigation system the basin irrigation system, which was applied in the UAR, was based on the water flooding of agricultural areas, during the yearly river rise in flood period (August-September-October). The mean depth of flooded water was 1.om; and flooding was feasible through basin canals deriving their waters from the Nile by means of head regulators. When the river goes down, the canal head regulators are closed, and basin waters drain, through escape regulators, to the Nile, following its falling level. The filling of basin usually takes place every year during the month of September. The drainage process ends during the month of November of the same year. Once this is completed, the land becomes freshly ready for cultivation. Only one winter crop could be produced by the utilization of the stored ground surface water. Harvesting takes place annually in the month of April, after which date the land remains uncultivated during the whole summer season, waiting for the next flood.

The total area of basin land amount to 913.000 feddan, which are annually flooded by the Nile water.

According to the High Dam execution programme, its first stage was terminated in October 1964, and out of said basin area 538.000 feddan were converted into the perennial system, accordingly. The remaining area of basin land will be completely converted into the perennial system by June 1968. Drainage projects, covering the whole basin area, will be executed during the 2nd five years plan, from July 1965 to June 1970.

With the spread of perennial irrigation, more drainage will be needed to avoid the accumulation of salts in the soil, thus diminishing its fertility. Drainage is also very important to protect the long cotton roots from choking if the underground water-table were left to rise. Although there exist main drains everywhere, yet they will need deepening and require more pumps .To overcome the high cost of the land the field / drains occupy, they are now being extensively replaced by pipe drains. This saves a big percentage of cultivatable land, reduces salinity, economises water and requires less upkeep.

The intended irrigation projects include the completion of the main canals under construction and the erection of the distribution and branch canals as well as the necessary installations and water works, such as regulators, bridges, syphons, etc.

As regards drainage projects, these include the construction of a complete drainage network, covering the whole basin area, as well as relative water works, such as bridges regulators, syphons etc.

The Agricultural Benefits of Basin Land Conversion Project

a) Due to the fact that the release times of Basin waters fall prior to those of cotton gathering, farmers used to remove the unreaped cotton trees, throw them over the roads and expose them to the sun rays to get them full matured consequently, an estimated loss of at least 1 kantar / feddan averages the cotton crop. This is besides the defection of the cotton quality. Yet, this loss in the cotton crop will certainly disappear immediately after the generalization of the perennial irrigation system.

b) The basin drainage times usually fall later than those suitable for winter cultivation, such as wheat, beans and berseem (egyptian clover); thus, resulting in the retardation of planting such crops, consequently, decrease in their yield was estimated to be 10-15%, such a decrease will be avoided after the application of the perennial irrigation system.

c) The perennial irrigation system will help to supply winter cultivations with the appropriate irrigation turns, with regard to their volumes and times, instead of having them dependant on the stored soil waters. This will produce a better crop, and realize an increase of about 10-15%.

d) To have a better use of the present times of filling, draining and drying basin land, through the cultivation of a new "Nil" crop, such as maize which could be planted in wheat-growing areas, following the harvesting process.
The land, which could be utilized, is estimated at 35% of the total basin area i.e. nearly 35.000 feddan.

e) The perennial irrigation system provides a better chance for the selection and cultivation of profitable crops, such as horticultural and vegetable crops.

f) The basin lands, after their conversion into the perennial irrigation system, will be utilized in growing sugar-cane, particularly in Kena and the southern part of the Souhag Governorates, where this plantation could be renewed. A new area of about 125.000 feddan is scheduled to grow sugar-cane, with a view to cope with the needs of the sugar factories included in the industrialization programme.

On the whole, as a result of the change-over from basin to perennial irrigation, the crop area will rise since a steady water-supply would be relied on.

<u>Projects of Underground water-storage for Irrigators</u> In lower Egypt, from Cairo through the Southern part of the Delta, there is an enormous reservoir of fresh underground water, equal in volume to several years flow of the Nile .Some part of this great underground store could be used for irrigation to supplement the water coming from Lake Nasser. This will allow greater flexibility in the timing of water use, facilitate the maintenance of the water-table at the proper level, and make it possible to irrigate lands above the level of canal commands. In the Nile Valley and the Delta, it might have the further advantage of-making it possible to maximize the use of the water for both agriculture and electric power. Water released through the turbines in the winter time might be stored underground and pumped out during the summer season when it is needed for agriculture. This would require the use of electric power for pumping, and in addition would involve capital costs for pumps and wells. .

Other possibilities for downstream storage exist such as in wadi Rayan and the Quarun Lake. Other solutions to the problem of storing water downstream, is the construction of a series of dams between Aswan and Cairo. These dams would be used to store all of the flood run-off and have the effect of keeping the Nile River at flood stage during all twelve months of the year.

Other Projects for Land Reclamation U.A.R. government has launched other schemes for land reclamation and the utilization of the deserts. In these, artificial rainfalls, underground water, syphons across canals, harnessing solar energy and other methods are coped with.

The improvement of agricultural techniques taking place now will help raise the productivity of already cultivatable land. The intensification of mechanization will improve methods of ploughing and weed control, allow greater timeliness and regularity of operations, as well as release land which would otherwise be put under fodder crops for draught animals, and speedier reclamation of uncultivated land.

Importance is also being given to the future increased need of fertilizers, since perennial irrigation involves constant use of the land and keeps off the alluvium-bearing flood, which causes the rapid exhaustion of the soil.

Conclusion A third of the total flow of the river runs to the sea during the flood season without producing much benefit for the people of Egypt. The flood waters undoubtedly have some utility, in flushing salt out of the soil, but their immediate usefulness in terms of crop production is small. The High Dam will help tp put every drop of water to a highly beneficial use.

Various means are being considered to increase the economic returns from irrigation water. In the past cropping patterns and crop rotations in Egypt have been based on the need to obtain maximum production from each acre of cultivated land, using the water naturally available during each season. Now, when all the water can be made available on demand at any time of the year, it should be possible to adjust cropping patterns, rotations, and times of planting in such a way as to maximize economic productivity per unit volume of water.

The Application of Technology - The Use of Power in Agriculture

DISCUSSION

John R. Harding (U.K.) (written contribution)

'Electricity for world agriculture' was the title of an I.E.E. Paper by Golding and Finn-Kelsey of the E.R.A. in 1962 (1). This was mainly concerned with the scope for public supply as, I expect, is the paper to be presented at this Conference, though it did mention a paper by Kirloskar and Paraki (2) on small Diesel plants. - In contributing to the discussion (3) I referred to small steam plants which, by using organic wastes as fuel, could 'live on the land' for irrigation and allied purposes. At least two types of such plants have been produced in the past (4,5), with no commercial development, mainly, I suggest, because, almost by definition, those in most need can least afford them. Harold Wilson agreed with me (6) (at least before-he was Prime Minister), though his Ministry of Overseas Development has not, so far as I am aware, in spite of its name, done anything to carry out his ideas. The same remarks apply to the United Nations F.A.O.

I would only make two references to the technical problems before turning to my reason for seeking to contribute to your deliberations. Obviously these are the need for such plants to be as nearly foolproof - and lack-of-maintenance-proof - as possible. Good progress has been made and almost the worst problem, scale formation, is no longer serious due to the availability of magnetic water conditioners which have the effect of preventing it and allowing the products -to be washed down as sediment. A new development is in hand in Oxford University Engineering Laboratories which eliminates the water problem altogether by employing a high molecular weight working fluid to operate on the Rankine cycle in a sealed unit with an external heat source, rather like a domestic refrigerator unit in reverse, the output being in the form of D.C. for pumping or other purposes (7).

My object is to suggest that the Women's Engineering Society, could make a contribution to this particular problem by using the opportunity afforded by this International Conference of engineers to form a Standing Committee to serve as a nucleus for its study by all interested, both here and in the other countries represented. I see from Mary Stott's article in the Guardian that your President is a member of the Council of Engineering Institutions, One of the objects of which is to act on behalf of its constituent Institutions in expressing views for the profession as a whole. Surely this is a subject, wider than the field of anyone Institution, of great human urgency where the need is for a period of study and experiment, leading in due course to the publication of a Code of Practice available to all.

Finally, before practical results could be seen in the field, it would be necessary for those administering aid to the countries concerned - and this applies to any form of power in the countryside - to establish agencies for hiring out and servicing such plants and associated equipment and, in due course, for securing a contribution from the users either in cash or in kind. Clearly, this could not be considered until the plants have been proved in this service and are available in quantity at a price based on quantity production.

The tragedy, which this conference is about, comes down, in the last analysis, to the fact that where fuel is available for the collecting, mechanical or electric power is cheaper, not more expensive than the overall cost of the bullock power used today. The fact that its use can only commence by hire was proved in this country a century ago, and after a few generations the increased productivity enabled every farmer to buy his own tractor.

I should perhaps add that my own interest is that of a retired engineer having a little time to devote to these problems. My only personal contribution has been to build, by way of a hobby, a self-propelled steam plant which, with only minor changes, could get anywhere accessible to wheeled traffic, with some water supplies, and deliver about 6 H.P. when it got there (8).

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The App1ication of Technology - Increasing Food Production

4 July 1967

In the Chair **Dorothy U. Mizoguchi (Japan)**

The use of beef and dairy catt1e to increase the world's food supply

Rowena O. Chester (USA)
(presented by Emma C. Barth (USA))

Man-made lakes as a source of freshwater fish production in Africa

Letitia E. Obeng (Ghana)

The role of biological sciences in enhancing food production

K. Chandrasekhar (India)

Technology trends in food production in the Philippines

Magdalena A1de Temp1a (Philippines)
(presented by Daphne F. Jackson (UK))

Discussion

Dorothy utako Mizoguchi, B.Pharm.

Graduated from Tokyo Women's College of Pharmacy in 1942. Research chemist, Itsuu Laboratory (1942-45), and Laboratory of Pharmaceutical Chemistry, Institute of Pharmaceutical Sciences, Tokyo University (1945-50). Technical editor, Journal of the Pharmaceutical Society of Japan (in Japanese) and the Chemical & Pharmaceutical Bulletin (in foreign language). Joined the Cancer Institute, Tokyo, in 1961 to set up Cancer Chemotherapy Information Centre, and became technical editor of GANN, the Japanese journal of cancer research. Lecturer, Tokyo College of Pharmacy. Certified consultant for documentation in science and technology. Many papers and books on technical writing in English, editing and publishing of scientific journals, etc.

THE USE OF BEEF AND DAIRY CATTLE TO INCREASE THE WORLD'S FOOD SUPPLY

By **R. O. Chester**, B. Engr. Physics, Ph.D.

Dr. R. O. Chester obtained the Bachelor's degree in Engineering Physics at Cornell University and received the Ph. D. for work on radiation damage to semiconductors at the University of Tennessee. In 1958 she joined Oak Ridge National Laboratory and is working on solid state radiation detectors. In 1960, the study of agriculture became an avocation. She raises beef cattle and is a member of the American Angus Association and the Production Registry International.

Summary Beef and dairy cattle can make a significant contribution to the world's food supply. They can produce high quality protein from cellulose and nonprotein nitrogen compounds. Furthermore beef and dairy cattle can be raised on land that is unusable for other crops. Cattle raising in East Africa, Israel, and Costa Rica are discussed.

There is a tendency to dismiss the contribution of animal agriculture to the world's future food supply. Animals introduce an apparent inefficiency in the food production chain from soil to man because only a fraction of animal feed is converted to human food. However, animals, such as ruminants, use feed that is low quality protein or nonprotein material, usually inedible by man, converting it to a high quality protein for human nutrition. Furthermore, this high quality protein food can be produced by ruminants which forage on land uneconomical for the production of human food.

This paper discusses the possibility and desirability of increasing the productivity of cattle, one type of ruminant. A comparison is made between plants and animals as protein sources. The desirability of increasing the protein supply from ruminant animals in general and cattle in particular is discussed. The cattle industry in several developing countries is evaluated and suggestions are made about the future of animal agriculture.

Animal vs. Plant Proteins Humans require a minimal diet of proteins from plant or animal sources to produce protein within the body. The joint FAO / WHO Expert Group on Protein Requirements in October 1963 (ref. 1) recommended a basis for assessing human protein requirements. Average protein requirements estimated on this basis vary from 40 to 52 grams per capita per day. This variation is due to, in part, the age, sex, and body weight of the population, but principally to the biological quality of the available protein. All protein sources are not equally adequate to meet nutritional requirements. There is a difference in the quality, concentration, and availability of amino acids between animal protein and vegetable protein.

In general, animal protein sources more nearly meet the amino acid requirements of humans than do the usual vegetable protein sources, particularly cereal grain sources which provide a very large portion of the protein intake for people in many countries. This is because the concentrations of lysine and tryptophane, essential amino acids, are higher in animal protein sources, such as milk, meat, fish, and eggs, than in most vegetable and cereal protein sources. In addition to supplying amino acids and minerals, some animal proteins, such as meat and milk, are also a source of vitamins, particularly B-12, thiamine, niacin, pantothenic acid, and calcium.

Although the amino acid deficiencies of cereal proteins can be corrected by adding synthetic amino acids or plant products high in the necessary amino acids, there are practical problems. (1) Synthetic production often is not economical and the correct optical isomers are not always produced. (2) Bacterial cultures can produce large amounts of balanced protein with an inorganic source of nitrogen, but the product is not very palatable. Consumer preference and palatability are vital in any diet. It is significant that all better-off nations automatically change toward a diet with more animal products, fruit, and vegetables as prosperity increases (ref. 2) because a mixed diet including animal protein foods is preferred by most consumers. (3) Schemes to increase protein production by synthetic methods invariably require large amount of capital which is scarce in developing countries. An increase in cattle production can often be achieved with very little capital investment. (4) Plant sources of amino acids to correct deficiencies are not always available (ref. 3). When plant sources are available, processing the plant proteins makes a more concentrated and more balanced protein product, but the world's supply of protein is not increased by this method. (5) The average consumer or supplier of primarily cereal proteins must know which specific amino acids are deficient and the quantity of amino acids to be added without creating an imbalance in the product. In summary, animals are the preferred source of protein because of the nearly ideal amino acid content, good flavor, and smaller capital investment.

Increasing the Supply of Animal Proteins The question before us is whether these animal protein supplies can be increased in the countries which are now low in their supply and whether this is an economically possible or desirable thing to do.

My belief is that increased efficiencies in animal production are possible and will be rerealized primarily with the ruminants, beef and dairy cattle. Ruminants, such as antelope, bison, buffaloes, camel, deer, giraffes, goats, llamas, oxen, pronghorns, and sheep, were chosen as possible protein suppliers with increased efficiencies because they, less than other animals, eat food that could be eaten by humans.

Ruminants characteristically have a four-part stomach, the first of which is the rumen. The rumen does not possess animal enzymes but, rather, contains billions of bacteria and protozoa. These microorganisms digest the feed materials ingested by the animals and synthesize the B vitamins and the essential amino acids. Thus, the rumen is a low-cost fermentation plant for amino acid production. The ruminant derives its nutrients by absorbing the soluble products of the microbial fermentations or by digesting the microorganisms in the lower digestive tract. Using its unique rumen, the ruminant converts grass, other low protein cellulosic forages, and nonprotein nitrogen feeds into high-quality protein suitable for human consumption.

Cattle were chosen as possible protein suppliers because they, more than the other ruminants, are widely distributed in large herds throughout the world. The large but low-productivity cattle populations are a sizeable resource in many of the developing countries (ref. 4). There is also a large reservoir of very productive meat and milk varieties of cattle in developed countries which can be used to upgrade the low-productivity herds.

One of the fundamental goals in the advancement of any country is to determine the resources of a country and to develop these resources. Although tills paper discusses only cattle, the contribution of ruminant species other than cattle should not be underestimated. There is need for effective research programs to evaluate the potentials for production and genetic improvement potential as well as programs to develop effective means of achieving these potentials. For example the water buffalo in India has higher milk production than the indigenous cow and may have a greater potential as a dairy animal in that climate (ref. 5).

The Cattle Industry in Developing Countries There are two methods of cattle management. Either one alone or a combination of both can be used to develop cattle resources. The first method is to efficiently use indigenous cattle and natural range plants. The second method is to use the highest productivity cattle that can be obtained and to provide for them as much intensive feeding and protection from extremes of environment as necessary to achieve the productivity of which the animals are genetically capable.

The first management method should be used to set the cattle industry goals of a developing country. The use of cattle and plants well adapted to the environment minimizes the number of changes in the existing husbandry practices required to make cattle a profitable food source. A minimum number of changes means a greater likelihood of success in having the changes accepted by cattle owners. Success at this stage of cattle management will then support a gradual change to the, management concept of adapting the environment to fit the needs of the highest productivity cattle.

The problems of beef production in the developing countries of the world are sometimes similar but seldom identical to those of the developed countries. For this reason it is usually impossible to transpose techniques, equipment, housing or animals directly from the developed to the developing areas. Most of the highest productivity herds are in developed countries where management and climatic conditions support such animals. There is abundant evidence showing that the breeds of highest productivity will neither thrive nor reproduce to their full potential in an extreme climate such as the tropics without intensive management practices and protection from the climate. For example, in tropical East and Central Africa the average life of a nonindigenous bull is less than six months, and crossbreeding of indigenous with high-productivity cattle has not produced sustained beef yields. The best sustained beef yields in the tropics are from well-managed indigenous cattle (ref. 6).

Therefore it is necessary for the developing countries to undertake research programs to determine the capabilities of the native cattle and range plants under various management systems. Examples of excellent programs of this nature are those being carried out with the East African zebu cattle and the East African rangeland at the Mount Makulu Research Station, Chilanga, Zambia, Northern Rhodesia and at the Central Research Station, Mazabuka, Northern Rhodesia (refs. 6,7). The effects of two types of practices within the first management method on the live-weight gain and productivity of zebu cattle reared on native grass without supplementary feed were investigated in an especially noteworthy scientific manner. The customary herd management practice in this area maintains a nutritional level that fluctuates from "barely adequate" in rainy seasons to "gravely inadequate" in dry seasons. The research station management maintains a nutritional level that fluctuates; from "adequate" to "moderately inadequate." The primary changes in the customary herd management to produce research station management are (a) the cattle are permitted adequate grazing time instead of being kraaled during the night (and often much of the day), which resulted in only 4 to 11 hours per day available for grazing; and (b) the number of animals is kept small enough so that the carrying capacity of the natural forage is not exceeded during the dry season. This modified management practice produces up to 50% more beef from the native cattle and range. The Meat Research Unit, Animal Husbandry Division of the East African Agriculture and Forestry Research Organization, Muguga, Kenya, has examined the carcass composition of cattle managed in these two ways (ref. 8). One of the conclusions is that, if management practices are such that the more adequate nutritional level is maintained, the cattle can be in optimum condition for slaughter 6 months to 1 year sooner than the 3 to 4 year period for typically managed cattle. Usually the better managed animals weigh 15 to 20% more at slaughter age.Let me stress that this increase is obtained by good herd management in the natural environmental conditions. No attempt was made to shield the cattle from the environment, only native cattle were used, and no feed supplement was used until the final 3 months of fattening before slaughter.

The results of this research can now be used as a basis to change East African husbandry practices to increase beef production as well as to evaluate the performance of nonindigenous cattle and various management systems.

Not only should this first method of management, that is, the efficient use of indigenous cattle and range plants, be useful for developing countries, but as long as there is rangeland available that cannot be used economically for other purposes, this type of management will produce human food on otherwise improductive land.

The second management method of environmental alteration or compensation to allow the effective use of high-productivity cattle is a goal for the distant future for developing countries. Many areas of developed countries, could increase their beef production with greater use of this management method. Implementing an intensive management method is not a simple matter. Skilled personnel are required. Reliable and well developed feed supply and feed storage systems as well as processing and distribution facilities are a necessity. However, this management method provides the greater yield of beef per unit of feed. If the conditions for high-productivity beef production are maintained, then dairying as well as beef production becomes practical. In general, dairying is not economical in an environment where the feed supply fluctuates to less than adequate levels, because the production of milk is more sensitive to deficiencies of environment than any other economic animal function. Nutritional deficiencies which would merely show the growth rate of beef cattle may almost completely suppress milk production--not only for the period of the deficiency but for the balance of the lactation.

Israel is an example of a country where environmental modifications have been introduced so that nonindigenous high-productivity dairy cattle can produce at a level comparable to that in their country of origin. Although two-thirds of the 73,000 dairy cattle in Israel are crossbreeds of European and Damascus origin, one-third are pure strains of European high-productivity breeds, and they do very well. The optimum functioning of the high-producing dairy cattle under adverse environmental conditions may be attributed to :

strict disease control and prevention, a high level of nutrition and a full feed supply during all seasons, provision for a lower heat load on cows by stabling in open sheds throughout the year and sprinkling the cows with water to promote cooling from evaporation, selection for genetic heat tolerance from crossbred or purebred strains, and skilled husbandmen taking care of the, cattle.

Because the economy and natural conditions of Israel cannot support two separate breeding programs for milk and beef production, the dairy cattle are bred for both high milk and maximum beef yields. The bull calves are used for beef and the heifers become dairy cows (ref. 9). Dual-use cattle is a very realistic goal. In fact, many cattle bred primarily for high milk productivity have excellent beef qualities (refs. 10, 11).

Costa Rica is another example of a country with a tropical climate that has a profitable milk production (ref. 12). Both crossbred and purebred dairy strains of cattle are used, with higher production from the purebred strains. A system of economic incentives plus an educational campaign was used to encourage good husbandry and sanitation. Dairy plants pay a premium for milk according to the hygienic standard of the milk. The result has been a drop in milk rejection by the processing plants from 40% to less than 0.5%. The problems created by the great difference between the volumes of milk produced in the dry and rainy seasons were solved by paying the farmer a higher price year round for the same amount of milk as he produced during the dry season. The Costa Rican program is an excellent example of the power of economic incentives in bringing about sociological change.

Some developing countries are assisted by international agencies in increasing their dairy production. Kenya, for example, with UNICEF aid is building a milk processing plant at Mariakani and a milk spray-drying plant at Nahuru. Kenya’s dairy industry is rapidly developing and exports of milk and milk products go to neighboring Uganda and Tanganyika (1964) (ref. 13).A Dairy Training and Research Institute has been recently established on the campus of the Philippines College of Agriculture at Laguna. The institute is a joint project between the Philippine government and the United Nations Special Fund, and is one of the few places in the world where training in dairy science under humid tropical conditions can be obtained (ref. 14).

The second management method of environmental alteration to allow effective use of high productivity animals can be used to produce 5 to 10 times more beef than is now being produced in a number of countries. For example, it is not unusual for animals from herds of low productivity to require from 3.5 to 6 years to produce a beef animal weighing 650 to 800 lb and to require from 16 to 20 lb of feed to produce each pound of live-weight animal (ref. 15). In contrast, there is 1 year production of beef animals from high productivity herds weighing 1000 to 1100 lb using not more than 8 to 9 lb of feed to produce each pound of live-weight animal.

Decreasing the optimum slaughter age and increasing the size at slaughter age is an increase in utilization efficiency of food producing resources for two reasons. First, the shorter time required to reach slaughter weight means that less feed is used for maintaining weight while gaining additional pounds. Second, tests at Iowa State University (ref. 16) have shown that feed conversion efficiency increases with the rate of weight gain. About 30 lb of feed is saved in reaching slaughter size for each 0.1 lb per day faster gain. That is, the cattle gaining 4.0 lb per day will require 750 lb of feed less than the cattle gaining 1.5 lb per day to grow from 400-lb calves to 1050-lb slaughter animals furthermore, the 4.0-lb per day cattle will reach slaughter size in just over 5 months, while the slow gainer will require 14 months. In brief, the cattle that gain weight rapidly produce food faster and more efficiently than those that gain weight slowly.

In summary, to increase cattle production a developing country should institute research programs to determine which management practices optimize the performance of native cattle and range plants. As these practices are adopted, a gradual change to the more intensive management practices necessary to support the highest productivity cattle can be made.

The Future of Animal Agriculture Ruminant animals, such as cattle, may offer an opportunity to maintain an animal agriculture almost indefinitely. The studies of A.I. Virtanen, Nobel Laureate of Finland, indicate that it may be possible that the organisms in the rumen could synthesize all the essential proteins that a cow requires so that no proteins need be provided in the animal's diet (refs. 17,18,19). Virtanen was able to produce high quality animal protein food without feeding the animal any protein whatsoever. These experiments have far-reaching implications because they demonstrate that the ruminant is potentially capable of producing milk protein without competing for the available plant protein supply. During Virtanen' s experiments, the dairy cows, over extended periods of time, have maintained normal body functions, body weight, and reproduction. Milk production remained at about half the level of normal high producers, or about 4500 lb per year. The major point of interest here is that this milk is complete normal in every respect--its content of proteins, vitamins, and the other normal chemical constituents is the same as that of milk from animals fed conventiona1 diets containing protein.

Virtanen states: " If a cheap, sufficiently digestible carbohydrate feed can be prepared from straw, wood, sugar cane waste, or even synthetically, it may be possible to remove by milk production, protein deficiencies in vast areas inhabited by undernourished peoples" (ref. 19).

Industrially-produced urea is an example of a nonprotein nitrogen substance now used in cattle feed. In some parts of the United States, urea competes economically with some of the grain in cattle feed supplements (refs. 20,21). As urea production increases and human consumption of grain increases, urea should become much more attractive as a cattle feed supplement, and eventually may be the major nitrogen source in cattle feed. Cattle can be used to salvage some industrial wastes and by-products. An example of a useful salvage material containing nonprotein nitrogen is the 15 billion pounds of whey that is available each year as a by-product of the cheese industry in the United States. At present whey poses a serious disposal problem. A problem. A process is being developed at Pennsylvania State University for the production of a high-nitrogen cattle feed from this whey so that whey will be an economic asset, rather than a disposal problem (refs. 22, 23).

Research should now begin to test the potential of ruman microorganisms to support animals when they are receiving a variety of materials which have little or no food value to man or do not compete for land used for human food production. This research should also be extended to determine which chemical or microbiological processes might transform substances not now considered as feed materials into usable ingredients for the food ration of the ruminant. Now is the time for this type of information to be obtained so that when and if conditions require a modified animal agriculture, man will be able to maintain his plane of nutrition without drastic changes in his diet.

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MAN-MADE LAKES
AS A SOURCE OF FRESHWATER FISH PRODUCTION IN AFRICA

By **Letitia E. Obeng**, B.Sc., M.Sc., Ph. D.

Dr. Letitia E. Obeng graduated with an honours degree in Zoology from the University of Birmingham, United Kingdom, in 1952. While lecturing at the College of Science and Technology (now University of Science and Technology, Ghana) she worked on helminth parasites of small rodents and especially on the genus Inermicapsifer and was awarded an M.Sc. degree by the University of Birmingham. At the Liverpool School of Tropical Medicine she studied aspects of freshwater biology and was awarded a Ph.D. for work done on the Simuliidae of North Wales. Simulium damnosum which breeds in streams in Ghana is an intermediate host of human onchocerciasis. In 1965 she was appointed as Director to set up within the Ghana Academy of Sciences, a new hydrobiological research institute to study the inland water system of Ghana which includes the newly created three thousand square mile Volta Lake.

Summary The construction of dams is becoming increasingly important in the economy of some developing countries. Although primarily dam construction projects are intended for hydro-electric power production, they have come to be regarded as a means of establishing freshwater fisheries to provide protein food for local consumption. The provision of a large body of water for fisheries is only a first step in the process; many more factors have to be considered. The aquatic environment because of its nature, presents ecological problems which make fish culture relatively more complex than agriculture. Although much information has I been collected on the biology of streams and rivers over the years, the changes which result whey new lakes are formed as a result of damming rivers present new complex problems. These include complications resulting from the chemical,

physical and biological alteration of the character of the new environment and its effect on the fertility of the medium. For efficient fisheries to be established on man-made lakes sound hydro biological research has to be organised and results effectively implemented. Local fish biology and technology, fish processing and marketing have to be thoroughly investigated. In tropical countries, lake-side health problems become intricately connected with fishery projects and need to receive vital attention in the development of fisheries on man-made lakes.

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In recent times, man-made lakes have come to occupy a place of prime importance in the economy of countries that make them. This is particularly true of some developing countries for which dam construction appears to have become a necessary step for economic emancipation and industrialisation. Primarily the harnessing of the waters of rivers to provide hydro-electric power is the expressed purpose for creating new lakes but it is becoming increasingly common to look on dam construction as a multi-purpose project. Invariably, the institution of irrigation schemes utilising the waters from impoundments and the establishment of freshwater fisheries become important subsidiary services. The Volta River Project of Ghana, for instance, was designed to produce power for domestic and industrial use, but right from the onset, it was a stated intention to use the water of the Volta Lake among other things, for establishing an irrigation scheme to revitalise the Accra plains, and to establish lake fisheries and transport. A similar approach to the utilisation of artificial lakes has been adopted in connection with the Kainji and the Kariba Dam Projects.

In a number of countries in tropical Africa, insect pests and constant severe droughts seriously tamper with successful production of cattle for protein and the repeated assertion that deficiencies in proteins, phosphates, iodine and some other vital elements are the common characteristics of normal diets of local people in Africa has become almost proverbial.

Where a country has a sea board, marine fishery practices may have been conducted for many years, but in some places, ineffective organisation of local processing and transportation have made fresh fish unavailable to inland areas. Where large rivers exist, efficient development of inland fisheries could answer the extremely urgent necessity for supplementing the diet of local people with fish protein to raise its general nutritional level. Against this background, the exploitation of an inland water system with its rich store of untapped fish resources becomes almost all obligation in the quest to provide enough food for all.

Africa has more than ample of its share of the world's water resources. There are a number of lakes as well as large rivers with extensive catchtment areas (Fig. 1). Within what used to be British Africa alone, Worthington (1958) estimates over sixty thousand square miles of water.

Theoretically, tropical waters are expected to be highly productive but this is not a generalised condition and productivity may be determined by a number of ecological factors lake Victoria, for instance, less than two decades ago, was producing only an average of about a ton of fish per square mile of its accessible surface. On the other hand, another East African lake could at that time produce up to sixty tons of Tilapia per square mile of water.

In West Africa and certainly in Ghana where large natural lakes do not exist, river fisheries of various forms and degrees have been practised for generations and local fishermen have an almost uncanny knowledge of local fish and fishery. Fish catches from the Volta River tend to vary annually. Records for seine net catches at three places on the river show unregulated fluctuations. At Kpandu the average catch per haul (in lb.) from 1945 to 1950 was 32.2, 18.9, 25.6, 18.8, 21.2 and 11.1 respectively. Total catch for 1949 and 1950 in three fishing areas is presented in the following table.

	Dzifadzi	Buerta (Total catch (lb.))	Yeji
949	13,583	15,680	9, 178
950	8,013	16,474	16,474

(Compiled from Gold Coast Fisheries Report 1950-1951)

The eratic fluctuation is quite likely the result of some ecological changes which affect certain species of fish.

With the tendency to construct dams and produce new large lakes, the prospects of establishing inland fisheries has become greatly enhanced and the amount of money and efforts expended on the construction of dams make it almost imperative to study and understand the ecology of created lakes. The need to use them for fish production on a profitable scale demands intensification of hydrobiological research in order to obtain information of practical application.

In the past fisheries projects which have been initiated in the Seychelles Islands and on lake Nyasa have failed. There are several factors which may tend to limit the progress of inland fisheries in some parts of Africa. It is intended in this paper to examine some of these factors and discuss how they affect the utilisation of man-made lakes as a source of increased fish production.

A number of problems which affect the effectiveness of artificial lake fisheries are common to the rivers which are dammed to produce the lakes. In addition, other complex peculiarities accompany the physical alteration of a river to a lake and produce chemical and biological changes which affect the fauna.

Foremost, therefore, a realistic approach to the use of new lakes for fisheries is a scientific knowledge of the ecology and biology of the parent river. It is necessary to know the limnological and limno-chemical nature of the river, its fish fauna and their biology. With the construction of a dam, I the created lake characteristically takes on a great size and depth. This phenomenal change alters the nature of ecological data which may have been previously recorded.

Ghana's Volta lake, for example, is expected to cover a final area which will be well over three thousand square miles. Its shoreline will exceed over four thousand miles and it will have a max imum depth of up to about three hundred feet. Thus, from the narrow Volta River, a lake has formed which covers about four per cent of the total surface area of the whole country (Fig. 2). The lake has already swallowed up some of the tributaries of the river but it still receives a mighty supply of water from a large number of streams and rivers. The enlargement of the river-bed to accommodate the lake causes a slowing down of water movement which has an immediate as well as long-term effect on productivity in general and on fish biology in particular. Changes in the chemistry of the water resulting in reduction of essential ions like sulphates, for example, affect the development of plankton (Beauchamp, 1963) which is an important item of fish food. Some fish species succumb and perish under the altered conditions in the new environment. Others survive but against such barriers to breeding and spawning facilities that their successful establishment as lacustrine species become greatly impeded.

In tropical regions, a limitation is imposed on the fertility of deep lakes by the development of stable stratification. The minimal penetration of light encourages the establishment of a deep layer of stagnant water within which much nutrient matter becomes locked up, thus lowering the fertility potential of the medium. The effective productive area tends to be limited vertically to an upper section in which gases and chemicals necessary for primary productivity, plankton and invertebrates which form fish food as well as the majority of fish are found. In Lake Tanganyika, for instance, it is estimated that only the upper hundred meters of its one thousand and four hundred meter depth is aerobic (Beadle, 1963) and there are indications of similar stratification in other lakes in Africa. This stratification is by no means peculiar to tropical lakes, but in temperate zones, changes in climate make it possible for the lower layer to get mixed up with the upper layer, thus bringing up the nutrient rich lower water to the surface seasonally. This phenomenon and the change in current speed, and other limnological factors contribute much to alteration of the faunal composition.

Another factor which poses a problem in African fisheries is the large number of fish species in African inland waters. In contrast with about fifty species of fish in European inland waters it is estimated that African inland waters have over two thousand species of fish of which a large number are of commercial value. The Tilapias have become accepted as commercially important in Africa. Extensive studies have been conducted on the biology of the group by research laboratories like that of the East Africa Freshwater Research Organisation at Jinja. But the Tilapias form only a fraction of the fish potential of African waters. In the Volta River for instance, more than a hundred and fifty fish species are supposed to occur. The commoner ones include the catfish Chrysichthys sp., Labeo sp., Distichodus sp., Momyrus sp. and Lates niloticus.

There is a certain amount of information on catches of these fishes and some observations of migration of fry and adult on record but there is a wide gap of missing data on their biology of the fish. To obtain maximum production, there is need for trained personnel and organised laboratories to carry out a penetrating study of the ecology of the fish fauna and their relationship with the remaining fauna and flora of the medium. It has been estimated that the formation of the Volta Lake will make it possible to establish a freshwater fisheries with an annual yield of about fifteen thousand tons of fish. With the evolution of appropriate management and effective fishing, processing and marketing procedures, the supply of fish protein for food would be greatly improved.

Man-made lakes show much promise of improving food quality and providing electricity and all the blessings it brings. A curious development which accompanies man-made lakes is the eventual development of aquatic weeds. Kariba's Salvinia auriculata burst unexpectedly on the unsuspecting biologist but it has to be accepted now that weed growth is a normal process which results from the inundation of previously dry but fertile land. On the Volta lake, a number of aquatic plants have already been recorded. Although the two most dangerous plants, the water hyacinth, Eichornia crassipes, and Salvinia auriculata have not yet appeared in Ghana, there is a long list of plants already recorded. The water lettuce, Pistia stratiotes, Salvinia nymphellula, Ceratophyllum demersum, Scirpus cubensis, Cyperus distans and Utricularia inflexa are among them.

In 1965, the weed growth on the Volta Lake did interfere with boat movement (Plate 1) on a section of the lake but it was temporary. The real importance of the weed growth lies in the fact that the plants support a variety of aquatic invertebrates some of which are implicated in the spread of certain parasitic diseases. The river fisherman is exposed to infection with onchocercia - sis in areas where the immature stages of S i m u l i u m occur. Inundation reduces this hazard by slowing down the water flow and eliminating much of the breeding sites of the fly. In the process, however, the created lake brings its own dangers by providing sluggish waters which favour the establishment of vectors of the lake fisherman's occupational disease, schistosomiasis. The growth of weeds on new lakes encourages the establishment of molluscan populations. On the Volta lake large samples of snails have a ready been taken from the invertebrate fauna associated with Pistia stratiotes, Ceratophyllum demersum and other plants (Obeng, 1966). Bulinus forskalii and B. rholfsi common in the samples, both act as intermediate hosts of vesical schistosomiasis. Worse still, the floating habit of Pist i a s t rat i o t e s makes the plant a disseminating agent for the snails Samples taken from floating plants showed that on the Volta, Pistia stratiotes can transport snails over considerable distances. From a weed focus growth 25 miles away in a wing of the lake, snails have travelled with Pi s t i a s t ra t i o t e s to the open water and towards the dam site.

Schistosomiasis is a human debilitating disease which can seriously disrupt successful fishery development on man-made lakes. In Ghana biological control with a cichlid fish Serranochromis macroc ephala, a reputable snail eater from the Congo, has been tried in the past and found unsuccessful.

To complicate health problems further, Pistia stratiotes also supports Mansonia species of mosquitoes which transmit rural filariasis in some countries. There is much evidence to show the serious threat which aquatic weeds impose on man-made lakes fishery development. If tackled early, much expense and waste can be avoided later.

The rivers of Africa have much to offer in the establishment of freshwater fisheries. They have also a number of problems which are not solved by damming them to form lakes. Man-made lakes have a mighty potential in fish but this can only be realised through organised investigation and study of the physical and chemical nature of the medium, the biology of the fish and the effect of the other fauna on the production of fish and fishery practices. With an effective application of knowledge acquired from ecological studies and research, man-made lakes can be managed to contribute their share to the provision of enough food for all.

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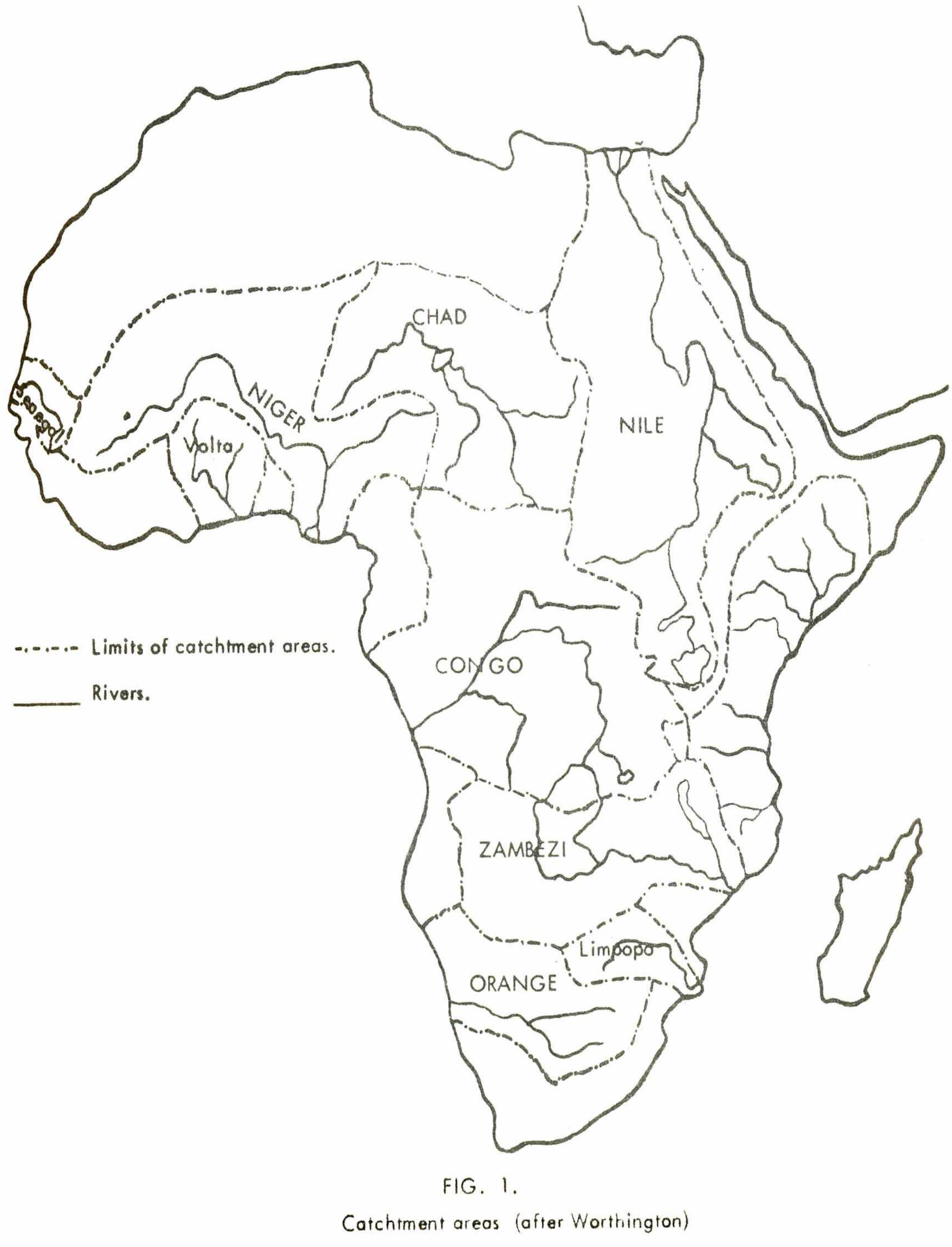


FIG. 1.

Catchment areas (after Worthington)

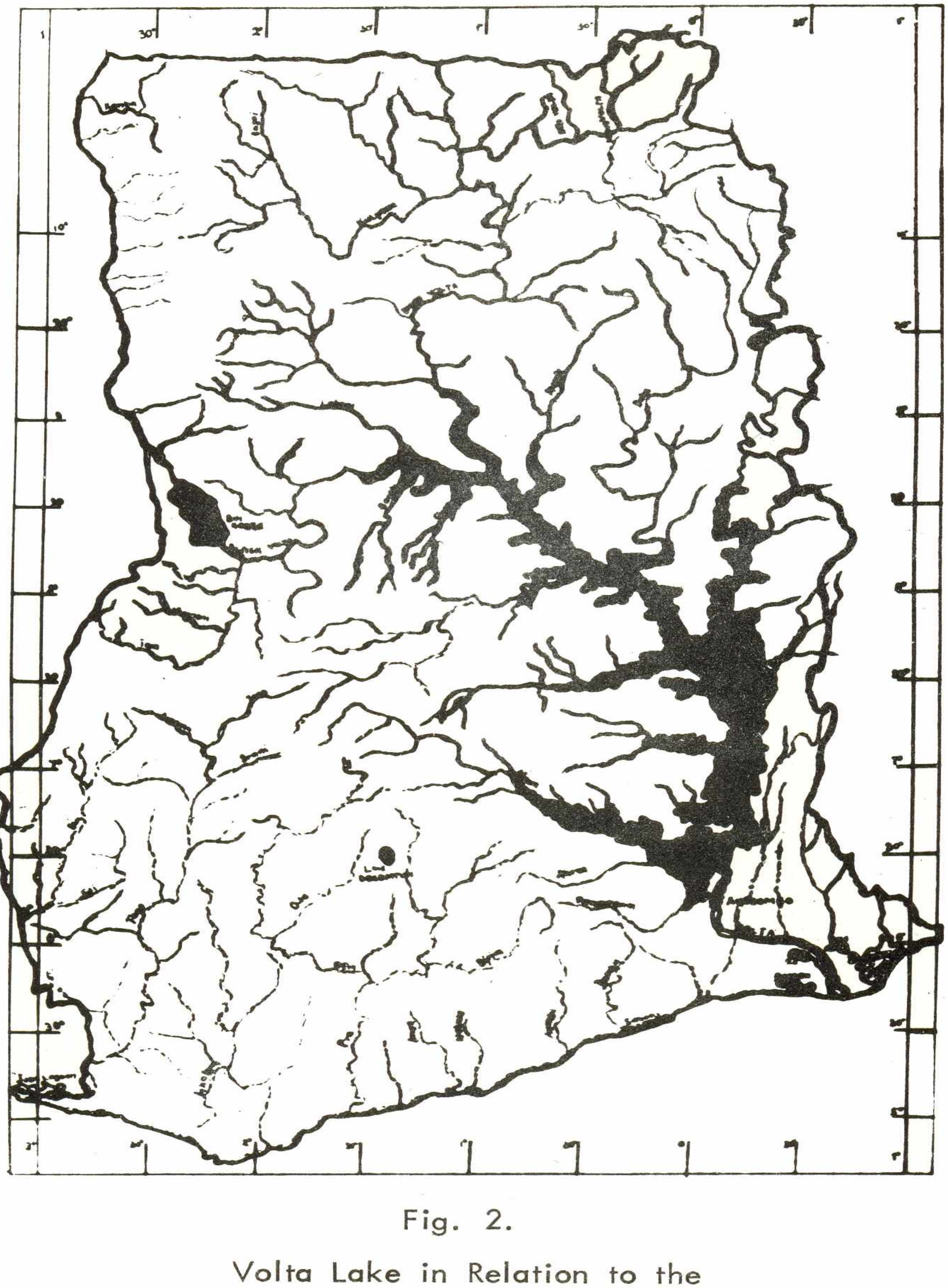
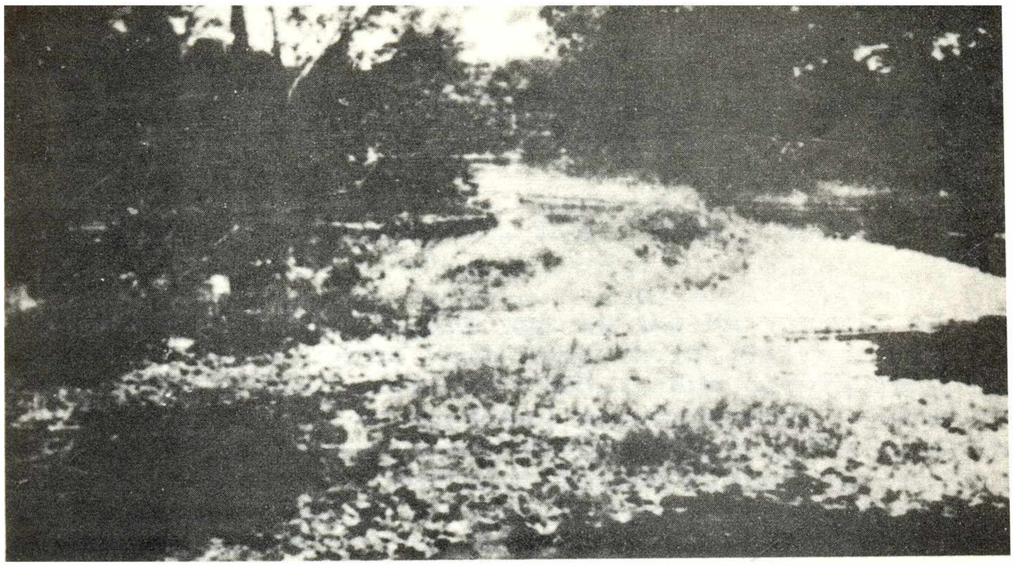
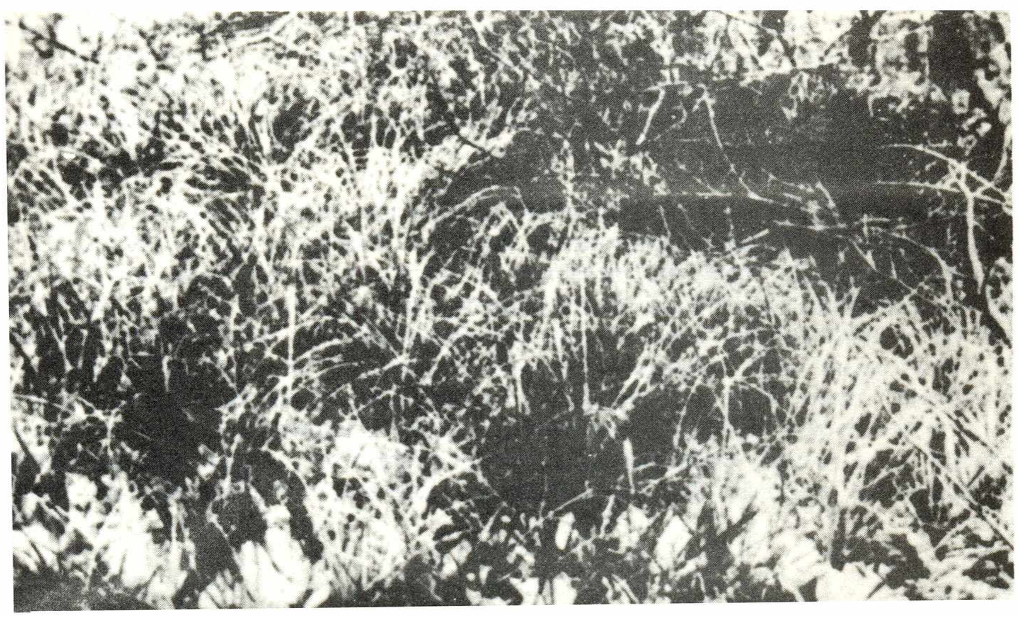


Fig. 2.

Volta Lake in Relation to the
Inland Water System of Ghana.



Growth of weeds along a part of the original bed of the Afram River, now part of the Volta Lake.



A dense growth of *Pistia stratiotes* and grasses in the Afram section of the Volta Lake. The boat from which the photograph was taken was brought to a complete standstill as a result of the filtering mechanism of the vessel getting choked up and the propeller getting entangled with weeds.

Plate 1. Aquatic Weeds on the Volta Lake

THE ROLE OF BIOLOGICAL SCIENCES IN ENHANCING FOOD PRODUCTION

By **K. Chandrasekhar**, B.Sc.(Hons.), M.A., M.Sc., Ph.D.

Dr. K. Chandrasekhar studied Zoology at the University of Madras and was awarded the B.Sc. degree with Honours in 1945 and the M.A. degree with Genetics as special paper in 1946. She specialised in Crustacea and got her M.Sc. degree in 1948 and was appointed Lecturer at the Banaras Hindu University. Along with teaching, during spare hours,she carried on research on Reproduction in Fishes for which she was awarded the Ph.D. degree in 1954. In 1961 she was promoted Reader in Zoology, the post which she is holding now. Since 1948, she has been the Head of the Zoology Dept. in the Women's College of the same University and has been responsible for equipping the B.Sc. Honours Laboratories and has been looking after the Department's administration. In 1965 she was invited by the Chairman of the Zoology Dept., University of Washington, Seattle, U.S.A. to work on Experimental and Embryologioal Neuroendocrinology and was also the recipient of the International Fellowship awarded by the American Association of University Women. She has many scientific papers published to her credit.

Summary The biological sciences can help in reducing plant diseases and destruction; plant and animal Genetics can help weed out the unwanted and select the sturdy. Endocrinology helps in increasing animal protein and minimising population multiplication. Agricultural techniques applicable in temperate zones are unsuitable to tropical belts. Development of indigenous techniques are suggested as the way to make tropical lands yield more. Fish is the best readily available source of protein, minerals and vitamins, to be supplemented with cereal and vegetable foods. Protein from oil-seeds, nuts and pulses are highly nutritious and equal to animal proteins. A change in food habits is necessary.

THE ROLE OF BIOLOGICAL SCIENCES IN ENHANCING FOOD PRODUCTION

By **K. Chandrasekhar**

Technology is a superstructure founded on facts furnished by the basic sciences. Therefore, until and unless the basic sciences are nurtured and made to produce more food, there is every danger of the superstructure crumbling down. In most countries planning is lop-sided. Too much stress is laid on industrial development while agriculture and animal husbandry programmes have been given a second place, with the result that in most of the Asian countries there is food shortage and lack of balanced diet.

Both plant and animal genetics can be usefully employed in weeding out the unwanted, and in bringing out the best quality in Nature. Texas cows can yield good milk in large quantities, but they are easily susceptible to disease and cannot withstand heat. Indian bulls, on the other hand, have been found to be disease resistant and can withstand heat. A combination of Texas cows with Indian bulls can give excellent results. Parasitology, microbiology, protozoology and pathology can reveal the causes of plant or animal destruction, dwrindling production, feeble products and other defects. To cite a single example, study of the life cycle of Puccinia, the wheat 'rust', helped to save hundreds of acres of wheat. Since insect pests form the greatest menace to food crops, entomological studies are of immense importance in protecting food crops.

Recent strides made in the field of endocrinology have opened a wide field, which, if properly pursued, can result in the production of large quantities of nourishing food. The gonadotrophins produced by the pituitary control reproduction in fish and other vertebrate animals. By injecting the pituitary hormones, breeding can be hastened in fishes.

Nutrition experts at the Coonoor Nutrition Laboratories, India, have shown that fish is the most nutritious of all foods. It contains five of the most essential amino acids required for proper growth and maintenance of health. As well as providing basic protein, fish also contain minerals such as sulphur, phosphorus, calcium, iodine and so on. Fat is also present, the proportion varying with the type of fish. Fish has vitamins too. Riboflavin, essential for sight, is found in abundance in most fish-flesh and liver. Thus, fish is the best source of nourishing as well as of protective foods. Supplemented by rice or potatoes and simple leafy vegetables to form a balanced diet, this would be ideal for rice eating countries like India, Ceylon, Burma, China, Indonasia, Malasia, Africa and many of the innumerable islands scattered in the Indian, Pacific and Atlantic Oceans.

Due to lack of properly developed fisheries departments in most of the Asian countries, large quantities of this food-fish are lost. In tropical countries spawning takes place prior to the rainy season, so that when the rains commence and the rivers get flooded, a large percentage of the eggs, fry and fingerlings are washed away and thus lost. In the same way the eggs of those fishes which migrate from the sea to the fresh-waters are lost. The loss of thousands of tons can be avoided, if fisheries stations are established near those spots where the fish breed and the eggs are collected and transferred to sheltered areas.

There are many ways by which fish production can be increased such as protecting the breeding grounds or providing artificial breeding grounds similar to the natural ones. Most fish are fastidious about their breeding habitats. Legislation has to be brought in to prevent exploitation of certain groups of fishes, considered a delicacy locally, and to prevent fishing of 'gravid' females. By careful study and observation fishery experts can tabulate the breeding seasons of different species of fishes in different localities.

While constructing dams, considerable attention should be given to preventing destruction of fish by curbing their free movement and destroying their breeding habitats: in India this has not been done.

Fish also form a rich source of manure which can enrich the soil for the growth of vegetables, cereals, pulses and fruits, particularly grapes and many varieties of citrous fruits.

Although fish provide such rich food for human consumption, their maintenance cost is negligible. For instance, in Uganda, yields of 300 lb/ acre come from just stocking a pond with tilapia, which grows to a weight of about 1 or 2 lb. without any help. With a little addition of elephant grass and sweet potatoes, the annual production can be boosted to 2000 Ib /acre.

The greater part of the ocean still lies unfathomed; if brought under control this could solve all the problems of the undernourished populations for a long time to come. Non-utilized fish stocks range from 2 ½to 4 times our present catch.

Careful and planned researches in genetics can be utilized to yield better dairy and poultry products, while the proper and selected application of endocrinology can bring about quicker and greater yields. But this requires extensive research and its application, especially in the Asian countries, automatically brings in the question of finance.

In the field of agricultural products, stress should be laid on the growth of plants suitable to the climatic conditions. Experiments have show that agricultural techniques applicable to temperate zones are not applicable in the same unmodified way to tropical zones. To cite an instance, rice crop japonica grown in Japan, North China and United States yielded more crop with nitrogen fertilizer while the rice crop indica grown in S. China, India and other Asian countries would not yield more with the increase of the same nitrogen fertilizer. This is also true of other crops. So, indigenous methods applicable to the particular climatic conditions should be explored. This requires time and money; but the population growth will not stop while the experimentation is going on. Therefore speedy methods should be employed to control the increase in population and enhance the production of food that is easily and readily available.

In addition to fish, which is one such source, there are protein-rich pulses, nuts and oil-seeds. The protein production from oil-seeds almost equals animal protein; but very little of this protein is used for human consumption. After the extraction of oil, the residue is given to animals. Although attempts should be made to educate adults on the importance of not wasting such a rich source of protein, it is best to begin such an education at a very young age.

Comparing the "primary calories" consumed in the US, in Western Europe and India: the Indian eats his grain directly and unchanged. In addition, in his 2000 daily calories he gets about 6 grams of animal protein per day. An animal uses perhaps 400 calories of vegetable energy food to produce these 6 grams of protein, so the Indian's consumption of "primary calories" is about 2400. The Western European feeds about half his agricultural produce to his animals, and eats about 20% of his diet calories as animal products. Thus, to get his total 2850 calories daily, he uses up 6750 calories of total agricultural production. Americans feed the bulk of their plant material to livestock and eat about half of their diet calories in the form of meat, milk or eggs. This means a consumption of almost 11,000 'primary calories' to provide an average diet level of 3150 calories.

In a country like India, there is not enough energy food - grains - to feed the cattle. Moreover, the live-stock yield is poor even if valuable vegetable produce is wasted on them. Therefore, the best procedure is to tap the rich protein that is available from oil-seeds, pulses and nuts. It is still more imperative in Africa where live-stock raising is almost impossible due to tse-tse fly and other disease menaces. Pulses grow easily in the tropical countries. They are a rich source of protein and also fix atmospheric nitrogen in the soil and thus make the soil rich for other crops. Due to illiteracy and ignorance, farmers in many of the tropical countries are unaware of this simple method of cultivation by 'rotation of crops'.

Most Asian countries lack speedy and efficient transport and proper storage facilities. To avoid wastage of food, inexpensive freezing and other storage facilities should be made available to the farmers.

Last but not least, is the necessity to change conventional modes of eating. In countries where rice and other cereals are consumed in large quantities, cheaper but nourishing and tasty substitutes should be introduced. For instance, rice could be reduced by introducing a bowl of tomato, greens or vegetable soup. To begin with, this should be introduced in schools, where noon-day meals are provided and in hotels where rice forms the major part of lunch or dinner. Before doing this, people should be enlightened on the importance of a balanced diet by broadcasting over the radio, television and the movie, or in remote places by direct education by biologists.

TECHNOLOGY TRENDS IN FOOD PRODUCTION IN THE PHILIPPINES

By **Magdalena Alde Templa**, Supervising Scientist, NSDB, M.S.Ch., B.S Ch.E., A. U.

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SUMMARY To cope with the fast expanding population in the Philippines the application of modern techno1ogy for food production is the trend. Agricultural farm implements and machinery, fertilizers, better strain of rice, control of pests and diseases are adopted to increase the yield. The conservation and preservation of fruits and fish through new methods and techniques are being applied. Off shore areas are explored for more fish production and the use of modern methods of fishing and electronic devices are being adopted. The coconut is studied extensively and its by-products utilized for food. A food yeast was processed from the coconut water that could serve as a protein substitute. The livestock industry is also being developed for more beef, milk and other by-products.

TECHNOLOGY TRENDS IN FOOD PRODUCTION IN THE PHILIPPINES

BY **MAGDALENA ALDE TEMPLA**

Food is one of man's most important necessities in life. With the world's population constantly expanding, focus on food production becomes a must. According to Food and Agricultural Organization (FAO) reports in 1966 the world's population rose to 70 million, but no additional food was grown. Food and Agricultural Organisation (FAO) experts believe that about the end of the century where production that can be conceived will bring enough food supplies for the population at the rate it expands.

The world's population is expected to go from over 3 billion to over 6 billion in 32-34 years by the end of the century. It is estimated that the population will double in 24-26 years in the Far East, India, Latin America and the developing countries in Africa. In 1965 the world food production per capita dropped by 2 percent. Food and Agricultural Organization reports showed increase up to 4 percent in North America and 1 percent in Western Europe.

The Philippines with its fact growing population is facing the same situation. Shortage of rice and other commodities are being felt. With thie dilema on hand the Philippines has a problem to solve and therefore all possible means are now being taken to intensify its food production. The adoption of modern technology is the trend in the Philippines.

The Philippines composed of about 32,000,000 people with about 7,000 islands is an agricultural country. But at present the farmers still adhere to the old ways of farming and therefore production is not what it is expected to be. The government and private entities have intensified their researches on food production.

The country has given great attention to rice production. Rice is the main food of the Filipino people and the Philippines is short of rice inspite of its being an agricultural country. Through Scientific investigations better varieties of rice and corn are being propagated. The Los Bahos Agricultural College of the University of the Philippines, the International Rice Research Institute (IRRI) and other private agencies have devoted to rice research.

A rice variety has been found by the International Rice Research Institute (IRRI) that would yield from 100-200 cavans per hectare. The average yield of most farmers is 27 cavans per hectare. IR-8-288-3 known as the miracle rice the new rice strain produced and developed after 6 years of science research and experimentation by the International Rice Research Institute (IRRI) has been recommended by Director Dr. Robert. F. Chandler.

The government through the Department of Agriculture and its agencies has made the farmer utilize fertilizers and pesticide to improve yield in their crops. The rate and efficiency of various fertilizers for rice, sugar cane and coconut production have been studied; the application of liquid fertilizer which started in 1962 resulted in better yields with sugar cane, coconuts and other crops. The study of rice virus diseases in the Philippines and development of measures for their control were undertaken. It included field surveys, transmission studios for the identification of viruses, determination of effects of viruses or rice plants and screening of resistant Varieties.

Four virus diseases namely orange leaf transmitted by Inazuma dorsaks, tungro by Nepholettix impicticeps, grassy stunt by Nilaparvata bigens, yellow dwarf by Nepholettx impicticeps, have been identified. A number of resistant rice varieties have been found. It was found out that rice plants suffer most when infected young. Preventing infection by controlling insect vector should be emphasized in the young stages of plant growth.

Agricultural development programs are now in operation in the provinces.one of them in Riza and in full operation reported by Dr. Orlando J. Sacay , Executive Director of the Agricultural Development Council for Rizal used seed (IR-8). In his report Dr. Sacay said that 36 farm management technicians had a yield of from 100 to 200 cavans of rice.

A mechanical process on the production of pinipig a rice product (Equivalent to quaker oats) has been studied by Martin Hugo and R. Garces of the Engineering Research Laboratory. The palay (rice kernel) is previously soaked in water is put into a rotary kiln roaster. From the kiln, the roasted pa1ay passes the two stage roller press a de-flaking device and a fan whereby the rice hulls are separated from the grains. The resulting product is conveyed by gravity to a bin for storage and packing. Pinipig is an equivalent to oat meal.

Studies in the control of coffee rust or coffee plant have been undertaken. Research on citrus such as studies on the virus disease and its control have also been done.

In the Cagayan Valley, many technological problems exist, the most common are:

1. The valley is underpopulated and much land remains unsettled.

2. Poor transportation presents a serious limitations to the development of adequate marketing Facilities.

3. Inadequate farming equipment and crude farming practices.

4. Limited industrial activity.

5. Lack of diversification of crops and inadequate financing accounted for low crop production.

6. Inefficient utilization of existing men and carabao power.

The solutions to these problems are being implemented by:

1. The application of scientific methods and modern agricultural practices on an underscale.

2. Development of cheap farm implements and

3. Development of irrigation systems.

In Nueva Ecija, Central Luzon State University (CLSU) the use of a CLSU rice thresher (28" x 46" McCormick - Deering) was used. The study consisted of applying this thresher on two varieties of rice Raminad Peta BPI-76 and Tjere Mas rice varieties. Threshing was done at the feeding rate of 14-17 bundles and at a cylinder speed of 800 rpm.

Results of experiments revealed a threshing efficiency of 97.47 % based on palay grain losses during threshing.

Determination of field capacity of various types of soils and a comparative study of the methods of making mechanical analysis of soils using different dispersing agents have been investigated by Central Luzon State University, Nueva Ecija. .Quality of the soil used plays a very important role in giving the highest yield capacity.

The eradication of rice field rats was also great concern as most rice and corn fields were being infected. Measures were taken to eradicate them from these infected areas.

The Philippines abound with fruits and vegetables all the year round but these fruits with the exception of a few instances are grown in backyards and not cultivated in commercial scale. Many seasonal fruits and vegetables go to waste because they are not conserved or canned. Various agencies like the Los Banos Agricultural College, University of the Philippines are conducting researches on the production of these fruits and vegetables in a commercial scale. Its conversion to other food products is being done. Among them are the mangoes, bananas, citrus fruits, tomatoes.

These fruits if only properly cultivated and grown with the aim to export and also to preserve would mean an additional food source of vitamines. With the application of modern technology the Department of Agriculture, with its agencies the Agricultural Productivity Center, Bureau of Plant Industry, and private agencies such as Araneta Agricultural University and others have conducted research studies on the improvement of variety, control of diseases and pests and their utilization and preservation. In Mindanao the Del Monte Company has canned pineapples and tomatoes. The latest of plans of the National Science Development Board (NSDB) is a Project on freeze drying for the preservation of such fruits any vegetables specially those that are seasonal such as mangoes, pineapples, citrus fruits, guavas and strawberries. Studies on the cultivation of banana for commercial purposes is also being undertaken.

The fermentation of Philippines fruits into wines and ascorbic acid have been studied. Methods of artificial coloring of fruits have been done by subjecting the fruits in an air tight chamber to low concentration of a coloring substances (ethylene or acetylene gas) under controlled temperature and humidity.

Preparation of banana flours from various varieties of banana such as bungulan, Gloria, lacatan, murado Saba, carinosa and botoan were used in the processing of banana flours collected from Batangas. The banana flours produced retained the odor and flavor of fresh banana. The color varied from cream to brownish cream. These flours were tried for bread baking by mixing with wheat flour in the proportion of 25:75 mixture. Cassava tubers has also been used for flour manufacture.

Studies on the preparation of mango juice powder was worked in the National Institute of Science and Technology (NIST). Sweetened mango juice was dhydrated to a vacuum product with about 1-2% moisture at a temperature not exceeding 65 degree centigrade and a vacuum of 27 inches of mercury.

Studies on preservation and their mineral and vitamin retention have been undertaken on the santol, papaya, banana and guava. A comparative study of the pectin content and quality of fruits for jam and jelly production using passion fruit, santol, pomelo and banana were tried.

The use of ionizing radiation for food preservation was undertaken jointly by the Philippine Atomic Energy Commission (PAEC) and the Philippine Women's University. Mangoes, onions, sweet potatoes and citrus fruits were irradiated. Shelf life of irradiated tubers were extended to as much as 6 months. Refining of green mangoes after irradiation was delayed by two weeks.

Antiquated fishing methods still prevail in the Philippines. This is largely responsible for the poor catch fishermen make. Consequently importation of sardines, salmon and other fish had been resorted to.

Steps have been taken to solve this situation by the exploration of fishery resources such as going into deep seas and off shore areas, besides coastal and inland water. Efforts are also being intensified to step up production of coastal and inland water by improving fish cultural practice to increase fish production.

Under the Reparations agreement between Japan and the Phi1ippines reparations equipment. In the form of machinery fishing boats and electronic devices were availed of. A great contribution to the advancement of the fishery science are the electronic devices. These communications equipment enable fisherman to maintain contact with each other and pass the word where schools of fish are located. With fish finders, existing fish catching devices could be modernized.

with the echo-sounders the fisherman can detect schools of fish both vertically and horizontally in mid-layers of water where formerly it was not known that they existed. Navigational aids like the sonar or ardic have taken the blindness out of fishing. This enables the fisherman to navigate under, very adverse conditions at greatly reduced costs. Radio signal time measurement systems have made it virtua11y impossible to 1ose fishing gear or position at sea .These modern navigational aids are being acquired for the fishery schools. They are essential for future fisherman who must be trained to operate their boats.

The Commission on Fisheries have been conducting studies on the processing of fish and fish products such as sausages, fish cake, fish paste and fish sauce. Accelerated fermentation by the use of enzymes reduces the fermentation period of fish pastes and sauces from eight months to one year to 4 weeks with a comparable product. Methods of lengthening fish products by the use of antibiotics have also been done. The utilization of minor aquatic products are being undertaken. Improvement of fish handling practices from time to time the fish is caught until it reaches the consumers table is also being done.

Various methods of fish preservation have been tried. The best fish are those that are deep frozen quickly after catching, glazed after freezing, stock in constant temperature freezing room and thowed when taken to be sold out. This has been the practice among the fishermen.

Improved methods on effective smoking for fish and new foods have been tried. The use of assorted wood heat and dense smoke is used. Fresh guava leaves an aromatic grass is used in smoking to add flavor to the smoked fish. This is one of the methods used for preservation of fish besides sun drying.

Researches on the coconut one of the main crops of the country has been fully undertaken. One of the principal exports of the country is copra a sun dessicated coconut. Competition from other countries quality and in price has reduced the exportation of this product for some time. The National Science Development Board (NSDB) With its implementing arm the National Institute of Science and Technology (NIST) has developed through the aid of a consultant from the Armour Foundation a fluidized method of drying fresh grated coconut meat which produces a very superior quality of dessicated oil. The oil extracted from it is colorless oil fit for food use and the meat after expression is a white material that can be used as flour , for candies, and mixed in cookies. The earliest attempt to mechanize was back in 1938 where one of our outstanding chemists Dr. Vicente Lava extracted the oil from the meat by centrifugal type of extraction better Known as the Lava process. Dr. Dionisio Birose1 also wide studies on the extraction of coconut oil. Several devices have been made such as the natural electric drier for drying the coconut macapuno flour by Dr. Santiago Cruz of the Institute of Engineering and Technology of the Araneta University. Other equipment and devices were invented and developed by Dr. Santiago Cruz of the Araneta University for extraction of coconut oil, giving a water clear oil with by-products such as the white flour from the coconut water syrup the copra cake and the paring oil.

The latest on coconut research which has been the work of Miss Dolores Hipolito of the NIST on a strawberry flavor food yeast from the coconut water. The use of an isolate from fermenting strawberry known as R. Pilimanae was found to yield. 51.01% dry yeast which gives a pleasant fruit flavor, better than that from Torrulopsis Ulilis. This research has been very significant as it is a cheap source of protein which could be used as foods for millions. Protein is one of the basic needs of the human body. Fifteen per cent of the human body is made of protein and is considered one of the essential nutrients body for a normal metabolism. A continuous supply of protein within the reach of everyone is of vital importance.

Yeast has been one of the sources of protein which provides a good supply of amino acids and a natural source of vitamin B. The National Institute of Science and Technology (NIST) has dons some researches in the production of food yeast from coconut water. This was undertaken by Miss Dolores Hipolito of the NIST.

The coconut water that just goes to waste in the process of drying the coconut meat to copra has been found to contain the essential nutrients for growth and stimulant factors for many types of micr oorganisms. With these Characteristics Miss Hipolito made use of the water, molasses, etc. for the production of food yeast. Molasses is another residue from sugar manufacture.

Seventy six yeast isolates were prepared from various fermenting fruits, Palm saps, starchy materials, and four pink colored yeast isolates from grape, mango, strawberry, and water melon. The four pink colored yeast isolates were selected due to their high protein content, pleasant odor and flavor.

The strawberry Rhodotorula Pilimanae yeast isolates was found to have the best flavor and odor among the four pinks yeast isolates. This was used for propagation. Coconut water medium, supp1emented with, ammonium sulphate and trisodium phosphate were adjusted to the right pH and sterilized at 10 pounds pressure for 30 minutes. After cooling it was seeded asceptically with the fermenting medium and aerated for 48 hours. This innoculum was used for seeding the fermentation in the pilot plant production of food yeast. The fermentor was filled more than half-full ,with coconut ,water and molasses to adjust to the right concentration of sugar- and the necessary food nutrients for the propagation of the food yeast. This was sterilized at 15 pounds pressure for 20 minutes.

After fermentation was completed, the yeast was centrifuged and washed. It was dried at 50 degree centigrade. The yeast obtained was 51.01% dry yeast. It is pinkish in color ,with pleasant fruity flavor and better in taste to that obtained from Torulopsis Utilis.

Studies have been made on the preservation and processing of fruits and vegetables, such as mangoes, banana and other tropical fruits. The latest of studies that are being planned and undertaken by the National Science Development Board (NSDB) is freeze drying of such Philippines fruits and vegetables that are seasonal such as mangoes, pineapples, citrus fruits, oranges and guavas, blackherries and vegetables.

The National Institute of Science and Techno1ogy (NIST) made studies on various Philippine fruits such as bignay mandarin Mango, lanzones, etc. As a result the details, aytec kamachili, cashew, kolobat, pomegranate, mango, Indian and piko variety, sapedilla pomili and kalamansi were found to be good sources of ascorbic acid (Vitamin C).

Studies on the preservation by refrigeration and the bottling of the concentrate were also undertaken. Fruits such as pineapples, mangoes, duhat (blackberry) were studied and fermented into wines.

The effect of various cooking procedures on cooking and the retention of vitamin B in pork and beef had been studied also by the National Institute of Science and Technology (NIST). The nutritive value of 2l8 locally processed food were included. The nutritive value of some processed foodstuffs in the Philippines were also undertaken by the NIST.

Studies on the manufacture of vermecelli (locally known as sotanghon) from the mongo bean have been undertaken. Processing of this cheap source of protein has been made. The “sotanghon” is a vermecelli produced from a processed mongo dough from the yellow variety of mongo bean.

The coconut a wonder crop of the Philippines has been fully studied and processing methods have been developed to utilize all its parts. From the water, by the fermentation process has enabled the production of vinegar, protein yeast (good cheap source of protein), and nata de coco, a gelatinous non calorific food that could be a substitute for gelatin. From the coconut meat after the extraction of oil (used for frying oil, sales, etc) a flour has been processed which when mixed with a certain proportion in food gives a palatable flour cake and bread. Recipes for cooking the coconut meat into cookies, break fast foods,etc. have been done.

Improved processing methods have been developed by V.Subralmanyan ,V.A. Paterno and D.Salon on the possibility of production an edible product by drying coconut in the open at ordinary temperature . Pared and unpared coconut kernels are dried to 7-10% moisture in 5 to 6 days. Then they are packed in Jute bags after dusting with ammonium carbonate and calcium hydroxide. The chemicals do not affect the flavor of dry coconut .The dried coconut is reconstituted into fresh coconut by steeping into water The resulting product is good material for oil and flour manufacture .These experiments proved that the Coconut kernels could be dried in the open at ordinary temperature provided that the kernels are protected Against bacterial or a fungal growth. Slides on the splitting up of the coconut oil its component fatty acids are also being undertaken by the NIST. The conversion of this fatty acid into chemical derivatives used in many different industries would be a great help on stabilizing the loss in exportation of the copra.

The chemical and biological analysis of Phillippine foods such as cassava, rice and sugar have been undertaken with the aim of utilizing them into useful processed food products. The processing of cassava a tuber has also been attempted.

Methods of artificial coloring and opening of fruits have been studied by F.A. Quinitio (Food Nutrition Research center) National Institute of Science and Technology. The matured fruits are subjected in an air tight chamber to low concentration of a coloring substance (ethylene or acetylene gas) under controlled temperature and humidity.

Poultry and piggery raising in the rural areas have been encouraged with the help of various agencies. The poultry feed have been improved and the introduction of antibiotics to prevent diseases have been practiced. The U.P. College of Agriculture with the assistance of the National Science Development Board (NSDB) has conducted researches on swine improvement through breeding. The project aims to develop a breed of swine that would combine the good bacon and lard qualities of foreign pigs with the Philippine pig. The development of strain of S.C. white leghorn for high egg production, livability, and hatchability is also being conducted. The Bureau of Animal Industry is undertaking researches on the beef production of different grades of cattle. The comparative study of some cattle grades for milk production is also being investigated. The increase of fresh milk supply at low cost is quite important. People resort to canned evaporated milk in the absence of fresh milk.

With all these efforts to intensify food production through the application of modern techniques and machinery it is expected that the problem of food shortage in the years to come would greatly be alleviated.

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The Application of Technology - Increasing Food Production

DISCUSSION

D. F. Hollingsworth (U.K.)

I should like to congratulate Dr. Obeng on an extremely interesting paper and would like to ask her whether the eating of fresh fish from lakes is common practice among the people who live around the waters - do they like it, do they know how to cook it - are these factors being taken into account in the biological programme and also are there any schemes for preserving the fish or transporting it to other parts of the country?

L. E. Obeng (Ghana)

Even before the formation of the lake there was quite a lot of fishing going on in the river. Up until recently, refrigeration was not very well done and the traditional methods of preserving fish were smoking, salting and drying and they have been practised for generations and in this way the river fish is transported to various parts of the country. But up till now, the quantities have never been adequate. The Institute is primarily trying to find out the biology of the lake, of the fish and whatever is in there, with a view to aiding maximum production and also to instruct the fisherman where to fish, and when to fish, depending on the movement of plankton and things of that sort. We have only just started and it will take a number of years to get the cycles quite understood.

E. Ricketts (Kenya)

Recently in East Africa they have developed a very large fishing industry and the fish are filleted, frozen and transported to Nairobi, which is both distant from the lake and the sea and is not a natural area for fish. We are becoming conscious of the need to educate people in the areas inland that have not been used to eating fish, both in the use of fish and getting their palates accustomed to this new variety of protein food.

D. E. Ajakaiye (Nigeria)

In Nigeria, up country, there is a lot of beef, and mutton and fresh fish is regarded as a luxury - it is very expensive and only those who live close to the rivers eat them. The greatest problem now is refrigeration and allover my country now there are fish farms where the Government has put a lot of money into existing lakes to encourage fish production and these fish are refrigerated and taken allover the country.

K. Chandrasekhar (India)

I wondered whether tracer elements have been tried to increase the yield of fish in these lakes.

L. E. Obeng (Ghana)

We have not started to introduce anything into the lake at all. The lake is only about three years old now and is very large and at the moment we are trying to find out what there is. However, part of our programme will be to introduce certain irons into the water leaving the dam when the irrigation scheme begins, to help the growth of plants. I would like to make a special appeal to the engineers and bio-chemists. When water lettuce appears on a lake which is used for something else, it becomes a problem but if we could eat the plant people would harvest it and then we would not have the problem of clearing it.

L. M. Guillerault-Danel (France)

Is it possible to consider a study being done, so that we could use water lettuces in the same way as seaweed, by burning them to get fertilizer.

L. E. Obeng (Ghana)

I have been assured that once it is burnt there is nothing useful left.

D. F. Hollingsworth (U.K.)

I think it may be possible to get the protein out of water hyacinth, by a protein extraction process.

A. Azmaz (Turkey)

Dr. Obeng you emphasised the need for research and investigation on the biology of the lakes and the fishes and for better production. I am wondering if any research is being undertaken now and if so who is sponsoring and / or financing such research.

L. E. Obeng (Ghana)

We have a system in Ghana which I think is peculiar to us. We have our Universities where a certain amount of research goes on but in addition to that we have the Ghana Academy of Sciences. This is in two sections: one is a purely learned society, similar to the Royal Society, to which people are elected by merit to become Fellows of the Ghana Academy of Sciences; and the other section is rather like a research council which runs research institutes. We have ten full-time research institutes, including one for research into the soil, one for crops, one for cocoa, one for building and roads, and one for national health pharmacy, I think. My Institute is one of the most recent ones which was set up to do all the research necessary to help with the lake's management. It is a full-time research institute with both Ghanaan and ex-patriate staff, studying all aspects of hydro-biology affecting the lake.

w. Stallard (South Africa)

I would like to say a few words about the problem of educating people to eat foods which are of value to them when they have very little money to spend. This has been tackled in the Johannesburg area with the urban Africans through the medium of Bantu beer which is very popular and part of the social structure of their lives. They drink it by the half gallon in fact. This now has a protein additive which in half a gallon per day will form 35% of the protein required by an adult person. This is proving so successful that it is being sold at a rate of 2¼ million gallons per month in the Johannesburg area alone.

P. Harding (South Africa)

One of our friends in South Africa developed a cereal, they put about 20 years research into this, and it is very cheap and contains a lot of nourishment but one problem was when it went on the market that poorer people would not buy it because they maintained that because it was cheap it could not have very much in it. So at first they were very reluctant to buy it and this presented us with a problem.

D. E. Ajakaiye (Nigeria)

I would like to thank Mrs. Chandrasekhar for her interesting paper from India. It was stimulating to hoar that fish is the most nutritious of all food were milk and all the other foods taken into consideration before you came to this decision?

K. Chandrasekhar (India)

I did not quite follow the question but I feel that the answer would be that milk has more water in it than that of fish flesh and fish has more minerals and fats which the milk lacks.

A. Azmaz (Turkey)

I would like to address my question to the delegates from India and Ghana, Miss Mizoguchi who is in the Chair, said yesterday that you have to choose between either the fishery or the reclamation of the land. Now in a country like Turkey where the nutrition of the people is equally important as the reclamation of the land, it becomes very difficult to decide which one of the two is more essential for the welfare of the country. Is there a problem of this kind in Ghana and India and if so what is the choice between the two.

K. Chandrasekhar (India)

This problem of reclamation of land does not arise as far as India is concerned, because ours is a vast country and we have quite a lot of land still which can be inhabited and which can be brought under cultivation.

L. E. Obeng (Ghana)

I think the same thing applies to Ghana, we do not have any problem with land reclamation. We are primarily agricultural, we have a large area for planting carbohydrate food stuffs, we do not have much land for producing meat, but in spite of all that we are not vegetarians. We used to depend a lot on fish from the sea but now with our lake we are hoping to have more fish from the river, but it has not interfered with our agriculture at all.

D. U. Mizoguchi (Japan)

On the question of land or fish Japan has, of course, very small areas of land and a very great population, so we send fishing fleets out into the open sea but that open sea is getting narrower. It used to be a national limit of 3 miles off the coast of a country now they are making it 12 miles, 20 miles, 30 miles, so the open seas are getting narrower and narrower. We have to think of that too. Deep water fishing helps to solve some problems of fishing.

I. Ghose (India)

Regarding the question of land, I would like to say that round Calcutta there is a very big land reclamation project going on because of the crowded conditions in Calcutta city, and the Government has a plan to provide accommodation for everybody. There are several fisheries and the fishery owners gave a lot of opposition to the Government against the reclamation of land and it became a legal dispute. This is still unsolved as the public want accommodation and housing as well as fish to eat.

M. C. Phillips (U.K.)

I would like to speak as a nutritionist at this Conference. I work in the field of applied nutrition, which Miss Hollingsworth referred to in her talk yesterday. I work in the area of educating the consumers in this country about what is the nutritional value of food, and how to construct a balanced diet. Now I would like to illustrate the difficulty of this problem by saying that the Indian lady has talked about fish being the most nutritious of all foods. She was speaking to a Conference of educated women and I feel that it should be made clear that as nutritionists we try not to stress the value of a single food in maintaining health. It is the importance of a balanced diet, which is the right combination of food, which matters much more than the concentration of nutrients in one particular food. May I say about fish that although it is a nutritious food it is not by any means a completely balanced food, it lacks the mineral iron, for instance, and it lacks vitamin C, and so one cannot rationalise and say that this is the most nutritious food. It does not really matter if you get your protein from fish, meat, cheese, eggs, or milk, all that matters is a balanced diet with the right combination of foods.

The Application of Technology - Future Trends **5 July 1967**

In the Chair **Paula Ta1paert (Belgium)**

Application of physics to some economic problems in Nigeria
Ebun Adegbohungbe (Nigeria)

Meteorology and the world's food supply
G. M. DeSanto and H. E. Cramer (USA)
(presented by Aileen Cavanagh (USA))

Application of statistical quality control to the food industry
Ana Maria Flores (Mexico)
(presented by Cicely Thompson (UX))

Production of synthetic food materials: a statistical survey
Mary Nan Steel (USA)

Comment accoitre la fixation biologique de l'azote
T: Rouquerol (France)
(presented by Danielle Masson (France))

La production industrielle de proteines alimentaires à partir du petrole **C. Y. de Mayo (France)**

Discussion

Paula F. Talpaert

Paula Talpaert was in 1944 - last year of the dark times of German occupation - qualified as Chemical Civil Engineer by the University of Ghent. She accepted directly to assist Dr. Engineer F. Bosch, Professor of Inorganic Industrial Chemistry with his research works for the SIRIA, about methods of micro-analysis of hydrogen, oxygen, nitrogen **...** in metals, and others. In 1948 she was appointed leader of a control laboratory in the pharmaceutical factory: "Ancienne Maison Louis Sanders". In 1958 she joined a clinical laboratory, where she became acquainted with biological and biochemical problems. In 1959 she was promoted lecturer in Chemistry in a School for Technical Engineers in Mechelen.

APPLICATION OF PHYSICS TO SOME ECONOMIC PROBLEMS IN NIGERIA

By **Ebun Adegbohungbe**, M. Sc. London, D. I. C.

Ebun Adegbohungbe is a lecturer in Physics at the University of Ife Nigeria. She obtained her degree in Physics at the University College of Ghana. She did a Post-Graduate course in geophysics at Imperial College London and was awarded the degree of M.Sc. in 1963. She joined the staff of the University of Ife in October 1963 and has since been engaged in research on the use of modern nuclear magnetometers for magneto measurement in Equatorial Zones. She has recently completed a research Project on "A new method of making vector measurement in the Equatorial Zone using the Proton Precession Magnetometer".

Summary A sketch of the food problems in Nigeria is given and its relationship to the problems of Capital for Development in Nigeria. One of the ways of inviting large capital to Nigeria is by exploitation of the mineral resources of the country. The special problems of mineral exploration in Nigeria are discussed and reference is made to the advantages of magnetic method for mineral exploration in Western Nigeria. A case history of the search for Iron Ore in Akunnu area of Western Nigeria is described. The future plan of the Department of Physics in the field of geophysical studies and research is discussed with special reference to mineral investigation in the region. In conclusion, Industrialisation in Nigeria is discussed. It is the answer to the country's, economic problems.

APPLICATION OF PHYSICS TO SOME ECONOMIC PROBLEMS IN NIGERIA

By **Ebun Adegbohungbe**

The first question to be asked is, "what are the economic problems in Nigeria". The problems are numerous hence the solutions will in no doubt be equally diverse. Analysis of the economic problem is briefly discussed under the following headings

1 .Food Problems in Nigeria
2. Problems of Capital for Development
3. Exploration of Natural Resources

1. Food Problems in Nigeria. Nigeria is predominantly an agricultural country and this in fact means that on the average it is always possible to eke out something out of the ground for consumption. There are two main seasons - Rainy Season and Dry Season. An average village farmer has plenty to eat and keep his family well fed during the Harvest season but during the Dry season, he survives primarily on what had been preserved mostly in dried forms. Generally speaking therefore he never really starves when it comes to having enough bulk material to feed one's stomach. But there are other deficiencies in his feeding like milk, meat, eggs which he cannot produce and have to be bought with cash from shops and markets. Lack of these items often leads to malnutrition in children whose parents are poor and most parents fall under this category. Malnutrition in children often led to various diseases and high rate of mortality. Even in many cases where the Government has set up many poultry farms and many eggs are being produced daily for the public to buy, the prices are such that the majority of the population in towns and villages have just not got the money to buy them. Hence whichever way you look at it, an average family must have enough means of livelihood or jobs which will provide him with sufficient cash to meet the demands of modern life. The mere fact that he does not actually starve does not make the problem any less acute especially when one considers the effect of malnutrition on the children. What then can the Government do to help the people. Young educated and trained farmers will require capital to set up modern farms. The average uneducated farmer cannot sell the extra foodstuffs from his farm at higher prices because there are no markets for them. He depends mainly on the home markets. One way by which the Government can help the people is by setting up industries which will make use of both farm products and other natural resources. This brings us to the second problem.

2. Problems of Capital for Development. Before the Government can Bet up new Industries, there must be capital for Development. In cases where industries have been set up in partnership with overseas firms who provide part of the capital there had been partial success because in some cases raw materials have been imported at high costs for such Industries, with the result that prices of such articles are often the same if not higher than imported ones, hence selling is slow and expansion is very slow. One of the ways by which large capital can be diverted to Nigeria is by exploitation of the mineral resources in the country. This brings us to the third problem.

3. Exploration of Natural Resources. Exploration of the country' s mineral can be carried out in many ways. The Government can commission a group of experts to do the job, but this means some drain on the little capital because such work requires many experts and expensive equipment. In the case of geophysical exploration for oil and gas, the Oil Companies have done a lot of work in this respect but there is still a great need for more workers, and skilled scientists. Often as it is the case in Western Nigeria, the problems of mineral exploration are peculiar to the areas. Special techniques and new devices are required. Under circumstances like this, Universities in Nigeria cannot afford, and, in fact, must not work in isolation. Scientists in various fields of research and studies must bear in mind the problems facing the country. While I am not advocating that Scientists in Nigeria must dedicate their work and studies to the country's problem alone, nevertheless they must bear in mind these various problems and must their contribution to the advancement of the country. Scientists in Nigeria whether a Nigerian or an expatriate will be failing the country if he possesses the requisite skill and training and does not aspire to make his contribution to the development of the country.The problems of development in Nigeria are diverse and there are rooms for contributions from all, - Biologists, Chemists, Physicists, Engineers, Geologists etc. Geophysics is a special field of physics, which covers a very wide range of applications of physics. In Nigeria, a lot of work had been done by the Nigerian Geological Survey and Geology Departments in Nigerian Universities, but in the thick rainforest areas in Southern Nigeria, the problem is not that of how much is known of "the geology of the area, but how much can be known. Rock exposures are scanty and there are enormous areas of thick forest and thick soil overburden. " The consequence of this is that special techniques of geophysics are required for mineral exploration. Hence the methods and techniques of geophysics are important physical tools for the exploration of the mineral resources of Western Nigeria in particular.

The question then arises as to how physicists can make contributions towards the exploration of the country' s natural resources, bearing in mind the special difficulties which may be encountered. The magnetic equator runs across Nigeria and this fact has contributed a lot to the growing interest in Geomagnetism in Nigerian Universities But a great deal of the work done so far has been centred round the Equatorial Eleotrojet which is an anomalous current system in the Ionosphere round the magnetic equator. While every encouragement should be given to research workers in this field, we must not lose sight of another aspect of magnetic measurement which can help toward. the solution of Nigerian's economic problems as outlined, in the field of mineral exploration.

<u>Magnetic Method of Mineral Exploration.</u> Magnetic field measurement has now become one of the essential tools of mineral exploration. It is a well known fact that most rocks owe their magnetisation to the presence of magnetite and other iron compounds. The presence of iron ore in an area can be easily detected by making a magnetic survey in the area with modern magnetometers. The problems involved are two fold - method of measurement and detailed quantitative analysis of the results. within the last two years I have been engaged with the problems of magnetic field measurement in Western Nigeria and it is been discovered that often techniques which work perfectly at higher geomagnetic latitudes need a great deal of modification because of the special geomagnetic field configuration in Nigeria. Hence part of my research work in the Department had been centred round the development of suitable equipment for magnetic measurements in equatorial zones. The method of interpreting a magnetic anomaly in these special areas of Nigeria has proved specially difficult because of lack of any geological data which had helped a great deal in the interpretation of magnetic anomalies in higher latitude. Hence the question of mineral exploration in Nigeria is as much of a challenge to Physicists as it is to geologists. In many oases there are no outcrops of mineral zones and their detection had to be carried out using special techniques. In Western Nigeria we are faced with vast heavy forested areas with scanty rock outcrops. A typical example of this sort of problem is given below.

<u>Search for Iron Ore in Akunnu area of Western Nigeria.</u> Figure I shows a section of the area which was investigated. The vegetation shown in the picture is not as thick as the type encountered in many other parts of the region. Akunnu can be described as a semi-savannah area, Akunnu village is about 20 miles from any big size town. There is no water and no electricity. The inhabitants of this village and other nearby villages in the area are farmers. The agricultural yields of the area are poorer than those of other parts of the region. It will be correct to say that the people do not actually starve but their

diet is very poor and completely deficient in protein. Beans which are the only source of protein are harvested once a year. During the dry season when very 1ittle food crop can be obtained from the farms, the inhabitants depend solely on Gari which is a dried form of starchy food with little food value. At other times i.e. during the rainy season they can get plenty of yams, maize, vegetables and fruits. Meat diet is strictly limited to few games trapped by the farmers on their way to the farms. Meat is only taken on these rare occasions because there is very little cash actually earned during the year with which they can purchase meat, eggs and milk. There are no indications of any minerals in all the rook outcrops found in the area but the vigilant farmers collected few samples of iron ore in the laterite cover. The sizes of these samples vary from hand specimens to very small sizes. A party of Government geologists visited the area at one time but further geological search revealed no further information on the possible source of these few samples. This problem was brought to the notice of the Physics Department about two years ago. It became obvious that if there is iron ore in the area it cannot possibly be discovered by wild cat drilling without a prior thorough magnetic field survey because the mineral zone is underneath the surface. The electromagnetic method of geophysical exploration failed as a result of the thick overburden and weathered zones which are often encountered in the tropics. It as then decided to make a magnetic field survey in some parts of the area. A technique of measurement particularly suitable for the survey was adopted before the survey was carried out. The measurements revealed definite significant magnetic anomalies but the quantitative analysis of these anomalies is in progress. This has opened new fields of investigations which can be carried out in other parts of the region. There are more examples of such problems in the region. There are indications of gold, tin, nickel etc., which have to be investigated by geophysical methods because the mineral zones are underneath the surface. Hence geophysical method of investigation is a valuable tool for mineral exploration in the region and the study of geophysics is important to the economy of the country.

Our programme of studies in the department of Physics are flexible enough to accommodate a programme of research that will make concrete contributions to the economic development of Nigeria. The programme will cover research projects in Geophysics. We intend to draw out a comprehensive research programme in the field of applied geophysics which will aim primarily at solving some of the problems of mineral exploration in the basement areas of the country. The basement in the Western Region alone is close to 18,000 sq. miles in area, and the known economic potential of this basement area is very meagre indeed compared with metamorphic terranes in other parts of the world. The exposed rocks in the isolated hills form only a very small part of the area underlain by basement rocks, hence the search for valuable economic minerals must be extended to the unexposed areas. Consequently there will be many research projects in the various techniques of geophysics - magnetic, seismic, gravity, electrical, electromagnetic and nuclear methods, to keep the Post-Graduate students and the staff busy for a very long time. Fortunately the Government of Western Nigeria is aware of the importance of this field of study to the Region in particular and has financed certain specific projects but geophysical equipments are very expensive and the Government has other commitments. Hence we would always be grateful for any form of assistance from advanced countries of the world.

Industrialisation in Nigeria. Large and small scale industries which will depend on the mineral resources of the country must be built in order to improve the standard of living of the people. These industries will provide jobs for young school leavers. An increase in cash earned per member of a family means in effect that there will be more money available to purchase nutritious foodstuffs like milk, meat and eggs which are the main deficiencies of the average Nigerian diet. In addition industries which will make use of some of the farm products must be encouraged in order to provide more lucrative outlets for these products. Industries in Nigeria must develop along these two channels.

Conclusion. In conclusion, I will like to stress that the problems of food in Nigeria cannot be divorced from the major economic problems facing the country. Industries are needed in the country but such industries must make use of the country's mineral resources. Nigerian scientists, therefore, must make their own contributions in their various fields of learning and research, to the economic progress of the country.

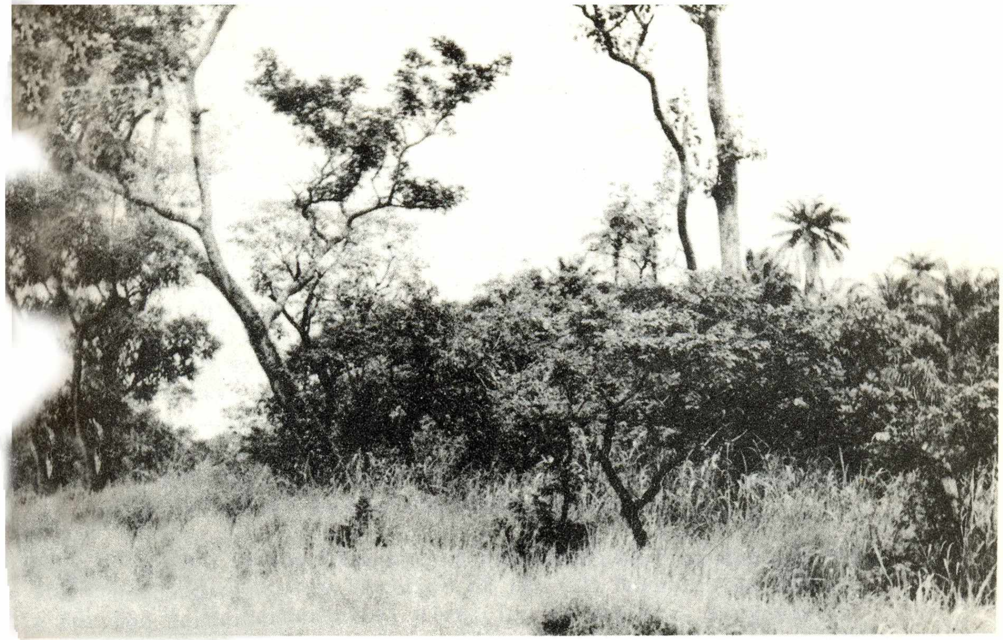

Fig. I A section of the area of investigation in Akunna, Western Nigeria.

METEOROLOGY AND THE WORLD'S FOOD SUPPLY

By **G.M. DeSanto**, B.S.,M.S. and H.E. Cramer, A.B.,S.M.,Sc.D.

Mrs. DeSanto is a Senior Scientist in the Laboratory of Applied Meteorology in the Technology Division of the GCA Corporation in Bedford, Massachusetts. She obtained the B.S. degree in physics at the University of Puerto Rico, and the M.S. degree in meteorology at New York University. From 1957 through 1961, she worked in the Research Department of the Grumman Aircraft Engineering corporation as a technical advisor on meteorological phenomena associated with space physics and aerospace engineering problems. For the past five years she has principally been engaged in basic studies of atmospheric dispersal processes and low-level atmospheric structure and has specialized in the adaptation of automatic data processing techniques to the conditioning, analysis, and interpretation of geophysical measurements.

Dr. H.E. Cramer is the Director of the Laboratory of Applied Meteorology in the Technology Division of the GCA Corporation and is responsible for the technical direction of research programs in atmospheric dispersal processes, air pollution, turbulent-structure, and microscale and mesoscale meteorology. After graduation from Amherst College, he obtained the S.M. and Sc.D. degrees in meteorology at the Massachusetts Institute of Technology. From 1949 through 1964, he was a Research Scientist at the Massachusetts Institute of Technology and, after 1952, the Leader of the Micrometeorological Research Group at M.I.T. 's Round Hill Field Station. The work of the Round Hill Group in atmospheric turbulence and diffusion processes has received international recognition.

Summary The importance of meteorological factors in all aspects of agricultural food production is described and the potential significance of recent advances in knowledge encompassing all scales of atmospheric motions with respect to the vast increase in food production required in the next few decades is indicated. These advances include the use of meteorological satellites for global storm tracking and for measurements of atmospheric structure needed for long range weather prediction; studies of the energy budget of the atmospheric surface layer and of the microclimate within crop stands and the relationship of these factors to crop growth; and, the modification and control of climate and weather.

METEOROLOGY AND THE WORLD' S FOOD SUPPLY

By **G. M. DeSanto** and **H. E. Cramer**

Introduction The doubling of world population expected by the end of the present century will clearly require a corresponding vast increase in world food production. According to United Nations' estimates, more than 85 percent of the projected population increase will occur in Asia, Africa, and Latin America, where the current average daily diet is some 300 calories less than the minimum of 2300 calories considered essential for normal health and activity. The problem is further complicated by the fact that increased population density will seriously reduce the per capita acreage of arable land. Since only about 10 percent of world's total land area (3.5 billion acres) is now so classified, considerably less than 0.5 acres will be available by the year 2000 to support each person in the present diet-deficient areas. Any long-range solution to the problem of feeding an increased world population must largely lie in helping these deficient areas to develop the ability to feed themselves by a massive increase in agricultural productivity. This can only be brought about through the adaptation of scientific and technological skills to the physical, economic, social, and political factors characteristic of each area.

Of the physical factors that govern food production, the meteorological factors that act to produce weather and climate are of paramount importance. In the past, the principal contributions of meteorology to food production have been in the areas of short-range weather forecasting and in the accumulation of the various statistical measures of environmental states that form the basis of climatology. Fore casting services in the United States have included advance warnings of severe weather conditions likely to damage crops or otherwise to interfere with food production and semi-quantitative predictions of regional temperature and precipitation patterns for the next 7-day and 30-day periods. Within the past quarter century, and particularly within the past decade, there has been a substantial increase in the number and quality of meteorological observations of all types. In addition, there has been a rapid increase in our knowledge of the physical processes responsible for weather and climate. This improvement stems from empirical studies based on the newer observational data and from laboratory and theoretical investigations. This work encompasses all scales of atmospheric motions from the global wind systems of the general circulations to the microscale energy exchange processes that occur in the shallow boundary layer immediately above the air-earth interface. These advances in meteorology have important and potentially far-reaching implications for agriculture and food production. Improvements in weather prediction for a broad spectrum of space and time scales only partially covered by existing procedures and in our knowledge of the physical relationships between food crops and environmental factors seem to be assured. Moreover, there exists the possibility of modifying or controlling environmental factors so as to benefit agriculture and other food producing activities.

The purpose of this paper is to describe recent developments in meteorology that are relevant to the overall problem of food production and to point out how these and future developments may contribute to increased food productivity within the next few decades. The discussion presented below treats the following major topics: the use of weather satellites for the global tracking of storms and for measuring long and short-wave radiation, and various other meteorological parameters that govern atmospheric dynamics; a review of the present outlook for weather control and modification, including the use of cloud seeding and other techniques to modify storms, to alter precipitation patterns, and to suppress hail and lightning; and studies of energy exchange processes near the air-earth interface that determine the microclimate within and near crop stands.

Meteorological Satellites Perhaps the most exciting and important development in meteorology during the past decade is the use of satellites to obtain cloud photographs and radiation measurements on a global scale. Since clouds are a characteristic feature of storm systems, weather fronts, and air masses, the availability of continuous, detailed information on cloud cover makes possible the identification and tracking of major meteorological events and aids in weather predictions for periods of 24 to 36 hours. Measurements of solar and terrestrial radiation are essential to research studies of atmospheric dynamics that provide the basis for possible climate control and modification and also provide valuable information for use in weather forecasting and the tracking of storms and air masses. These radiometric measurements are a1so directly related to photosynthesis and other processes that govern plant and crop growth. To date, the use of meteorological satellites has been principally an activity of the National Aeronautics and Space Administration (NASA) and the Weather Bureau in the United States. Two types of meteorological satellites have been used in the U.S. program -- Tiros and Nimbus. A description of these satellites and a summary of the results achieved thus far in the program are presented below. The following discussion is based in part on material contained in a recent book by Widger (1966).

Since April 1960, ten Tiros satellites have been placed in orbit and four of these are still in operational use. Each Tiros is in the form of a cylinder with a diameter of about 1 meter and a height of 0.5 meters. The weight of a Tiros satellite is approximately 120 kilograms, and the electrical power required for operating the various equipment is supplied by some 9000 small solar cells located on the sides and top of the external satellite structure. The meteorological sensors consist of two vidicon television cameras, one with a wide angle lens and the other with a narrow or medium angle lens for photographing the earth and its cloud cover, and radiometers for measuring reflected solar radiation and infrared radiation emitted from the earth and the atmosphere. Accessory equipment includes storage batteries, control devices and clocks, stabilizers for controlling the absolute directional orientation of spin axis of the satellite, beacon transmitters for use in tracking, telemetry for reporting information on the functioning of various devices, tape recorders for storing sensor output information when the satellite is out of range of ground data-acquisition stations, and radio transmitters and antennas for relaying information to and from ground stations. Some idea of the cost of the satellite program is given by the fact that approximately 15 million dollars was required to develop, build, test, launch and operate the first Tiros satellite. Successive Tiros have cost about 4 million dollars each: one million for building and testing the satellite, 2.5 million for launching and placement in orbit, and 0.5 million to operate the data acquisition stations.

The most spectacular achievement of the Tiros program has been the observation and tracking of some 93 typhoons in the Pacific Ocean and 30 hurricanes in the Atlantic Ocean from April 1960 through September 1965. During the same period, about one-half million useab1e cloud photographs were produced. From these, over 20,000 cloud cover analyses or nephanalyses were constructed and about 2500 special storm advisories -- both national and international -- were issued. The Tiros data are also being used to increase our basic knowledge of atmospheric physics. Feature of the first satellite observations to attract wide scientific interest were the spiral cloud patterns associated with major storm systems and cloud vortices formed in the lee of mountain ranges and islands (Fritz, 1961). Study of radar measurements from ground and airborne stations synchronized with Tiros cloud photographs in regions of moderate to heavy precipitation has led to new methods of weather radar operation that involve the integration of radar patterns over periods of several hours to obtain data representative of storm areas. Studies of the Tiros radiometric measurements have to date confirmed the general accuracy of the data and have laid the foundation for comprehensive studies of time and space variations of the atmospheric albedo and the outgoing long-wave radiation (Allison and Warnecke, 1966). An example of this type of information obtained from Tiros VII radiometric measurements is shown in Figure 1 (after Tepper, 1965). For the latitude bands from 60° N to

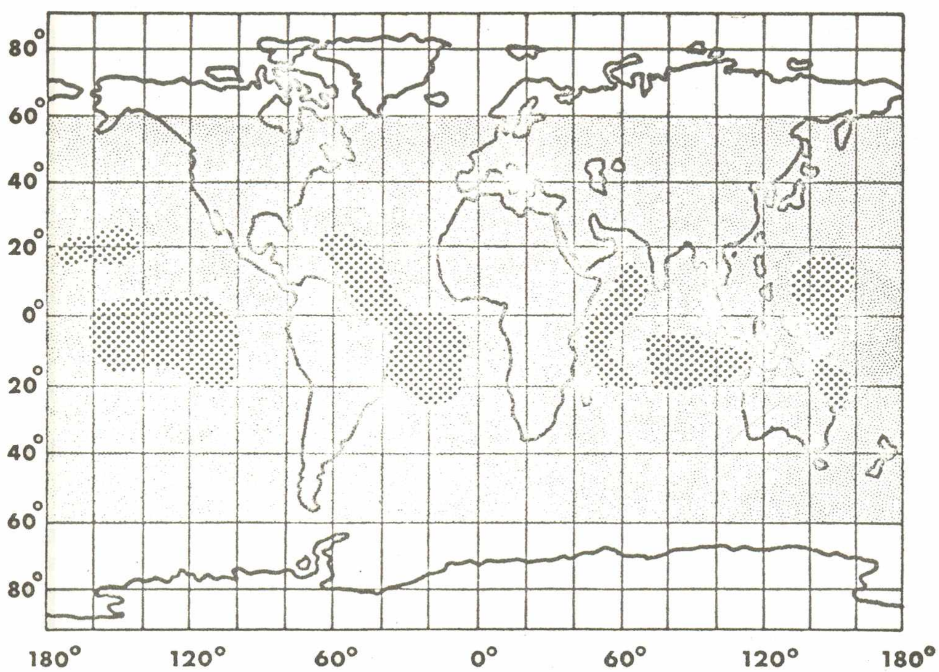

Fig. 1 Regions of strong solar absorption

to 60° covered by the Tiros VII orbit, the relative amount of solar energy observed by the earth's oceans and land ,masses is indicated by three shades - dark for very strong absorption, medium for moderate absorption, and light for ,regions of weak absorption. The figure indicates that the absorption of solar energy is highly concentrated within the ocean areas of equatorial latitudes.

Various non-meteoro1ogical features inherent in the Tiros data are of interest for their potential usefulness in agricultural applications. In the absence of clouds, the photographs reveal major topographic and surface features including bodies of water, vegetation and snow cover. In a recent study of potential peacefu1 uses of earth observation spacecraft, the University of Michigan (1966) has concluded that the prime measurements for agricultural applications are those per mitting identification of crops, areas covered by individual crops, estimates of crop yield, and general assessment of water availability.

The success of the Tiros program has led to the planning and development of a Tiros operational system by the U.S. Weather Bureau. The first phase of the system, which is expected to be operational in 1967, requires two spacecraft be in orbit at all times - one to provide global data and the second to provide local high-resolution data for local uses. Successive stages of system development call for the eventual elimination of one spacecraft and the development of high resolution infrared radiometric sensors to provide satisfactory nighttime cloud cover measurements on both global and local scales.

The Tiros system described above has a number of serious limitations. Of these, perhaps the most serious is that the Tiros measurements are inadequate for locating areas in which new storms might be expected to develop or for predicting changes in the intensity or trajectory of existing storm centers. The accomplishment of these objectives requires reliable quantitative measurements of radiative flux and vertical profiles of temperature, wind, moisture, and other meteorological parameters on a global scale. The Nimbus satellite program, which is designed to achieve the above measurement requirements, was started in 1959 and two spacecraft have already been placed in orbit. Nimbus I was launched on 28 August 1964 but became inoperative after about one month's operation due to the failure of the paddle wheel mechanism used in converting solar energy to electrical power. Nimbus II was launched on 15 May 1966 in a nearly circular polar orbit and is still performing satisfactorily. Results obtained from a preliminary analysis of Nimbus II data have been reported by Nordberg et a1 (1966).

Although the United States has taken the lead in developing meteorological satellites, detailed plans for an international cooperative effort in the use and processing of satellite information have been made through the World Meteorological Organization (WMO) of the United Nations. An International Meteorological Satellite Workshop, sponsored jointly by NASA and the U.S. Weather Bureau, was held in 1961 to acquaint scientists from twenty seven nations with the details of the Tiros program. During the past year, a World Weather Program has been initiated by the WMO that provides a long-range plan for the coordinated use of computer facilities, meteorological satellite data, and new techniques for probing the atmosphere.

Weather and Climate Modification One of the potentially most effective ways to increase agricultural food production is that of artificially modifying the microclimate of the atmospheric surface layer to produce optimum conditions for crop growth. Similarly, the prevention of severe weather phenomena such as floods, droughts, tornados, and hailstorms would clearly remove major causes of crop failure. In a limited sense, environmental modification has been successfully practiced by agriculturists for a long time as evidenced by the various methods available for protecting crops from frost damage and for supplying the water needed for crop production in arid or semi-arid regions. The use of thin chemical films to retard the evaporative heat loss from rice paddies (Mihara, 1962) may be cited as a recent example of small-scale environmental modification. Prior to the past decade, the purposeful modification of larger scale atmospheric processes was generally thought to be outside the legitimate bounds of science and technology. This point of view, however, has been radically altered by the recent advances in meteorology previously noted and by similar developments in the other disciplines that make up the environmental sciences.

As a result of the technical advances outlined above and a recognition of the potentially large benefits to world population resulting from even a small measure of success in weather and climate control, the U.S. National Academy of Sciences undertook a comprehensive 2-year study of the scientific and technical aspects of the problem. The results of this study (National Academy of Sciences, 1966) provide an authoritative and up-to-date assessment of the present status of weather and climate modification and the future prospects. The conclusions that are of direct importance to agricultural food production are summarized below.

Modification of Clouds and Storm Systems Available evidence indicates that cloud seeding techniques can increase precipitation amounts from some types of cumuliform clouds and from winter orographic storms by about 10 percent. This produces some areal redistribution of precipitation with a similar percentage decrease at longer downwind distances. The evidence for increased precipitation from the seeding of extratropical cyclones is at present inconclusive. Evidence for the effective suppression of hailstorms or the mitigation of crop damage from hail is contradictory. Cloud seeding experiments in the U.S., Switzerland, and France using silver iodide generators located on the ground or in aircraft have so far been inconclusive. Scientists in the Soviet Union report significant success through the use of antiaircraft shells and rockets to introduce silver iodide directly into the supercooled high-liquid-water-content portion of cumuliform clouds.

Experiments in lightning suppression are beginning to show promising results. The physical concept is to produce, through silver iodide seeding, an abnormal abundance of ice crystals that act to reduce the electrical potential gradient within thunderclouds and thus prevent the development of lightning strokes.

Modification of hurricanes and tornados is not likely to be successful until the development of adequate theories accounting for the genesis and behavior of these storms. Calculations show that brute-force techniques are likely to be ineffective.

The feasibility of dissipating supercooled fogs and low straws clouds over limited areas has been effectively demonstrated by the operational clearing of airport fogs in the western U. S., Greenland, and the Soviet Union. Dry ice, silver iodide, and liquid propane have all proved to be effective cloud-seeding materials. No significant progress has been reported in recent years in efforts to dissipate warm or non-supercooled fogs and stratus clouds.

Modification of the Weather and Climate Over Very Large Areas There is at present no known way in which predictable changes in the weather and climate over very large areas may be deliberately induced. Even if the technological capability of triggering massive atmospheric reactions should be developed, experimental use of this capability must be delayed until all the important consequences can be predicted with satisfactory precision.

Three avenues of research are suggested for improvements in existing knowledge of the feasibility of large-scale modifications in weather and climate - development of a comprehensive theory of natural climatic change; simulation of global atmospheric behavior using high speed computers; and, intensive study of energy-exchange processes in the air-earth, air-ocean boundary layers.

Modification of Local and Regional Climates The future potential of local (agricultural) and regional (desert) climate modification rests squarely on progress in understanding boundary-layer energy exchange processes. It appears theoretically feasible to ameliorate desert conditions in certain regions by altering the thermal properties of limited ground areas. As yet, no full-scale field tests of proposed methods have been made.

There is little question that weather and climate modification will play an increasingly important role in efforts to increase global food production. The most immediate contributions will be restricted to microscale atmospheric processes that influence the microclimate within crop stands and to mesoscale processes governing the precipitation amounts over surface areas of a few hundred square miles and the severity of hailstorms and other crop-damaging phenomena associated with thunderstorms. Further progress in weather control and modification will depend on the extent to which a satisfactory understanding of the complex physical processes that govern all scales of atmospheric motion can be achieved and the precision with which future atmospheric states can be predicted.

<u>Meteorology and Agricultural Food Production</u> Meteorology and crop growth are inextricably linked through the energy exchange processes that occur at the air-earth interface and in the adjacent atmospheric surface layer. Solar radiation arriving at the interface is the primary energy source for all atmospheric motions and for all plant life. Furthermore, the conversion of the incident radiant energy into stored chemical energy by photosynthesis and the physiological processes responsible for crop growth are both critically dependent on the microclimate within crop stands. The distributions of temperature, carbon dioxide, moisture, and other atmospheric constituents that comprise the microclimate in turn directly reflect the energy exchange processes occurring near the air-earth interface. Finally, these same processes form a vital link in the atmospheric energy cycle. A satisfactory knowledge of the energy budget and energy exchange within the atmospheric surface layer is thus requisite for understanding both atmospheric dynamics and agricultural food production.

Although certain features of the microclimate within and near vegetation canopies have been known for some time (Geiger, 1957), measurements of the energy budget within crop stands have been made only within the past five or ten years. These studies, which are still fragmentary, have utilized measurement and data-analysis techniques developed for micrometeorological investigations of energy transfer processes above open fields or general terrain (Lumley and Panofsky, 1964; Webb, 1965).

Energy transformations that occur within crop stands and the interrelationships among these transformations, meteorological factors, and plant growth may be briefly described as follows. Of the total solar radiation incident on a typical crop stand, approximately 50 percent is absorbed by the leaves and the remainder is either reflected back to the atmosphere or absorbed by the underlying soil surface. A small amount of the radiation absorbed by the leaves is converted to chemical energy by photosynthesis. Most of the remaining energy is used to evaporate water from the leaf surfaces or is lost. to the environment through convection. Also, the crop stand and the soil continuously emit long-wave radiation to the atmosphere. The energy budget within the crop stand is approximately given by the simplified heat balance equation

$$\mathbf{R = H + LE + S} \qquad \mathbf{(1)}$$

where R is the net radiation, or the difference between the incident solar radiation and the outgoing long-wave radiation, H is the vertical flux of sensible heat, L is the latent heat of vaporization, E is the vertical flux of water vapor and S is the sum of the sensible heat stored in the soil and in the crop structures. The vertical fluxes of sensible heat H and water vapor E may be defined by equations of the form

$$\mathbf{H} \, \alpha \, \mathbf{K_H} \;\; \partial\mathbf{T}/\partial\mathbf{z} \qquad (2)$$

and

$$\mathbf{E} \, \alpha \, \mathbf{K_E} \;\; \partial\mathbf{e}/\partial\mathbf{z} \qquad (3)$$

where K_H and K_E are the respective transfer coefficients for sensible heat and water vapor and the derivatives refer to the vertical gradients of air temperature T and water vapor e within the crop stand. This method of defining the fluxes is tractable only when certain rather restrictive assumptions are made concerning the coefficients and K_E. In practice, they are frequently assumed to be equal. Alternatively, the fluxes are more elegantly expressed in terms of the covariances; wT and we where the overbar denotes a time average and w is the vertical component of the wind velocity.

Highly specialized measurement and data-analysis techniques are required to obtain satisfactory measurements of the various quantities that determine the energy budget within crop stands. This largely explains the scarcity of empirical data; at present comprehensive measurements are available only for a few crops under very specialized conditions. Recent energy budget studies included those of Penman and Long (1960) Saito (1962), and Stoller and Lemon (1963) in wheat; Uchijima (1962) in rice; Begg et al (1964) in bulrush millet; and Brown (1964) in a cornfield. The latter found that 46 percent of the net radiation was used for transpiration, 13 percent for the evaporation of water vapor from the soil, 32 percent for sensible heat flux, and 6 percent for soil heat flux. The remaining few percent are presumed to be accounted for by storage which was not measured. In addition, the measurements indicated that 16 percent of the net radiation reached the soil surface beneath the crop. Calculations of the overall aerodynamic exchange coefficient for various crops based on daytime measurements are presented in Table 1. The wide range of values for the exchange coefficient shown in the table reflects in part the crudity of the measurement techniques and emphasizes the need both for required experimental procedures and many more comprehensive measurements. Until the energy exchange processes and the energy budgets within the various crops are known with satisfactory precision, an understanding of the dynamic interactions between crop growth factors and microclimate factors is not possible.

Table 1. Exchange coefficients calculated for the top and center of various crops as reported in the literat

Crop	Crop Height cm	Exchange coeffcient Cm^2 sec^{-1}		Wind speed Cm sec Top of crop	NOTE	Method	Source
		Top of Crop crop	center of				
Corn (Zea mays)	240 240 240 140 300 300	5400 2500 1400 754 700 250	2300 700 300 230 146 62	380 210 110 120 140 80	1 2 1	Turbulent Fluctuation Momentum balance Turbulent Fluctuation	Stoller and Lemon (1963) Uchijima And Wright (1964) Wright and Lemon (1962)
Bulrush millet (Pennseum typhoides s.&N)	250	3500	550	-----		Energy balance	Begg et al (1964)
Wheat(Triticum sativum)	100 130 60	1000 ------ 1000 900	420 100	----- 400 -----		Energy balance Turbulent Fluctuation Estimated from H_2O Vapour flux	Saito (1962) Stoller and Lemon (1963) Penman and Long (1960)
Rice (Oryza savita)	80	600	90	-----		Energy balance	Uchijima (1962)

1 Corn tasseled.
2 Corn not tasseled, dense leaf area at top.

Measurements by Fritschen and van Bavel (1962) of the energy budget of evaporating surfaces in arid lands are of special interest due to the excellence of the experimental techniques and the importance of obtaining maximum utilization of arid lands in food production. From data obtained over a wet, bare soil surface and over an extended shallow water surface, these investigators found that the average daily sensible heat flux was directed into the soil or water surface and that the rate of evaporation from a wet soil surface exceeded that from a free water surface. Also, under similar solar radiation conditions, the energy loss due to evaporation was correlated with the wind speed.

Micrometeorologica1 factors enter into many other aspects of crop production that include the influence of low-level winds and turbulence on crop dusting (Inoue, 1960), the protection of crops from frost damage, and the wind transport of soil and snow. Within recent years, agricultural meteorology has become an important area of scientific enquiry that brings together such disciplines as atmospheric physics, climatology, plant physiology and soil mechanics. The current status of the work in agricultural meteorology is described in a recent monograph published by the American Meteorological Society (1965).

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STATISTICAL QUALITY CONTROL APPLIED TO FOOD CANNING

By Ana Maria Flores

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She has written two books besides her Thesis in Mathematics: “The Magnitude of Hunger in Mexico" and "New methodology for the Calculation of Index Numbers".

Summary: Statistical Quality Control is a powerful tool when applied to food canning. It is like an assembled product. The probability of the quality of the canned food is equal to the intersection of the quality's probabilities of every step followed during the process of manufacture.

It is necessary to give a high probability (close to unity) to every step, in order to obtain a minimum percentage of defective cans.

STATISTICAL QUALITY CONTIOL APPLIED TO THE FOOD INDUSTRY

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Statistical Quality Control applied to Industry is a powerful tool in the industrial and economical development of a country.

This technique has been advancing very rapidly and is an important branch of Mathematical Statistics. The theory of Probability and the Sampling Theory -- are applied to save time and money.

When an industry is trying to measure the quality of its manufactured --products, it is very likely, that if it does not use Statistical Quality Control, it will confront a disagreeable situation; the product will not have the desired quality, 3 great deal of money will have been spent, there will have been an ---unnecessary waste of material and much time will have elapsed in its manufacture before it can be sent into the national or international markets. The product will have little acceptance because it lacks the required standards, because of its high price and because it is offered out ot time!

The statistical Quality Control is technique that every industrial engineer should know so that it can be applied to the different steps of an industrial process. Its application is not difficult and it supervised by the engineer, any of the workers at the factory can apply it without neglecting his usual --occupation and with the feeling that he is being more useful to the Company he works for, and even creating a new ideas which can be very useful to the Industry.

There is a, lot of *literature* on the Theory of Statistical Quality Control and it is not the purpose of this paper to call attention on this know1edge.

In this paper I propose to give a more advanced step; by giving some ideas and formulae tending to help the food canning industries.

Canned foods are being sold very well the world over, but unfortunately they are sometimes dangerous to eat because they lack the statistical quality -control used during the process of their manufacture.

We should think of canned foods as a multi-assembled product:

Let A be the canned product ready for sale, let B_1, B_2....................... B_n be all the different steps taken in the manufacture of the product.

Then X_1, Y_1 Y_2 .... Y_n will be random variables related respectively, to A, B_1, B_2... B_n with normal distributions and with standard deviations

$$\sigma, \quad \sigma_1, \quad \sigma_2, \ \ldots\ldots \ \sigma_n.$$

We define

$$A = \left[|X| < 1.96 \ \sigma \right] \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (1)$$

$$B_j = \left[|Y_j| < 1.96 \ \sigma_j \right]; \quad j = 1, 2, \ldots\ldots\ldots n \ (2)$$

Taking for t as the value 1.96 at a confidence level of 95%.

Then

$$A = A' \bigcap \bigcap_{j=1}^{n} B_j \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (3)$$

because the event A consists of the intersections of the events A' and all the B_j and where A' is the event in which the normal random variable $\bar{X}'$ measures the --- quality of the assemblage of the B_j parts which distance from the mean $\bar{X}$ is less than 1.96 σ':

$$A' = \left[|X| < 1.96 \ \sigma' \right]$$

From (3) we obtain

$$A^c = A'^c + \bigcup_{j=1}^{n} B_j^c$$

Where A^c is the complement of A, and then

$$P\left[|X| \geq 1.96 \ \sigma \right] \leq P\left[|X'| \geq 1.96 \ \sigma \right] + \sum_{j=1}^{n} P\left[|Y_j| \geq 1.96 \sigma \right]$$

and now we can use a Theorem by Valle Flores*

Theorem: "If Y is a random variable and f, is an even function

$$\left[f(-x) = f(x) \right. \quad \text{(Borel), not negative and increasing on } \left[0, \infty \right),$$

then for every real number $\gamma \geq 0$ we have:

$$P\left[|Y| \geq \gamma \right] \leq \frac{E\left[f|Y| \right]}{f(\gamma)}$$

where P is the probability of the event and E is the expectation of the random function (Y)."

Then by (4) and (5):

$$P\left[|X| \geq 1.96 \ \sigma \right] \leq \frac{E\left[g \ (X') \right]}{g\ (1.96 \ \sigma')} + \sum_{i=1}^{n} \frac{E\left[f_j \ (Y_j) \right]}{f_j \ (1.96 \ \sigma_j)} \ \ldots\ldots (6)$$

Where the g and f_j are the real functions of the real variables which satisfies the above theorem

* See "Boletín de Técnicas y Aplicaciones del Muestreo". N° 9. pps. 11 - 12

Now, we have to choose adequately the random functions J and f_j so as to set up on advance the control on the M' and y_j (the quality control in the manufacture of the parts B_j and the assemblage of them), so as to guarantee enough quality of the industrial product A.

For Example, to guarantee the following probabilities:

$PA^c \leq 0.05$, or equivalently, $PA \geq 0.95$

As an application to the above, let us suppose that we are interested in the fish canning industry.

Let us consider A as the lot of fish cans manufactured and ready for sale, and B_i the different steps taken for the canning of the product.

B_1= Selection of the best fish from among all the available fresh fish in the factory
B_2 = Cutting of the fish into pieces, of say, one pound each.
B_3 = Taking out the bones from these pieces.
B_4 = Preparation of the tomato sauce.
B_5 = The pouring of the sauce into the fish.
B_6 = Treatment of the cans such as sterilizing in boiling water and chemicals
B_7= Packing the cans with the prepared fish.
B_8 = Sealing the filled cans under pressure.
B_9 = Cooking the filled cans at high temperatures to avoid bacteria.

In this case we can see that not all the events are independent, and so, we need to use some formulae for the independent events in order to calculate the total probability of obtaining a good reasonable level of quality in the final product A.

Suppose that we have the following probabilities in every step:
$P(B_1) = .995$
$P(B_2) = .990$
$P(B_3) = .985$
$P(B_4) = .984$
$P(B_5) = .959$
$P(B_6) = .979$
$P(B_7) = .999$
$P(B_8) = .968$
$P(B_9) = .999$

Then, if the first two steps are subject to a conditional probability, we shall have

$$P(B_1 B_2) = P(B_2 / B_1) P(B_1)$$
$$= .990 \times .995 = .995$$

Then

P(A) = 985 x 985 x 984 x 959 x .979 x .999 x .968 x .999 =

P (A) = 0 87

Which is the probability of the quality product A, the canned fish Or also, the probability of A^c which is the possible error in the quality, will be P (A^c) - 0.13

Which means that it is likely that 13% of the cans are not in perfect --- quality.

The function g(x) and $\int_j (Y_j)$ are induced by the random variables X and Y_j and can be known when one takes simples of the x and Y_j respectively .

As we can see from the example given, it is necessary to know and to measure the probability of the quality in every one of the steps taken, and to try to ---- improve this quality in order to obtain the best quality possible in the canned product

That is the reason why statistical quality control must always be used in food industries.

PRODUCTION OF SYNTHETIC FOOD MATERIALS: A STATISTICAL SURVEY

By Mary Nan Steel, A.B., M.A.

Miss Steel holds degrees in sociology and psychology from the University of Kanisas. She has been concerned with the use - of statistics in physical and chemica1 experiments at the National bureau of standards, Washington D.C, since 1950. Her work has contributed to a number of publications including a technical paper dealing with high-speed computer programming.

Summary This paper summarizes statistics on the production, sale and value of synthetic vitamins, flavors, and amino acids in the United States from 1945 to 1965 and discusses the observed trends. In absence of statistics on the production in other countries, U.S. import statistics and information from industrial journals are examined for indications regarding quantities manufactured in other countries. U.S. shipment statistics are given for yeasts and are evaluated as a measure of the quantities being made. Production statistics for feed grade synthetic urea are also presented. The foregoing data are discussed in relation to the potential roles of synthetic and biosynthetic materials in meeting the world food deficit.

PRODUCTION OF SYNTHETIC FOOD MATERIALS: A STATISTICAL SURVEY

By M. N. Steel.

Introduction A relatively new and expanding industry the can meet the world's growing food shortage is that of synthetic food. To the scientist and engineer, the rapid development of this industry presents an unparalleled challenge. The scientific basis for the synthesis of food has been well established. Only applied research and the engineering remain to be done to prepare for large-scale production. (1)

The problem of food shortages has always been with man. For hundreds of thousands of years he had to forage for his food. Food gathering was his chief activity and a large area of land was required from which to gather food for each person. About nine thousand years ago agriculture appeared upon the scene. Gradually it came to be that a few persons were raising enough food for large numbers of people, and a much smaller area of land was needed to produce food for all. This new order of things released many individuals for different activities. Thus, a new social structure emerged.

With the coming of the scientific era man has evolved many new foods as well as new ways of farming. Through scientific study and the use of statistically designed experiments he has learned to control the products of the soil and to produce more and more food on less and less land. Furthermore, he has learned about nutrition not only for himself but for his animals as well. By the careful planning of an animal's diet, the farmer can produce a larger animal in less time and with less food and the animal, in turn, produces more abundantly.

Science and technology have at hand numerous resources for the solution of the world food problems. Many contend that the problem of nutrition could best be solved by the simple solution of education at the community and home level where immediate success could be obtained. Such an approach is practical and has the advantage of delaying failure until more ambitious solutions can be developed. The real problem, however, is that of producing food rapidly enough to keep pace with the world's increasing population and, at the same time, furnishing the whole of the world's people a diet that is balanced in nutrients. (2)

World Food Needs There are two indices of need in the world's food supply; the one is a quantity index measured in calories; the other, the quality index, is measured in protein consumption. (3) In the economically developed countries of the world the average number of calories per person per day is 3060 as compared to 2150 for persons living in the economically undeveloped countries. Of greater significance is the difference in the daily per capita consumption of proteins and in particular that of animal protein. These statistics are summarized in Table 1. It is shown that in the diet-deficit countries the total protein consumption is 58 grams per person per day, only 64% of that in the diet-adequate countries where each person consumes, on the average, 90 grams per day. Even more important is the animal protein consumed; there the difference is greater still. The 9 grams per person per day- consumed in diet-deficit countries is only 20% of the 44 grams per person in the diet-adequate countries. (4) In an attempt to secure enough nourishment the "have-not" people consume larger quantities of high-carbohydrate foods and pulse proteins. This results in a need for larger production of these food materials, while at the same time the population suffers from malnutrition. The high mortality among children and the poor development of the se who do survive have proved to be the result of protein deficiency. Furthermore(the adult population on a diet insufficient in nutrients suffers from a lack of initiative, vigor, and a capacity to undertake the new methods of food production needed to keep up with the demand of the ever increasing population.

It becomes obvious, therefore, that the changes which appear simple on the surface may well be very difficult to implement. The increase in food production cannot keep ahead of the increase in population for many years. In fact, the 1965/66 food output was no larger than that of 1964/65, but the population increased by around 70 million persons with the result that the per person production of food fell by about two percent. (5) One alternative to mass starvation is to mobilize the world's engineering and scientific resources for an operation of unparalleled, but not impossible, magnitude in the chemical production of food by direct synthesis and by use of biochemical methods

Amino Acid Requirements When Rose discovered threonine in 1935, all the amino acids, which adult man required pre-formed in the diet, were synthesized. (6) From 1828, when Wohler synthesized urea, the scientist has made many natural substances from non-living materials, dispelling the belief that the substances necessary to living matter were in any way different from those connected with non-living matter. In the 1940's Rose and his associates delineated the eight amino acids required by adult man and thus separated the requirements for protein nitrogen into two parameters. (7) The first is the requirement for those eight amino acids which cannot be synthesized by the tissues (a ninth, histidine, is essential to childhood growth), and the second is the requirement for a nitrogen source from which the body can synthesize the remaining fourteen amino acids as required. Furthermore, the body must have these essential amino acids in a definite proportion in order to utilize them efficiently. Studies have been made from which a chemical score has been determined for the essential amino acids and it has been shown that if one of these is in short supply, the remainder can be used only in proportion to the amount in which that one is present. (2)

Table 2 shows the ideal pattern established by the Food and Agriculture Organization (FAO). Tryptophan is taken as unity because it is required in the least amount. Many consider egg as the ideal food, and its pattern is shown as an example of a complete nutrient. Meat and milk also contain the amino acids in about the proportions needed by the human body. Lysine is deficient in the common cereals, wheat, oats, rye, barley, and rice, while the pulses, peas, beans, soybeans, peanuts, and the like have a small quantity of methionine that limits the efficiency of the proteins. This indicates the inadequacy of a diet lacking in animal protein and emphasizes the needs for supplementation.

All of this discussion points to the fact that conventional methods of food production are failing to meet either of the needs of diet-deficit regions in which two thirds of the world's people live; quality and quantity of food are had by a favored few in these regions. Intensive efforts to improve standard agricultural production have made great strides in the West but their introduction in the food-deficit countries depends on the educating and training of large numbers of persons in new ways. Another limiting factor is the weather. A recent illustration is the failure of the monsoon rains in India, resulting in a disastrous crop failure.

Advantages of Synthetic Production Neither depending on the weather nor requiring the retraining of large numbers of persons, the synthetic food industry can meet the world food needs both in quality and quantity. Once standard facilities for production are developed, they can be replicated any place in the world, and production can be controlled and redirected within wide limits. (8) From the standpoint of improving quality, synthetic food production is already a successful operation. By supplementing the food for farm animals, an increase in production has affected the market for a number of years. In fact, farm animals are all too often fed a more carefully balanced diet than man, even in the developed countries. By adding methionine and vitamins as supplements in feed for poultry, it is now possible to produce a three-pound broiler with 25% less feed and in two weeks less time than formerly.

The use of the term "synthetic" refers to products made either by direct chemical methods or by microbiological processes conducted in chemical engineering equipment; in other words, products made in a factory and not dependent on the products of agriculture. This is important to keep in mind because this type of synthetic food production is free of any demands upon the land.

The business of this synthetic food industry is the production of the essential nutrients of food; it is not concerned with putting these nutrients into the form of multitudinous natural food products. The essential nutrients include two groups: the macronutrients--carbohydrates, fats, and proteins--and the micronutrients--vitamins, minerals, and aesthetic constituents, the flavors and colors.

The synthetic food industry is so new and is made up of such widely scattered components that it is scarcely recognized as a single industry even by those engaged in it. The production units are for the most part located in firms engaged in the manufacture of organic chemicals and pharmaceuticals. Some units, however, are associated with industrial operations, as seemingly remote from food as petroleum refining and the making of paper.

Survey of Synthetic Products The purpose of this paper is to present the statistics of the production, sales, and value of some of the synthetic foods which are now being produced and to make some projections based on these data which would show to some extent the capabilities of this young industry to meet the world' s food needs.

From the standpoint of statistics the data relating to many of the products are fragmentary and incomplete. Few of the products have been manufactured in sufficient quantity or for a sufficient length of time to show well-defined trends of production with time. Like Sukhatme (9) in writing his paper on the world's hunger and future food needs, we have found the data available to be incomplete and confounded. Because of the newness of, this industry much of the information we wished to obtain was confidential. The principal source of information in the United States is the yearly report of the U. S. Tariff Commission, Synthetic Organic

Chemicals. Here production and sales figures are summarized, but the publication of these data is limited to commodities manufactured by at least three companies and is published only with the manufacturers' permission. General classifications such as the ones with which we are dealing, amino acids, vitamins, flavors, etc., contain different chemicals and different numbers of chemicals from year to year. Therefore, any projections made from these data must be interpreted in light of all of these limiting factors.

The production statistics in countries other than the United States were also unavailable. In general these figures are in basket classifications or are of such small quantities that no records are as yet maintained. We are presenting a few of the import statistics summarized from the U. S. Department of Commerce yearly publication, U. S. Imports for Consumption. We can draw some general conclusions as to the commodities being produced and the areas in the world that have the beginnings of this new industry.

In evaluating these data we want to keep in mind that this industry concerned with the production of food might bear a rather close resemblance in its development to the growth of other industries which at one time in history, and even now to some extent, have depended on products of agriculture. Synthetic fibers, dyes, rubber, plastics, detergents and shoe materials are among the products that have been developed on a commercial basis at times in competition with surpluses of products made from naturally occurring materials. Some of these non-food agricultural products, such as dyes, have almost completely displaced their natural counterparts while others merely supplement the natural commodities. One notable exception is synthetic rubber which, in a successful form, was developed in a crash program in World War II when natural supplies were cut off. In three years' time this industry reached the level of a plantation industry that had required thirty years to develop. Furthermore, if food requirements are estimated at 2350 calories per day per person, the 1 1/2 million long tons of synthetic rubber produced in the United States in 1964 would have required, for, an equivalent amount grown on plantation, land capable of providing food for 18 million people.(10) Today the natural product and the synthetic rubber are sold in approximately equal amounts, with the synthetic beginning to take the lead.

Synthetic food products fall into three broad categories based on volume of production and unit value.

The first category includes small volume / high unit value items such as the vitamins, flavors, colors, and amino acids. There products range from vitamin B_{12} (cyanocobalomin), of which only 1000 pounds were produced in the United States in 1964 and sold for $6,852 per pound, to the amino acid methionine (and its hydroxyanalogue) of which 3025 tons were produced at $l.06 per pound in carload lots.

The second category, the intermediate production / value range, includes food and feed yeast, fat made by synthesis from paraffins, and glucose produced by the hydrolysis of cellulose. The fat and glucose were manufactured in large tonnages in Germany to meet wartime emergencies but are no longer made since they are not economically competitive with natural products. It seems likely that, with large scale production, the amino acids used for supplementing the proteins of cereal grains and oilseed will be brought into the intermediate range with prices well below $l.00per pound.

The third category includes large volume / low unit price items. Urea is now the only item in this category. It is used in huge quantities each year for the feeding of cattle and sheep. In 1964 alone, 119,436 tons were produced and sold at 4 cents per pound.

Raw Materials The raw materials for the production of these organic substances may be in any form of their elements conveniently available.

The products we have surveyed are made chiefly from industrial by-products, liquid petroleum and natural gas. Nitrogen of the atmosphere fixed as ammonia may be employed directly in the synthesis of amino acids and in the growing of yeast for food and feed purposes. Inorganic mineral products needed in small amounts are readily available while hydrogen and oxygen may be obtained from water and the atmosphere. (11).

The survey data of the production of synthetic food materials are given in Tables 3 - 7. Figures 1 - 5 present a graphical representation of the data from which the trends can be seen.

Production of Vitamins. Table 3 presents a summary of the production and sales statistics for synthetic vitamins in the United States from 1945 to 1965. By 1945 the vitamin market was well established; in that year, a total of 2945 thousand pounds of vitamins was produced in bulk form and 2516 thousand pounds were sold at prices ranging from $3.42 per pound for niacin, first synthesized in 1937, to $456.82

per pound for vitamin B_6, first synthesized in 1940. (12)

The relatively steady trend upward in production and sales can be seen in Figure 1. That these two factors follow one another closely is not surprising since the manufacturer can control his production to meet the sales demand, thus preventing either over supply or under production. Natural food supplies which depend on the caprices of nature do not have this advantage.

An increase in export may account for the gradual increase of production over sales of this commodity, a statistic we did not evaluate in this survey.

The wide fluctuation in sales value noted in the figure can be explained by studying the price range per pound in Table 3. The sales value figure includes all the vitamins sold within this wide price range and amounts varying from less than a thousand pounds, for newly synthesized vitamins, to several thousand tons of those having established markets. The varying number of manufacturers should also be noted. The lower end of the price range, $3.42 in 1945 to $1.24 in 1964, is consistently the price of niacin--one of the first vitamins to be synthesized successfully for commercial production. From 1945 to 1965 there is an almost steady decrease in its price. Similarly, vitamin B_{12}, introduced in 1952 with the sale of 94 pounds at $9l,787 per pound, was sold in the amount of 1000 pounds at $6852 per pound in 1964. Though the price seems absurdly high, the 2 to 4 microgram daily requirement per person costs less than .002 cent at this price. More important is the fact that in a little over ten years research on the production of this vitamin enabled the price to drop to 7.5% of the price at which it first came on the market. This same increase in production efficiency can be noted in the over-all increase in vitamin production, which in 1964 was five times that in 1945,with the decrease in price on the order of 75%.

Table 4 summarizes the production of Vitamin C, ascorbic acid. Its production accounts for over half of all the vitamins produced in 1964. In Figure 2 the data for production and unit sale price for the past 20 years show the "classic" trends. The price of $1.93 per pound of 1964 is about one sixth of the $11.02 quoted in 1945. The sharp price drop around 1952 resulted in a rise in production as lower prices increased the demands. There is indication that the price decrease is tapering off while the production will probably continue to increase with the demands made by an increasing population. At the current price the daily requirement per person of 75 milligrams would cost only one eightieth of a cent in bulk.

Until 1963 the import of synthetic vitamins to the United States was included in a basket classification. In 1963 the import of this commodity was enough to require its inclusion as a separate item. Imports were reported from five European countries and Japan and amounted to over 60 tons ranging in price from $2.48 to $12.64 a pound, totaling $750,894. In 1964 ten countries were included, from which over 200 tons totaling 2.3 million dollars were imported. By 1965, the United States imported synthetic vitamins from 12 countries in the amount of 250 tons at over 3 million dollars. Of this amount almost 100 tons at 3. 00 per pound were imported from the Netherlands alone, while Japan accounted for 55.5 short tons.

In addition to the general classification, "synthetic vitamins", the import statistics list niacin, vitamins B_1, B_6 and C in separate categories. Between 550 and 650 tons of niacin were imported from Italy in 1964 and 1965, and the imports of vitamins B_1, B_6 and C were chiefly from Denmark and Japan.

It can be concluded from this information that the production of synthetic vitamins is well established in many areas of the world and that a supply is available relatively close to almost any country making a demand for them. Research and development have provided efficient large scale production methods with the resulting decrease in price, a price that creates both a demand from consumers and a profit for the manufacturer. These large-scale methods can be expanded rapidly and, because they are geared to automation, there is need for training only a few operators to handle the equipment.

Production of Amino Acids The data for amino acid production in the United States are presented in Table 5. They appear to present a clear cut picture of steadily increasing production and sales and the gradual price reduction. It was the plan to present these statistics for the specific amino acids required for human nutrition, but in gathering this information we discovered the complexities of the statistical reports. Over the twenty-year period represented in Table 5, a total of 93 different chemicals are included as few as 18 were included in 1964 while 56 different items were included in 1955. The chemicals in which we are interested are basketed together with numerous salts and derivatives, some of which may have little value as nutrients. In Figure 3, a large dip occurs in all of the curves for the year 1963. This resulted from the omission of certain chemicals which had been reported in previous years as amino acids of medicinal grades but were recently determined to belong to different categories. At present a concerted effort is being made by those compiling these reports to make certain that the chemicals are included in the correct category. In 1964 methionine and its derivatives were produced by enough manufacturers and in large enough amounts to be given a statistic of their own. Three thousand twenty-five short tons were produced at $l.06 per pound. Four manufacturers reported this commodity, although lysine is produced by at least four companies in the United States, the production data are not yet made available. It should be noted that the number of companies reporting amino acid production has varied over the years with 11 reporting in 1964. The price range has been relatively, narrow, but the "classic" trend is beginning to show up as the sales value begins to level off and a continued production increase is reported.

It is interesting to note that meat contains only about 20 percent protein, so that by comparison pure amino acids at $1.06 to $1.62 per pound would be equivalent to meat at 21 to 35 cents per pound.

The fact that such a large number of amino acids, salts, and derivatives have been made over the years in experimental quantities indicates a possibility that quick expansion to large-scale production could be effected. McPherson (8) has estimated that to supply 20 grams of protein per person in terms of a mixture of the essential amino acids, to the population of Asia and the Far East in 1990, would require 9.96 million metric tons or five times the synthetic rubber produced in the Western world today. If this synthetic food were produced from petroleum it would require 4.5 kilograms of petroleum per person, whereas the consumption of petroleum for fuel per person per year is on the order of 115 kilograms and is rising at a rate of 10% per year.

The import statistics for amino acids were included in a basket classification until September 1963. The totals reported through 1965 are shown in Table 5b. Since no breakdown was available either of the chemical constituents or their prices, it may be guessed that the unit price of 95 cents in 1963 as compared to $l.50 in 1965 indicates a larger number of different amino acids of varying price range is being imported to the USA. The countries from which the amino acids were imported included those of Western Europe, Canada, Israel and Japan.

Production of Aesthetic Constituents Although we are not dealing with formulation of the food products through which synthetic foods are being introduced, it is well to note that the eating habits of man are slow to change and that the synthetic food products introduced into his diet must appear in texture, consistency, color, odor and taste pleasing to the senses. Modern polymer science can point the way to the control of texture and consistency, and synthetic products are available to provide any desired color and the great majority of the appealing odors and tastes of natural foods. Most of the synthetic flavors and fragrances are identical in composition with natural products. Table 6 gives the statistics of these products in summary. The flavors are reported together with perfume materials but comprise the greater quantity. Figure 4 shows the "classic" trends. Over five times the amount produced in 1945 was produced in 1965. The unit price reached its peak in 1954 and is continuing to decrease. This can be generally accounted for by the large quantity of monosodium glutamate which is now one third of the flavor market. As an additive in modern methods of preserving standard food products, glutamic acid has been a boon to that market.

Methyl salicylate (synthetic wintergreen oil) has been a stable commodity for many years. Looking at the graph of its production in Figure 4, a slightly different price trend is noted both in quantity produced and price. The production follows a relatively slow trend upward, a trend expected in an established commodity being used by an expanding population. By 1946 the price of this product was 30 cents per pound while today it is 50 cents; for a seven-year period it held at around 55 cents. Once a commodity is established its price tends to move with the price index as methyl salicylate has done. The price break of 1965 may have been caused by the over production of 1962, which in turn may have resulted from a new production process. At any rate, the manufacturers' production the past two years has been controlled to match the sales demand.

Ninety-nine percent of the production of the dye industry is now synthetic. In the United States the contents of food colors are carefully controlled by law, as are those of drugs and cosmetics and interestingly enough, these are reported together by the Tariff Commission. Even with this well established commodity we observe a price break the last few years. Looking at Table 6 we note the number of manufacturers has been reduced to six. Again, new competitive production processes are indicated.

Imports show that Japan and Taiwan exported 222 short tons of monosodium glutamate to the United States in 1965. Until 1963 this product was in a basket classification. Vanillin, another synthetic flavor, is manufactured chiefly in Canada; import statistics indicate more is being produced each year in Western Europe. In 1955 the United States imported 97.5 thousand pounds at $3. 00 per pound. In 1965, 928.9 thousand pounds were imported and the unit price had dropped to $2.30.The import of saccharin increased from 38,886 pounds in 1955 to 765,498 in 1963 with the price stable at $1.60. The decrease in imports of the past two years reflects an increasing domestic production no doubt brought about by the low-calorie drinks now popular in the United States.

Production of Yeast The production of yeast for food and feed purposes includes brewers' yeast and primary grown yeast including torula extracts and other yeast products. It should be distinguished from yeast used for baking. Production statistics do not seem to be available, but the Census of Manufactures does give statistics for the quantity and value of shipments, which may be taken as a measure of production. These data are shown in Table 7. Any changes in the quantities held in stock in the plants producing the yeast would probably represent only a fraction of the annual production. Also, any quantities utilized by the producing firms would be included in the shipments reported since shipments include interplant transfers.

The data were not presented as food and feed grades until 1963. , In that year fifty million pounds were shipped, of which 35% Has food yeast. It was valued at 28 cents per pound in comparison with feed yeast at 7 cents.

Yeast on the market at the present time is, in part, surplus yeast from brewing which must be debittered before use. The primary grown yeast is produced from industrial wastes, such as spent sulfite liquor from papermaking and whey from the manufacture of cheese, which would otherwise present a disposal problem. The sulfite liquor hexoses and pentoses and the whey lactose from milk serve as the nutrients for the yeast. In fermentation ammonium salts are added as a source of nitrogen together with the necessary mineral elements.

The production of yeast could be considerably increased by the greater utilization of industrial wastes and by processes based on the hydrolysis of cellulose from wood to glucose which would then be used for fermentation. The very large-scale production that is in prospect, however, involves the culture of yeast on petroleum. This is a subject to which the major oil companies of the world are giving a great deal of attention. Here again the yeast utilizes an unwanted product in that it grows on the paraffin wax and other alkanes in the oil and thereby serves to refine the oil. (13)

In the current world food situation, yeast is of interest from several standpoints. It contains high quality protein to the extent of 40 to 55 percent, as well as significant amounts of certain vitamins and minerals. The protein is rich in lysine, the amino acid in which most cereals are deficient. Thus yeast would be particularly useful as a supplement to the high-cereal diet in the food deficit regions of the world. Furthermore, the composition and the amount of the protein can be modified by the selection of the variety and strain of yeast and by altering the composition of the substrate on which the yeast is grown. In production, yeast can be grown very rapidly and is readily obtained as a white, bland product that can be readily incorporated in a wide variety of food products.

The United States imports of yeast are not large. In 1965 the principal item was 899,250 pounds of dried brewers yeast from Canada, valued at $75,819 or about 1/2 cents per pound. However, there appears to be a great deal of interest in yeast throughout the world judging from research articles relating to the subject in recent European, Russian, and Japanese journals. Of particular interest is the very large potential source of yeast that will be provided by a chain of paper mills being constructed in Siberia. Several of these mills will have capacities greater than any existing mills, including integrated, forest-industry complexes.The production of yeast is listed among the products to be made in some of these plants. The extent to which the great quantities of waste will be used in this production is not known (14).

Production of Nitrogen Sources for Cattle Feed Urea has been used for fertilizer for many years. Only in the past ten years has a feed grade of this commodity been listed separately in the available production statistics. Yet, of the 2.4 billion pounds of urea produced in the United States in 1964, 9.9% was feed grade, representing a production output of over 119 thousand short tons. The production and sales statistics for urea are given in Table 8a. The number of companies reporting the manufacture of this commodity has grown from two to eight since 1952. Unlike the manufacturers of some of the other products we have surveyed, those who have come into the urea manufacturing business have stayed. The modest price of four cents per pound continues to hold and accounts for a business of over 11 million dollars annually.

Figure 5 shows the steady upward trend in production. The fact that the quantity of sales exceeds that listed for production can be accounted for in that the sales include estimated values of urea in nitrogen compounds.

The production of this commodity has not reached its peak. Chemical and Engineering News frequently makes note of new plants under construction throughout the United States and in other parts of the world. Of special interest was an article (15) calling attention to a new process developed in Japan that integrates urea and ammonia loops resulting in reduced costs in equipment, raw material, and utilities. It noted that the world capacities for urea production passed five million metric tons in 1965 and should hit 12 to 16 million metric tons by 1970. Fedor (16) estimates that 1,875 thousand short tons of urea were produced in the United States in 1965, representing a 17.06% growth in the last five years. Anticipating a growth rate of 15.75% in the next five years, he concludes that 1970 production will be between 3050 and 3580 thousand short tons. The 1965 capacity represented a 21.97% growth in the past five years, with a 19.86% growth rate expected in the next five, bringing the 1970 capacity to 5580. Of this, 12% is used in animal feed.

The import statistics are given in Table 8b. Canada is the chief source of United States imports, accounting for over 50% of the 1965 import of 451,570 thousand pounds. Since 1950 imports have come from twenty-one different countries, representing every continent of the world. It is reported (17) that two Italian firms will provide equipment and know-how to build two plants in India, each with a capacity of 600 metric tons of ammonia and 1100 tons of urea.

No data are given for the quantity of this production that is feed grade, but three specialists at the U. S. Tariff Commission have estimated that 10% of United States urea imports are feed grade, and it can be assumed that a similar proportion applies to over-all production.

It is of interest to note the work of Finnish Nobel laureate A. Virtanen (18). He has developed a feeding process for cattle that depends on the gradual build-up in the cow's rumen of a microbial population capable of synthesizing amino acids from nitrogen supplied to the animal in the form of ammonium salts and urea. During their dry period, Ayrshire milk cows were fed a synthetic diet consisting, finally, of 20 pounds of 9 gram briquettes containing starch, cellulose, sucrose, urea, and ammonium salts, plus 8 pounds of cellulose-rich wet paste, small amounts of cord oil and vitamins A, D, and E, and also salt and essential minerals. The cows received cellulose impregnated with silicic acid instead of hay. The cows fed on this protein free synthetic diet produced milk with the usual protein content, and calves whose meat was equal in quality to that of cattle on a normal diet.

Conclusion The population explosion and the space age demand new sources of food supply and, indeed, new types of food. Synthetic food production can help solve this problem, first by adding a new source of food and secondly by releasing large acreage for greater production of the standard food commodities.

Furthermore, it is realistic to assume that man is on the threshold of a new era in his struggle to feed himself. By applying engineering advances in building needed equipment and plant facilities, the engineer and scientist have the ability to change the pattern of everyday living, indeed, the course of civilization. In the future, a few technologists will be able to run equipment which, by direct chemical synthesis and biochemical processes, will furnish both human food and animal feed for a vast population.

Two possible paths are open to the development of the new synthetic food industry. As one alternative, the present small industry can continue to develop in the Western countries in competition with an abundant supply of natural food and can continue to grow at a pace determined by profits and by competition with other industries for capital, facilities, and technical personnel. The other alternative is a program of greatly accelerated growth undertaken in the developing countries of the world, with massive governmental supports, for the purpose of forestalling widespread famine and overcoming malnutrition and under-nutrition within the next few decades.

This last approach is within the realm of possibility. Reports in industrial journals indicate that industry is beginning to expand its synthetic production. It is not unusual for an industry, on the threshold of new development, to guard its plans for expansion from its competitors.

In this paper we have tried to bring together the information available on the production, sales, and value of some of the basic materials of this new industry and give some indication of what can be expected in the future.

Just as agriculture did not come into being overnight, the age of synthetic food will come into being slowly. For a long time synthetic food will provide a supplement to our accepted agricultural production but someday it could be our major source of food supply. The trends are there, and the benefits to be derived from such a new order are so closely related to the needs of our scientific age and the demands of the world's increasing population that there is no doubt that the new order is upon us.

It is unfortunate that the data available concerning this new industry are inadequate. Governments and technical leadership need this information in guiding the development of the synthetic food industry. This survey will have served its purpose if only it calls attention to the need for more adequate gathering of this information.

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TABLE 1

Average Daily Intake - 1965*

	Region	
	Diet -Adequate	**Diet -Defict**
Calories	**3,060**	**2,150**
Total protein, gms	**90**	**58**
Animal protein, gms	**44**	**9**

* - Source: FAO-1966 - Reference (4)

TABLE 2

Pattern of Requirement for Essential Amino Acids* (Ratio in relation to Tryptophan)

L-amino Acid	FAO Pattern	Whole Egg Pattern
Tryptophan	**1.0**	**1.0**
Threonine	**2.0**	**3.1**
Isoleucine	**3.0**	**3.7**
Lysine	**3.0**	**5.4**
Methionine & Cystine	**3.0**	**3.7**
Valine	**3.0**	**3.9**
Leucine	**3.4**	**5.4**
Phenylalanine & Tyrosine	**4.0**	**4.7**

* - Source: Reference (7)

TABLE 3

U.S. Vitamin Production 1945-1965*

year	**Production[1]**	**Sales** **Quantity[1]**	**Value [2]**	**Price Range per Pound**		**No. of Mfrs.**
1945	2,945	2,516	48,933 53, 559	3.42-	456.82	22
1946	2,495	2,648	47,077	3.25-	381.31	29
1947	2,278	2,168	39,698	3.14-	304.10	35
1948	2,610	2,275	58,714	3.06-	245.67	34
1950	3,455	2,981	64,011	3.63-	1,560.40	32
1952	4,932	3,765	76,401	3.62-	91,786.77	36
1954	5,381	4,070	82,811	3.56-	67,720.43	35
1955	6,139	5,131	78,252	3.24-	426.00	34
1956	7,198	5,648	78, 110	3.20-	22,640.00	34
1958	9,763	6,920	73,741	2.10-	18,223.00	29
1959	10,845	7,271	68,684	1.72-13-	008 .00	29
1960	11,063	7,995	75,958	1.40-10,	059.00	29
1961	12,560	9,967	67,964	1.40-	9,739.00	31
1962	12,355	9,280	64,474	1.24-	10,205.00	30
1963	14,874	10,519	60,578	1.16-	8,519.00	28
1964	14,105	10,629		1.24-	6,852.00	21
1965						

1 - Thousands of Pounds

2- Thousands of Dollars

* - The data are those for medical chemicals in bulk; they do not include finished preparations such as tablets and capsules manufactured from bulk chemicals.

Source: U. S. Tariff commission,
Synthetic Organic Chemica1s

TABLE 4

Vitamin C and Derivatives *

Year	**Production**[1]	**Sales**		**Price per Pound**	**Number of Manufacturers**
		Quantity[1]	**Value**[2]		M
1945	1,307	1,098	12,092	11.02	2
1946	728	885	9,577	10.82	2
1947	657	656	7, 163	10.92	4
1948	956	768	8,365	10.89	4
1950	1,228	1,174	12,576	10.71	3
1952	1,405	1,249	12,986	10.40	4
1954	1,835	1,646	13,326	8.10	3
1955	2,354	2,154	15,005	6.97	3
1958	4,171	3,343	13,776	4.12	3
1959	4.764	3,148	10,808	3.43	3
1960	5,275	4,039	13,348	3.30	3
1961	6,497	4,790	13,334	2.78	3
1962	6,406	4,380	10,754	2.46	3
196)	7,851	5,196	10,849	2.09	3
1964	7,409	5,348	10,329	1.93	3
1965					

1 - Thousands of Pounds
2 - Thousands of Dollars

*Source: U. S. Tariff Commission,
Synthetic Organic Chemicals

TABLE 5a

U.S. Amino Acid Production 1945-1965*

Amino Acids, Salts and Derivatives

Year	Production[1]	Sales Quantity1	Sales Va1ue[2]	Price Range	No. Of Mfrs.	No. Of Chemical
1945	177	188	502	1.98-129.70	21	32
1946	270	280	863	2.30-329.36	22	33
1948	464	426	1,292	2.25-162.56	18	41
1950	929	736	1,942	2.53-127.50	16	41
1952	1,506	1,300	3,251	1.95- 22.08	22	50
1954	1,771	1,463	3,547	1.69- 2.91	23	33
1955	1,773	2,007	4,901	2.33- 49.00	29	56
1956	3,604	2,952	6,940	1.72- 60.50	26	51
1958	4,249	3,869	7,366	1.88- 13.22	25	39
1959	4,880	4,446	7,146	1.60- 22.00	21	30
1960	5,163	4,214	6,330	1.47- 15.50	22	29
1961	5,946	5,106	7,320	1.25- 15.00	18	25
1962	5,007	5,492	7,210	1.30- 44.50	20	27
1963	3,057.	3,283	4,256	1.30	16	21
1964 1965	7,788	7,523	8,610	1. 06- 1.62	11	18
Overall						93

1 - Thousands of Pounds
2 - Thousands of Dollars
*The data are those for medical chemicals in bulk; they do not include finished products.

TABLE 5b

Imports of Amino Acids and Amino Acid Salts*

Basket Classification to 1963

Year	pounds	Dollars	No. of Source Countries
from			
Sept. 1963	466,965	445,243	9
1964	522,634	871,918	9
1965	688,787	1,029,794	11

*Source: U.S. Imports TSUSA: Bureau of Census Department of Commerce

TABLE 6
Aesthetic Constituents
U.S. Production and Sales*. 1946 -1964

Flavor and Perfume Materials	1946	1948	1950	1952	1955	1958	1960	1962	1964
Grand Total-Production	19,197	22,192	28,278	27,742	41,974	43,432	55,288	76,267	90,570
Sales-Pounds	17,633	19,016	25,416	35,307	35,843	39,700	47,061	63,448	80,037
Sales-Dollars	24,990	26,71 0	37,994	44,658	52,555	52,246	60,103	75,962	83,734
Methyl salicylate-Production	2,342	2,832	3,080	2,470	3,130	3,193	3,408	6,270	3,784
Sales-Pounds	2,403	2,908	3,210	2,482	3,398	3,243	3,184	4,155	3,738
Sales-Dollars	732	1,025	1,236	1,129	1 ,623	1,804	1,768	2,77	2,006
Unit Price	.30	.35	.39	.45	.48	.56	.56	.55	.54
Monosodium glutamate-Production		6,159	8,577	11 ,642	16,500	17,702	21,640	31,474	38,632
Sales-Pounds	no	6,071	8,753	11 ,816	14,717	18,502	20,660	29,455	36,630
Sales-Dollars	data	9,388	13,822	19,991	20,839	19,727	21,567	26,692	24,843
Unit Price		1.55	1.58	1.69	1.42	1.09	1.04	.91	.68
Food, Drug, Cosmetic Dyes									
Production	803	1,140	1,468	1,074	1,585	1,695	2,191	2,349	2,710
Sales-Pounds	829	1,097	1,278	1,150	1,494	1,611	2,128	2,020	2,630
Sales-Dollars	2,433	3,835	4,935	4,334,	5,675	6,685	8,593	7,955	9,970
Price Range	2.38-13.62	2.59-17.22	2.08-18.52	2.13-18.99	2.54-19.52	3.26-19.76	3.17-15.81	2.86-17.71	2.83-16.74
Number of Manufacturers	7	7	7	8	8	7	6	6	6

*Data reported in thousands

Source: U. S. Tariff Commission, Synthetic Organic Chemicals

TABLE 7

Shipments of Yeast in the United States[1]*

Year	Quantity[2]	Va1ue[3]
1947	37,076	4,336
1954	41,625	6,123
1958	62,792	5,940
1963	50, 237	7,268
Food	17,676	4,956
Feed	32, 561	2,312

1 - Shipments include interplant transfers
2 - Thousands of pounds
3 - Thousands of dollars

* ... Source: Census of Manufactures
Bureau of Census
U. S. Department of Commerce

TABLE 8a

Year	Production[1]	Quantity [1]	Value[2]	Price per Pound	No.of Mfrs
1945-through-1951 only urea melamine resins reported					
1952-through-1955 urea-feed grade listed: No statistics published					
1956	-	-	-	-	4
1957	136,396	130,113	6,160	.05	5
1958	149,626	-	-	-	5
1959	-	161,896	8,196	.05	6
1960	189,979	189,226	8,624	.05	8
1961	203,010	214,769	9,359	.04	8
1962	222,764	228,211	10,027	.04	8
1963	252,702	259,140	11,258	.04	8
1964 1965	238,872	257,925	11,325	.04	8

Urea in Feed Compounds
U.S. Production*

TABLE 8b

Urea Imports to the U.S.**

Year	Chief Source Country	Quantity [1]	Value[2]	Unit Price	No. of Source Countries
					-
1950	U.K.	27,462	1,407	.05	10
1955	U.K. & W.Ger.	157,858	7,990	.05	9
1960	Canada	164,268	7,113	.04	10
1962	Canada	376,080	13,969	.04	12
1963	Canada	574,424	14,984	.03	14
1964	Canada	542,970	17,868	.03	13
1965	Canada	451,570	15,352	.03	11

1 - Thousands of Pounds
2 - Thousands of Dollars
* - Source: U. S. Tariff Commission:
Synthetic Organic Chemicals
**- Source: U.S. Imports TSUSA: Bureau of Census
Department of Commerce

FIGURE 1

U.S. VITAMIN PRODUCTION AND SALES

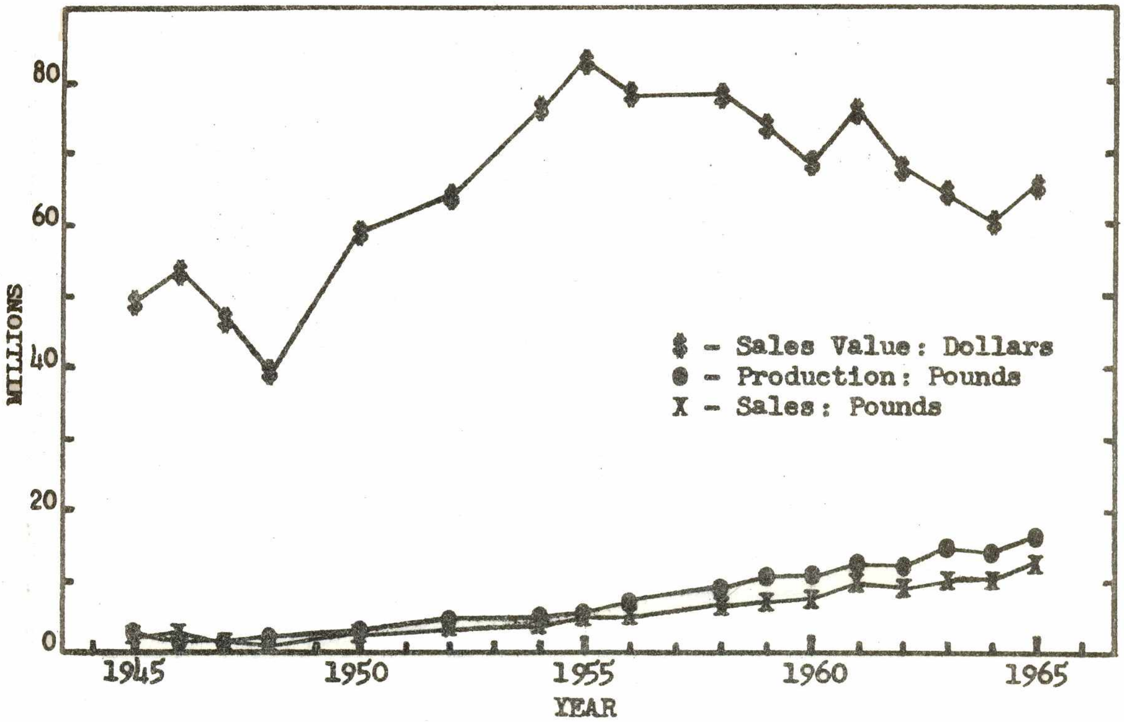


FIGURE 2

VITAMIN C AND DERIVATIVES

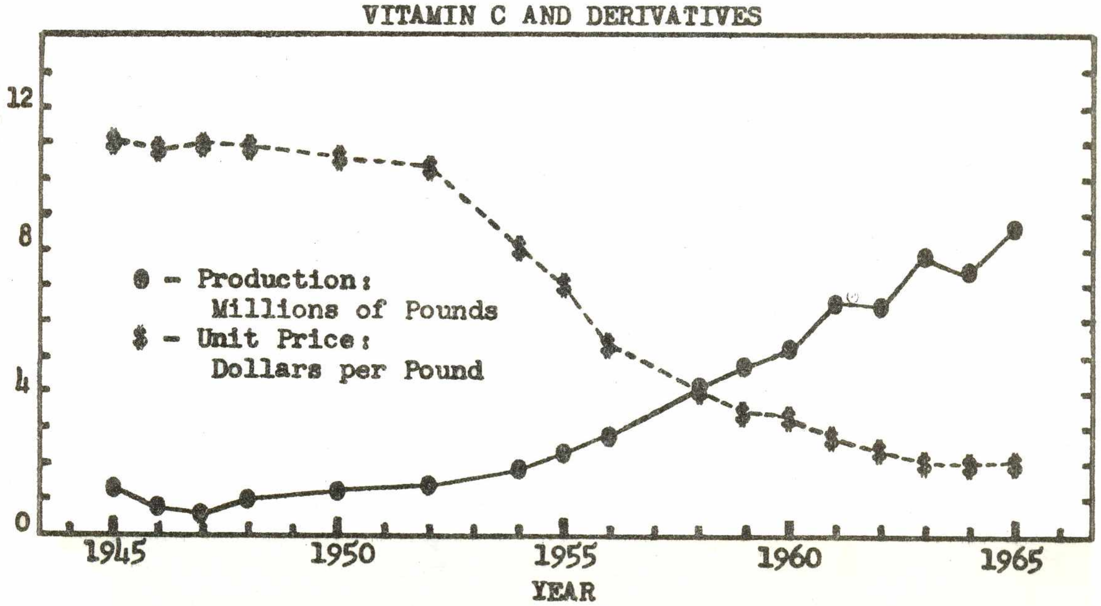


FIGURE 3

U.S. AMINO ACID PRODUCTION AND SALES

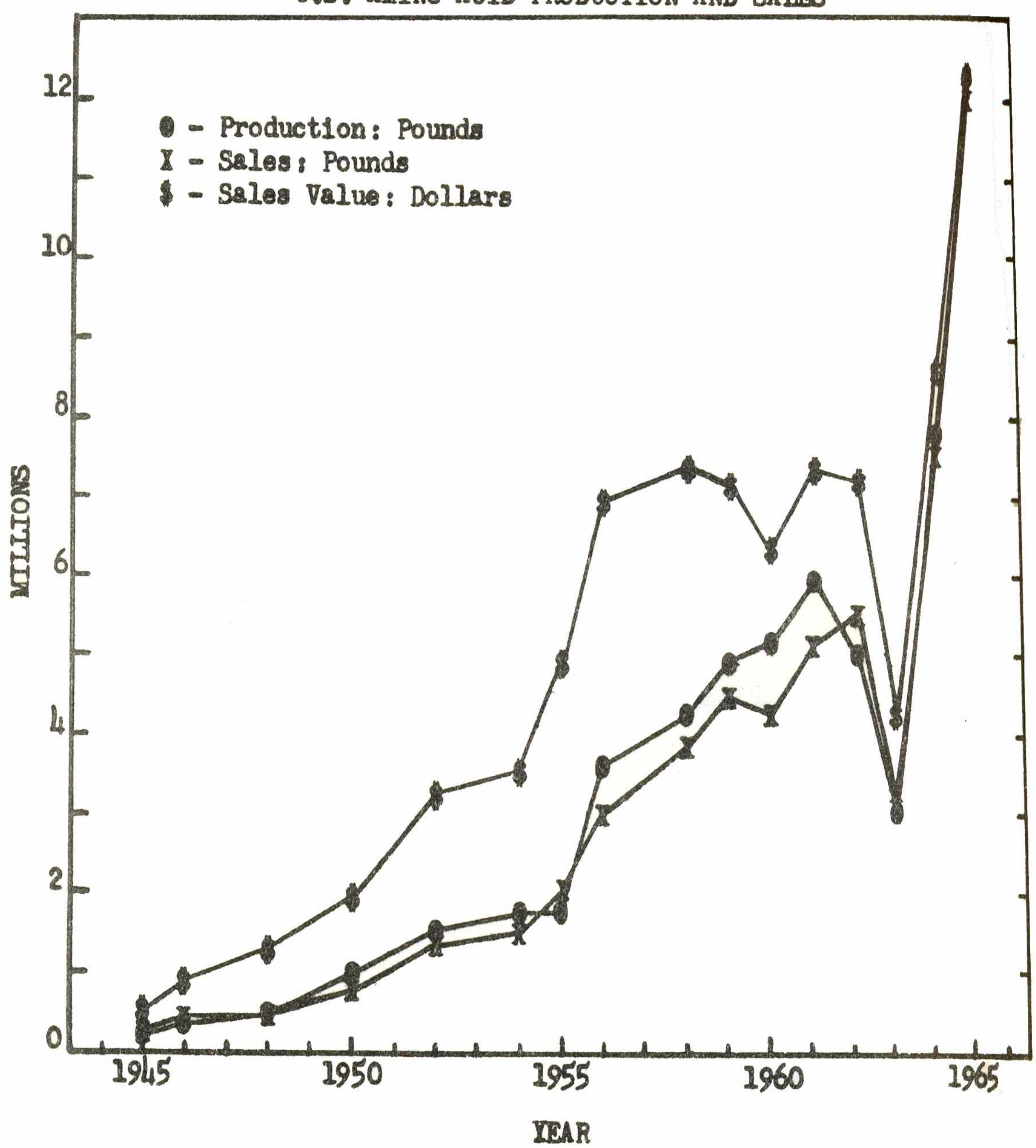


FIGURE 4

AESTHETIC CONSTITUENTS

U.S. PRODUCTION & UNIT PRICE 1945-1965

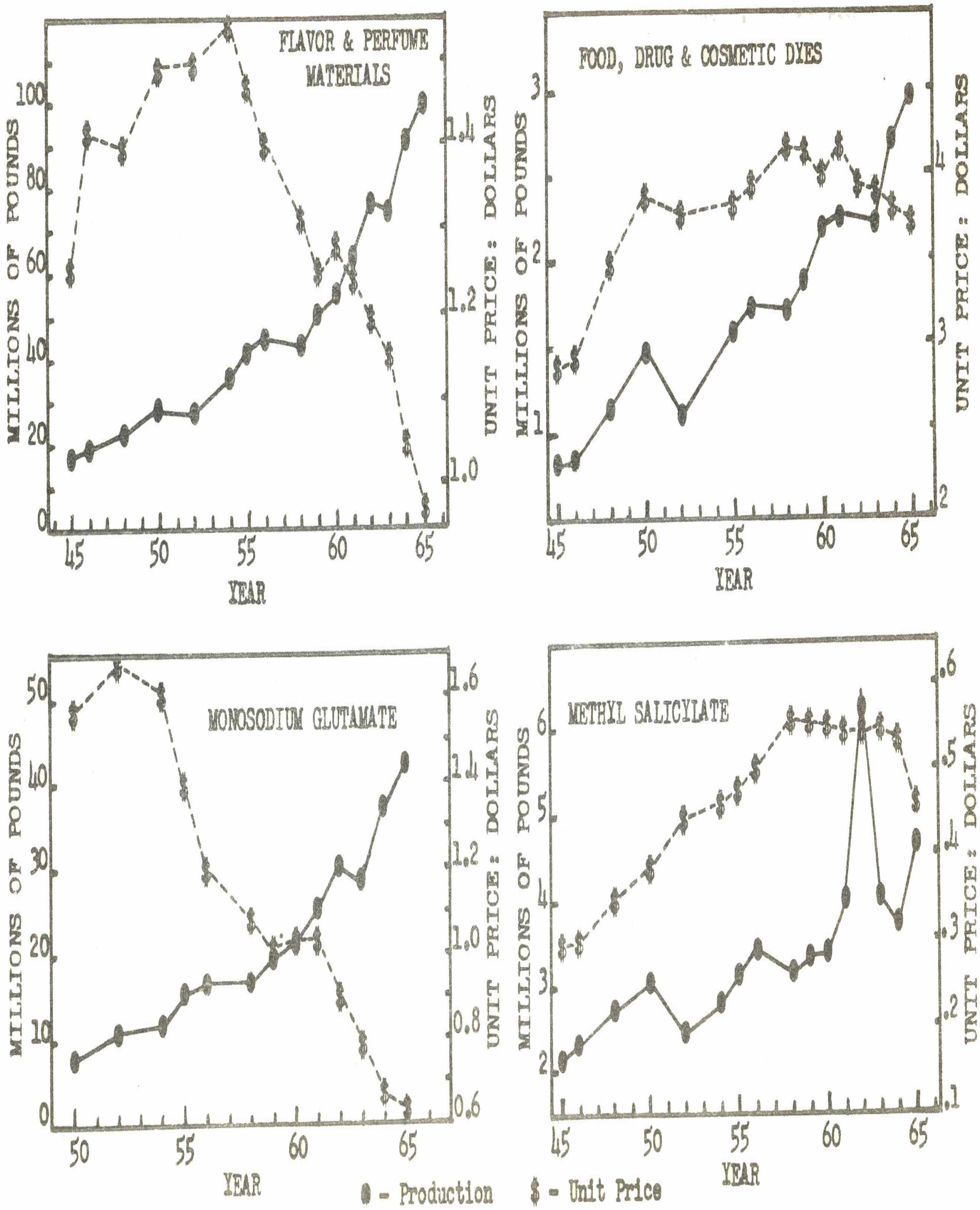
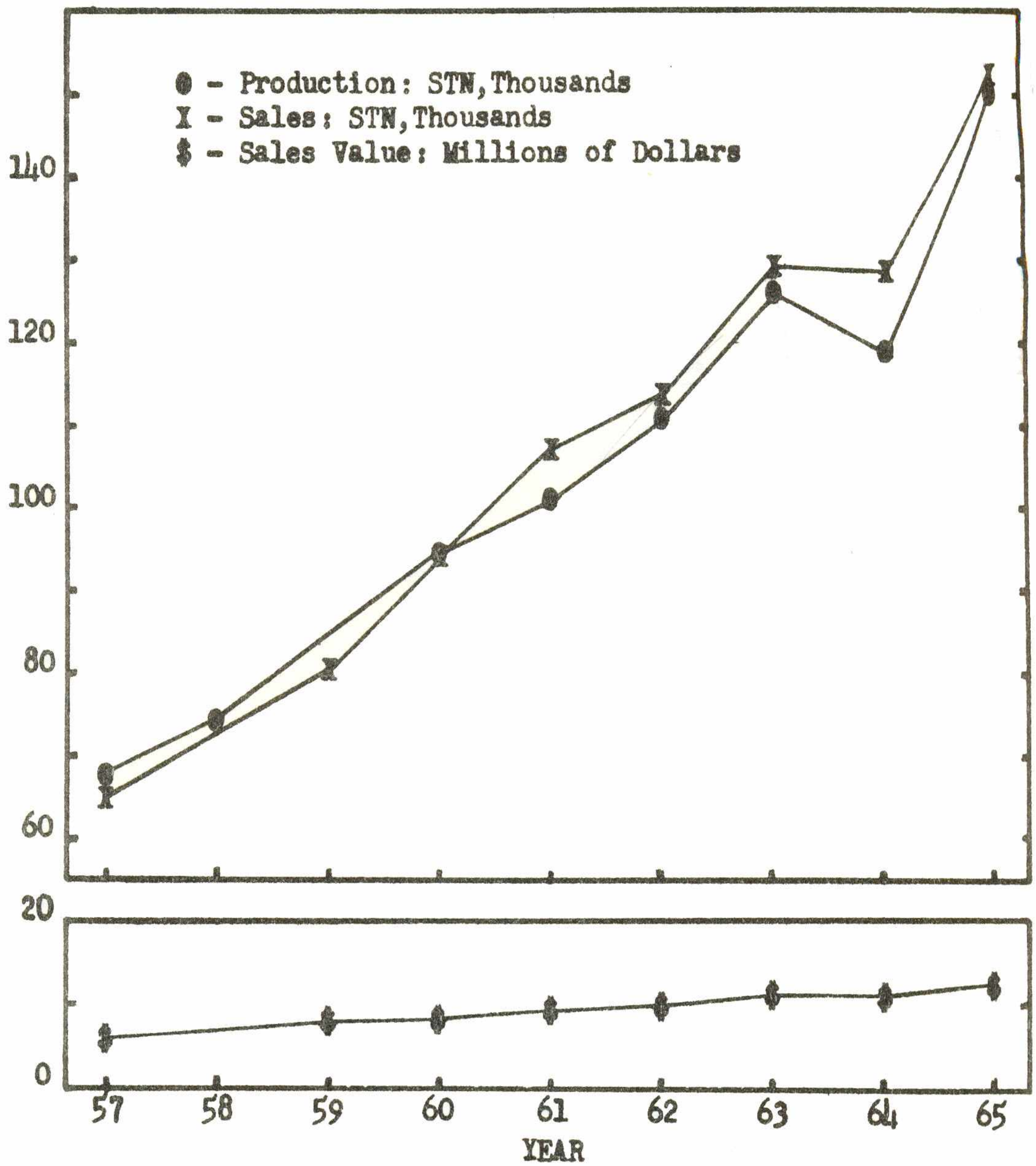


FIGURE 5

U.S. UREA PRODUCTION AND SALES



COMMENT ACCROITRE LA FIXATION BIOLOGIQUE DE L'AZOTE (AVEC REFERENCE A LA FIXATION BIOLOGIQUE DE L'AZOTE DANS LES TERRES DE RIZIERE.)

par Mme T. ROUQUEROL

Mme T. ROUQUEROL, Ingènieur agronome de l'Institut National Agronomique de PARIS en 1930 - De 1931 à 1936 : Institut Pasteur de LILLE - Docteur es/sciences en 1936 après une thèse sur: "Extension de techniques employèes en Pathologie animale à l'étude des réeactions de la cellule végétale à certaines infections". De 1933 à 1934 séjour dans le laboratoire de physiologie végétale de la Citrus Experiment Station à RIVERSIDE (California) et publication d'un travail sur " l 'Etude physiologique de la cellule à mycorhizes" en collaboration avec le Dr H.S. REED. En 1939-40, laboratoire de Pathologie Végétale de l'Institut Agronomique de 1a Molina (Pérou). En 1957, laboratoire de parasitologie de la facumté de Médecine de MONTPELLIER, puis Centre de Recherches Agronomiques du Midi ("Sur une amibe parasite des riziéres en Camargue" et "Sur la fixation biologique de l'azote dans les terres de riziéres en Camargue")

Résumé : L'auteur rappelle que l'incorporation de l'azote atmosphérique à la matière vivante est effectuée par 2 catégories de microorganismes :

1) les fixateurs symbiotiques capables d'initier la synthèse des composés azotés organiques dans la cellule du nodule. Ce groupe qui comprend les Rhizobium symbiote des légumineuses est relativement bien connu.I1 est possible d'augmenter la production des Légumineuses en favorisant le développement de ces bactéries, et la vulgarisation des procédés employés peut faire espérer une augmentation de cultures vivriéres de base dans beaucoup de pays sous développés.

Le second groupe est constitué par les fixateurs dits libres : Azo tobacter, Clostridium, Cyanophycées. L'emploi des procédés de bactérisation destiné à multiplier ces germes dans la terre a conduit à des résultats inconstants. Les Azotobacter et les Cvanophycées ne sont pas ubiquistes.

L'Auteur pense que les conditions offertes par les terres de riziéres, celles de Camargue en particulier, sont favorables à ces germes et suggère que les recherches soient poursuivies afin de favoriser et de diriger leur activité dans ce milieu particulier

COMMENT ACCROITRE LA FIXATION BIOLOGIOUE DE L' AZOTE (AVEC REFERENCE A LA FIXATION BIOLOGIQUE DE L' AZOTE DANS LES TERRES DE RIZIERES)

Par Mme T. ROUQUEROL

On ne peut accritre la quantité d' aliments disponibles à l' humanité qu' en accroissant 1a masse de matiére synthétisé par les organismes qui sont ses pourvoyeurs : animaux et végétaux. Les animaux dépendant eux-mêmes des plantes, c'est au régne végétal qu' incombe en derniére analyse la tache d' accomplir les synthéses organiques à partir du monde minéral.

La matiére vivante est formée de 4 élémenta majeure :
l'Oxygéne qui a la supériorité pondérale,
l'Hydrogéne qui domine par le nombre des atomes - c'est le grand combustible,
le Carbone autour duquel le matiére vivante s' édifie,
l'azote, quantitativement le dernier, qui a cependant une importace comparable à celle des elements précédents car il n'y a pas de protoplasme sans azote.

L'Hydrogène et l'oxygène sont les constituants de l'eau sans laquelle aucune vie n' est possible. Aussi l' exécution de tra vaux concourant à une meilleure répartition et distribution des réserves d' eau douce est inscrite en premiere ligne de tous les plans d'augmentation de production.

Le Carbone qui n'existe dans l'atmosphère qui nous entou re que dans la proportion de 4 parties pour 10.000 est incorporé dans la matiére vivante aU niveau de la cellule à chlorophylle qui constitue le centre principal de synth`ese des hydrates de carbone.

Ce phénomène de photosynthèse est connu dans ses grandes lignes, encore que bien des étapes comprises entre l'entrée du gaz carbonique et la synthèse de l'amidon ou des sucres soient encore obscures at fassent l'objet de nombreux travaux.

Mais on ne sait encore que peu de choses sur la facon dont l'azote, dans lequel baigne le monde organisé, s'incorpore à e matière vivante.

La plante satisfait ses besoins en azote en puisant dans les réserves du sol;une longue chaine d'activite microbienne opère 1a minéralisation de l'azote des débris organiques ou des acides humiquss et pourvoit ainsi l'azote ammoniacal ou l'azote intrique, matière premiers de la synthèse des acides aminés par la plante.

Les réservee d'azote organique du sol ne seraient cependant pas suffisantes pour maintenir et encore moins pour accritre 1a masse de la matière vivants à la surface du globe.

L'établissement des bilans d'azote amène toujours à la constatation d'un déficit. I1 suffit de penser au lessivage des continents par les eaux de ruissellement et a leur écoulement vere la mer pour comprendre que dans le fond des océans s'immobilise
un gissment d'azote actuellement inutilisable pour l'humanité.

Comment donc fournir au sol ce complement d'azote qui permettra à la couverture végétale d'augmenter en poids ? J.C.LIPMAN & A.B. CONYBEARE évaluent à 16,45 millions de tonnes la quantité d'azote exportée par les récoltes des surfaces cultivées aux Etats-Unis pendant l'année 1936. Sur cette masse 0,48 tonnes auraient été fourniee par les engrais chimiques, 2,57 par des fumures organiques, 3,60 proviendraient de la minéralisation des réserves organiques du sol. Le reste, c' est à dire la plus grande par tie (9,83 millions de tonnes) a été puisé ailleurs.

Nous faisions remarquer precedemment que la biosphére est entourée d'air dont 75% est constitué par de l'azote moléculaire gazeux. les agents capables d'opérer la synthése des acides aminés à partir de cet azote moleculaire sont des cellules microbiennes.

Ces microorganismes se divisent en deux categories:

Le premier groupe est capable de contracter avec les racines de certains végétaux des associations qui constituent un des types les plus parfaits de symbiose. L'entité nouvelle créée par l'implantation des microorganismes dans les tissue végétaux a, en général, une forme nodulaire. l'évolution d'azote atmosphérique se fait au niveau de ces nodules dans lequel il est presque impossible de dietinguer la part jouée par le microorganisme,de celle jouée par la cellule hote. Dans le cas de Rhizobium, bactéries symbiotes d'un grand nombre de légumineuses, la fixation d'azote commence lorsque la bactérie se transforme en bacteroides dans le nodule qui s' est formé. Elle prend fin lorsque ce bactéroide disparait par un phénoméne de lyse. Mais tout porte à croire que ces bacté roides, agent de la fixation, n'en soit pas Ie siège. Leur action pourrait etre una action réductrice et enzymatique, et le role de la plante serait de fournir les sucres qui souniront au premier composé azote formé, ainsi qu'un pigment dont la nature est voisine de celle de l'hémoglobine et dont le role n'est pas encore trés bien connu.

L'isolement de ces microorganismes, la connaissance de leurs exigences ont permis de favoriser leur activité : on a ainsi pu augmenter le degré de nodulation de légumineuses cultivées, donc le niveau d'azote de ces plantes, on a pu, et ceci est part culièrement bénéfique pour la production, introduire de bonnes plantes fourragères daos das régions où elles ne pouvait précédemment se maintenir dans des conditions naturelles. La luzerne était autrefois inconnue dans les terres acides des Ardennes, de la Bre tagne, de Vendée ou du Massif Central.

Les travau de DEMOLON, MANIL, BONNIER et OBATON ont montré que cette plante pouvait facilement y etre acclimatée à condition d'apporter en meme temps que les samences une quantité suffi sante de bactéries symbiotes pour faciliter la nodulation. Cet inoculum de bactésries est apporté en général sous forma d'une pâte enrobant la graine : c'est ce qu'on appelle la bactérisation des samences. Ces faits sont connus depuis longtemps, la bactérisation des graines de légumineuses avait été préconisée en Allemagne dès la fin du siècle passé, mais ils n'ont pas été vulgarisés a grande échelle. Il existe certainement de vastes territoires dans lesquels la production des légumineuses peut etre améliorée à la lumière de ces donneés de microbiologie. Il est souhaitable de voir les Institutions Nationales s'adjoindre des services techniques qui serain chargés de l'exécution du programme tendant à l'augmentation de production de légumineuses. On sait en effet que pour grand nombre de pays sous développés, la source la plus importante de protéines est précisément constituée par des légumes (haricots) qui joints au riz constituent la base de l'alimentation.

Un second groupe de fixateurs d'azote est constituè par les microorganismes fixateurs dits libres ou non symbiotiques, vivant de facon independante dans la terre.

L'efficacité de ces microorganismes est beaucoup moins connue et beaucoup plus difficile à apprécier.

Ces espèces ont été cependant décrites depuis longtemps par BEIJERMCK & WINOGRADSKY. Une longue série de travaux a été depuis, publiée sur le sujet sans que l' on soit arrivé à des résultats aussi satisfaisants que pour le premier groupe.

Cependant l'école des microbiologistes russes prétend avoir obtenu des accroissements de récolte par enrobage de graines au moyen de culture d'Azotobacter.

Ces résultats, rarement reproductibles, ne sauraient cependant tous etre contestés et l' on peut espérer arriver à favoriser par des techniques appropriées l activité des fixateurs libres comme on favorise celle des Rhizobium.

L'action favorable des Azotobacter serait doe, non seulement à l' enrichissement en azote du sol consécutif à leur multiplication, mais aussi, et peut-etre surtout, à la sécrétion de substances de croissance dont ces germes doués de remarquable autotrophisme seraient responsables.

Le résultat de ces expe~iences d'enrobage semble varier beaucoup avec les conditions dans lesquelles sont faits les semis et avec la terre a laquelle les graines sont incorporées. MISHOUSTINE a révélé des résultats significatifs dans un cas de cultures en serre alars que les essais sur les terres de grande culture sont trés inconstants. Cette inconstance se retrouve d' ailleurs dans les numérations de fixateurs libres, effectuées sur échantillons prélevés dans différents types de terre : Azotobacter ou Beyerinckia peuvent etre totalement absents de certaines terra ou au contraire tres abondants. les numérations effectuées dans les riziéres de Camargue donnent pour les Azotobacter des chiffres compria entre 10^4 et 10^5 par gramme de sol sec. Ces chiffres se classent pami les plus élevés de ceux qui ont été publiés. 1,1% seulement des sols selon BECKING attendraient cette richesse. L' écolagie de 1a rizière semble donc favoriser le developpement de ces germes.

Nous avons essayé par différents tests biologiques de réaliser une mesure de l'activité de ces microorganismes dans leur milieu naturel. Nous avons défini un coefficient de fixation qui mesure l'enrichissement spontané en azote d'échantillons de terre maintenus au laboratoire en conditions contrelées. l'expérience mantre que ce coefficient varie rapidement, et suivant une grande amplitude. la fixation de l'azote dans ces terres serait donc trés irréguliére dans le temps pour un même sol.

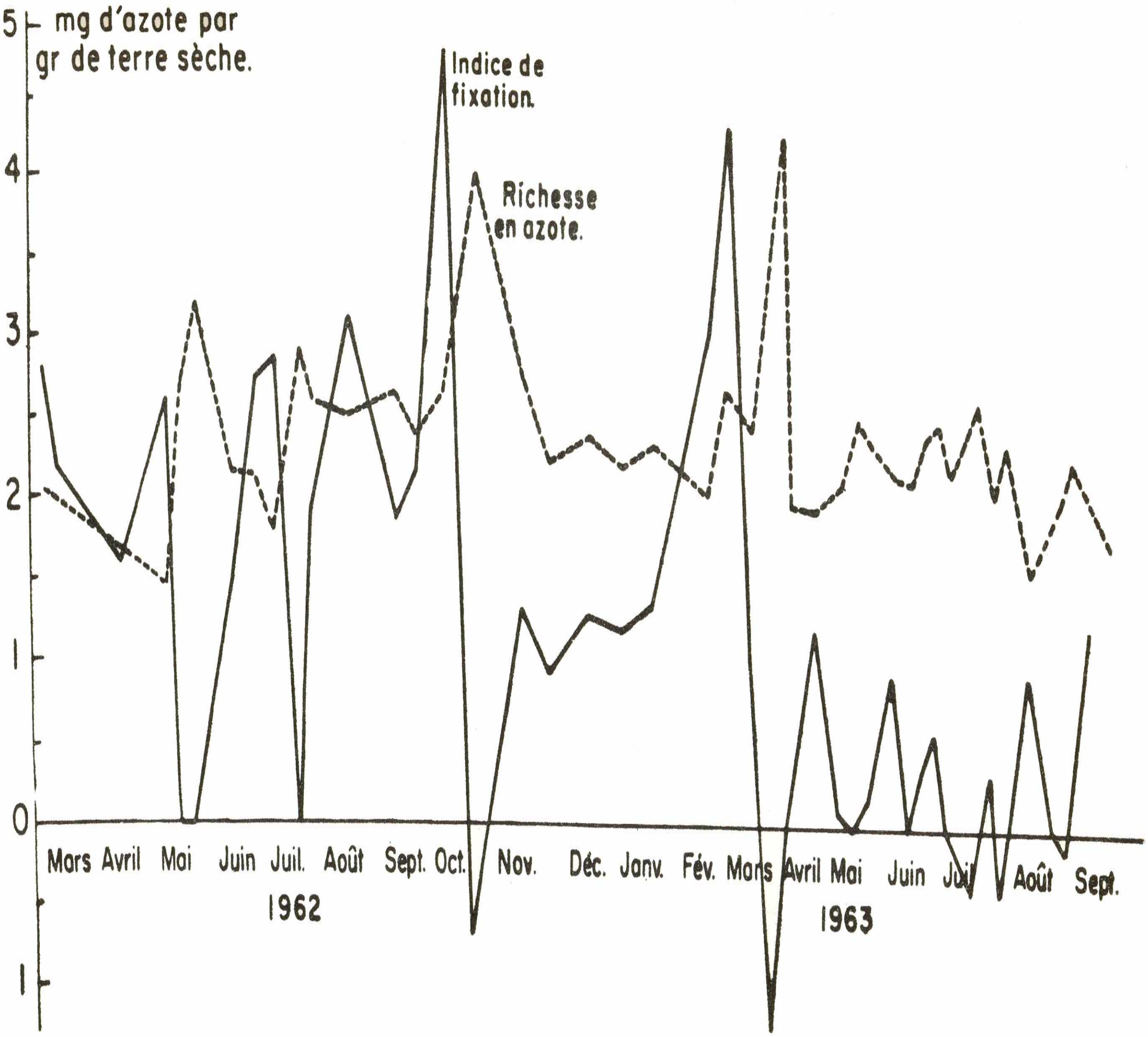
On sait encore peu de choses sur les causes ds cette variabilité. Elle peut etre liée à des variations de substrata libérés de façon fugace par l'activité des autres microflores. Les mesures de SALEH-RASTINE & ROUQUEROL montrent que les glucides solubles mesurés sur les extraits hydroalcooliquea de ces terres, varient eux-mêmes rapidement et avec une grande amplitude. libérés par des activités microbiennes dans l'horizon superficiel ils sont consommés sur place, ou bien migrent en profondeur et sont perdus pour l'activité microbienne.

Il emble encore un peu tot pour espérer intervenir efficacement sur l'activité des fixateurs libres en rizière car les facteure écologiques sont encore trop mal connus. On peut cependant y tenter des essais de bactérisation, que les conditions du milieu semblent devoir favoriser. On pourrait aussi envisager l'introduction de certains substrats de coot peu élevé. GUDIN travaillant sur les bactéries métabolisant les résidua du pétrole a entrepris un travail dans ce sens.

Notons pour mémoire que lee cyanophycées, trés abondantes dans certaines rizières tropicales et également douées de propriétés fixatrices ont été cultivées dans certaines conditions favorables (Watanabe) et que l'ensemencement de rizières par des inoclum massifs de ces algues a produit un accroissement significatif de récolts.

Nous pourrons en conclusion résumer rapidement ce qui précède:

Des techniques microbiologiques et culturales ont permia un accroissement important des récoltes de Légumineuses,donc des protéines d'origine végétale.Il est plus difficile d'intervenir sur la fixation d'azots effsctuée par les germes non symbiotiques. dont noua connaissons lea exigences de façon moins precise. On peut cepsndant espérer y arriver, et coopérex de la sorte à l'acti. on générals de la lutte sntrepriss contre la faim dans le monds.


mg d'azote par
gr de terre sèche.
Indice de
fixation.
Richesse
en azote.
5
4
3
2
1
0
1
Mars Avril Mai Juin Juil. Août Sept. Oct. Nov. Déc. Janv. Fév. Mars Avril Mai Juin Juil. Août Sept.
1962
1963

LA PRODUCTION INDUSTRIELLE DE PROTEINES ALIMENTAIRES A PARTIR DU PETROLE.

C. Y. de MAYO - Ingéenieur E. C. P. et E. N. S. P.

Madame C.Y. de MAYO a fait ses études d'ingénieur a l' Ecole Centrale des Arts et Manufactures (E. C. P.), et a l'Ecole Superieure de l'Ecole Nationale du Petrole et des Moteurs (E. N. S. P.).

Après une carrière d'Ingénieur dans l'Industrie, elle a été ingénieur de Recherche Scientifique à l'Institut Français du Pétrole, puis assistante de Monsieur Champagnat, Directeur du Service de Recherches Scientifiques et Techniques à la Société Française des Pétroles BP.

Elle est actuellement Ingénieur Conseil en Organisation des Services Recherches et Developpement, et dans différentes branches spécialisées de Recherches Scientifiques.

RESUME - Les 2 / 3 de la population mondiale souffre de malnutrition par suite d'une insuffisance de protéines d'origine animale. Les levures et certains micro-organismes, produits par des procedes de fermentation, contiennent des protéines très voisines des protéines animales. A côté les matières premières utilisées en fermentation telles que les melasses, les liqueurs sulfitiques de bois, les déchets de laite'rie, il en existe une, à laquelle on n'avait pas pensé jusqu' à aujourd'hui. C'est le pétrole, dont les fractions renferment des paraffines normal es qui peuvent être transformées en protéines par certaines levures et quelques micro-organismes. Ce procédé a été étudié au laboratoire par une grande société pétroliére qui a prouvé qu'il était possible de réaliser industriellement une production de protéines alimentaires valables en cultivant sur certaines fractions de pétrole, des micro-organismes sélectionnés. La fraction de pétrole est ainsi déparaffinée, les protéines étant élaborées à partir des paraffines normal es. Ce procédé pourrait être utilisé dans différentes contrées qui manquent de protéines animales, pour améliorer leur alimentation.

INTRODUCTION - La faim est un flèau mondial dont la première conséquence est 1' arrêt du développement normal, aussi bien intellectuel que physique, des 2 / 3 de la population mondiale. Ce problème, dont le monde occidental commence à se préoccuper, doit être resolu, si nous voulons sauver ce que nous a apporté notre civilisation actuelle.

Dans la plupart des contrées il ne s' agit pas d'une faim réelle,sensible, mais plutôt d'une malnutrition dûe en partie à l'ignorance des populations mais pour la plus grande part à 1' insuffisance des protéines animales produites. En dehors du nombre de calories nécessaires à l'homme pour vivre, il est indispensable que celui-ci trouve dans sa nourriture quotidienne une quantité minimum de protéines qui constitue environ 16% de ses tissus. Ces proteines sont abondantes dans la nature, mais l'homme ne peut pas se contenter de n' importe quelles protéines pour assurer la reproduction de ses tissus, ni fournir à ses enfants la possibilité de se développer normalement. Les protéines de céréales qui constituent la base de 1' alimentation de 2 milliards d'habitants du globe manquent en effet d' un certain nombre d'acides aminés dont l'être humain ne peut pas faire la synthèse. 1l doit done trouver journellement dans son alimentation des protéines qui contiennent les acides aminés. Seules les protéines d'origine animale en contiennent en quantité suffisante et sont capables d'assurer une alimentation valable. Pourtant certaines protéines de micro-organismes, et en particulier celles des levures, ont une composition assez voisine de celles provenant des animaux, Elles contiennent jusqu'à 10% de lysine. C' est la raison pour laquelle Jean Rostand disait des levures dans une préface écrite en 1964 : (1) " Leur importance est considérable sur le plan économique : en raison de leur richesse en protéine, de leur teneur en vitamines hydrosolubles, elles sont largement employées pour la nourriture du bétail. Et l' on peut prévoir qu'elles seront à l' homme lui-même une ressource de grand prix pour subvenir aux besoins alimentaires d'une population dont l'accroissement continu éveille déjà de sérieuses inquiétudes".

Les moyens de production traditionnels de protéines d'origine animale ne semblent pas suffisants à l' heure actuelle pour obtenir rapidement un accroissement de la production de 20 millions de tonnes par an, que prévoit la Food Agricultural Organisation, pour procurer à chaque être humain une ration a peine suffisante pour survivre. De nouveaux procédés de production doivent être envisagés et le sont dans divers domaines : production d'algues, extraction de protéines, des tourteaux, ou des feuilles, culture de microorganismes sur certaines matieres premieres. Parmi ces procédés, il semble que la fermentation, c'est à dire la culture de micro-organismes sur divers milieux, soit u'n procédé valable et facilement exploitable.

LA FERMENTATION.- C'est en 1680 que Antony van Leeuwenhoeek observe pour la première fois la prèsence de globules microscopiques qui semblent provoquer la fermentation de la bière. Mais ce n'est qu'en 1857, après les études de Gay Lussac (1810), Cagniard de la Tour (1835), et Schawann (1840). que Pasteur prouve que ces globules sont des micro-organismes vivants qui se reproduisent. Il découvre que les levures peuvent vivre sans air (anaérobiose) en produisant de 1' alcool et du gaz carbonique et se multiplier rapidement en présence d'air (aérobiose).

Les levures une fois semées sur un milieu nutritif contenant du carbone et de l'hydrogène, en presence dlair, se reproduisent rapidement, à condition de trouver dans le milieu certains produits dont elles ont besoin : azote, sels minéraux, eau phosphore, etc... Le milieu nutritif utilisé est en général un sucre végétal soluble dans l'eau, ou hydrate de carbone qui est pour lei levure une source de carbone, dlhydrogéne et d' oxygéne.

La levure, synthétise alors les acides aminés dont la formule est de la forme R – COOH , R representant un radial hydrocarbure renfermant parfois des atomes de soufre . NH2.

Ces acides aminés, reliés entre eux par la liaison peptidique (acide COOH et amine NH2), forment alors les protéines qui constituent elles-mêmes les éléments essentiels des tissus vivants, aussi bien végétaux qu'animaux. Les protéines ainsi synthétisées peuvent avoir des compositions en acides aminés différentes. On connaft une vingtaine d' acides aminés, mais les protéines en contenant entre 600 et 20.000 peuvent se présenter sous des formes variant à l' infini.

Or les protéines de levures ont une composition en acides aminés qui les rapprochent des protéines de viandes (lysine 10 %, cystine 5.6% methionine 1. 6 %, leucine 7 %, trytophane 2.2 %) (2); c'est à dire que les levures sont des aliments qui pourraient être utilisés pour remplacer la viande.

L' idée de consommer des levures, ou même certains autres microorganismes analogues produits industriellement, peut sembler faire partie du domaine de la science fiction. Mais si l' on considère notre alimentation normale avec attention, nous constatons que cette idée n'est pas révolutionnaire car les micro-organismes font partie depuis longtemps de nourritures traditionnelles On en trouve dans le pain, la choucroute, les fromages, le vin, le cidre, labiere, le vinaigre, les sauces chinoises. C'est l'ignorance qui nous fait éprouver une inquiétude et qui crée en nous une crainte non justifiée devant l' apparition d'aliments non habituels.

L'industrie de la fermentation produisant directement des levures consommables s' est pourtant développée depuis la guerre. Il est vrai que le développement est lent et que la production sert à l' alimentation animale, Mais pendant la guerre des levures ont été produites pour l' alimentation humaine en France et surtout en Allemagne. Actuellement encore, une unité industrielle de 40 tonnes / jour existe à Formose et sa production est entièrement utilisée pour l'alimentation humaine.

En général, dans les pays où la nourriture est suffisante, les unités de fermentation sont construites non pas pour produire des protéines, dont on n'a pas besoin, mais pour utiliser des sous-produits : mélasse de l'indu strie sucrière, liqueurs sulfitiques de bois de l'industrie du papier, déchets de laiterie, etc. La qualité des produits n'est pas toujours constante, et certaines industries sont saisonnières. Toute la production (10 000 tonnes / an en France) est entièrement utilisée pour l'alimentation du bétail, excepté une petite quantité, généralement produite par les unités de production de levure pour la boulangerie, qui est vendue sous forme de levure diététique.

TRANSFORMATION BIOLOGIQUE DU PETROLE EN PROTEINE - L'idée d'utiliser le pétrole comme matière première pour cultiver des micro-orgaismes a été developpée par Monsieur Champagnat, qui était alors Directeur des Recherches Scientifiques de la Soeiété Française des Pétroles B.P. La fermentation du pétrole est un procédé très voisin de la fermentation des mèlasses ou des sous-produits de laiterie. C' est une culture de micro-organismes, en cuve, sur un substrat, source d'hydrogène, de carbone et d'énergie, Mais ici, au lieu des hydrates de carbone, le substrat utilisé est constitué par des paraffines, clest-à-dire un composé de carbone et dlhydrogène que l' on trouve dans le pétrole. Au lieu de mélasse ou de liqueur sulfitique de bois, on utilise une fraction de pétrole. Comme il est probable que le pétrole lui-même est d'origine végétale ou animale, le substrat utilisé ne change que de nom, mais non pas de provenance. Il est aussi naturel que la terre, ou le fumier, source de tous nos produits alimentaires. De nombreux micro-organismes sont susceptibles d' lutiliser des produits provenant du pétrole comme source de carbone et d‘ hydrogène pour prodllire de la matière vivante, à condition de trouver dans le milieu de l'azote, des sels minéraux, de l'air et surtout de l'eau. On trouve des- souches variées dans le sol des raffineries, dans les bassins de décantation et même sous le bitume des routes. Des procédés actuels de recherche des gisements de pétrole utilisent comme indice la présence de certains micro-organismes dans le sol.

TRANSFORMATION BIOLOGIQUE DU PETROLE EN PROTEINE - Le pétrole brut tel qui ‘on le tire des gisements est un liquide noir et visqueux qui contient un grand nombre de produits différent, appartenant à la classe des hydrocarbures, ainsi nommés parce qu'ils sont formés d'atomes de carbone et d'hydrogène.

Le pétrole distillé dans la raffinerie fournit différentes fractions dont les plus légères sont les gaz, butane, propane.. . . etc. . .. Viennent ensuite les essences, les gasoils, les fuels et enfin un résidu noir qui peut servir de bitume. Ce résidu lui - même peut encore être distillé sous vide pour donner toute une gamme d'huiles et un résidu qui peut aussi être utilisé comme bitume.

Toutes ces fractions, gaz , essence, gasoil, fuel, huiles, contiennent une certaine quantité d'hydrocarbures saturés de formlile chimique. CnH2n + 2. Parmi ceux-ei les hydrocarbures à chaines droites constituent ce que l’on appelle les paraffines normales. Les huiles de vaseline vendues en pharmacie sont des paraffines normales, extraites des huiles de pétroles et purifiées.

La plupart des micro-organismes susceptibles d'élaborer leur matières vivantes à partir du pétrole n'utilisent que les paraffines normales, exactement comme ils n'utilisent que les sucres ou hydrates de carbone des mélasses ou des liqueurs sulfitiques de bois. La seule différence vient de ce que les hydrates de carbone contiennent des atomes dloxygène tandis que les paraffines n'en contiennent pas. Il faut alors fournir une quantité d ‘oxygène, par soufflage d'air qui doit être plus importante dans le cas de la fermentation du pétrole que dans le cas de fermentation des mélasses.

Ici encore, les micro-organismes doivent trouver avec les paraffines les éléments indispensables à l''élaboration de la matière vivante, c'est-à-dire de l'eau, des sels minéraux et de l'azote. On utilise généralement des nitrates ou des sulfates d'ammoniac, c'est- à-dire des engrais utilisés en agriculture, en solution dans l' eau.

Pourtant la culture des micro-organismes sur le pétrole posait un certain nombre de problèmes qui ont fait l ‘objet d'une longue recherche en laboratoire. Ces problèmes peuvent se résumer ainsi :

1) Choisir la fraction de pétrole la mieux adaptée;
2) Choisir les micro-organismes les plus reproductifs dont les protéines correspondaient à une composition en acides aminés intéressante pour l'alimentation.

3) Trouver le moyen de fournir une quantité importante d'air
4) Choisir le sel susceptible de fournir l' azote.
5) Enfin réaliser l'homogénéite du substrat. Ici la fermentation du pétrole pose un problème particulier, les paraffines n'étant pas solubles dans l'eau comme les hydrates de carbone, On a dû trouver un moyen pour émulsionner ces paraffines dans l'eau.
6) Résoudre des problèmes de lavage et d' extraction des micro organismes produits, questions d'ailleurs assez souvent traitées dans toute fabrication industrielle d'aliments mais qui devaient être traitées ici dans des conditions particulières

RESULTATS OBTENUS AU LABORATOIRE - Des études systématiques effectuées dans le laboratoire d'une raffinerie de la Société Française des Pétroles BP ont permis de résoudre ces problèmes et ont conduit à la construction en 1963 d'une unité semi-industrielle dans le midi de la France. La fraction de pétrole choisie a d'abord été un gas oil, c'est – à - dire une fraction moyenne distillée à la pression atmosphérique.Il contient suffisamment de paraffines normales pour représenter un substrat intéressante

Les premiers micro-organismes choisis ont été des levures dont les cellules sont relativement grosses; on pouvait espérer obtenir une production rapide et facile à purifier.

Les milieux nutritifs ont fait l'objet d'études poussées afin d' améliorer les rendements, les vitesses de production, les possibilités de séparation des crémes de micro-organismes.

Une petite unité de 60 l a été montée afin de résoudre certains problèmes et a permis de prevoir la construction d' une unité semi-industrielle plus importante et qui devait marcher en continu

Le premier produit dont on a parlé sous le nom de Concentré Protéine BP a fait l'objet d'un article publié par son promoteur, Monsieur Champa-gnat, dans la Revue de l'Institut Français du Pétrole, en 1962 (4), Une analyse des protéines prouvait que celles-ci contenaient une quantité appréciable de lysine. qui les rendraient particuliérement intéressantes pour l'alimentation Ce premier résultat a permis d'envisager la possibilité de fabriquer directement des protéines pour les hommes, sans passer par l'intermédiaire des animaux. La transformation des paraffines par les micro-organismes en matière vivante conduit à la disparition de celles- ci du gasoil utilisé, c'est - à-dire que cette réaction correspond à une opération généralement réalisée en raffinerie par un refroidissement des produits et une filtration que l' on appelle un déparaffinage. Le point de congélation du gasoil traité est plus bas que celui du gasoil matière première, clest-à-dire que celui-ci se trouve valorisé du point de vue commercial. Cette façon d'envisager le problème peut faire espérer une production de protéines à des prix relativement faibles bien qu'il soitiencore impossible, à l' heure actuelle, de l'affirmer, le gasoil sortant devant subir un traitement d'épuration avant d' être utilisé.

Le concentré protéine BP, s' il est utilisé pour l' alimentation humaine ou animale doit remplir certaines conditions et satisfaire à des essais de nutrition sur des animaux afin de connaritre les conséquences de l'introduction dans leurs nourritures du nouveau produit. On a donc réalisé en France les premiers essais sur des rats, en remplaçant une partie des protéines habituellement consommées par le concentré protéihes BP. Ces premiers essais ont ete suffisamment bons pour que lion envisage de développer le procédé. C' est alors qu' en 1963 la première unité semi-industrielle a été constiuite dans une raffinerie afin de produire les quantités de protéines nécessaires à l'alimentation de plusieurs générations de rats, de poulets, et plus tard de porcs.

L'UNITE SEMI-INDUSTRIELLE - La premiére unité a été réalisée avec un fermenteur le Françis Marillier couramment utilisé en levurerie (3). Ce fermenteur a été adapté aux exigences de la nouvelle matière première. Il fonctionne en continu, le gasoil, l'eau et les autres éléments nécessaires étant introduits dans la cuve à débit constant. On ensemence le milieu une première fois en micro-organismes et l' on commence le soutirage quand la quantité de matiéres vivantes est suffisante pour se reproduire à un rythme constant. L'air est soufflé en continu afin d'apporter aux micro-organismes la quantité d' oxygène indispensable à leur multiplication. La réaction produite dans le fermenteur étant exothermique il est nécessaire pour assurer une température constante, qui correspond à un rendement maximum, de refroidir la cuve ce qui est assuré par une circulation d'eau froide. Les crémes de levure vivante sont extraites du milieu acqueux par centrifugation puis lavées plusieurs fois de façon à ce que le produit sortant soit débarassé de toutes les impuretés. Ces crèmes, assez épaisses, très analogues aux crèmes fabriquèes dans les unités de fermentation de levure pour le pain, sont alors traitées par des procédés devenus classiques dans la production de levures diététiques, ou des levures destinées à 1' alimentation animale. Elles sont desséchées de façon à ce que la quantité d'eau restante soit trop faible pour que le produit final puisse se détériorer. Cette dessication doit tuer les micro-organismes qui deviennent ainsi digestibles.

Le concentré protéine B. P. est produit sous la forme de pou, très légèrement colorée en jaune. ayant un léger goût de fromage.

PRODUCTION DE PROTEINES PAR FERMENTATION DU PETROLE - La production de proteines ou meme de concentrés protéines vitaminés par culture de micro-organismes sur fractions de pétrole semble être un procédé d'avenir Les premiers résultats de nutrition d'animaux étant bons, les essais se pour sui vent sur une plus grande échelle dans des laboratoires spécialisée en Hollande, en France et en Angleterre. Une ferme expérimentale d'élevage est en fonctionnement au Nigéria. La Société B.P. a monté d 'autres unités semi industrielles en Ecosse (3). D'autres sociétés de pétrole développent des procédés analogues. Tous les essais de nutrition ou de toxicité sur animaux sont indispensables et doivent durer suffisamment de temps pour que lion soit certain qu'il n'y a aucun risque à nourrir des animaux d'élevage avec des aliments enrichis de ces protéines. Toutes les précautions seront prises et sont d'ailleurs exigees par les gouvernements des pays avant que le produit soit définitivement accepté.

Il est probable que la plus grosse difficulté sera un élément psychologique, l'ensemble des être humains ayant quelque appréhension à abandonner des habitudes prises depuis des générations et à s'adapter à de nouvelles nourritures. Comme le disait Pascal, ce qui nous parait naturel vient souvent de nos habitudes. Mais l'accroissement continu des populations ne peut pas aller sans changement des coutumes de l'alimentation normale, qui ne peut plus être assurée par les procédés traditionnels de production lents et peu rentables. En effet, tandis qu'un boeuf de 500 kg. ne produit que 500gr. de protéines par jour, le même poids de micro-orgariismes peut en produire 750 kg. (4).

La fabrication de protéines alimentaires à partir de microorganismes cultivés sur des fractions de' pétrole peut permettre d'accroitre rapidement la production annuelle et d'augmenter celle-ci de 20 millions de tonnes que dema de la Food Agricultural Organisation, simplement pour assurer à chaque individu une ration à peine suffisante. Ces cultures de micro-organismes peuvent sans doute se réaliser sur plusieurs fractions de pétrole. Certaines Sociétés utilisent le gas oil. d'autres tentent de transformer directement les gaz de pétrole en matiére vivante (3). La construction d'unitéi de fermentation dans les 750 raffineries réparties dans le monde peut assurer cette production. La répartition géographique des centres de production serait alors assez homogène sur la terre. Il faut songer qu'en 1980 la population mondiale peut atteindre plus de 6 milliards d 'hommes et que le problème de l'alimentation humaine ne peut s'améliorer que dans la mesure où l' on prévoit son développement.

Les avantages de ce procédé industriel de production sur les moyens traditionnels utilisés jusqu 'à nos jours sont faciles à énumérer et montrent bien que ce projet est valable. Ce procédé est indépendant des climats, des sols, des saisons, ce qui permet d'assurer une production régulière. Il permet de fabriquer des produits de qualité constante et de prévoir à l'avance les quantités nécessaires. Les moyens de contrôle seront entre les mains des diététiciens, qui peuvent apporter leur garantie à la qualité du produit. La main-d'oeuvre nécessaire à la marche des unités construites est peu nombreuse et il est possible de l' éduquer rapidement. Enfin, la matière première est abondante et bien répartie sur le globe terrestre.

FORMES DIVERSES DES PROTEINES - Les protéines pourraient être produites sous des formes différentes. Plusieurs laboratoires spécialisés, tant aux EtatsUnis qu'en Europe, effectuent des études scientifiques -qui ont pour but de transformer les protéines naturelles en divers produits consommables `a goûts divers. Chaque jour cette nouvelle science fait des progrés. On trouve dans le commerce différents produits à base de protéines transformées, tels que les bouillons solubles, les sauces fermentées d' origine orientale, et même la choucroute. Il est donc possible que, dans un avenir proche, on puisse transformer les proteines provenant de la culture sur pétrole en divers produits alimentaires dont le goût serait adapte aux différents pays susceptibles de les consommer. On peut encore extraire les acides aminés et les considérer comme des médicaments contre la malnutrition. De toute façon, et quelque soit leur forme, les protéines devront etre considerees comme des suppléments à des aliments dont la valeur nutritive est insuffisante : farines des diverses céréales qui sont à la base de 1'alimentation des 2/3 de I'humanité. Dans ce domaine, chaque jour la science fait des progrès, et l'on sait déjà qu'il est possible de valoriser les protéines dans lesquelles certains acides aminés sont absents, par exemple la lysine, en y ajoutant des protéines contenant ces acides aminés. Cette addition accroit la valeur biologique des aliments pauvres et permettra sans doute d'envisager une solution du proplème de la malnutrition mondiale sous un jour moins sombre qu'il n'apparait aujourd'hui

CONCLUSION - Il semble que l'amélioration du niveau, de vie des pays mal nourris soit une condition essentielle de développement et que cette améliora, tion ne puisse se faire que dans la mesure où l'alimentation des populations deviedra suffisnnte en qunlité. L'intérêt et le devoir de nos pnys est d'aider dans cette voie les gouvernements qui savent se rendre compte de l'importance de cette question. Il est possible que les peuples en cours de développtement passent facilement de leurs traditionnels modes de culture à la production industrielle d'aliments, comme ils sont passés sans heurt des chariots ancestraux à. l'avion de transport, sans franchir, comme les peuples d' Occident, tous les échelons intermédiaires. Les organisations qui se préoccupent de résoudre le grave problème de la faim doivent être soutenues, même si leur but nous semble du domaine du rêve. Tant de réalisations actuelles paraissaient, il y a seulement quelques années, faire partie du domaine de la fiction quand ce ne serait que d' aller faire un tour entre les planètes. Rappelons que Paul Valéry disait que toutes les civilisations sont mortelles. La nôtre ne conservera ses avantages acquis que dans la mesure où tous les peuples du monde pourront en profiter.

Nous espérons que l'idée d'un chercheur français aboutira à la création d 'une nouvelle forme de production, d 'aliments, qui contribuera `a résoudre le problème de la faim dans le monde,' qui, comme le disait Jose Castro (5) est une source féconde de calamités contre laquelle notre génération doit starmer en vue d'une difficile victoire.

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The Application of Technology -Future Trends

DISCUSSION

K. Saruhashi (Japan)

I am very interested in the paper presented by Miss Cavanagh. Weather is one of the most important factors in food production, not only on land but also at sea. Basically, food production depends on the total energy of solar radiation and assessment of water availability. In Japan we have about 200 millimetres of rainfall a year on average. Most of the rainfall is brought by typhoons which have as much energy as that , produced by a nuclear explosion. We get some 20 or 30 typhoons a year and productivity of the land depends on the number and scale of typhoons. On this point may I ask whether you have any idea on the modification of hurricanes.

E. Cavanagh (U.S.A.)

I am substituting on this paper. However I did read it before I dared read it aloud and I noticed in the course of the text that there is a specific statement that there has, as yet, been no success in controlling this sort of tropical storm. Apparently there is research going on in this area but the author specifically indicated that they are not yet far enough advanced to have an effective control mechanism.

D. F. Hollingsworth (U.K.)

I really only want to make a comment about the paper on quality control. I think that a trouble which is plaguing the food industry in any country which is using a great deal of processed food preserved in cans or in some other way, is an increasing tendency for foreign bodies to get into the food bits of splintered bone, bits of glass or bits of , cans. I think that if engineers could direct their attention to the problems of detecting these unwanted materials this would help the food industry and the consuming population.

R. Winslade (U.K.)

If I might reply to Miss Hollingsworth. Of course there are a great many devices for detecting foreign bodies in cans, bottles and packages. This is by no means a neglected part of engineering. However, some materials are more difficult to deal with than others and it may be some time before all unwanted matter can be dealt with. Non ferrous metals are difficult, ferrous metals are both easy to detect and to extract, glass, bits of string and the occasional cigarette end are a serious problem. I believe that all too often the fault lies not with inadequate equipment, but with carelessness and neglect of basic rules of hygeine by operators and supervisory staff.

M. M. Moody (U.K.)

I very much appreciate that Miss Cavanagh is not expected to answer questions on a paper she hasn't written, but there was the comment that there had been no experimental work on fertilising the deserts. Through unfortunate circumstances we have none of our Israeli friends with us but I would have thought that the irrigation of the deserts which has been undertaken in Israel was to a great extent controlling the thermal temperatures of the desert.

E. Cavanagh (U.S.A.)

The problem in food production from deserts is more a matter of water supply than of need for fertilisation of the soil. Most of the sands need only some growth of vegetation in order to be self sustaining so I am certain that irrigation projects are the answer to the problem of food production in desert areas. I do know that in the USA there are several rather large desert areas, but as we have no desperate agricultural needs we have not attempted to utilize them, but they have been found to be exceptionally rich in soil bases. Irrigation is something I am not competent to discuss but I can point out this fact about desert or arid lands. I did notice in the paper that thermal properties were considered. I don't think that the author, in the context of the paper, defined these too carefully but they would include things like heat conduction and evaporation properties as well as the actual temperature properties of the soils.

A. Azmaz (Turkey)

I just want to make a comment on the point of what is being done in Israel. I am not from Israel, but I have been there for about four months, and I have seen that they are fertilizing the desert area and growing plants there. I have also seen their research institutes where they demonstrate and explore methods of fertilizing the desert.

R. E. W. Kropveld (Netherlands)

Although I am not familiar with the subject I believe that there have been trials with some kind of dew hut, because even in the desert dew falls and there is the possibility of collecting it. Of course this is rather expensive and I know of nothing on a large scale.

J. Webb (U.S.A.)

I just want to add a comment about deserts and what irrigation has done Miss Cavanagh said it has generally been found that when we irrigate, the soil itself is quite fertile, usually only some nitrates need to be added. I live in the Pacific North West in an area where irrigation of the desert areas of Washington and Oregon has been carried out on a vast scale in the past 10 to 15 years. During this time we have noticed a pronounced change in our climate as a result of the new green areas in Eastern Washington.

R. E. W. Kropveld (Netherlands)

I would like to put a question to the Nigerian delegate. You were speaking about finding ores in a magnetic way and the new methods you have developed for this, of course there are already existing magnetic methods of finding ores, so I suppose that what you mean is that you have specially developed methods because of difficulties introduced in a highly vegetated area.

E. Adegbohungbe (Nigeria)

The technique developed was to solve that very problem.

R. U. Qureshi (U.K.)

I will very briefly try to say what a balanced diet is and how the quality or the value of a particular diet is assessed. For the purpose of balanced diets, first of all, there are five necessary ingredients which must be present in a diet - carbohydrates, fat, protein, vitamins and minerals. All these together add up to make essentially a palatable menu. It is the menu value of the diet which is more important rather than the presence of anyone item in a diet, therefore from this we learn that no single food item can ever be called a complete diet, it has to be composed of these five essential ingredients. Of all these I will take just protein to illustrate the biological value of diets. For that purpose WHO and FAO have given a reference protein pattern against which all the proteins are evaluated; this reference protein contains ten essential amino acids. If we describe these ten essential amino acids as ten strips of a barrow and if we try and fill this barrow up to the brim, then if we can do that we will call the biological value of that protein 100% But if anyone of those strips is short of the top level then howsoever hard we try we will never be able to fill that barrow up to the brim and therefore never be able to get a complete or 100% value of that protein. Therefore, this amino acid which is short of the top level is called the limiting amino acid and there is no protein known which doe s not have a limiting amino acid one sort or another. What determines the biological value of a protein is roughly quality x quantity. Quantity is nitrogen x 6.25 and quality is net protein utilization x digestability. The product of these gives the biological value of the protein and every protein is evaluated this way. Most of the animal proteins are called first class proteins because their biological value is higher than vegetable protein and the concentration of protein, that is, the quantity of protein in most of the animal proteins is higher than that in the vegetable proteins.

D. C. Dju Chang (Taiwan)

In Formosa we have been successfully producing almost 40 tons of yeast per day. But the problem to feed the people is the palatability and digestability, so actually today we use more yeast for animal feeds because the animals have less choice than human beings. We still find digestability problems for the animals, so that use is still limited, between do produce very successfully by using molasses. The process we use is a kind of open tank process, and operates 24 hours a day. So the industrial problem of producing the synthetic food is much less than the human problem of consumption.

C. Y. de Mayo (France)

Perhaps I could reply to that. The manufacturer of yeast is a manufacturer of micro-organisms and it is possible to transform these microorganisms into several things, either they can be consumed directly and form a supplement to traditional food or proteins can be extracted from these micro-organisms. At the present time there is a laboratory study going on concerning the transformation of these proteins and by various chemical or biological techniques it is possible to transform them and give them various tests. We can produce synthetic beef steaks using polymers and yeasts that have been converted to polypeptides and which have the taste of meat or fish or whatever you like. This is a science which is still in its infancy but which is going to develop and will make it possible to use all these proteins that we have been developing industrially,

A delegate (France)

What I should be very interested in is the purification of yeasts. I see that you have derivatives of gas oils as your raw material and probably there is sulphur and aromatics which you cannot allow to get into the food. How do you eliminate them?

C. Y. de Mayo (France)

The problem of purification which is being handled on a semi-industrial scale in this refinery in the South of France begins by centrifuging, we start by drawing off the cream of yeast and then we centrifuge this a first time so as to get a fairly concentrated product. Then we carry out various washings with detergents which are acceptable for feeding and then we carry out extraction using various processes either by extracting protein or by using solvents. These are processes which are practically classical in the manufacture of certain kinds of bouillon which are extracted from wastes using solvents, so it is quite possible to clean the gas oils using solvents. Remember we are not producing an industrial product, this is still on a laboratory scale, and we have laboratory rats in Holland, Scotland and France, we have even an experimental farm in Nigeria, to see what the influence of these micro-organisms is on these larger animals under difficult climatological conditions. All of this is on an experimental basis and we really cannot start selling the product industrially until we are sure that several generations of animals have been brought up on the product without any disturbances.

K. Saruhashi (Japan)

I would like to direct my question to Miss Steel. You showed us the relation between production and price and I would like to ask you about the relation shown in figure 3. Does this mean the difficulty to develop a new technique of mass production of amino acid.

M. N. Steel (U.S.A.)

I am only a statistician and I do not know production techniques that are used only accumulated the information. But it is indicated that when a more efficient production technique is developed the price does drop, that is the goal of the manufacturer. To sell his product to more people it has to be in a price range that the public will buy and therefore this is very important and it is of course the business of the engineer to develop these new production techniques.

J. Knott-ter-Meer (Germany)

I would like to refer to a book by Ruth Harrison - animal machines - and ask whether we as human beings have the right to exploit animals as though they were machines. I am thinking of battery chickens for example, where they are kept in tiny cages purely for the sake of egg production these chickens are fed on hormones and to prevent the outbreak of any disease they also have to be given anti-biotics. Do you think these eggs afterwards will have a bad effect on human beings. The same thing applies to calves who from birth are kept in very small dark stables just to keep the colour of the meat nice and pale and these calves are also partly fed on hormones which no doubt will have a very bad influence on human health within the forseeable future. I just wanted to refer here to this mistaken path that technology has taken.

C. Y. de Mayo (France)

All micro-organisms are vegetables and they can do away with the use of meat. The day we eat micro-organisms we shall all be vegetarians, the problem can be solved.

J. Shaw (U.K.)

I would like to refer to Miss Steel's paper, figure 4, where she gave us a graph of the millions of pounds of production of flavour and aroma materials per year. I am very interested in measurements in particular and I am wondering how one assesses the flavourability of a substance.

M. N. Steel (U. S.A.)

In the USA we have very well defined laws about flavour and aroma materials and when they report the statistics they are all bracketed together. Of course, as far as the flavours are concerned, in the chemical laboratories they try to evolve the flavour material by chemical analysis that matches the natural flavour material. These statistics in the USA tariff commission report, included medical, organic, synthetic chemicals so they are anything that is used - anything which has passed the requirements of the law and I believe that you will find that the greater proportion of these is due to the very common synthetic flavours. I referred to mono-sodium-glutomate which is a flavour enhancer, I think we owe this to our Japanese friends, and now it is really the major part of our market. You can count on the figure representing primarily the flavours that can be used in food materials.

L. Arnold (U.S.A.)

I would like to reasure the lady from Germany that I grew up on a farm, we raised dairy cattle, chickens and many vegetables and although we do use controlled lighting and certain additives to the feed I must say that the first I have ever heard of keeping calves in small dark pens to produce pale meat, was today. We do control the feeding and breeding of animals in order to improve the stock but I would like to comment that we also take our own young and herd them into modern cubicles and stuff their heads full of anything from mathematics to latin. I do hope that the day will come when these additions to our present food production will form a larger proportion of the diet and bring good diet to many many more people. But as the technology move s slowly we have to do what we can and we certainly are doing the best we can to treat our animals as part of our life and not as machines that are exploited. The farming methods are certainly improving as time goes along but I have never felt that there was any exploitation of the kind referred to, in the life I led as a small girl on a farm.

R. U. Qureshi (U.K.)

Up to now in the field of nutrition we cannot use a complete synthetic diet for animals or humans so they should be used as a supplement not as a complete substitute of natural food.

C. Y. de Mayo (France)

On this, the gentleman was referring to the biological value of proteins, and the advantage of being able to produce proteins with a known composition in terms of amino acids, is that they can be used later on to supplement the protein of vegetable origin and give them a greater biological value. They are, as you say, supplements but which make it possible to give cereal proteins the value of animal proteins, simply by the addition of certain amino acids that may have been extracted from the industrial production of yeasts or micro-organisms.

D. F. Hollingsworth (U.K.)

May I add a word about the importance of a mixed diet. I do very strongly agree with the remarks by the lady from Tai Wan. I do also agree with the remarks from America about the production of animal foods. I have read Ruth Harrison's book and do know what she says, and there has been a considerable enquiry in this country about the welfare of animals. We are, for example, on the nutritional side investigating the nutritional value of some of the foods which are being produced by intensive methods. Such work as we have already done in this country suggests that there is not very much difference in nutritive value between animal products which are produced by free range methods, that is, old fashioned farming, and intensive methods of farming. We have done some work on this, some work is in process and some papers are published, and there is one in the press now about the nutritive value of beef Produced by free range methods and by intensive methods of production. That is one point on facts which I would like to make, but on philosophy I would like to make another point. I think as I said in my opening paper that the world food situation is so serious, that we must advance in research on all possible ways of increasing food production and, in particular, I think it is extremely important that all countries should be increasing protein production by all available means, and therefore I have been delighted to hear this paper this morning from France about the yeast production, and the efforts which they are making to make this material palatable for human beings as well as suitable for animal food. There were arguments yesterday about the merits of fish and milk and meat, about the merits of cereal foods and pulses and all the rest and I have a strong feeling that some people may be rather confused here about the very difficult thing of nutrition and the methods of assessing the nutritive value of all these materials. I am therefore very pleased that Dr. Qureshi took a few minutes to say a few elementary facts about nutrition. The point of my remarks now is not I think that any of us can try to solve all these difficult problems at this Conference, but I do want to make the proposal and to urge the organisers of this Conference. It was a marvelous idea to get together various types of engineers, various chemists and biologists and nutritionists with the object of trying to improve the food supplies in all the countries. I do urge that in future considerations of all of us, all these disciplines should keep together because it is no good for the nutritionists to talk about good nutrition without considering production problems. It is no good for the industrial people to consider making an enormous batch of something and producing it if the people are not going to be able to eat it. I do hope that people will keep together and cooperate, this is a terribly important lesson for us all.

E. M. E. Lenthall (U.S.A.)

I have a small point to make. I think the inclusion of mono-sodiumglutomate and other sodium forms makes it very limiting for those of us who are on a salt free diet. Is there any other chemical preservation which could be used instead of putting these sodium forms into practically every kind of preserved food?

M. N. Steel (U.S.A.)

I would turn that question over to the nutritionist, if any of them are aware of the substitutes for mono-sodium-glutomate for people on a salt free diet because I do not know the answer.

A delegate

Speaking as a dietician, I would have thought that a patient on a salt free diet would have to have other kinds of flavours. The traditional things to do are to add onions and lemon juice and other flavours and to try not to have manufactured foods with mono-sodium-glutomate in them.

M. N. Steel (U.S.A.)

There is one comment which I think is most interesting about the limiting protein. The grain cereals, rice and wheat are limited by not having lycene in sufficient quantity. I was told just before I left the States that a lot of the wheat now being shipped abroad from the USA is being treated by a vat method by which it is soaked in lycene before it is shipped abroad. Therefore, the wheat that is being sent has this additive in it. These are the ways in which these products are gradually being used with the natural food products and to me the important thing is to think of it as an evolutionary process. After all, we are in space and time and the ways we do things now are certainly different from the ways in which our ancestors did them. All these synthetic products are coming into being slowly but when you think of the growth of the population and how farm lands are being taken over for housing, something has to be used instead and that is why we have to begin thinking in these terms. You must not get a fixed idea and say it cannot be done, you have to have the vision to think ahead, think in terms of what can we do to protect the health of the future generations as well as our generation. Food problems have cropped up because these things have failed to be thought of before and it is our opportunity in this generation with our scientific ability to create these things before it is too late.

<u>The Application of Technology – Preservation</u> **5 July 1961**

In the Chair

Mahin Rahmani (Iran)

The role of aircraft in food production **Katharine Stinson (USA)**

Application of microbiological techniques to food problems

Umrana Ahmed (Pald stan)
(presented by Constance E. Arregger (UK))

Discussion

Mahin Rahmani (Sanei)

Mahin Rahmani received her B.Sc. in Physics from Teheran University in 1957 and in 1960 the Diploma of "Ecole Nationale Superieure des Télécommunications de Paris". From 1960-62 she was a Research and Teaching Assistant at the "Institut d' Eleotronique de l' Université de Paris" working on "Nuclear Magnetic Resonance".

She spent 1962-1964 as a Research Assistant at the Physics Department of M.I.T. working on Color Centers (Solid State Physics), and in 1964 she became a member of the Division of Sponsored Research at M.I.T. For this work she obtained a Doctorate, and in 1965 she returned to Iran to work as Assistant Professor at the Teheran University Nuclear Centre, to continue research and to teach Solid State Physics.

She is a member of Sigma X society in U.S.A. and was the Iranian representative at the First International Conference of Women Engineers and Scientists in New York.

THE ROLE OF AIRCRAFT IN FOOD PRODUCTION

By Katharine Stinson. BHE (Aero.)

Katharine Stinson received her engineering degree from North Carolina State University. In 1941 she joined the U.S. Civil Aeronautics Administration (now Federal Aviation Agency) as a Junior Aeronautical Engineer. In 1951 she was appointed Chief Specifications Staff. Aircraft Engineering Division, a position which she held until 1962, when she was made Chief, Regulations and Procedures Branch. Since 1964 she has been Technical Assistant to the Chief. Engineering and Manufacturing Division of the FAA. She was President of the Society of Women Engineers 1953-55.

Summary Aircraft can play a major role in increasing the food output of the world. The full potential has barely begun to be realized. Aircraft are now performing agricultural work in at least 45 countries where about 270 million acres of cultivated land and forest are treated annually from the air. For large scale field applications aircraft are fast becoming the accepted means of application the world over.

THE ROLE OF AIRCRAFT IN FOOD PRODUCTION

By Katharine Stinson

One of the most serious problems facing the world today is hunger. The need to produce food in sufficient quantities to match the world's expanding population is one of man's greatest challenges today and for the future.

There are several ways in which the world food situation can be improved. One is by increasing our farmlands. Jungles can be cut down, water can be brought to the barren deserts, and farm areas can be pushed further into the artic seas. Work along these lines is being done.

Another way of increasing food production **--** a way which could make a greater contribution sooner and at less expense **--** is by putting our present farmlands to better use. Aircraft provide the means for accomplishing this through their unique ability to work so much faster than any other machines and to do so where and then other equipment is incapable of performing at all.

Aircraft are now performing agricultural work in at least 45 countries, where about 270 million acres of cultivated land and forest are treated annually from the air. Aviation's contribution to humanity in this regard is surely well recognized.

Most people have little understanding of the beneficial relationship between agricultural aviation and the food they eat, the clothes they wear, the wooden houses in which they live, the trees which shade them and even the game for which they hunt and fish.

The use of aircraft in agriculture began as early as 1911 when experiments to combat insect pests were conducted, but it was not until World war II that the airplane came into general recognition as an agricultural tool.

The rapid growth of aerial agriculture began in 1945. New and powerful insecticides such as DDT were developed during the war and techniques were evolved by the military services for effectively spraying insectridden areas that had to be occupied by troops. It was a simple matter to apply this wartime experience to aerial spraying in peacetime. Furthermore, surplus military aircraft were available in large numbers and at low cost. Combined with the availability of pilots trained during wartime, these factors helped to promote the growth of agricultural aviation.

In 1947, about 200 aircraft were utilized for agricultural purposes. Today, all together, about 16,000 helicopters and fixed wing aircraft are employed in agricultural duties throughout the world.

In terms of acreage treated by aircraft per year, the USSR, with more than 133 million acres (in 1965), and the USA, with 70 million acres (in 1964), are in a class by themselves. Australia is third with over 16 million acres; New Zealand is fourth with 15 million acres; Argentina is fifth with 9 million acres and Canada is sixth with 7 million acres.

Agricultural aviation operations in the world are quite varied. Airplanes and helicopters not only work faster than land vehicles but are better fitted to fight plant diseases, for example, when the soil is soaked and the fields are accessible only from the air. The airplane is appropriate for large open areas and the helicopter is well suited to certain specialized operations.

Aircraft are widely used for agriculture in those countries where access to crop fields is made difficult by vast roadless areas. The topography of the Argentine Republic lends itself well to aerial protection of agriculture. The central pampas - a vast area of some 400,000 square miles of practically contourless country - forms one of the world's richest areas for extensive cultivation and stock-raising and offers conditions where aircraft can be used for agriculture to perhaps their greatest advantage. Aircraft were first used there in 1947 to combat locust invasion. The beef production in Argentine has been increased considerably as a result of agricultural aviation.

Similarly, it should be possible to increase beef production in large areas of the African savannas by improving the pastures. The airplane would be almost the only equipment required. The airplane can free the land from undesirable grass species by "chemical plowing", then sow good grass species, spread fertilizers, carry out top dressing, check the growth of weeds by spraying weedkillers and, where necessary, destroy the tsetse fly by spraying insecticides.

In Australia and New Zealand, for example, millions of acres of poor land have been treated in this way to restore fertility and promote the growth of pasture. This treatment in turn has sucessful1y combated the problems of water loss, soil erosion and flooding. Through aerial sowing and applications of top dressing alone, the New Zealand mutton production has been increased by as much as 60 percent. The use of aviation as an aid to farming is one of the principal reasons for New Zealand's ever increasing production of meat, wool and dairy products.

During dry summers and icy winters, many flocks are short of fodder. A recent development in aerial farming has been the dropping of supplies to isolated or stranded flocks. A striking instance of the aircraft's role in such situations is the dropping of bales of hay during the lambing season to provide shelter for the young lambs.

The inaccessible hilly grazing lands of New Zealand have been made useful as a result of the aerial application of top dressing, and as a follow on fencing materials are dropped by aircraft along proposed fence lines. In 1963-64 over 1.290 tons of fencing posts and building materials were dropped. Poisoned bait is dropped from aircraft to control the development of various animal pests such as mice and, in Australia, opossums.

With nearly two-thirds of its 21,000 sq. km still desert, Israel is obliged to turn every scrap of its arable land to account. Due to wide spread use of irrigation canals. it is difficult and in some parts of this country even impossible to enter fields with ground equipment to combat pests. One of the most damaging threats to agriculture is the locust. Locust swarms can be quickly and effectively controlled only by aerial application. Problems such as this have led to wide-spread use in Israel of agricultural aviation. Efficiency of operation has risen quickly as more and more fields are treated by air and as the use of aerial application becomes more versatile. Fertilizing, pest, and locust control, defoliation and weed killing are now being carried out in that nation extensively by air.

In addition to the agricultural aerial applications, artificial cloud seeding is in progress in Israe1. The purpose of this undertaking is to cause rainfall from clouds, which generally do not release the needed quantity of water they contain. The cumuli formed over the sea near Israel are now through cloud seeding compelled to rain out after drifting inland.

In Japan agricultural aviation got off to a relatively late start, but it has developed rapidly and its future is promising. The airplanes prime use there has been in suppression of rice, diseases and insect pests and secondly in forest protection. The practical starting date for these activities was 1958. Helicopters here prove much more suitable than fixed-wing aircraft partly because there are too many obstacles for the latter in the rice fields, and particularly because of the scarcity of suitable landing places.

Research being carried out at present in Japan to develop new fields in agricultural aviation covers: application of granular herbicides before or after transplanting of rice seedlings; control of rice stem borer by applying gramular insecticides in paddy fields; simultaneous control of two different diseases or insect pests by applying mixtures of insecticides and fungicides; tests on spraying in paddy fields; aerial spraying in fruit orchards; control of ticks injurious to cattle in pasture land; control of diseases of seaweed and application of fertilizers on seaweed.

In Russia, a significant part of the overall chemical work in agriculture is conducted by agricultural aviation. Among the crops treated from the air in Russia are maize, potatoes, flax, turnips, vineyards, orchards and cotton .Aircraft perform nearly 40 percent of the pest control and plant disease work, 100 percent of the work on defoliation and dessication of cotton, nearly 80 percent of the work on weed control and nearly 15 percent of the work on introduction of mineral fertilizers. The volume of aerial spraying and dusting increases yearly due to the fact that agricultural aviation has high technical and economic advantages over ground technology.

Of special interest, perhaps, is the fact that Russia posses about half of the world's total area covered by aerial application. In 1965, this acreage totaled 133 million acres. The Tass news agency estimates that by 1970, some 250 million acres will be undergoing cultivation by air.

In order to discover economic effectiveness of agricultural aviation, comparative appraisal of aviation and ground means of mechanization was made, using for comparison two forms of work: control of the sugar beet weevil and fertilization of winter crops with mineral fertilizers. The latter test was conducted under the conditions of the Ukraine. In both cases airplanes were considerably more productive than ground means of mechanization.

The aviation chemical method of pest control ensures reduction of labor consumption as compared with labor needed for the use of ground means of mechanization. This is turn allows a significant amount of manpower to be freed for other agricultural work.

The great economic value of agricultural aviation is apparent in other respects. It sharply reduces the need for other means of transportation; i.e., trucks and draught animals. The spraying of fields by aircraft makes it possible to use smaller quantity of water and chemicals for mixing the working solutions. For instance, in controlling the sugar beet weevil the tractor sprayer requires 8 times as much water as the airplane and takes considerably more time.

In order to treat a sugar beet field 740 acres in area by the spraying method a one-horse sprayer requires 21 days time and a tractor sprayer requires 9 days, but an AN-2 airplane requires only 2.2 - 2.5 hours.

In 1964, over one million acres of cultivated land were treated by aircraft in the German Democratic Republic (DDR). With this achievement East Germany has placed itself in the front ranks of those countries that make an intensive use of aircraft for agricultural purposes.

The development of agricultural aviation in Yugoslavia is increasing rapidly and its use is expected to parallel the increase of agricultural (arable) land.

Aerial applications in France are mainly concerned with insect pests attacking colza, with mildew and oidium of vines, and with weeds in cereal crops. French aerial applicators also have to their credit a number of fertilizing, seeding and weedki1ling operations in the Rhone delta rice fields, where the use of aircraft has more than paid for itself if only in manpower saved. An interesting series of treatments on rape seed have been carried out in France for pollen bettle control. Helicopters are used extensively in France. One helicopter spraying orchards and vineyards does the job of 300 ground workers and the spraying generally results in a 25 percent greater harvest.

Aircraft have been used very successfully for spraying olive trees in Spain and Italy. The olive fly throughout the Mediterraneam basin has done 100,000 million lire worth of damage a year. This is equal to two-thirds the value of the whole Italian crop. Good results have been achieved using both helicopters and fixed-wing aircraft. Over 100 trees per minute can be sprayed by air.

India used aircraft for the first time in 1944-45 for agricultural purposes to carry out reconnaissance work on the desert locust in inaccessible areas. From 1951-54, about 35,800 acres were sprayed with insecticides from the air to annihilate this pest. Some seeding of desert plants from the air was also done for desert afforestation.

In order to boost food production and intensify plant protection work, the Government of India plans to treat 2.4 million acres annually from the air. Protection of rubber trees forms a major part of the agricultural air work performed in India.

During the past 20 years the loss of farm workers in the U.S.A. has mounted to 44 percent, and this loss has been largely offset by agricultural aviation. By no other means can crops be treated so efficiently and quickly. For example, a tractor can spread fertilizer at the rate of three to five acres per hour. An aircraft can spread 100 acres per hour and, further, yields are increased by 10 to 20 percent.

Because of the large population increases, the farmer must constantly increase the amount of food grown. In 1850 an individual American farmer had to grow food for five people; in 1950 for 10 people; in 1960 for 23 people.

Various crops are sown from aircraft In the case of rice, one of the main crops sown by air, partially sprouted seed could be dropped while the fields are still flooded thus giving the crop a chance to develop ahead of the weeds. The extensive use of aircraft for rice production is based mainly on the advantages of speed. In California, rice is usually fertilized and seeded within a period of two weeks. This is possible only with aircraft.

Frost prevention is an important use of agricultural aircraft in the U.S. It has been demonstrated that the passage of aircraft back and forth over orchards can be made to agitate settling cold air, thereby causing a slight rise in temperature which is sufficient in some cases to prevent frosting of blossom or fruit. This technique has been carried out successfully on orange groves and apple orchards.

In defoliation, various chemicals are applied by aircraft to the foliage of certain crops to facilitate harvesting or to improve quality. These chemicals are generally of three types; those which cause a drying and shedding of the foliage, used most commonly on cotton; those which bring about a drying only, used on such crops as cotton, rice, seed crops of alfalfa and clover and potatoes; and other chemicals which product hormone action to delay the fall of ripening fruit. Chemicals are also used to improve the quality of the crop by bringing about more uniform maturation.

Again, in the United States the downwash of air from helicopters rotor blades is used to "blow" rain drops off ripe fruit to prevent splitting after the fruit heats in the sun following a shower. This technique has been used on cherry orchards in California and date trees in Arizona. The helicopter has also been used for the "beating" of certain fruits and nuts, to facilitate harvest.

Aircraft are used in the U.S. to check on the development and general condition of crops; to inspect fallow and grazing land for drainage, insects and the state of pasture; and to locate and inspect herds of sheep and cattle. They are also used to check the functioning of irrigation systems and the condition of fences.

In regions where stock-farming is widespread, aircraft-are used to herd cattle, to find strays, and to drive them in the right direction. Low flying aircraft are also used in the United States to frighten away birds that are feeding on ripening crops.

In the U.S. geophysical surveys made on the basis of aerial photography and field work are widely used to evaluate soil and water resources in planning their conservation and use. Aerial photographs can provide amass of useful information. Types of vegetation, categories of soil, geological features, water courses, water levels, and sub-soil water resourses are all revealed by aerial photography.

Streams and lakes are restocked by dropping hatchery-raised fish fry from aircraft. This is also done in several other countries including Canada, New Zealand and Norway. In the United States beaver and pheasant also have been dropped to restock some areas.

The airplane has become an important tool in the use of some new biological techniques for control of pests, as for example, in the case of the screwworm fly, a serious pest of livestock. Using a biological technique instead of chemicals, the U.S. Department of Agriculture scientists eradicated the screwworm fly in the U.S. Over 3 billion screwworm flies were reared artificially, rendered sexually sterile by exposure to Cobalt 60 and dropped from airplanes fitted with tied release mechanisms. More than 50 million flies were released weekly over an area of 85 million square miles. When these flys mated with the native females, the eggs would not hatch. This eventually resulted in a form of self-destruction.

Agricultural aviation also contributed to the eradication of the Mediterranean fruit fly discovered in Florida in 1956. The prompt, use of aircraft for applying a newly-developed bait spray once a week, I treating an area of almost 7 million acres, eradicated the pest within months thus preventing inestimable future fruit losses.

An attempt has been made in this paper to give a general picture of the uses of aircraft in agriculture today. Agricultural aviation is far from simple. It is a highly specialized branch of aviation. It could also be called a most complicated form of agricultural mechanization.

There are certain signs that agricultural aviation is entering a stage of mature development, and that it is now approaching its most important and exacting role - that of sustaining and increasing world food production in the face of growing hunger and a decreasing agricultural labor force.

The general trend of agro-economic development in the world today favors a further expansion of agricultural aviation. The labor problem in agriculture is becoming more and more acute in the Western world, so that, only by mechanization, with agricultural aviation playing an important part, can production be maintained at even its present level.

Increased mechanization is vital to increase world food production and agricultural aviation is a form of mechanization which brings rapid results.

It is not necessary to treat areas field by field. From a greater height than is usual for aerial applications and using larger airplanes, some agricultural areas could be treated as a whole. The immediate effect of such aerial seeding and fertilizing would result in an almost automatic increase in food production.

When the existing food shortages and deficiencies are considered in combination with the rapidly increasing world population, the result, in terms of sheer human need, is seen to be such as to demand the quickest possible action by all who have the capacity to help. Any method which reduces the time taken to complete any operation must be considered. Despite the arguments which arise in many developing countries that labor is still cheap and practically available at all times, it is doubtful whether the fear of further increasing underemployment temporarily or locally should be accepted as an argument against the use of a more efficient means of distribution. Such thinking is too reminiscent of the classic case of the giant steam shovel at London Bridge, biting off tons of - earth with each "mouthful". Two unemployed men were watching and one said bitterly "If it weren't for that ruddy machine, there would be work for hundreds of men with picks and shovels", "Or", said the other, "millions of men with teaspoons."

The food situation of most of the people in the world is very serious. The present world population is nearly 3,300 million people. Not more than about one in a hundred will ever have what we would consider a good square meal. About two-thirds of this number - nearly 2,000 million people - are seriously undernourished, and go to sleep hungry every night.

This time tomorrow the population of the world will have increased by 180,000. By this time next year it will have grown by 65,000,000. If this rate of increase continues, the population of the world by the end of the century will not be about 3,300 million, as it is now, but about 6,000 million.

The vigorous development of agricultural aviation in the next 10 years is assured. New techniques are being developed which will contribute to this growth, such as the "ultra low volume" spraying of certain insect pests at only 12 fluid ounces per acre. Manufacturers are developing airplanes especially for agriculture - Safer aircraft with better takeoff and landing capabilities-and bigger payloads; dispersal systems to allow wider swaths; and application techniques which do a better job of getting the chemicals where they are needed.

There is no simple solution to the world food problem. Aircraft alone are not the answer, but aircraft, utilized to their full potential and coupled with the advancing medical and socialogical developments, can contribute much toward a peaceful and hunger-less world population.

It is hoped that the proper authorities of the many countries of the world will recognize this potential and take the steps necessary to promote agricultural aviation, which after all, serves the common good.

APPLICATION OF MICROBIOLOGICAL TECHNIQUES TO FOOD PROBLEMS

By Umrana Ahmed, Ph.D. (Leeds)

Dr.(Mrs.)Umrana Ahmed passed her M.Sc. in, Microbiology in 1959 from the university of Karachi. She worked as a Demonstrator in the same department for one academic year. In 1960, she was awarded Commonwealth Scholarship for higher studies in United Kingdom. She obtained her Ph.D. in Biochemistry from the University of Leeds where she worked on the Metabolism of Cresols by Soil Bacteria. Since August 1960 she has been working as a lecturer in the Department of Microbiology, University of Karachi.

Summary Spoilage of food and disease transmission through foods is discussed.

Spoilage is the process by which food is rendered unfit for human consumption.

Chief methods of food preservation involving microbiological principles are discussed.

An account is also given of the microbiological tests which are carried out in the laboratories of food and other control. These tests provide information concerning the quality of food and sanitary conditions under which food was processed.

A bacteriological examination of a number of foods marketed in Karachi, revealed that these foods not only contained a high total bacterial count but also a number of pathogenic organisms. Similar results were obtained for frozen shrimps.

APPLICATION OF MICROBIOLOGICAL TECHNIQUES TO FOOD PROBLEMS

By Umrana Ahmed

The under-developed countries are facing a food crisis. There prevails not only a shortage of food in general but also a serious shortage of foods of high biological value.

A study of the microbiological condition of food suggests that there is another problem which is of immediate public health concern not only in under-developed countries but the world over. It is necessary that one should have a knowledge of the microbiological condition of food, so that recommendations can be made to minimise health risks to the consumer.

Human diet consists of perishable foods, that is, foods that are susceptible to deterioration by the activities of micro-organisms. Since the major food stuffs are proteins, carbohydrates and fats, they act as excellent culture media for the growth of micro-organisms. These organic compounds are utilized by micro-organisms to obtain energy and food for growth and repair. As a result of the biochemical activities of micro-organisms the food is changed with respect to appearance, flavour odour and other qualities. The micro-organisms contaminating food may be saprophyte or pathogenic. Spoilage is the process by which food is rendered unfit for human consumption. It usually involved alteration in flavour, colour, odour and production of sliminess etc., Many types of spoiled food can be eaten with safety for example moldy bread, bacon or other foods can be taken without causing any harm to the consumer if the odour and taste have not become unpleasant. Some spoiled foods, may cause mild indigestion. There is, however, the dangerous possibility that the food may be contaminated with clostridium botulinum. This is an aerolic organism producing a deadly (exo) toxin. The term food poisoning is restricted to infection by entric pathogens contaminating food, or ingestion of food containing exo toxins produced by staphylocic or clostridium botulinum.

In connection with spoilage, the proteolytic micro-organisms are particularly important. These micro-organisms digest proteins with the production of H_2S, sulphydryl compounds and (or) amines. These compounds though themselves are not poisonous in the concentrations involved have vile smells. Eggs have a high sulphur content and their spoilage results in H_2S production rendering them completely impalatable.

In order to avoid spoilage, it is necessary that special methods be used for food preservation.

Preservation of foods is one of the most important factors in the solution of the International Food Problems, particularly in the developing countries like Pakistan. Every year we suffer a collosal loss of seasonal fruits and foods. This is due to two reasons -

(i) Lack of the development of Food Processing Industries,
(ii) Shortage of men trained in Food Technology and Food Microbiology.

As a result of the improved methods of preservation and transportation the problem of the shortage of food has been solved to a great extent. Countries which are unable to raise all their own food can import the food to feed their heavy population. Our diet has also become more varied and balanced. Perishable foods are now available throughout the year instead of only seasonally.

The preservation of food is accomplished by reducing or inhibiting microbial growth, enzymatic activity and atmospheric oxidations. The factors responsible for food spoilage may be controlled by food processing procedures or by additives (food additives). Only a relatively few chemical additives are routinely used in food preservation industry and their use must comply with Food and Drug Adminster regulations.

Food can be preserved by a wide variety of procedures. These methods may be used singly or in combination depending upon the chemical nature and type of the food and the availability of facilities. Principles of these methods have been discussed in the following paragraphs.

<u>Drying, Dehydration and Evaporation</u> "Drying" normally refers to sun-drying or other natural drying. "Evaporation" refers to drying by the application of artificial heat under natural draft. "Dehydration" implies drying under controlled application of artificial heat and mechanical circulation of air or the production of a vacuum.

The principle involved in any of these drying procedures is the same, namely the removal of water without injuring the food materials with respect to its use.

Preservation through dehydration or drying is accomplished by the removal of water from the foodstuff to a point where microbial activity is inhibited. The limiting moisture content for bacterial growth depends upon environmental factors, pH, and salt content. A moisture content of 15% or less in flour or cereal products prevents bacterial spoilage and 18 - 20% moisture in dried meats inhibits bacterial growth. Humidity control is very important in order to prevent mold growth on the dried product.

The superiority of the dried product depends to a large extent upon the efficiency of treatment prior to drying for example harvesting, washing, peeling and subdivision, dipping, sulphuring and blanching.

Nutritive quality of the dried products is slightly lesser than the fresh product and the components most commonly affected under storage condition are carotene and ascorbic acid (sensitive to oxidation), ribo flavin (unstable to light) and thiamine (destroyed by SO_2).

Preservation through dehydration is a very important and economic method of food preservation.

Food Preservation by Temperature Control

This method includes food preservation by refrigeration and by freezing.

The principle involves the use of a very low temperature thereby lengthening the keeping time of finished product. At refrigeration temperature micro-bial activities, enzymatic action and oxidation are very much retarded but still occur to an appreciable extent. This is further accomplished by preserving foods at freezing temperature at which undesirable changes are further retarded. However, freezing itself causes marked changes in many foods and is the cause of spoilage of many perishable foods. In general the lower the holding temperature the better the preservation of the flavour and texture of the commodity.

Foods may be preserved by slow freezing method or by quick freezing method, The later method is better than the former because in the slow freezing process large crystals of ice are formed which destroy the tissues and cells of the frozen product when defrosted. Sometimes chemical additives are also added before the product is frozen.

Canning

The preservation of foods in hermetically sealed containers through the agency of sterilization by heat is called canning. The basis upon which the preservation of foods in hermetically sealed containers rests is the destruction of micro-organisms by heat and the prevention of the entrance of others.

Canning is one of the most widely used and effective methods of food preservation. Almost any type of the food can be preserved successfully by this method. Nicolas Appert was the first man who employed heat and hermetic sealing in the preservation of foods. Since the time of Appert the canning procedure has undergone a great progress through extensive scientific researches. Modern practice of canning differs from the older one in the more efficient utilization of heat treatment and in the use of certain chemicals during canning operations and also in the type and forms of the tin. In the modern canning operations tin containers are used instead of glass containers employed originally by Appert.

The different canning operations require thorough understanding because of the growing importance of the canning industry. More than 400 different types of foods and food combinations are preserved by canning. The list includes practically all of the fruits and vegetables, a wide variety of meat and meat specialities, sea foods, soups, fruit and vegetable juices.

Food Preservation by Use of Micro-organisms

Micro-organisms are not only harmful for mankind but are also equally, beneficial as many of them are used as starting material for the production of certain kinds of foods and to increase the keeping time of such foods. Starting cultures used in the manufacture of selected types of foods possess dual role; firstly, they produce unfavourable environment for undesirable bacteria through biochemical activities and secondly they produce characteristic flavours to the finished product. The production of acids like citric, acetic and propionic acids by micro-organisms in sauer kraut pickles, sourmilk, and cream lowers p^H of these products to an appreciable extent thereby killing acid susceptible species of microorganisms. The production of these acids imparts characteristic flavour to the food.

Preservation of Foods by Use of Chemicals

Very few food additives are in common use in food processing industries and their use must abide by the regulations of Food and Drug Administration Act. The principle of this procedure of food preservation is based upon the anti-septic properties of chemical additives. Preservatives may be defined as substances which have anti-septic properties under the conditions of use. Effective inhibition of microbial activity prevents spoilage.

Microbiological examination of foods

A number of microbiological tests on the quality of food may be carried out in the laboratories of food plants or of other control agencies. Microbiological examination of foods provides information concerning the quality of food and sanitary conditions under which food was processed. These tests also show the effectiveness of the method of preservation. After identifying the organism, responsible for spoilage, it is also possible to trace out the source of contamination. Proper measures may then be taken to avoid further spoilage.

Microbiological techniques for food examination are not particularly specialized. Microbiological tests may be quantitative, to estimate total numbers of organisms or may be qualitative, to detect certain kinds of organisms. The type of examination performed is determined by the type of food product to be examined and also the specific purpose of the examination.

Microscopic Examination

Microscopic examination can be used to obtain qualitative or quantitative data concerning the microbial flora. The specimen may be observed in a stained, fixed film or in a wet preparation. If the food sample is a solid, such as dried eggs or cereals, it is first necessary to prepare a solution or suspension from which the smear can be made. Microscopic counts for moulds are routinely performed on tomato products and the results can be correlated with the presence of decomposed raw materials. Microscopic examination of food is utilized when the numbers of microorganisms are high in excess of one million / gram. This type of examination provides immediate information regarding the relative number of organisms Present and also the predominant type. Cultural techniques are utilized not only to determine the total number of bacteria but also to enumerate the different types, an information which cannot be had from microscopic examination.

Plating and other Cultural Procedures

Agar plate counts are used for the estimation of total numbers of microorganisms in foods. However, in some instances more accurate numbers are calculated from liquid media inocculated with decimal dilutions. Plate counts are commonly employed in routine tests in food plants during handling and processing of foods and also on equipment coming in contact with foods.

For the detection and enumeration of special kinds of micro-organisms selective culture media, treatments and environments are used. Before making a count for spore formers the specimen is heated to kill the vegetative cells prior to planting. For counting mesophibic bacteria as in flour or dry milk to be used for making bread, a heat treatment of 10 - 15 min. at 80°c is recommended. If more heat resistant spores are involved such as spores of bacteria spoiling canned foods a more secure heat treatment such as heating at 100°C for 5 min is necessary. Halophilic organisms have to be cultivated in higher salt media, while for asmophiles, media high in sugar are required, yeasts and moulds are grown in media acidified to p^H 3.5 - 4 with lactic, tartaric or other organic acids. Oxygen is supplied for aerobes and anaerobic conditions are employed for anaerobes. Especial selective medias are prepared by adding chemicals that inhibit all but the desired organisms. Selective media used for coliform bacteria are desoxycholate agar, violet - red bile agar and brilliant - green lactose peptone bile. Examples of other selective media are bismuth sulfite agar for salmonella, telluriteglycine agar for staphylococci and anti-biotic containing media for yeasts.

Some differential media contain indicator materials to aid in the identification of definite types of organisms e.g. a p^H indicator to detect acid or alkalic forming colonies, sulphate and citrate of iron to bring out black colonies of sulfide spoilage bacteria. Sterility tests may be made on packaged food by inocculating samples into culture media from aseptically opened container. Tests can also be carried out for the sterility of containers and caps or covers. This is done by pouring culture media into the container or cap and followed by inocculation. Alternatively, they may be rinsed with sterile water or buffer solution and the rinsing used for inocculation.

Results of Laboratory Examination of Foods

A number of qualitative and quantitative tests have been performed, in this department, on various food products. These foods included cakes, ice cream and a number of Pakistani foods sold in the shops. It was found that in addition to a large number of non-pathogenic bacteria, these foods also contained, in significant numbers, the enteric pathogenic organisms. The pathogens, in many cases, were salmonella penatyphi A and B causing para typhoid fevers and species of shigella which are responeible for causing bacillary dysentary. These observations clearly indicate the risks involved in eating foods which have not been prepared under good sanitary conditions.

A bacteriological investigation of frozen shrimps was also carried out in our department in cooperation with a local firm engaged in the manufacture of frozen shrimps (Anwar & Khan). This work was undertaken not only to determine the microbial flora of frozen shrimps but also to trace the source of pathogenic organisms, if any, in the processed product.

Shrimps are one of the most important marine foods which abundantly occur in the sea coast of Karachi. They are exported in large quantities.

The initial microbial load on shrimps is comprised of many species of bacteria, yeasts and moulds. The rate of spoilage of frozen shrimps is dependent to a large extent on the number and kind of micro - organisms present. If the proteolytic species are present, putrifactive changes occur much more quickly (Faulkner, Marine, Betly and Natts).

Any measure taken with the initial product to reduce the microbial load will control, to some extent, the rate of spoilage following defrosting of the product. Such practices as washing and peeling of shrimps have a very great influence on the number and types of micro-organisms. If properly conducted, the peeling process reduces the microbial load more than 90%. However, even though the peeling is adequate, faulty and unhygenic practices in commercial plants are responsible for re-contamination of the product.

The importance of bacteriological investigations of frozen shrimps lies in the fact that they may harbour the enteric pathogens. However, the presence of non-enteric pathogenic organisms like E.coli is equally important as their presence indicates faecal pollution.

Bacteriological examination was carried out on raw shrimps, washings of raw shrimps, frozen shrimps, hand washings of the workers and ice used for freezing the shrimps. Qualitative results of these samples are presented in the following table:

Samples	**No. of bacteria /ml. of the samples**
Raw shrimps	5,800,000
Washings of raw shrimps	5,900,000
Frozen shrimps	870,000.
Water from the tap connected with the public water supply	140,000
Water from storage tank	6,100,000

When qualitative tests were performed on frozen shrimps it was found that almost all the common enteric pathogens were present. These were salmonella panatyphi; salmonella paratyphi B, shigella dysenteriae, shigella dysenteriae and proteus morganii. The non-pathogenic species included E.coli, alkaligenes fecalis, AK, meta-alkaligenes and paracolone bacilli.

In case of other samples, only S panatyphi B was isolated from hand washings of the workers and the ice used for freezing the shrimps. However, E.coli was isolated from almost all the samples, along with Alk fecalis, alk-metaalkalingenes and para-colone bacilli, E.coli was also isolated from the public water mains.

These findings suggest that the factory workers and the water supply are the two main sources of pollution.

The results of these bacteriological examinations show that the problem of food control is important throughout the world. The essential requirements for the production of safe foods are that they should be prepared under good hygenic conditions and that the products known to be particularly prone to contamination with pathogens should be subjected to some terminal treatment to destroy these pathogens. As a measure of the adequacy of the sanitation practised during processing and of the safety of the final product, the foods should be marketed with a bacteriological content not exceeding specific values.

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The Application of Technology - Preservation

DISCUSSION

D. Mizoguchi (Japan)

I would like to point out in connection with the Pakistani paper that micro-organisms are not only a menace to food, but they can also be very important in food production. Because of climatic conditions, we, in Japan, use a great deal of micro-organisms in the fermentation industry. This industry is very large, for example our wine, saki, is a fermentation of rice, and we have other common foods for which we use fermentation by micro-organisms. In recent years we have used micro-organisms to produce antibiotics, some of which are used as medicines and some for cattle and poultry feed. More recently we have tamed the rice blast disease which is a fungus micro-organism.

A. Azmaz (Turkey)

I would like to know from Katherine Stinson to what extent research based on aerial photography is being carried on in the U.S.A., and to what extent it is considered safe and how much it is practised in other parts of the world.

K. Stinson (U.S.A.)

Speaking of the use of aerial photography in relation to agriculture, it is being used quite widely, especially in developing new land. Aerial photography is used to map the land before it is ploughed and also in geological surveying to determine which lands are suited for which crops. It is used widely in the U.S.A. but I am not familiar with its use in other countries.

K. Chandrasekhar (India)

I would like to refer to the first paper from the U.S.A. which mentioned that forest should be cut down to increase land for agriculture. In India we found that cutting down forests results in disaster as it minimises rainfall.

__--__ (U.S.A.)

I wonder if there is anyone here who has information on the various uses of food preservation, the various methods which are most feasible for the nations where the problem is greatest.

__--__ (U.K.)

In answer to that question I would think that for the warmer countries drying is about the safest because in canning you can get bacteria which are not killed by the canning process.

A.M. Janovicz (Austria)

In connection with the spraying of insecticides by aircraft I should like to be reassured regarding the effect of such toxic chemicals upon human beings and upon animals. In our neighbourhood in the Vienna forest, after spraying, all the birds, ants and other useful creatures died, it was also harmful to the population around there.

K. Stinson (U.S.A.)

This is one of the big problems and is why aerial spraying requires such specialized knowledge. It requires knowledge of the chemicals that are being used and it requires very exacting techniques on the part of the pilots flying the aeroplanes in dispensing the chemicals and insecticides. With some of the new chemicals that are now being developed it is hoped that the methods of dispensing will eliminate some of these hazards.

D. Mizoguchi (Japan)

In connection with what the delegate from Austria said and Miss Stinson's reply about aerial spraying of chemicals, this is also a big problem in Japan where land is small and human habitation is very close to the agricultural areas. We very much need the development of new less toxic and more easily controlled chemicals. With some of the chemicals we now use, we know, for example, that organophosphorous compounds used for rice blast disease stay in the rice grain and that because of this the mercury content of the hair of Japanese is much greater than that of Europeans. So although we are happy to have found a means of fighting rice blast disease, we have to admit that there are always two sides to a new development.

<u>The Application of Technology – Distribution</u> **5 July 1961**

In the Chair **E. Jesse (Netherlands)**

New directions in food packaging **Olive Salembier (USA)**

Some aspects of food transportation **Ruth I. Shafer (USA)**

Food transportation by air **M. E. Russell (USA)**

Discussion

Else Jesse

Else Jesse joined the Conference as a technical interested publicity woman (contact person for the Netherlands). Her university education (Leiden) is in Law and since 1961 her first jobs were at solicitors offices - pleading behind the bar and contacting clients, as both tasks are together in hands of the Dutch solicitor.

After four years of bar she changed over to an insurance company where she is now an intern legal adviser.

NEW DIRECTIONS IN FOOD PACKAGING

By Olive Salembier

Mrs. Olive Salembier was educated in Canada, and after graduating from engineering short courses in Packaging at several American Universities, she served as Staff Assistant, Engineering Extension Division, University of California from 1956 to 1960. She is President and Chief Engineer of Specialized Packaging & Engineering Company of Phoenix, Arizona, and is Arizona Vice President of the Society of Packaging & Handling Engineers; and Senior Life Member and National Secretary of the Society of Women Engineers. She was the first American woman to be nationally honored for Industrial Packaging Design, winning a First place Award for corrugated packaging in 1961, and a Second Place Award for military packaging in 1965.

Summary The historical background of food packaging and its relationship to man’ s survival is outlined. The use of various materials is discussed, with particular reference to the impact of plastic packaging on present day food packaging. The paper is concerned with the packaging of bread, meat, milk and other food products, and with shipping containers, container testing and transportation methods for worldwide distribution of these products. Packaging legislation and education are briefly touched upon, and finally an attempt is made to forecast some of the, packaging methods of the immediate future.

NEW DIRECTIONS IN FOOD PACKAGING

By Olive Salembier

Packaging always has been, is now, and will continue to be an essential of survival. In the United States alone in the year 1965 the average citizen bought 113 glass containers, 236 tin cans, 676 folding boxes and over 2,000 paper bags - not to mention a huge quantity of plastic containers. But man cannot really take credit for inventing packaging. Obviously the first packaging engineer was a woman: Mother Nature. Perhaps it all began back in prehistoric times when Mamma Dinosaur presented Pappa Dinosaur with a few dozen potential offspring, all neatly packaged in tough, durable, non-breakable, scratch-resistant, leathery eggs. Nature's packages have been with us ever since. For example, what is a cocoon but packaged "instant butterfly"? And what packaging engineer has improved on the original packaging of the egg or the banana? Man's first package was probably a hollow tree. Later he learned that he could carry a whole armful of flint spear heads in a sack of animal skin. Some of the earliest packaging known consisted of alabaster slabs hollowed out to contain cosmetics. And of course we cannot overlook the human packaging of the Egyptians in the form of mummies. Earthen containers, leather bags and hog skins for liquids and solids, and the early wine skins probably predated pottery packaging. When man developed pottery, packaging became an art form. The pottery packages of the ancients have come down to us intact through the ages mainly because our ancestors did not have the knack of making disposable containers. The pottery package was used and reused time and again until it was either broken or replaced by a prettier one. Since much of what we know about the ancients comes from studying their artistic containers, future civilizations may learn about us from our present day packaging methods. Future generations will ponder today's crush-proof cigarette boxes; tubes that put stripes on toothpaste; aerosol containers that dispense everything from shaving soap to mustard; "metered" packages that give just the right amount of laundry detergent; and pre-cooked frozen foods in plastic bags may be standing on some museum shelf two thousand years from now.

Packaging Technology In the 1950's researchers in countless packaging laboratories patiently generated exciting new concepts in packaging technology. Like drops of water these ideas collected to form new packaging trends, influencing each other, and forcing together some packaging concepts that before were regarded as self-sufficient. With a turbulence characteristic of challenging ideas, these rivers of thought form a huge reservoir of new packaging technology. Recognition by packaging engineers that these new concepts, like the old, were universal in application opened the pathway to new packaging ideas in the early 1960' s. Today no individual packaging activity, cotainer form, or marketing technique is closed to drastic change. Packaging is a complex business and it is getting more complex every day. The accelerated technology of the past decades is pouring forth an un-diminishing flow of new multiple-function packages, materials and packaging techniques. The result is a complex ferment with glass, metal, plastics and paper in almost limitless combinations, not only vying for bigger shares of traditional markets, but also moving boldly into new fields.

Packaging engineers, scientists, engineers and marketing men work their combined brainpower overtime to devise new and competitively attractive methods of protecting, containing and dispensing products. The concept of "custom tailoring" for specific packaging jobs has reached a new peak, and new materials are now available in such quantity and variety that the told effect is almost bewildering. The battle among materials for markets has entered a new high-powered stage, and frustration and exasperation can be classed as a occupational disease in packaging. Research and testing are an integral part of the development of any new packaging form Packaging laboratories are equipped with radioactive sources such as cobalt 60, radio-isotopes and electron beams to be used with intricate apparatus such as electrophortic chromatographers and emulsion polymerizers. Long range fundamental research is carried out in the fields of chemistry, metallurgy, physics and engineering. For example, the potentials of irradiation as a means of improving the keeping qualities of packaged foodstuffs are arousing worldwide interest. It has been determined that irradiation significantly lengthens the active storage life of soft fruits; and, in combination with conventional heat treatment, it does the same for preserved meats. It also performs well in the prevention of insect infestations of dry cereals and grain products. Manufacturers of even such traditional container forms as cans, cartons, glass bottles and jars have incorporated so many “alien” materials into their respective technologies that today's finished package bears little technical resemblance to its predecessor only ten years ago.

Plastics As a result of technological research, a constant stream of new plastics are inviting attention. Films are coming into their own with the development of a stronger product suitable for use on high speed machinery and the resultant steady reduction in cost. Food containers of polystyrene primarily, and linear polyethylene in ever increasing amounts, are now seriously threatening wax-coated paper and metal containers which have dominated the dairy packaging business for so many years. Regardless of what plastics are used, or how the containers are molded, plastic containers have made great strides because of certain inherent advantages, such as the ability to maintain product freshness; the lack of packaging material contamination of the foods; and reusability of plastic containers and lids. The uses to which

available in which the low-energy radiation alters the physical properties, such as tensile strength, and permits the film to be subjected to a more severe orienting process.

Polystyrene: This material, in film form, has good dimensional stability and is low in cost, but its major handicap is brittleness and low tear strength.

Polypropylene: A polyolefin is lower in density than polyethylene but possessing higher tensile strength particularly when biaxially oriented. The material provides high clarity and gloss, good machinability, low water-vapor transmission and reasonably good resistance to gas permeation, grease, and various chemicals.

Polyviny chloride: With the advantage of low permeability to oxygen, and at the same time, its barrier properties, rigidity, slip and gloss, it can be tailored to specific requirements by modifying the use of additives and by extruding or casting the film.

Impact polystyrene: The advantage is low price which is competitive to paper, but is attacked chemically by so many foods that its use is limited to low-fat cultured dairy products.

Oriented polystyrene: Inert, non-toxic, tasteless and odorless, it is one of the lowest priced transparent packaging materials available. Biaxially oriented, polystyrene will not react to ordinary extremes of heat and cold, nor cloud up and crack with age.

Rapid changes in the uses of plastics in packaging indicates a requirement for a massive reappraisal of all the old concepts and theories relating to its usability. The packaging engineer must avoid the pitfall of basing his planning on what he THINKS are the limitations inherent in various materials and techniques. The initial impressions, formed in the early stages of plastics development, regarding that can and cannot be done have a tendency to take root and grow into a body of folklore and myth that lags far behind the reality of advanced technology.

<u>Bags and Pouches</u> The alacrity with which European consumers take to revolutionary packaging concepts for traditional products has been demonstrated repeatedly in the past few years. Particularly notable is the successful marketing in France of the national beverage, wine, in thermoformed single-trip polyvinyl chloride cup containers with peel-off heat-sealed foil closures. Now available are single-portion servings of wine packaged in heat-sealed pouches that consist of a lamination of aluminum foil and cellophane. Notched for easy corner opening, the flexible container is said to be leakproof and to preserve the full flavor of wine over extended storage periods.

Pre-made bags or pouches made on the packaging line are of great importance in the meat packaging industry. There is a wide variety of vacuum chamber sealing equipment available, offering speeds up to 35 sealed pouches per minute. One of the most commonly used comprises a central vacuum chamber designed to take five or six pouches per cycle. It is a semi-automatic hand-loaded machine very simple in operation and economical to run. Pouches can be fed to the vacuum chamber on a conveyor, and a single operator can produce up to 40 vacuum packages per minute. Almost all countries manufacture machines of this type: The French Souividex, the Swiss-built Swissvac the British Nuvac, and the Dutch Awo-Compak, which forms plastic pouches from twin reels around whole or sliced products then seals the pouches hermetically under vacuum or gas flush, are among the better known. The boi1-in-bag concept, which began with heat-sealable poly ester film, for the cooking of vegetables, has now been expanded to include such items as seafood, with the important attraction that the pouches prevent heavy odors. Fresh frozen fruit, packaged by the see method, can be readily thawed by putting the bag under running water, or can be cooked by dropping it in boiling water.

An important new development in the plastic bag field is the concept of an entire bag packaging system known as Autobag, patented by the United States firm, Automated Packaging Corporation. Comprising a self-contained packaging station, polyethylene bags are supplied on a roll, blown open with air, and positioned for speedy loading through a hopper. The bags are perforated for eacy separating and sealing on the impulse sealer which is integrated into the machine. An imprinter is available as a part of the equipment which simultaneously identifies the product. Where continuous strip packaging is required for a variety of small products, the machine is equipped with a pass-through heat sealer which permits processing of entire rolls containing thou sands of filled and sealed bags, which are easily separable for use as required. Consistent packaging production levels averaging 2,000 pack ages per hour are possible through the use of various automatic feed, weigh and count equipment.

Cans and Bottles Aluminum cans with easy-opening tops, which do not require an opener, are now used for most types of beverages in the United States. Canned soft drinks and carbonated beverage sales have skyrocketed since their introduction. The glass manufacturers, in order to maintain their market, have introduced non-returnable glass bottles. Non-returnable soft drink bottles increased in 1966 by 45 per cent and non-returnable beer bottles showed an increase of 13 per cent. In the period since 1960 these soft drink bottle shipments have increased 280 per cent and beer bottle shipments 142 per cent. In many areas local government bodies are unhappy about the introduction of both cans and non-returnable bottles. In Eskiltuna, Sweden, building superintendents have asked their national association to petition the government to issue restrictions on the use of non-returnable glass containers. They argue that the increasing use of disposable glass bottles bas resulted in more work since apartment house dwellers toss empty bottles down central disposal chutes into paperboard collection barrels, with the result that broken glass not only damages the trash receptacles, but also poses a formidable handling hazard. Similar legislation has been considered in British Columbia, Canada. The throw-away aspect has been taken too literally by the public with the result that parks, beaches, and resort areas are becoming littered with broken glass. It is emphasized that bottles tossed on roadsides constitute a fire hazard to the Province's forests because glass can magnify and concentrate the sun's rays. It has been humorously suggested that all non-returnable containers should be printed to look like flowers so that as the highways become cluttered they will atleast be decorative. Perhaps a more sensible approach would be enforcement of anti-littering laws, rather than a legislative ban which represents a capricious barrier to packaging progress.

Packaging of Eggs In the United States alone, in the year 1965, the loss from broken eggs in packaging amounted to over $25,000,000.00. With the introduction of plastics, new ideas in egg packaging, replacing the traditional molded pulp, continue to appear. A new development from England is a transparent multi-cavity one-piece polystyrene egg container vacuum formed in matching halves. The container is light-weight, competitive in cost to pulp and board egg packages, and allows the consumer to see the eggs prior to purchase. Mating studs and cavities on the lip ends of the matching halves of the polystyrene container provide secure closure and reclosure. Brand information can be printed on the flat strip that forms the hinges of the container. A new package composed of a compartmented molded pulp tray with a biaxially oriented polystyrene lid, gives stacking strength to the container without interfering with the visibility of the product. Shrink overwrapping of egg cartons to provide a visible pack is also being used. Some attempts have been made to market unshelled eggs, but these have not met with notable success. Several years ago packagers offered a shell-less egg wrapped in a plastic container. From the point of view of preservation and convenience the package was entirely successful, but the consumers were repelled at the sight of a raw egg packaged, and the idea was withdrawn from the market.

Meat Packaging Rigid and semi-rigid thermoformed trays for retail sale of fresh meat made of polystyrene and foamed polystyrene sheet are competing strongly with paper pulp trays and those made of treated paperboard. Biaxially oriented polystyrene trays which have excellent transparency and permit the shopper to see the meat from top, bottom and all sides before buying, have been most successful. For meats, other than red meats, films and film laminations form the major portion of packaging materials used. Over the past decade, developments in film technology have provided meat packers with product shelf life that surpasses even the wildest dreams of ten years ago. One of the more significant advances has been the use of vacuum packaging. Cooked meats were the first products to adopt this system on a large scale. Weiners or frankfurters have progressed from bulk shipments with short shelf life, to individually packaged units packed under vacuum in high-shrink polyethylene. Poultry is most commonly packaged in shrink-type film packs incorporating a metal clip. The clear film which is not heat sealable, is generally available in thicknesses of .005 mil and .065 mil with exceptional strength, puncture, abrasion and temperature resistance.

Bread The baking industry, after changing from hand to machine wrapping, have tested, adopted and discarded a variety of wrap methods, materials and machines, But always the considerations are the same: hygiene, staling protection, consumer convenience and packaging speed. Pre-printed polyethylene, bags, sealed at the ends, were in standard use for many years. Unavoidable damage in opening destroyed the re-usability of the bag. As a result, the pony-tail twist method of closure was developed. Automatic machinery bags the bread, and a revolving belt readies the open end of each bag for closure by poly-styrene clips. The colors of the plastic clips can be changed regularly to denote packaging dates. In smaller bakeries the pony-tail effect is obtained by fastening plastic covered wire around the end of the bag. Frozen bread dough is now packaged in sleeves of nylon film which is crystal clear, repels oils and greases, resists abrasion and puncture, has exceptional strength and takes printing well. When the housewife wants a fresh hot loaf of home-baked bread she takes a loaf out of the freezer, inserts it into its sleeve, lets it rise at room temperature until the dough fills the sleeve and then bakes it in the sleeve.

The Battle For The Milk Packaging Dollar The economics of milk packaging indicates that at the present time, on a per trip basis, the cheapest form of milk packaging is the glass bottle which survives six to seven round trips. Returnable polyethylene bottles should be cheaper than glass since they would survive up to seventy round trips, but single trip plastic bottles are not yet highly competitive. Where reusable polyethylene milk bottles have been market tested, experience in handling, filling and capping the bottles has been very satisfactory. Another development in milk containers is a three-piece, deep--drawn polystyrene sheet container in quart and half gallon sizes. This package is radically new in its tapered rectangular shape, light weight and engineered rigidity. It also marks the first economic challenge by plastics in the one-quart size. These impact polystyrene packages, made from a rubber-modified resin, have strengthening ribs and embossed designs that create a hand grip area at the rear of the side panels. A two-piece blow molded high density polyethylene unit, which after forming is shipped nested to dairies, offers substantial savings in transportation costs. At the dairy the two halves of the container are heat-sealed to form a package ready for filling.

Another promising challenger in the consumer field of convenient, inexpensive and disposable dispensing containers for milk and other bulk-volume liquids, is a ten quart carry-handle “bag-in-bag,” used in conjunction with a permanent molded-plastics refrigerator storage unit. The single-trip container consists of an inner two-ply polyethylene film bag fitted with a two piece pull-open push-closed rigid polyethylene dispensing spout and an outer kraft bag specially treated to retard water damage. The twin .002 mil plies of polyethylene are reported to provide positive protection against the possibility of leakers. The customer is provided with an attractive injection-molded high impact white polystyrene refrigerator dispenser tray designed to fit easily on the top shelf of a refrigerator. Milk stays fresh for extended periods since air is exhausted during filling and the gravity-flow dispensing unit eliminates the possibility of air entering the sealed bag, which collapses as its contents are depleted.

Considerable development work has been done in France as well as in Sweden and England on containers which use the principle of the absence of air as a preservation method. The "no refrigeration" tetrahedral-shaped container is claimed to provide milk with a shelf-life exceeding one month without refrigeration. Automatically sterilized, sealed and crated, the package is produced from a single web of polyethylene coated paper and aluminum foi1. The tetrahedral shape saves twenty per cent in material over conventional containers.

Aseptic packaging of milk in glass containers is also in the development stage. The processing involves injecting steam into the milk while it is under continuous flow. Milk treated in this way is reported to lack the unpalatable "boiled" flavor of ordinary sterilized milk, which is heated in the bottle at lower temperatures. A method of steam sterilizing, filling and capping bottles in a vertical pressure vessel has been developed which gives such satisfactory reductions in the numbers of resistant spores, that milk can be kept in good condition for one month or more without refrigeration. It is generally accepted that when sterile milk is perfected, distribution and marketing patterns will radically change, as milk will then be sold on the shelf along with non-refrigerated products. The package will then playa more important role in functioning as a good display and selling tool.

Supermarkets Twenty-five years ago the average grocer considered his store well stocked with 1,000 items. Today his store would be denuded with fewer than 5,000 standard items. So much of the marketing process is dependent on packaging that the supermarket has learned to look on the packaging engineer as a major partner packaging materials are developed, improved, modified and combined to achieve optimum shelf life at the most economical price packaging systems are developed, or modified, to stress maximum productivity. Not only does good packing protect the vital qualities of freshness and flavor, but also it must add to the product's value in the opinion of the customer. Supermarket packaging is based on the customer's likes and dislikes. The customer does not believe in change just for the sake of change, but is willing to experiment with a new product or a new package if a convenience feature makes it attractive. TV dinners, with skillful designed compartments in which the meal can be both prepared and served; boil-in-bag products, which keep the flavor and the odor in the bag; pre-measured portions of instant products; and the visual packaging of meat and bakery goods are now accepted items. The standard paperboard carton for frozen food packaging has now been coated with polyethylene, eliminating the need for overwrapping and giving new dimension for attractive color printing.

Shipping Containers At the warehousing level it is essential that exterior packaging be designed to take advantage of the most efficient methods of handling. The container must have proper strength and rigidity and be of proper shape for stacking to make best use of available cubic space. Ease of opening of the containers must be designed to prevent damage to individual packages or products when the master case is opened at destination. Special tear-tapes and tear-strips which will easily open the container contribute to efficiency. Proper product identification markings are increasingly important for warehousing since so many markets are using computerized systems of inventory and stock control. The design of overpacks and separators for plastic containers is relatively new but extremely important in the field of packaging design, due to the difference in problems encountered in warehousing and shipping plastic packages as opposed to glass. In the packaging of glass containers the emphasis is on the cushioning characteristics of the material used to separate bottles within a shipping package. Top-to-bottom resistance to crushing of the containers is of little concern, because the glass bottles themselves support the loads normally encountered in warehouse stacking. With plastic bottles, however, the requirements are quite different. Cushioning between bottles is of little value, whereas compression strength is extremely important because of the soft nature of plastic bottles and their inability to sustain loads. Three vital factors must be considered:

1. The load carrying capacity of polyethylene bottles of different sizes made from resins of different densities.

2. The differences in weight between plastic and glass bottles of the same size.
3. The difference in cubage between plastic and glass bottles.

Also involved are ambient temperature; humidity; length of time in storage; and the stacking load on the bottom box in a tier. With the large variety of plastics being used, designs must be handled on a custom basis according to specific product and material used in order to establish proper standards.

Corrugated containers with built-in polyethylene liners provide an ingenious break- through in bulk packaging for shipment. The polyethylene liner is bonded to a tough, specially designed corrugated box, and is secured to the end flaps of the box with a special adhesive. The container will hold liquids, solids and granular products which must be kept either moist or dry, thereby eliminating the need for weighty drums, cans, bottles, kegs and pails. The package provides a leakproof, siftproof container which excludes moisture penetration and external contaminants at a substantial shipping economy.

Fishery salt which was originally shipped in bulk was difficult to handle and could not be stored outside or loaded if it rained. The problem was solved by the use of heat-sealed polyethylene shipping bags permitting storage outdoors and loading in wet weather. The total additional cost of less than $5.00 per ton, compared to bulk handling, represents a very low percentage of the value of the salt saved.

Shrink wrapped trays for shipment of canned foods are causing considerable interest. By this method corrugated trays, sleeved in clear shrink film, replace the traditional corrugated shipping cases, increasing the number of packs from 20 to 25 cases per minute. The cans are loaded on trays and overwrapped with a 0015 mil polyvinyl chloride sleeve around the double stacked trays. The film is then tightened by passing through a shrink tunnel, and the ends of the film sleeve are left open providing enough strength to be used as grips for lifting the pack. This type of packing lends itself to the bundling of high-volume supermarket items such as pre-cut refrigerated roasts, pharmaceutical goods, bakery, bottled and canned goods.

Molded foamed plastics must not be overlooked as exterior shipping containers. These foamed containers have excellent stacking strength even when wet. The trays can be used originally for harvesting produce in the field and, when filled, make ideal shipping containers, particularly for air movement, since they are light weight and strong. An important new development in handling and shipping is a folding aluminum shipping case which collapses to only three inches in height when empty. Specifically designed for transport, storage and display of perishable food products and packaged frozen food, their lightweight construction permits greater payloads in transit and easy handling and storage of empties.

World Wide Distribution Unless drastic action is taken, the fast burning fuse of the world's population time bomb wi11, with mathematical certainty, produce a global food catastrophe. It is axiomatic that the function of agriculture is to produce food, yet while some countries must work to solve their farm surplus problem, the rest of the world is badly in need of nourishment. The earth's population of three to three and one-half billions will double in the next 35 years, and the biggest part of this increase will occur in the least developed, most overcrowded, most underfed areas of the world. By the year 2,000, there will be three times as many people in the underdeveloped countries as there are in the more prosperous areas. It is obvious that, in the future, one part of the world will not be, able to produce enough food for the highly overpopulated and underprivileged areas. Packaging can go along way towards solving the problems caused by the population explosion. New methods of packaging now evolving will provide long term preservation and permit distribution of many items which traditionally have been confined to local consumption. By taking advantage of the ability to transport food many thousands of miles, the world can gain time, perhaps 10 or 15 years, to work out and put into effect a solution to the difficult problems caused by population explosion.

On the more pleasant side of the picture are the food items which might be classed as luxuries for which an export-import demand can be established. Foreign trade in foods can be greatly stimulated as transportation and distribution channels for the exchange of food are improved, and proper packaging for shipment may well be the catalyst. Transportation is increasingly filling its role in delivering food to foreign markets, and the speed and flexibility of air transportation make it possible for food to be delivered in prime condition to buyers almost anywhere in the world.

Packaging Education Packaging - a peripheral afterthought of production - has been a "step-child of industry" for decades, finally taking its rightful place as an engineering function. Michigan State University offers a four-year degree in the technical and managerial aspects of packaging, and by the spring of 1969 the school will have placed 800 graduates in packaging jobs. The society of Packaging and Handling Engineers, and other professional groups have solidly supported educational programs at a University level and in many instances have been instrumental in having curriculum changes made to include courses in packaging under the direction of one of the engineering or forestry.

colleges. Many universities sponsor excellent short courses, seminars, and extension courses in packaging; special educational programs by university and industry groups employ the talents of authorities in the packaging field.

The Challenge of Packaging The merchandising potential of packaging can only be realized if package design is considered as a planned process - part of the total marketing program. Before a successful container completes the journey from idea to finished package it must have the approval of engineering, research, development, legal, production, purchasing, advertising, promotion, sales and merchandising. The success or failure of all the billions poured into production, packaging and advertising comes at the moment a prospective purchaser picks up an item and examines it. Packaging, then, becomes a powerful force of communication. Packaging will never again be simple. One factor that can be forecast with respect to packaging is constant change - a change that will bring about something fresh and stimulating to give impetus to sales. There is a constant search for new ideas, new designs and better ways to make packages more convenient, economical and attractive. Packaging engineers must face the fact that only disciplined minds will be able to create order and relationship out of the complexity of new ideas in design, material combinations, containers and machines. Only the engineer who meets this challenge can become a leader in the changing field of packaging technology.

The Changing Face of Packaging Convenience will continue as the key word in packaging. To be expected in the immediate future, are more easy-open packages; look-in-the-can and cook-in-the-bag packages; dual function and other specialized purpose containers. The aluminum easy open can top which is now found on beer cans, soft drink cans and frozen citrus concentrates, is becoming all purpose and is penetrating such fields as snacks, coffee, meat, fish and baby food. Foil-fibre containers, which can be used with machine changes on existing filling lines, are ideal for frozen foods and provide a lightweight container giving drastic savings in initial costs and shipping costs. Steel foil, a newcomer to the market, promises a multiwall bag of steel foil and kraft paper, which, being puncture resistant, may hold products never before put in multiwall bags. A heat sealable pouch, fabricated by extruding polyethylene directly onto the surface of the steel foil, will have many uses.

New concepts in pressure packaging, eliminating the conventional product-propellant mix, offer opportunities to use "non-aersol" containers as pressure dispensers for a wider range of foods. A revolutionary disposable paper pouch for coffee is being produced in a doughnut-like shape designed to fit into regular percolater baskets. This pouch contains pre-measured coffee for brewing two cups of the beverage and for larger quantities several pouches can be used simultaneously.

New glass decorating methods especially designed for one-way bottles, placing the emphasis on cost reduction through more sophisticated application techniques will provide realistic competition for canned beverages. A new tamper proof closure has provided an aluminum screw-on top for single-trip beverage bottles. A bottle-shaped plastic coated paper container for beer, sustaining pressures of six kilograms per square centimeter during filling and two kilograms per square centimeter in storage, is also suitable for carbonated soft drinks.

Polyvinyl chloride (PVC) blow molded containers will reach 750 million units by 1970 in the United States alone for such food items as salad dressings, dry and liquid condiments, milk, citrus juices and concentrates, vegetable oils, syrups, margarine and mustard. Table wine, mineral oil and edible oil products are already being packaged in PVC bottles in France. Dairy products seem headed almost totally toward packaging in plastic containers, and biaxially oriented polystyrene may completely oust molded pulp and opaque plastics for meat packaging

Polyethylene tubes are being employed for the packaging of mustard, honey and many other items in direct competition with bottles. The material used is low density polyethylene which was available fifteen years ago and the dispensing fitment is also made from materials which have long been known. There will be many other examples of the use of existing plastics and processing technology to produce packages which will be acceptable to a public becoming accustomed to changes in packaging forms.

The acceptance of new types of packaging, together with the increasing technical knowledge being provided by educational institutions, should cause management to re-evaluate the place of packaging in the production function. Too often management considers product development and package development as two separate functions.Actually, the timing should not be sequential in completing the product and then designing and engineering the packaging. Many companies have brilliantly engineered their product line and just as brilliantly engineered their packaging line as a separate unrelated activity. By integrating the entire process, enormous savings and a greater assurance of an immediately acceptable packaged product will be effected.

Some promising packaging concepts may have drawbacks in cost, in production-line practicability, or in long-range consumer acceptance. Because packaging always has been; is now; and will continue to be an essential of survival, these problems will be solved, and the ever increasing challange to the imagination of the packaging engineer will continue to be met.

SOME ASPECTS OF FOOD TRANSPORTATION

By Ruth I. Shafer, B.A., SWE, ASME, WES

Ruth I. Shafer was graduated from the University of Wisconsin in 1934. She has been active in the heating, ventilating and air conditioning field since 1941. In 1951-52 she was Eastern Division Manager for OverHead Heaters, Inc., responsible, on the eastern seaboard of the United States, for the engineering and sale of Shafconaire, a specialty product for commercial and industrial heating. In 1953 she formed OverHead Heaters NewYork, Inc., franchised to distribute Shafconaire, Norman Products Co. gas equipment and several allied products, including her own brand-name furnaces and accessories - Risco. She remained President and Chief Engineer until, in 1957, she went to the ventilation and air conditioning section of Gibbs & Cox, Inc., naval architects and engineers, where she is currently employed as design engineer. She was Operations Chairman of the First International Conference of Women Engineers and Scientists held in New York in 1964.

Summary As the transportation of food is linked directly with material handling and refrigeration, the development of these technologies is reviewed with special emphasis on the design and operation of refrigerated containers. As one example of the transportation of food, there is an imaginary journey of a cargo of pineapple, typical of chilled commodities, from its source to the consumer.

SOME ASPECTS OF FOOD TRANSPORTATION

By Ruth I. Shafer

INTRODUCTION

The transportation of food over water is an integral part of water transportation itself.

Early man had to find food on the spot or provide a food pack to carry with him.His habitat was a cave, or the treetops, and ultimately was in a tribe, village, or larger community; and it was essential that he establish a cache or larder.

In the beginning, food was carried for the benefit of the carrier, whether he resorted to travel by water or land when he began crossing larger bodies of water, his problems increased two ways.He had to carry more food and devise a way to prevent spoilage.

As the craft grew in size, quantities became difficult to handle; and spoilage remained the item which could not be overcome by sheer space and manpower.As more craft plied the world's waterways, people exchanged foods.Delicacies from one area could be traded for those of others.Food surpluses in one spot - shortages in another - created a natural trading relationship.The use of waterways, with the ability to move large quantities over long distances, was a logical development; but the two basic problems of space
(i.e. handling) and time (spoilage) remained and increased.

World literature has little to say, specifically, about the ocean transportation of food.Such transportation has become a part of two technologies - material, or cargo, handling and preservation, or refrigeration.

This paper will try to outline how progress in these fields has been utilized especially for the transportation of food - not the unrefrigerated canned variety, which can be handled like any general cargo in boxes and crates, nor the bulk cargo, such as grains which can be handled like other dry bulk cargo.

Before leaving the subject of bulk cargo, however, may I recall some correspondence with the late Lydia weld, member of the Society of Women Engineers, who was graduated from Massachusetts Institute of Technology in 1903 as a Naval Architect. She wrote that in her days of inspecting ships, tallow candles were bought by the train load so the ship's holds could be inspected, as there were no lighting systems and there were many rats. The greatest problem in those days for the transportation of such cargoes as grain was the high humidity. In an attempt to solve the problem, open containers of silica gel were hung in the holds to dry the atmosphere. In the light of today's technology, it is not surprising that this was of little use.

When Lydia Weld asked, "How have you solved that problem?", the answer was, "Well, we still use desiccant containers in some spots; but controlled ventilation and dynamic dehumidification now solve these and other problems in most areas of modern ships. The dehumidification is done by liquid desiccants, such as lithium chloride (Kathabar System) or by dry desiccants such as silica gel or activated alumina (Cargo Caire). Dehumidified and recirculated hold air, outside (ventilation) air, or a combination, is introduced as determined by stripchart recorders of the hold and outside conditions (dew point and dry bulb temperature).

HANDLING

It is of interest that the Engineering Index was first published in 1884, under the title of Descriptive Index of Current Engineering Literature. Volumes appeared every several years until 1906, when publication became yearly. The first mention I could find of "cargo Handling" as a separate subject was in the 1925 edition. Volume 3 (1896-1900) listed under "Ships":

"See Mechanical Handling of Materials," but there were no references. Volume 4 (1901-1905) carried the same heading; but articles listed cited mechanical engineering improvements for cranes and dockside loading. The term "cargo handling" was mentioned as a major topic in the 1916 edition but without context.

A researcher doing a thorough job today - 41 years later - should have access to an information retrieval system. Lacking this, he must check headings such as "Ships - cargo handling, materials handling, automation, refrigeration, food" and a like number under the broad headings of trucks, railroads, transportation, automation, materials handling, ad infinitum.

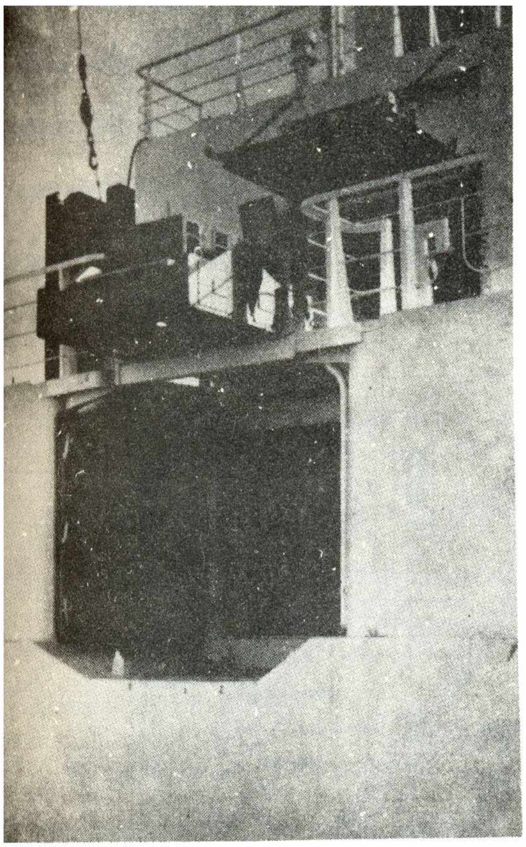
As is commonly known, the ancient method of loading a ship - even in the days of the Yankee Clipper at the turn of the century - was by a parade of stevedores with barrels, boxes, or chests on their shoulders. The earliest manpower-saving, time-saving device consisted of loading small packages in a net and hoisting the net by simple pulley arrangements. Today, gigantic cranes doing the same thing are a familiar sight. To lift more at one time, and save piece-by-piece handling, pallets were and are used, lifted from the dock, lowered to the hold and stowed as units, by hand truck or lift truck.

In 1950 Farrell Rolling Decks were introduced. Instead of dropping cargo through the center hatch and moving to the sides for transport, the decks themselves were made movable so that the sides moved to the ship center line where they were loaded. They were then rolled back to position (all controlled by the ship's own rigging facilities) and the center portion of the hold could be filled last.

Shipping concerns began to solve these problems in various ways. Pallets were designed to move on casters with criss-cross tracks on the decks, similar to the method still used for moving paper stock in a modern newspaper press. Fairly early some ships were fitted with two side ports. Lift trucks entered the forward one, discharged their cargo, and exited aft.

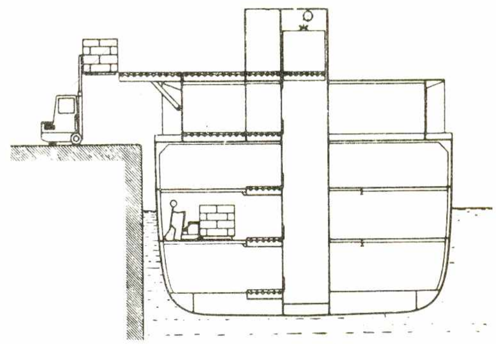
A far more sophisticated system has recently been built by a modern Spanish shipyard. Four unusual and advanced motorships were designed for pre-loaded pallets where suitable terminal facilities are available.

Basically, the ships have closed decks with bridge and machinery aft. They have two holds and raised fo' c' s' le and poop decks. There is also a trunk deck somewhat narrower than the main deck. In the larger hold there are two 'tween decks so there are tour levels for cargo stowage. Figures 1, 2,3,4, show how the cargo is loaded and stowed. This handling method, however, depends on properly mechanized terminals. (1) *



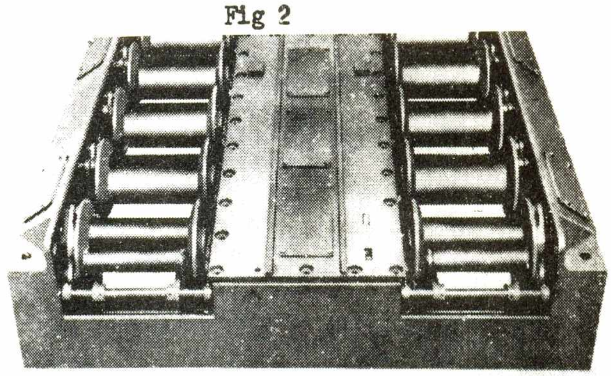
The portable overside conveyor section is rigged at the upper deck level. Behind is seen the rectangular lift shaft house and fork-lift truck garage. The door opening to the alternative position at trunk deck level is seen below.

Fig 1



Sketch showing discharge procedure from one of the three lower levels which have flush conveyor tracks. Cargo is handled overside at the most suitable level for shore trucks.

Fig 2



One of the powered conveyors which are inset into the dec
The detector pads are seen in the centre

Fig 3

*References will be found at end of article

General arrangement of the 'Astenc 94'. Note particularly the slightly narrower trunk above the freeboard deck, side doors, lift shaft and truck garages. The two 5-ton Thrige cranes are supplemented by a 3/15-ton Velle slewing derrick

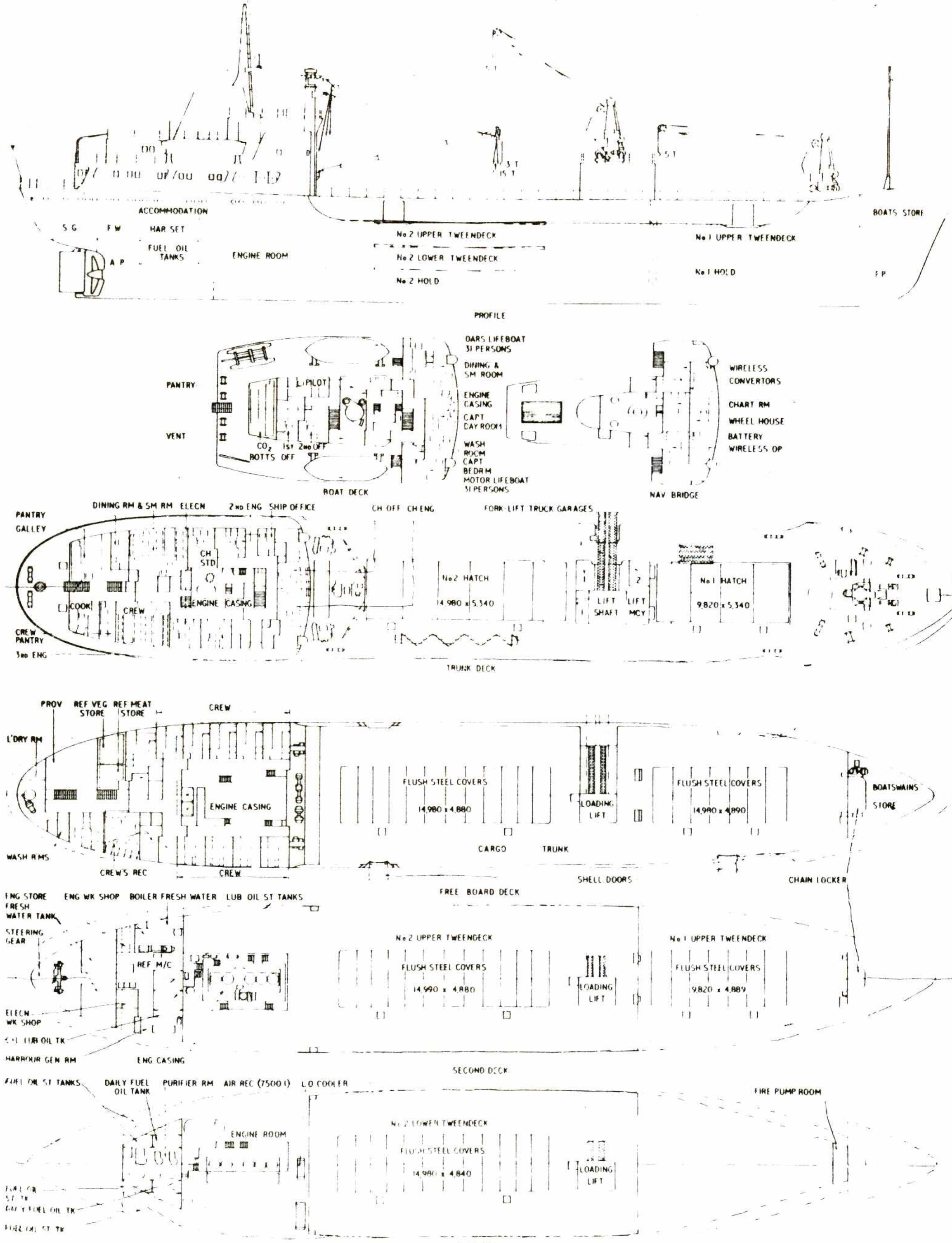
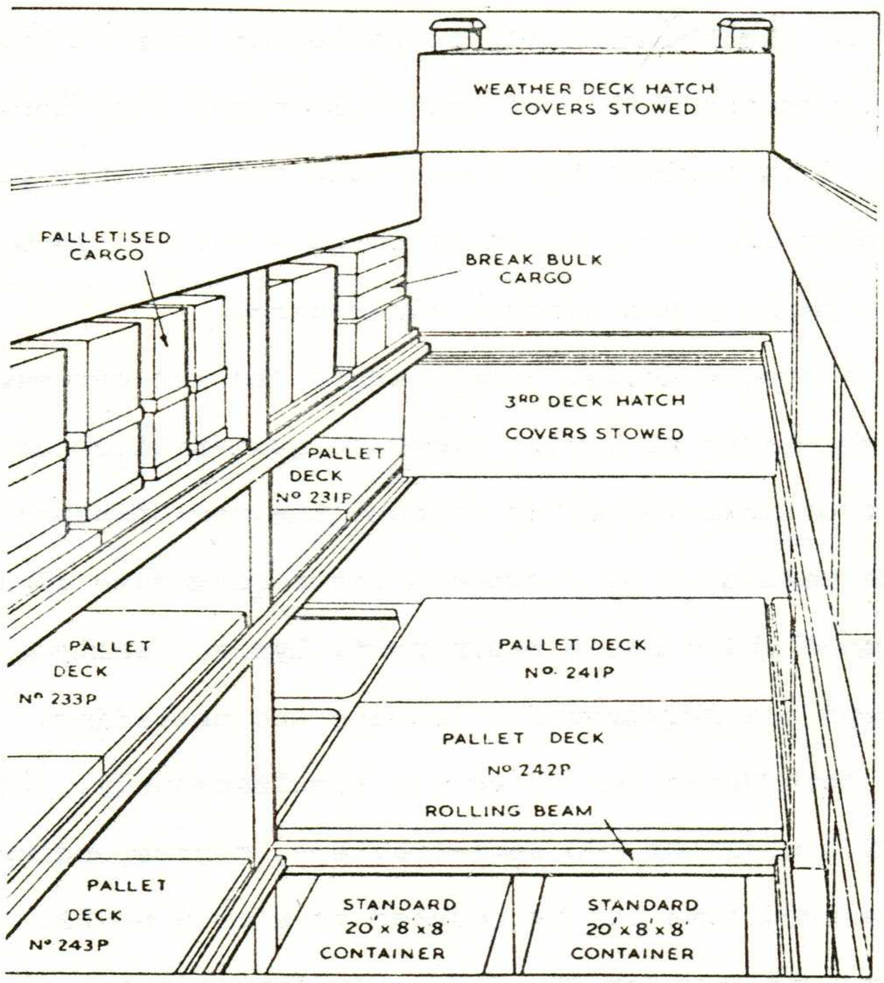


Fig 4

The Vickers Ltd Shipbuilding Group used a different approach and designed a Pallet Deck System not unlike the Farrell Rolling Deck.

At the second and fourth deck levels of a four-deck vessel, a series or portable roller beams are provided to take the Pallet Deck rollers; while at the third and tank top levels, the Pallet Decks run out directly flush with the hatch and tank top plating, If needed, flush hatches can be fitted at all deck levels instead of the portable roller beams. As in the Farrell system, all handling is done within the hatchway area. The Pallet Decks are moved in from the wings, loaded and returned to stowage position. The Pallet Decks are moved in pairs from alternate sides of the ship to maintain the ship's trim. In the Farrell System port and starboard decks moved simultaneously for the same reason. (2) See Fig 5. One of the basic reasons given for the design of all these ships: the ability to carry refrigerated containers.



Sketch showing interior of Pallet Deck Ship.

Fig 5

Inevitably the use of a container instead of a pallet has come to the fore. Each advancement has brought about more use of them with some doubt as to the advantages of containers vs. pallets. For those interested, a detailed history of the container can be found in the March 15, 1966, issue of Maritime Reporter.

United Steamship Co., Ltd of Copenhagen (DFDS) has a plan in operation to handle "rationalised cargo" (containers), pallet cargo, and regular cargo. The first cargo was bacon moving from Denmark to the United Kingdom, utilizing semi-trailer vans (containers mounted on two rear wheels) which can be rolled aboard. Other unitized products, not suitable to the trailer van but loaded on flats or pallets, are also rolled on by ship's trailers or trolleys, while miscellaneous cargo is still handled by fork-lift truck, crane, etc.

Early in 1966 the Copenhagen-Felixstowe Service was inaugurated with weekly departures by the "beer ship", so-called as beer is her basic cargo. This is a specially designed ship of the roll-on / roll-off type with bow port, having one trailer deck besides the lower hold and an extra portable 'tween deck. It too handles all three types of cargo - rationalised (or trailer van), unitized (or pallet) and general mixed cargo.

Late in 1966 a double-decker vessel began its run between Esbjerg and Grimsby carrying shipments of Danish bacon in semi-trailer vans. The ship is designed for structural integrity without the use of stanchions, so that both decks provide maximum free space and can accommodate about 108 semi trailers.The "bacon ship" has a stern port. Hydraulically-operated, or double-working ramps are required for loading and unloading. If the terminal has double ramps, both decks can be worked simultaneously. Thus, while rolling on and off a cargo of 200 semi-trailers, corresponding to 2,000 to 3,000 tons, turn-around time can be reduced to 4 or 5 hours a speed of 18 knots While under way and a bow thruster to cut berthing time, this rapid handling makes it possible for the vessel to perform two round trips each week. She is also equipped with portable ‘tween decks, providing for about 450 automobiles.

In 1966, a new passenger / cargo vessel, the m.s. "Winston Churchill" was put in service from Esbjerg to Harwich. The ship has both bow and stern ports and a trailer deck to accommodate 40 semi-trailers. She can also carry either 180 passenger cars or 80 cars and 40 more semi-trailers. Trolleys will "roll on" 15 tons of cargo which will be carried to the lower decks by elevators. Port time in both Esbjerg and Harwich is limited so about l50 cargo tons must be handled in one hour. The "Winston Churchill" can handle any type of heavy trailer or bus.

Ultimately DFDS hopes to move all traffic, much of it food, between Denmark and Great Britain in specialized tonnage. (3)

United States ships have also used the roll-on / roll-off system. The long trade routes covered, however, detract from the efficiency of this type of carrier.

The Roll-on/Roll-off trailership terminal must be readily accessible to deep water and have a marshalling area adjacent to the pier.

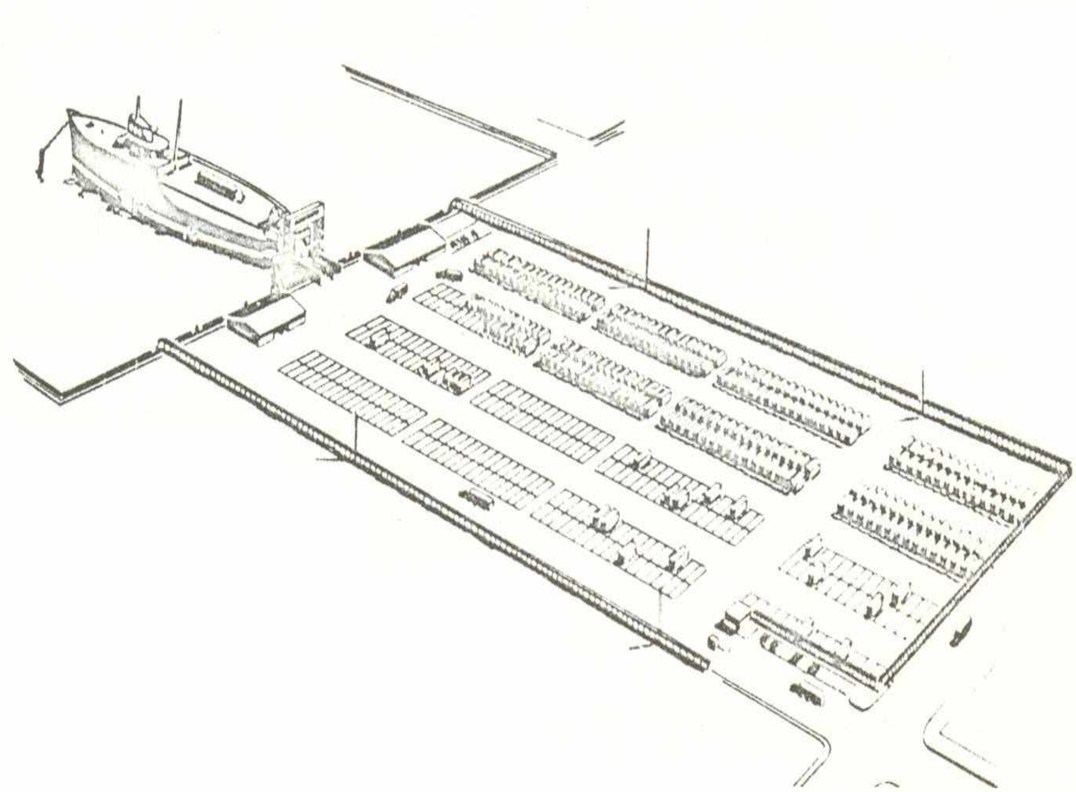
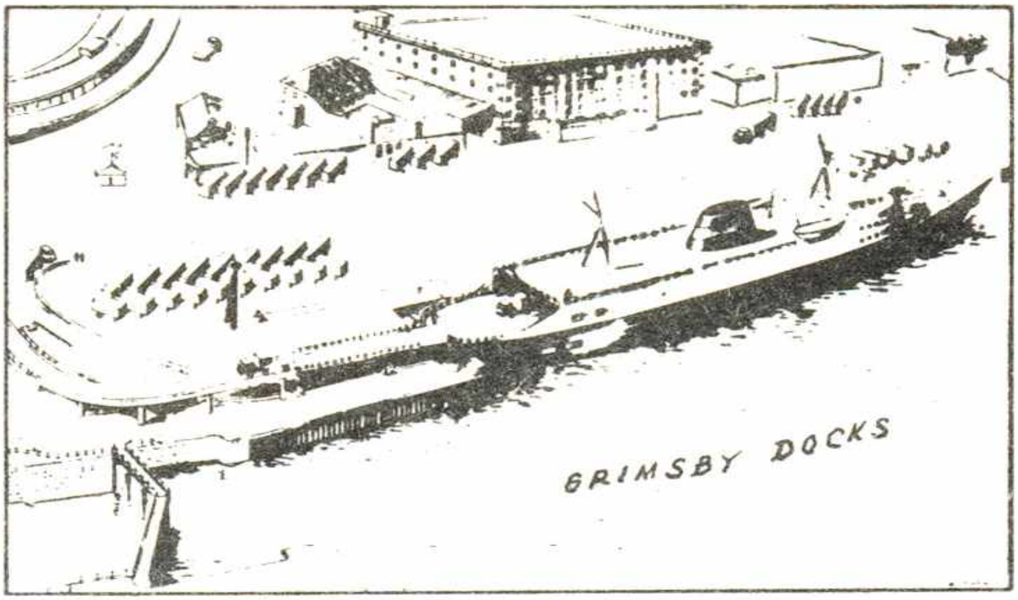


Fig 6



Grimsby's roll-on/roll-off terminal, planned for 1966.

Fig 7

Meantime in the United States the American Hawaiian Steamship Co. has had a container service from the U. S. West Coast to Hawaii for about 10 years as has the Pan Atlantic Steamship Company, which fitted their T-2 tankers with specia1 cargo decks for carrying trailer bodies. Both utilize trailer bodies with small wheels or standardized containers.

One of the most exciting developments in ocean-going transport is a program being implemented by Lykes Bros. Steamship Co., Inc., to be known as the Lykes Sea Barge Service. Instead of carrying containers or pallets, this ship will carry barges.By traveling long distances at high speed, the Sea Barge Carrier will service only large ports tar apart. At these destinations the barges will be unloaded and towed to smaller ports in the vicinity. This type of central distribution systems is new to the shipping industry and will permit very rapid turn-around for the mother ship, avoiding the costly delays in port and freeing the ship to carry more cargo.

The first concept of the Sea Barge called for a double-decker to provide "float-on / float-off " service by submerging the carrier at port. (Figure 8) As a 68-toot draft would be needed to accomplish this loading, the idea was abandoned. Special elevators are now slated to load and unload. The new design calls for three decks which will carry a combined load of 36 barges, bio of which will be carried on the elevator which is hung between cantilevers at the stern. The elevator has a lifting and lowering speed of six feet per minute and can empty the ship completely in about 20 trips.Its platform will be equipped with rollers at each side and the centerline to guide the barges into place. Hydraulically-operated gates will hold the barges in place in the fore and aft positions. Final positioning in the transverse direction will be done by mechanically-linked arms at the platform sides and at the centerline. Barges are unloaded from the elevator by a series of special dolleys. Barges themselves, of course, can be loaded with containers refrigerated or general, pallets, or any form or cargo.

Below the three barge decks are deep tanks for liquid cargo, some of which will be designed to carry either liquid or 160 20-foot containers. If more container space is needed, the upper barge deck can carry 468 20-foot containers, two high. Or, remove the upper deck with minor modification, and 1170 containers can be carried in open cells. The whole ship could be converted to containers providing space for 193620-footers.

“Roll-on / roll-off” operations may be carried out without any modification to the ship so that it is immediately available for carrying military equipment and unloading it on the beach, if needed. A more flexible ship can hardly be imagined. It must be remembered, however, that the ship is still in the idea-design stage and is still to be built and proven. World ports will have to be modified or constructed to accommodate her.Figures 9, 10, 11. (5)

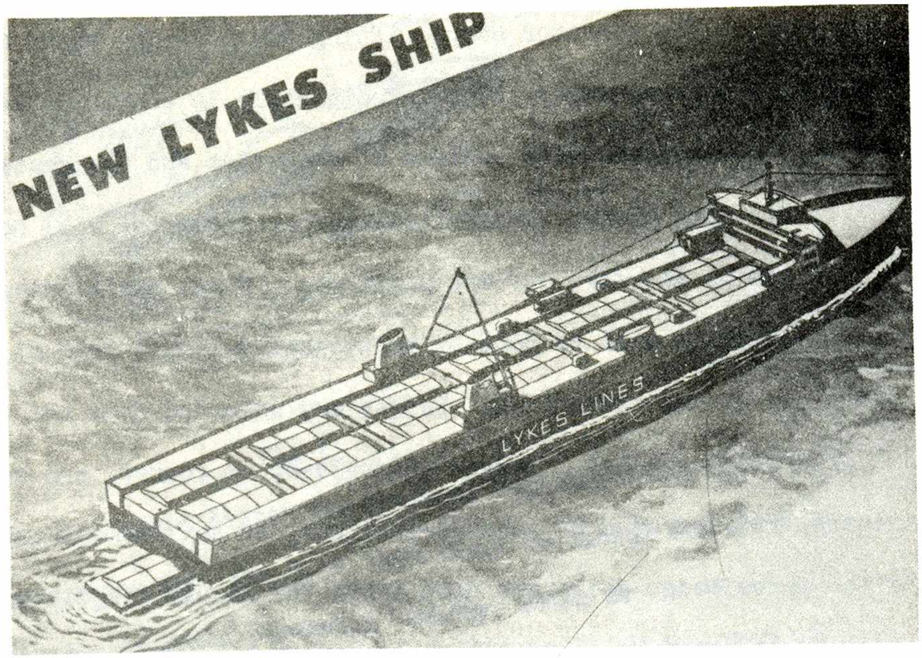


Fig 8

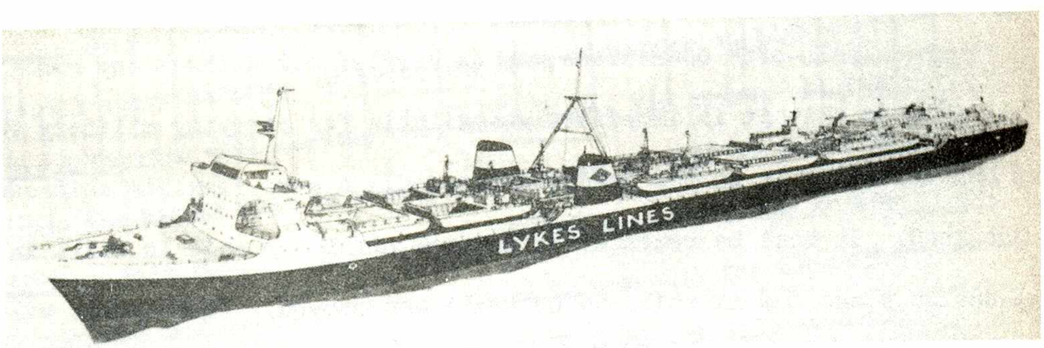
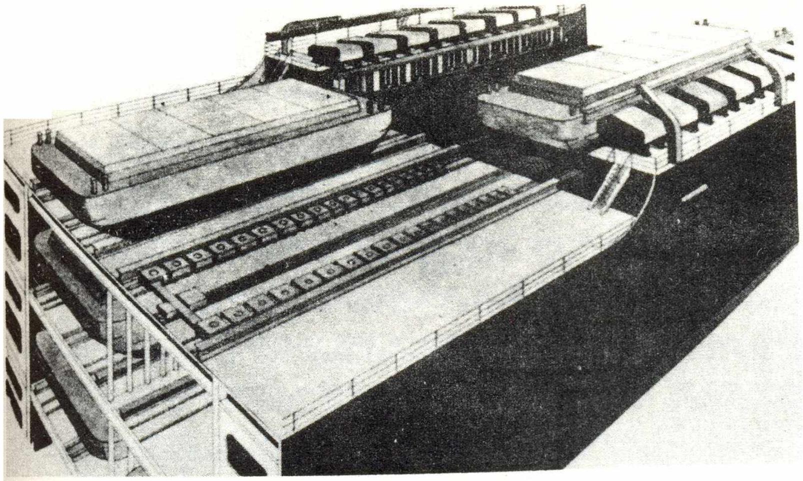
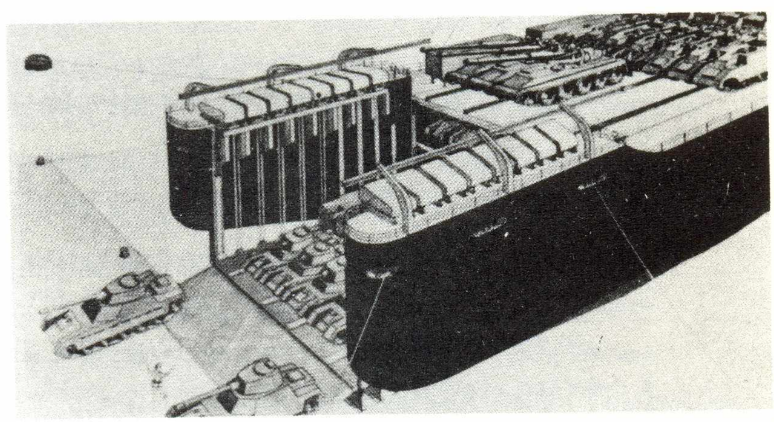


Fig.9



Detail view of elevator at upper barge deck showin;
dolly-hydraulic jack and barge moving units.

Fig 10



Sea Barge Carrier can be used for fast deployment of military roll-on/roll-off equipment without any conversion work.

- Figure 11 -

Meantime, while these companies are-approaching one part of the problem - that of providing rapid turn - around and high speed over water, Sea-Land service, Inc., and the Matson Navigation Co. separately have attacked the problem from the system point of view.

To so1ve the ship's problem, one needs simply to load and unload quickly and safely and carry cargo quickly and safely from one port to another. But the shipper and consignee, who are the ship's paying customers, need pick-up and delivery service door-to-door.

For years the Seatrain Line has utilized a container principle by transporting railroad cars on shipboard. Trucks, which travel faster with more accessible points of pick-up and delivery have joined the parade; and today, for coastal service in the United States and for some ocean transport business, the container is the method in use for truck-load or car-load service. According to the Maritime Reporter, March 15, 1966, approximately 60 steamship lines throughout the world offer container service for the Port of New York. As this is being written, the Port of New York has announced plans to build a container terminal on Staten Island.

While Sea-Land Service was undertaking to provide door-to-door service, Matson decided to make a study to answer these questions:

"1. Does containerization in the West Coast-Hawaiian trade offer enough reduction in overall costs to justify the a additional capital required,

"2. If so, what level of container shipping operations represents the best compromise between the amount of service offered and the cost of providing this service?

"3. Given a maximum level of container shipping operations, what is the proper size and number of vans in the system, the shoreside equipment and facilities needed, and the proportion of van-ships in the fleet?"

A detailed analysis of the study can be found in the April, 1959, issue of Modern Materials Handling. As a result, Matson ordered the construction of the "Hawaiian Citizen" discussed in greater detail later, and there are now six C-3 freighters with strengthened weather decks, reinforced hatch end beams and special deck fittings. They are carrying as many as 75 reinforced aluminum containers topside, with a capacity of 40,000 pounds in each container. Container size coincides with some over-the-road equipment vans with outside dimensions 8½ft. high, 8 ft. wide, and 24 ft. long.

It would not be accurate to say that the requirements for food transportation were responsible for developments in cargo handling; but surely it has always been a major factor, as each step forward in handling is accompanied by a story about the transportation of food.

In 1964 the Matson door-to-door container system was thoroughly there tested. In Fremont Nebraska there was a 36,500-pound lot of packaged frozen pork. Its destination was a supermarket in Honolulu, Hawaii. Specifications of shipment required that there has to be no re-handling of the product, that it be maintained at 0^{o} F_{o}: that it be delivered with a no-pilferage, no-damage guarantee. The meat was loaded in a refrigerated container, transported 1600 miles by truck (incidentally across America's desert), placed on shipboard in Alameda, California, and delivered to the supermarket by another truck chassis ten days after leaving Fremont. As the container had not been touched, except for loading and unloading as a unit, and as it had been constantly refrigerated by passing from System to system, the product arrived in perfect condition just as it had left the packaging plant, with no dents, gouges, or scuffed labels. (6)

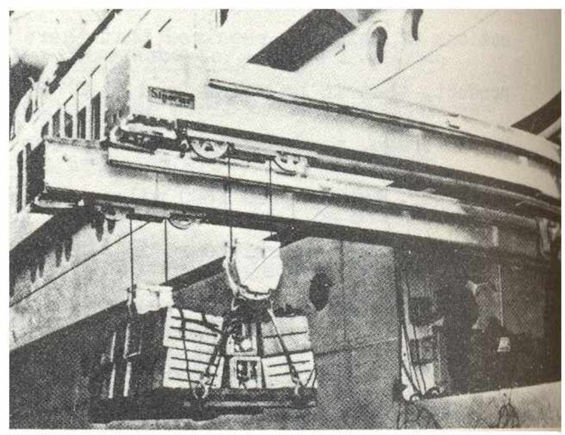
The Grace line has solved dock-side handling problems differently, by carrying her automatic handling equipment on board. Four passenger cargo vessels service the New York - South American run. As cargoes are diversified and distinctly different northbound from southbound, flexibility in the stowage areas and in handling equipment is vital. The ships can carry refrigerated cargo, vehicles, pal1etized shipments or general cargo in containers. They have a carrying capacity of 175 20-foot containers on and below deck in addition to 390,000 cubic feet of temperature controlled space and 24,000 cubic feet of deep freeze space, as well as 37,000 cubic feet of tank space f or liquid cargo.

Southbound, the principal cargoes are lubricating oils, detergents, vehicles and containerized general cargo. Northbound, they are fruits, frozen shrimp, cocoa beans, coffee, balsa wood, molasses and sperm oil.

Four gantry cranes on the main deck handle containers, automobiles, and palletized cargo. Under deck cranes linked electrically with elevators and conveyors carry cargo via four side ports. Ten vertical - pocket banana conveyors have a capacity of 2400 stems per hour. Figures 12, 13, 14,14a, l4b (7)

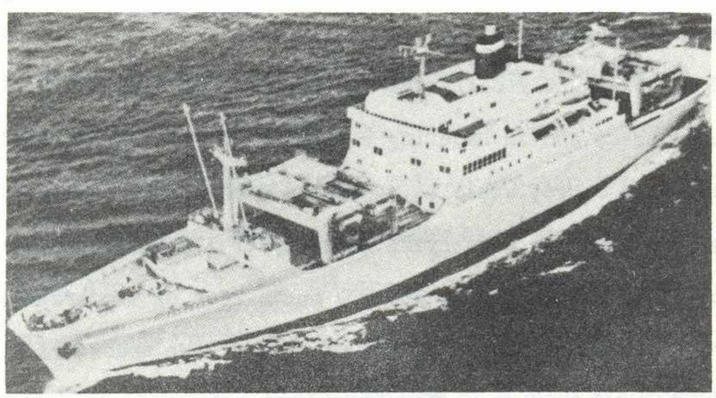
Simultaneous loading of a container by gantry crane and at side port by conveyor is shown in this view.

Fig 12



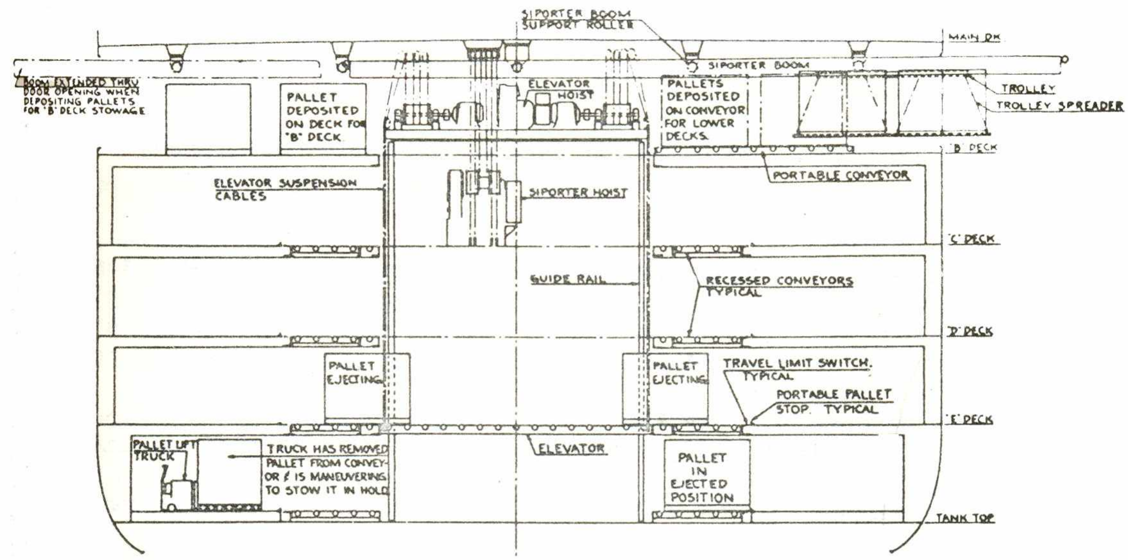
EACH OF THREE new Grace Line combination cargo-passenger vessels will be equipped with two Lake Shore Inc., Siporters with synchronized boom and trolley. They will be similar to extensible boom type shown here installed on APL ship 'President Cleveland'.

Fig 13



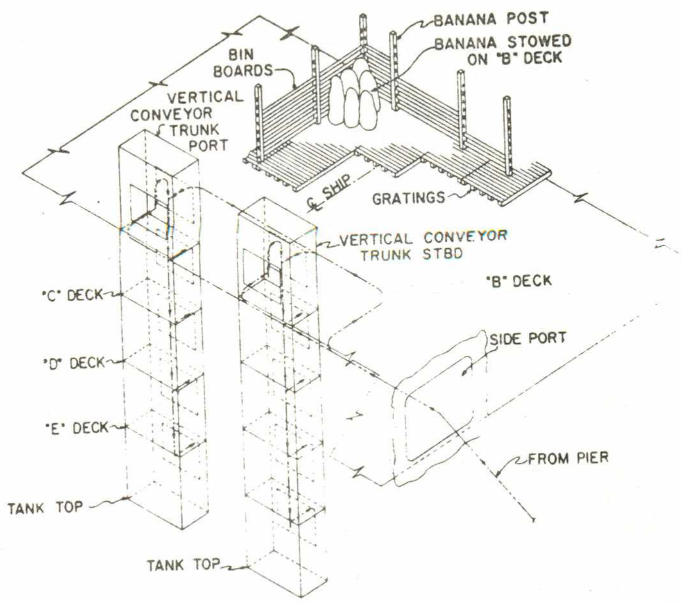
The SS Santa Mercedes sails out of New York harbor displaying her new green, white and black stack.

Fig 14 (13)



Pallet handling arrangement in Hold No. 3.

Fig 14a



Routing for banana handling during loading operations in Hold No. 3.

Fig 14b

THE UNICUBE

It is obvious that economic pressure to cut dockside time and costs and to accomplish speed of delivery has brought about many different approaches throughout the world. As efficient handling depends on terminal facilities which are extremely costly to build, it is time the world got together to synchronize its efforts.

Recognizing this, a study group was organized under the supervision of the Netherlands Committee of the ICHCA. G. C. Meeuse reports in the ICHCA Journal of July, 1965:

"In the multitudinous daily movements of goods only partial handling efficiency is achieved because loads, handling equipment, carrier's vehicles and storage spaces do not match. Chaotic situations exist with respect to sizes and dimensional coordination of storage and transport facilities. Goods are ill-matched with resulting poor loading efficiency, and attempts are made to reduce broken stowage by stowing the last empty spaces by hand, etc. Facilitation and acceleration of loading and unloading operations, and more efficient use of holds and storage space, can be achieved if cargo units are designed to match the holds and storage spaces, and if there is more uniformity in the dimensions of cargo spaces and of goods. Many attempts to achieve more uniformity in the case of transport - e.g. by the development of unit loads, have been made in recent years. These, however, offer only a partial solution and little has yet been done to secure uniformity of ships' holds. -----

"As has been mentioned before, development clearly tends towards rectangularity both in cargoes and in space. As the rectangle can be thought to consist of a combination of equal quadrangles, a three dimensional body can be thought to consist of equal cubes. As a space UNIT such an imaginary CUBE is introduced and is called UNICUBE. If Unicube is adapted to both the volume of cargo-holds and the dimensions of unit-loads the separate problems concerning loads and holds could be fused.

"The difficulties in cargo handling are to a large extent caused by the clearance (interior dimensions of the hold minus exterior size of goods) between the sides of the hold and the cargo itself.In cases where this clearance is too big broken stowage occurs; if it is too small, unnecessary handling-time or damage can result.

“The Unicube system is based on the assumption that a clearance of around 5% of the actual measurements of the cargo-holds and cargo as a rule would be acceptable. By accepting this uniform clearance it has been found possible to use one single unit for measuring the spaces and volumes con cerned. The cube has been chosen as the unit for measuring the internal dimensions of the holds and storage spaces.

“As the unit of length - standard metre - was originally a rather arbitrary choice, so the Unicube can be fixed by agreement." (8)

A good bit of space has been devoted to cargo handling, which applies to general merchandise as well as food; but the need to transport food is one of the prime factors involved in this development and certainly is responsible for the introduction of

REFRIGERATED CONTHNERS

In the United States over-the-road containers have by now been fairly well standardized because of regulations imposed by law. The width of 8 ft is dictated by highway and railcar clearances. Standard height is 8 ft and standard lengths are 10, 20, and 40 ft, although there are still a number of 24-foot units in use - some 8ft, 6in high.

Containers for shipboard use must be built to resist corrosion from sea air, to withstand ship’s motion, to be completely weather-tight and reliable, while still meeting the over-the-road goals of minimum weight and maximum cubic capacity. Refrigeration containers must have machinery adequate to cool "hot" produce, which means removing the heat of the field and to "pun down" the product to the desired temperature (29º to 35º F for chilled cargo - 0º F for frozen). Acceptable pull down time may be 48 hours for chilled and 72 hours for frozen; and this may need to be accomplished against an ambient temperature of 100º F. (Containers for desert caravans will have an even more stringent set of conditions!)

Over-the-road containers can be built with outside machinery spaces that can be installed on the rail car or truck chassis and they may be fitted with "eyes" or lugs for lifting; whereas such projections, which will interfere with stowage, cannot be tolerated on board ship.

For this reason most containers for shipboard use are especially constructed. They must be strong enough to stand the strain of handling and to accommodate the dynamic load imposed by other containers stowed on top of them. Sometimes containers are stacked six high in specially designed ship cells.

External structure may be steel or aluminum, with high tensile steel frequently used for corner posts, framing and bottom longitudinals. Extruded aluminum shapes are frequently used for he rest of the outer shell.The internal skin may be of plywood, steel, aluminum, aluminum clad plywood, glass-reinforced plastic, or plastic laminates. Battens (vertical posts) and gratings made of wood or extruded aluminum facilitate air distribution. To prevent contamination of the cargo, the materials must be as odor free as possible.

Insulating materials may be fibrous glass bats and rigid polyurethane sheets or foamed-in-place polyurethane. Whichever insulation is used, bonding between layers is essential and the containers must be air tight. They should be tested under pressure and with smoke to insure this tightness.

The packaged refrigeration machinery may consist of a liquefied petroleum gas engine-driven compressor, with air-cooled condenser for land operation and motor-driven compressor (with the same air-cooled condenser) for ship board use. All equipment, including the fuel tank, is built into the container. This takes space which could otherwise be used for cargo-end, in addition, the U. S. Coast Guard Regulations require removal of the LP (liquid petroleum) tank if the container is stowed below decks. For topside stowage the tank can remain. Removal of the heat generated by the air-cooled condensers is extremely difficult when the containers are stowed below decks.

Another system uses LP gas-driven compressor with air-cooled condenser on shore and motor-driven compressor with water-cooled condenser for shipboard use.

A third system uses a motor-driven compressor with air-cooled condenser for land with water-cooled condensers on ship. This requires a special chassis on land as engine, batteries, tank, etc.to drive the motor are not carried in the container.

Most popular arrangement for deck-carried units utilizes self-contained motor-driven compressor, powered by the electrical system aboard ship or truck, with air-cooled condenser. Below deek stowage requiresmore free space and greater ventilation to dissipate condenser heat, so water-cooled condensers are usually used and hooked up to a water supply, preferable fresh water.

Other refrigeration processes are sometimes used, either entirely, or as a supplement to reduce the load of the standard mechanical system. Liquid carbon dioxide can be used. For quick chilling, it is stored in liquid form under 300 psi pressure and zero degrees F temperature. A mechanical refrigeration unit is necessary to prevent CO_2 loss through temperature rise. The CO_2 is released by nozzle to create cold vapor and dry ice snow. The cold vapor is at minus 110º F for quick heat absorption. The dry ice snow sublimes slowly, refrigerating over a period depending on temperature and air circulation.

To maintain low temperatures, the CO_2 is carried in insulated pressure tanks and is distributed through tubes. No mechanical refrigeration is required except for air handling.

There is, of course, the older method of dry ice in blocks stowed in bunkers, which absorb heat just as wet ice does and as it used to in your old ice box. Liquid nitrogen operates like liquid CO_2. It is still in the development stage; but as it absorbs more heat per pound of liquid released and does not boil until the temperature drops to minus 350º F, it offers a more efficient solution. It is stored in a special cryogenic cylinder and released at low pressure under the control of a thermostat. Both liquid nitrogen and CO_2 are today more costly than mechanical refrigeration and both present a potential hazard to operating personel.

Two other systems are worthy of mention. One is called "ambient refrigeration." An insulated hold is cooled the same as any refrigerated cargo space. A small fan is installed in each container to circulate the cold air. This increases container space for cargo and simplifies ship board operation. It is especially useful where delivery from ship to final destination requires little time, although a portable refrigeration unit can be used for land transportation.

For small amounts of refrigerated cargo a portable air-cooled refrigeration unit, which circulates cold air to a number of insulated containers, can be used. Flexible hose is used to connect the air supply to and from one or more units. In all refrigerated containers positive controlled air circulation is mandatory and is usually accomplished as described on page 24. (9)

Let us assume that the world has adopted the Unicube, that all large dock-side facilities have been constructed to accommodate container ships; that ships' accesses have been modified to accept them and the holds built to provide a proper " fit " We now revert to the special theme of this paper transportation of food

In November, 1924, Llewllyn Williams, Esq presented a paper at the general meeting of the Society of Naval Architects and Marine Engineers. His subject was "The Design and Construction of Refrigerated Ships." Although today, we carry frozen cargo other than foods, his text dealt exclusively with food handling and he restricted his paper basically to the handling of fresh fruits, frozen food and chilled produce, the last two largely meat.

He says in part :

> " The difference in refrigerating machinery equipment between fruit carriers, frozen meat carriers, chilled meat carriers, and general cargo carriers may be briefly stated as follows:
>
> "Fruit carriers should be fitted with cooling equipment operating on the forced indirect air circulation system with ample provision for external ventilation, as the satisfactory carriage of the cargo depends almost as much on ventilation as refrigeration. A banana cargo is loaded in bulk and not dunnaged, but is divided by bins
>
> "Frozen meat carriers require no ventilation in service but have to be heavily insulated for the low temperature necessary, and can be, comparatively speaking, lightly piped on the bulkheads, sides and under ceiling with brine cooling pipes, cooling being by direct radiation from these pipes. The cargo is loaded in bulk suitably dunnaged for natural air circulation.
>
> "A chilled meat carrier requires to be designed with certain heights in the cargo spaces and very heavily piped with the piping under the ceilings, so arranged that the economic distribution of the meat-carrying rails will not be: interfered with by the arrangement of the piping or the particular design adopted in the vessel's steel work to be insulated. This cargo must be carried suspended from overhead rails, and therefore the steel structure of the deeks requires special attention for the loads to be carried. The cooling system requires to be very carefully arranged by skilled designers in order to procure the fine temperature adjustments necessary for the carriage of chilled beef, particularly on long voyages where temperature variations of more than half a degree in the cargo spaces are not allowed.
>
> "The general refrigerated cargo carrier would require certain spaces

such as deep holds suitable for the carriage of frozen goods in particular, with ‘tween-deck spaces arranged with air circulation for the carriage of fruit. This type of carrier might be considered as a combination of the first three in parts, and is the usual type of vessel which should be considered for general refrigerated trades as the nearest type of vessel which can care for any refrigerated cargo."

He continues to describe the various facilities for the three different types of cargo. Brine was then the only practical refrigerant available; and the pictures of the chilled meat holds look much like a typical old cold-storage plant, with heavy cork walls and many exposed pipes, and meat carcasses swaying from the ceiling hooks. (10)

As it is the area in which greatest advances have been made since Mr. Williams' analysis, except for cargo handling itself, I should like to restrict the balance of this paper to a description of the modern method of transportation of refrigerated produce.

Let us examine today’s solutions for the same problems discussed in First, to define the various types of food cargo requiring refrigeration. Basically, we separate " live" cargo from “ dead ” cargo. Live cargoes consist of living things, such as fruits and vegetables. They absorb oxygen and release carbon dioxide and water (the respiration process).This continues throughout the time of transportation. Ripening is often intended during transit. The speed of ripening is controlled. To delay it, the temperature is lowered or the atmosphere is changed by decreasing available oxygen and increasing Co_2.Incidentally, the process of respiration creates heat, a load which must be anticipated when designing the refrigeration system.

Live cargo falls into two classes - precooled and non-precooled or "hot". Hot cargo is delivered to the ship or packed in the container as it comes from the fields.

Chilled cargo has been precooled before arrival on shipboard, or before being loaded in the container and may be either live or dead (chilled beef, for example).

As live cargo must be protected from freezing, heating is a part of the Carrying temperatures usually range from 29º F to 35º F, except for special cargoes such as bananas which are maintained at 50º F to 55º F.

Bananas, mentioned in the williams paper, are now boxed before loading, green and the hands being removed from the stems. They are usually shipped green and ripened in transit or at a warehouse close to the point of shipment. In the banana holds of the latest Grace Line ships, the air from the air bulkhead (Fig. 15 and 16) flows from below upward between the fruit boxes. To accomplish this the change-over damper in the cold room (Fig. 16) is reversed so that air flows into the cold room through the top opening. This recirculated air, after blending with the fresh outside air, passes through the cooling coil and the fan, the resulting conditioned air being forced into the lower duct of the air bulkhead. It is discharged through the openings in the deck gratings and forced upward through the banana crates and returned via the upper duct in the air bulkhead.

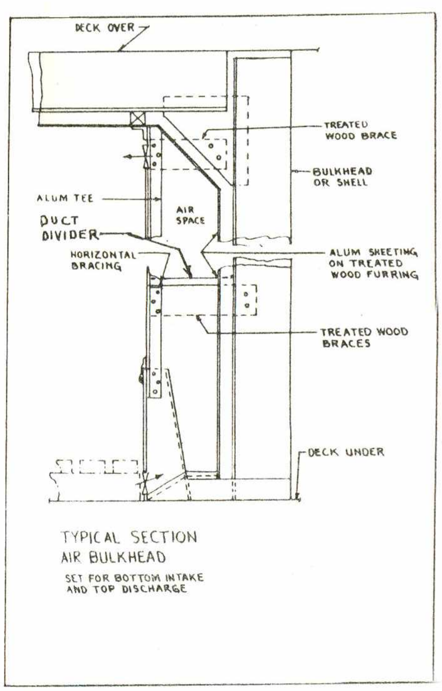


Fig 15

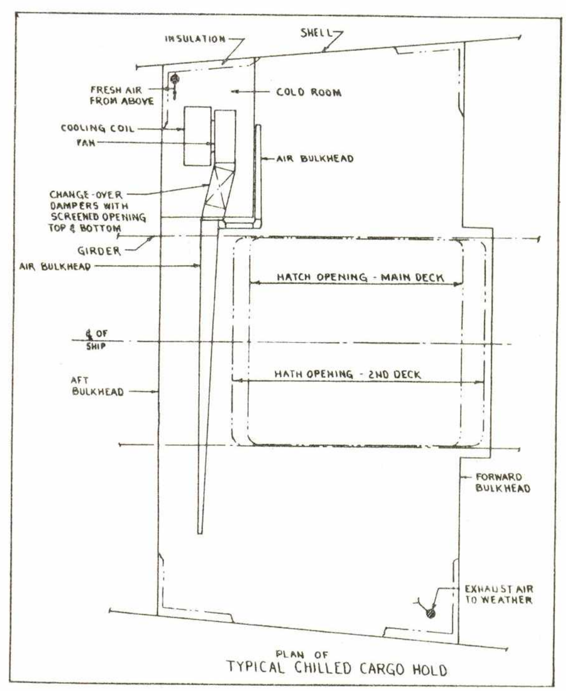


Fig 16

Chilled beef is still a critical cargo, but it is now handled by the indirect method of cooling (fan, coil and air distribution system). Some experts feel the prescribed $1 / 2^0$ F permitted temperature variation is unnecessarily cautious; but temperature changes must be very slight.

Frozen cargo should be delivered to the ship in a frozen state. The ship's frozen cargo hold will maintain frozen cargo at the recommended temperature of 0^o F to minus 10^o F. This is considered a safe temperature as it is well below the temperature at which most bacteria become inactive. All modern ships use the indirect method for cooling in the frozen cargo holds.

Latest developments, therefore, use the indirect method for cooling all refrigerated cargoes and have remote recording and operating equipment to reduce manpower and increase the quality of the delivered product.

Brine is still the most popular refrigerant for chilled cargo cooling coils. Today, however, instead of the familiar calcium brines, inhibited glycol brines are frequently used, promarily to reduce corrosion.

Refrigerated cargoes present the same handling problems as discussed earlier.It is natural then, that refrigerated containers have came into use.

The first container ship on which I personally worked was the Hawaiian Citizen. She is owned and operated by Matson Navigation Co. and is used for the run from the West Coast of the United States to Hawaii.

She was an existing ship to be refitted, and the first problem fell to the structural section. The hatches had to be increased to accommodate 20-foot long containers, and the holds had to be modified to accept the containers. Our job was to provide suitable ventilation.

"Typical Ventilation "(Fig 17), modified to deliver ventilation air at the deck and to remove exhaust air from overhead, answered the need in the container holds. Air supply terminals were located carefully to be sure that air was accessible to all containers. Hold decks were fitted so that containers could be dropped exactly in place, and, if refrigerated, plugged into the ship's power, condenser water and instrumentation systems.

As the Hawaiian Citizen travels to and from Hawaii, let us chose a suitable product - say pineapples - and follow through, with the help of imagination, and see exactly how they can be handled.

PINEAPPLES GO TO SEA

Modern farming methods can be used for planting and cultivation. As far as I know, automatic equipment for harvesting pineapples has not yet been devised; but I am sure it will be - perhaps a tractor-mounted scanner equipped with a basket that will travel among the pineapple plants and recognize and pick the mature fruit.

After picking, the fruit is graded, cleaned, pared, packed and frozen by a modern automatically controlled system, feeding the fresh fruit from the plantation to the freezing plant. The familiar table-sized packets or cans of frozen fruit or juice can then be packed in carton lots, which in turn can be palletized automatically and the pallets placed inside a standard refrigerated container. (Figs. 18, 19, 20) (11)

As seen in Fig. 21, one end of the container is reserved for the refrigeration machinery. Freon 22 is favored, although other refrigerants are some times used. A cold air diffuser mounted at the top of the machinery section, or just inside the cargo space, spreads cold air across the entire length of the container. A small air space is provided on all sides and the produce is stacked on a grid a few inches above the floor of the container so that air flows across all peripheries of the stowage and returns to the machinery space. In long containers booster fans are sometimes used to aid air circulation. Fresh air, dampered to suit climatic conditions, is introduced through openings in the machinery space. When the time comes to disconnect the container from its power source, these openings are closed by tight doors, so that you have, in effect, a very large package of frozen pineapple which will "hold" for some time (at least 8 hours) until it can again be given power.

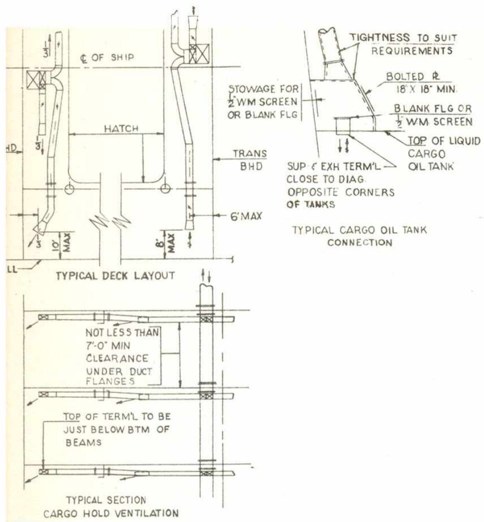
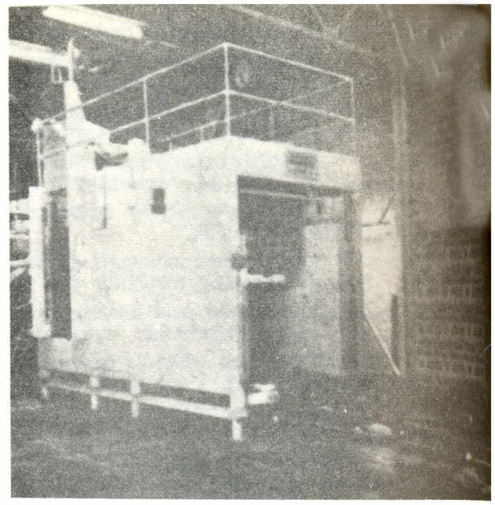
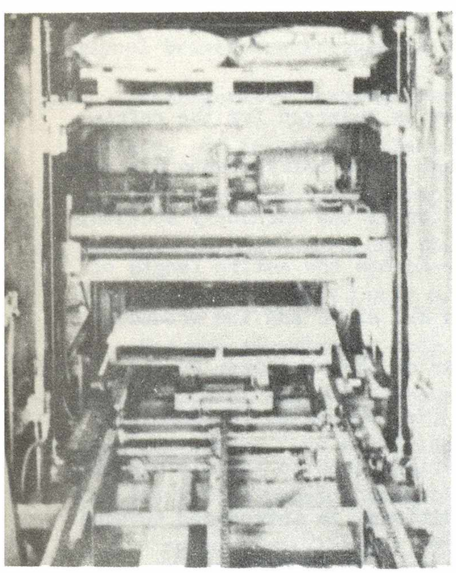


Fig 17



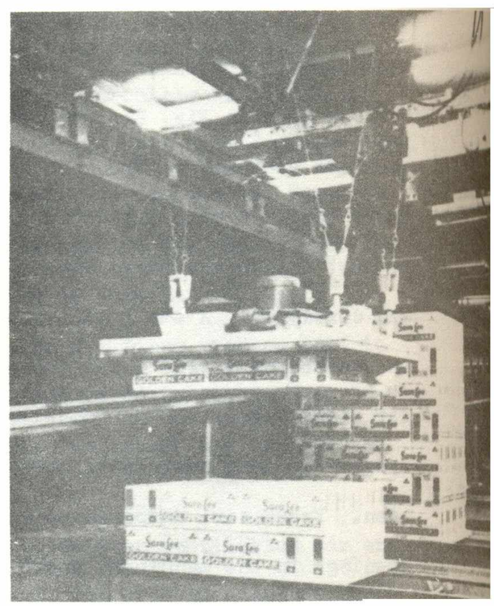
UNATTENDED AUTOMATIC palletizer dispatches loaded pallet of cased goods, toward shipping dock.

Fig 18



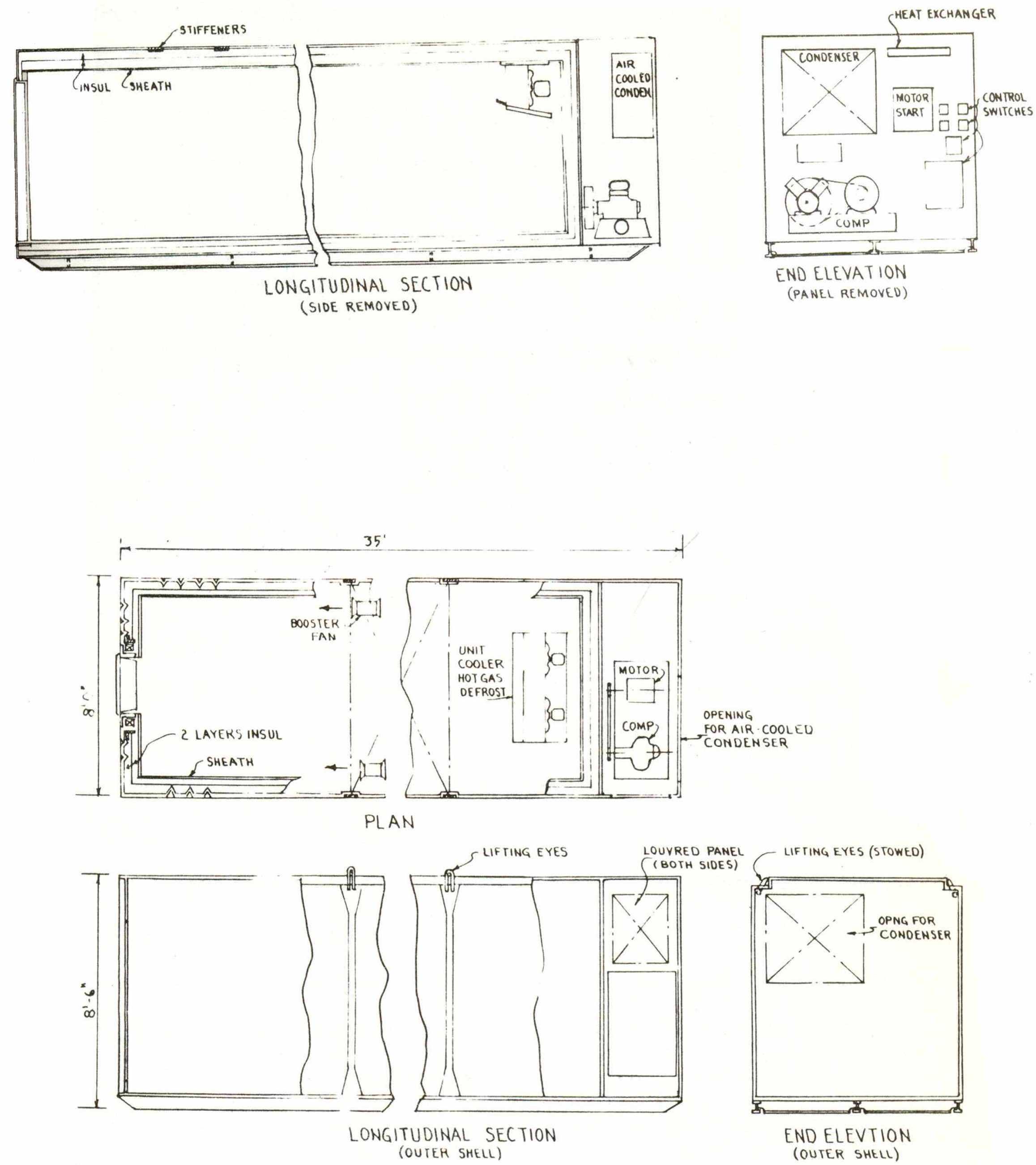
UPPER PALLET MOVES DOWNWARD as it is being loaded from above. Second pallet with sheet awaits turn to move into loading position.

Fig 19



MOBILE PALLETIZING EQUIPMENT stacks frozen baked goods in Chicago automated warehouse.

Fig 20



Special custom refrigerated container, designed for Grace Lines, by Bailey Refrigeration Co., Brooklyn, New York, U. S. A.

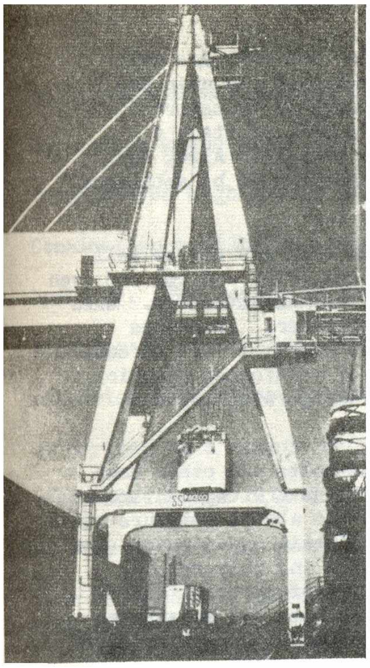
Let us assume, although it is geographically impossible, that our pineapple has been grown and frozen 200 miles from the nearest railroad terminal and that the rail depot is 1000 miles from the sea, and that overland road from rail to sea are non-existent or impassible.

My Hawaiian Pineapple, as we affectionately called her, is to be the ultimate carrier. Our particular containers are made of reinforced aluminum and are fitted with "notches" (lifting fittings) at the top so that the especially designed dock side cranes can pick than up much as you would use two pairs of ice tongs.

At the freezing plant a large truck chassis trailer arrives. The loading dock cranes drop the two loaded containers into position; they are connected to the power plant provided on the truck chassis and off they go.

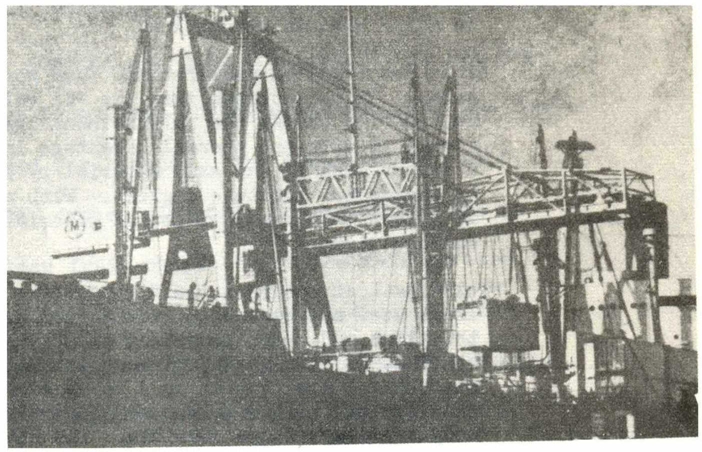
At the rail terminal, the fresh-air-intake doors are closed, the power is disconnected, the containers are lifted, perhaps simultaneously, to a piggy back rail car, connected to the power supply thereon, the intake doors to the machinery space are opened and off we go to the seaside port. I haven' t yet figured out how to disconnect the electrical plug and reconnect it without human assistance (The doors are easy, of course, as they are automatically closed when the current is cut); but somebody will.

A similar imaginary process takes place in the ship's port, except that the cranes there may accommodate a trainload of cars in one or two swings. (Figs. 22 and 23) After a rapid ocean voyage (perhaps in the future by surface effect craft) the pineapple arrives at its destination - London maybe? Here the processes are reversed and quickly the container arrives at the wholesale warehouse where it is unloaded and stored. As the distance is short, no refrigeration is required for this interval.



GOING ABOARD via huge new container loading crane at Enci nals Terminals in lamedo, Crane has 260 Ian dead-weight and was manufactured by Pacific Coast Engineering Co. Travelling crane is controlled by switches and handles 25 ton loads easily.

Fig. 22



EASING IT IN, big crane drops van gently to deck in exact position desired. Manoeuverability of crane and boom makes loading a high speed operation. At the same time, it improves safety conditions for both personnel and ship's superstructure. Note multiple cable rigging which gives load excellent.

Fig. 23

Perhaps the brand name on our pineapple 1s Birds Eye.If so, it will probably arrive here in Cambridge via a special new-type container. (Fig. 24) Here is a description from the November, 1964, issue of Transport (12)

> "An insulated and refrigerated vehicle is designed to maintain a subzero temperature for as long as possible. The main application at the present time is in frozen food or ice cream handling and it is worth mentioning that the United Kingdom consumes about #75 million, or nearly 200 ,000 tons of frozen food every year. Most of this is handled twice at sub-zero temperatures, once between the factory and the distribution center , and once between the distribution centre and the retail outlet. Birds Eye Foods have 6 factories and 45 distribution centres. The operate their own transport fleet for this part of the history and sub-contract the other part to S. P. D., and associate company. They have now become convinced of the merits of plastics integral construction and have bought revolutionary containers from Mickleover Transport Ltd. These containers use reinforced polyester skins and polyurethane insulation foamed in situ.

“The advantages of using reinforced plastics for the skin are well mown. There are no joints for moisture ingress and the skin has sufficient mechanical stability to prevent damage in transport environments. It does not rust or corrode and will maintain a reasonable surface finish for the life of the vehicle. Also, the pale self-co1our and smooth surface allows Birds Eye to be ambitious in their vehicle decoration.

“The advantages of polyurethane foam applied in situ are not as well known. It is accepted that the 'K' value is low (0.12 - 0.16) and even as inserted blocks the polyurethane foam has thermal advantage. When foamed in situ the thermal advantage is much greater. It offers a direct link to the skin material by adhesion and it is not affected by accidental moisture ingress. With a skin of reinforced plastics it offers the ideal structural material for refrigerated vehicle construction.

“This ideal structure is self-supporting so that bolts and other heat leaks need not be used. It will not distribute heat along or through the skins and, most important of all, it will not absorb moisture under conditions of frequent movement in changing climatic conditions. The theoretical superiority of a reinforced plastics and polyurethane sandwich has been realised for some time but 'proof by trial' has only recently become possible. The outcome has been the acceptance of the revolutionary construction by Birds Eye for both ran and road bulk handling.”

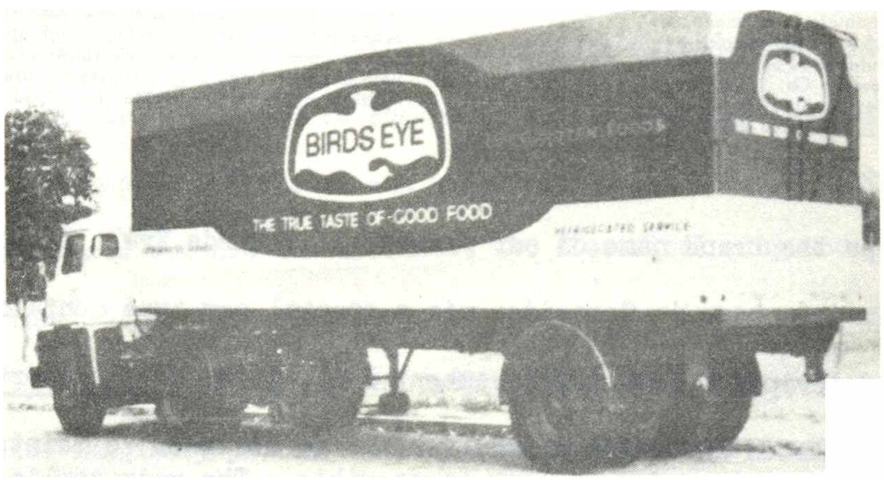


Fig. 24

Meantime, other consumers like the delicacy of fresh pineapple. How shall we cater to their tastes from the same remote plantation ? Like bananas, the fruit is picked before it is quite ripe. They are carefully crated in

boxes with air ports or slats to provide air circulation. These are loaded in a container with ventilation ports. Again we start the refrigeration system, but this time, we cool the air far less. Ventilation air (fresh air) is introduced and conditioned. Air flows around the fruit to prevent decay and remove gases given off by the product, at the same time maintaining temperatures high enough to prevent freezing but low enough for preservation. Combination cooling and reheating control not only the temperature but the humidity. The latter is important to prevent drying which can ruin the fruit. Ripening is controlled as described for bananas. The ocean journey will otherwise be similar to that of the frozen pineapple unless it happens to be carried on a modern refrigeration fruit ship. There the refrigerated cargo spaces are fitted with air duct bulkheads for positive circulation of conditioned air through all the cargo. Figs 15 and 25 show the arrange cent of cold air diffusers, air duct bulkheads and cargo.

CONCLUSION

In conclusion, ocean going transportation is being pushed economically. It is mandatory that rapid turn-around be accomplished; that ships travel quickly; that automation be utilized to cut down labor costs; that cooperation among the shipping companies of the world bring about standards or each company will be faced with providing all its own facilities at every port of call. The transportation and handling of food are among the most imperative reasons for accomplishing these goals.

It seems clear that, although tremendous advances have been made in the last few years, more needs to be done to produce the perfect all-purpose refrigerated container; and more research and testing are needed , to determine the ideal atmosphere for special cargoes. Eggs, lettuce, and bananas, for example, do not make happy bedfellows in the same container.

Meantime, it is deplorable that the over abundance of food in some areas of the world cannot be shipped at low cost to those who are starving.

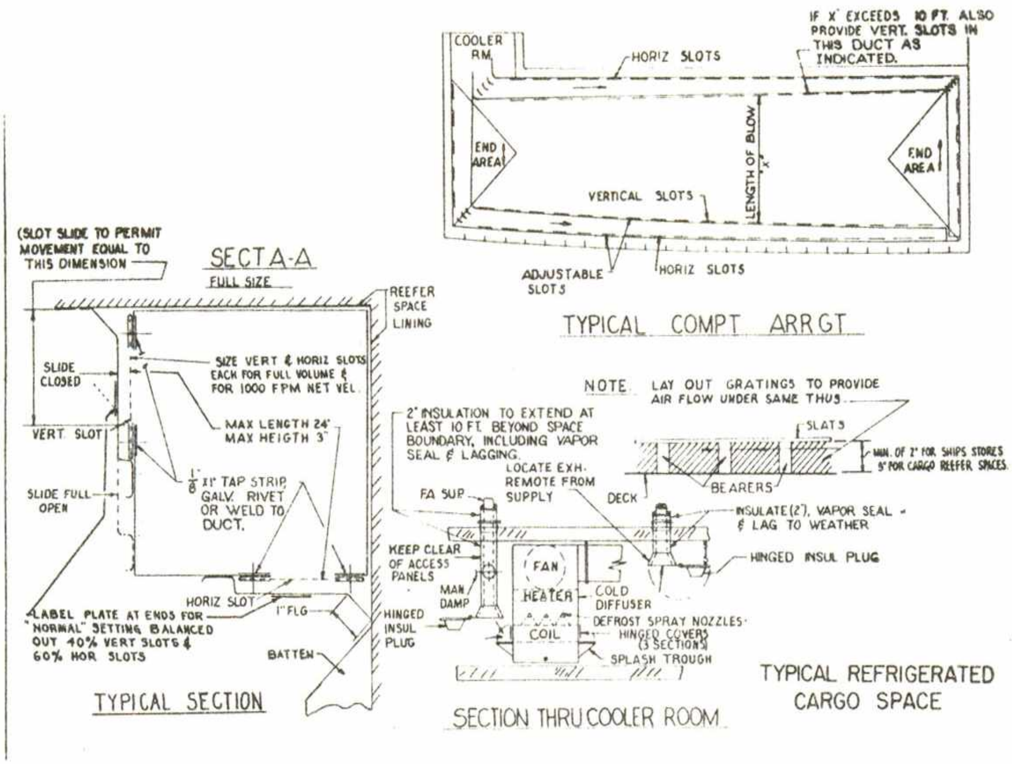


Fig 25

I should like to thank my friends in the Society of Women Engineers and my colleagues at Gibbs & Cox., Inc. for their patience in reading and suggesting. I am grateful to Mrs. Winifred D. Gifford, Exec. Secy of SWE, for her editorial help, and to Mr. Bailey, President of Bailey Refrigeration Co. for permission to use his special container design. Especially, I thank Mr. John W. Markert, Marine Engineer and Consultant with the U. S. Coast Guard, for his help and guidance in the technical areas of refrigeration on board ship.

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FOOD TRANSPORTATION BY A I R

By H.E. Russell

Miss Mary Ellen Russell received a B.S. and, M.S. from the University of Washington in Mathematics, Geology, Zoology and Education. She completed additional post-graduate work in Geology and Mathematics at the University of Washington and Statistics at Stanford University. From 1936-1942, she was a High School and Adu1t Education teacher of Science and Mathematics. In 1942, she joined the Boeing Company as a Flight Test Analyst and is now on the Electrodynamics Staff of the Commercial Airplane Group as a Research Engineer responsible for hyperbolic and satellite navigation. Miss Russell is an associate member of Sigma Xi and a member of Phi Sigma, Pi Lambda Theta, the American Association for the Advancement of Science, the American Astronomical Society, the American Association of University Women, the Air Force Association, the American Geophysical Union, the Institute of Electrical and Electronic Engineers and the Society of Women Engineers.

SUMMARY Air transport of cargo is a rapidly expanding industry. The jet age has widened the cargo market to include the shipment of food. Improvements in airplane design, operating efficiency and cargo handling have made it possible to dispatch food to disaster areas anywhere in the world or to rush fresh fruits, vegetables and other perishables to a distant market with no deterioration in quality. This paper will discuss market trends in food transportation by air now and in the future. It wi11 be shown how these trends are related to packaging and handling techniques, airplane and air terminal design and economics. Also, the influence of geography and the political climate will be indicated.

FOOD TRANSPORTATION BY AIR

By M.E. Russell

This is the air age Airplanes are popular and air transport is an expand in enterprise with a new technology. The speed and flexibility of the airplane, its ability to fly directly between any two points on the globe have created this new Industry.

The history of flight shows that commercial flying was begun as a means of transporting people and their personal baggage. Air mail service was added. Cargo was carried, only when space was available or where there was no other means of transportation. In times of crisis, food and other supplies might be rushed to a critical area by air. The American Red Cross used air drops by parachute from small planes to deliver food to families in disaster areas. Twenty years ago, airplanes began carrying cargo regularly, because a market existed for high value goods, small in size, light in weight, including perishable and exotic foods to fulfill the needs of a gourmet clientele.

The evolution from the propeller driven to the prop-jet and now the pure jet aircraft has given impetus to air cargo business. Today, though air freight is less than 1% of all freight, it has soared beyond all predictions; Scheduled airlines had an average annual growth rate of more than 15% from 1961 to 1965. In 1964, air freight registered a gain of 26.9% over 1963 and for the first 8 months of 1965 was up 33 1/2% over the same period in 1964. (ref. 2) The U.S. Department of Agriculture shows a 50% gain in 1965 in the use of air in transporting agricultural products. Before the recent strike, several major airlines, reported increases of 25-50% in perishable shipments in 1966 over 1965 figures. Figure 1 illustrates this growth.

FOOD TRANSPORTATION Table 1 is a representative list of foodstuffs being air lifted by carriers at this time. It should be noted that these perishables require special handling at the terminal and aboard the aircraft. Temperature, humidity and space must be controlled. Cold-temperature holding rooms at terminals assure that perishables reach their destination as fresh as where received. A limit of five hours in transit requires no particular care in many cases. Dry ice may be used to maintain low temperature. Perishables are moved quickly to de liver a high quality product and take advantage of early market changes. In addition, air transportation extends the shelf life of the food and reduces spoilage and waste. To ship live animals, each airline has established its own units of space per animal per unit time to ensure the cargo arriving in first class condition.

Some foodstuffs do not lend themselves to air transport. For example; only in uncommon circumstances would one fly potatoes, and wheat, except in the form of some of its processed derivatives, will probably always go by surface transport.

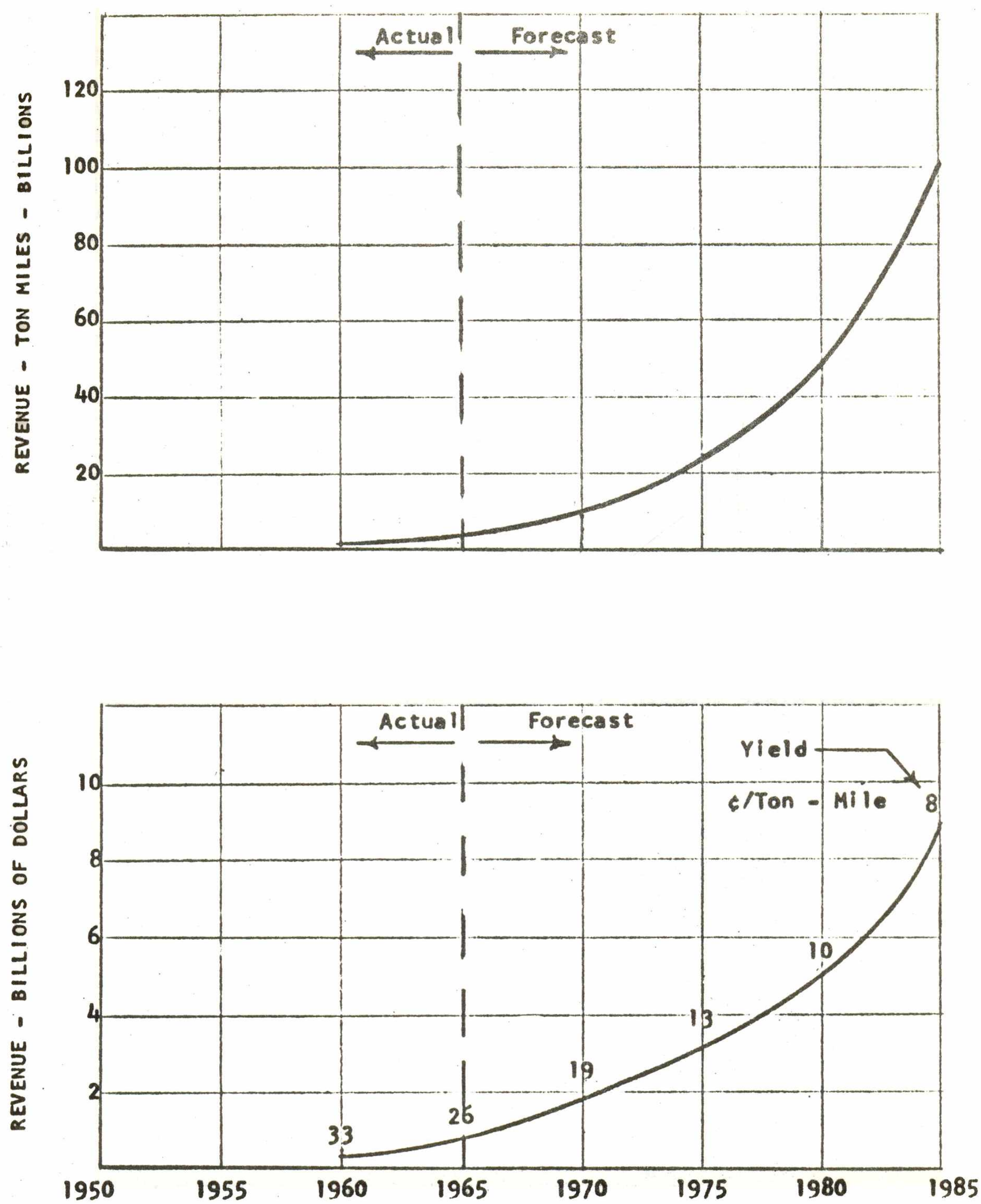


FIGURE 1 - WORLD CARGO FORECAST

FRUITS

apples	nectarines
apricots	oranges
bananas	papayas
cherries	peaches
figs	pears
grapes	persimmons
grapefruit	pineapple
mangoes	plums
melons	

BERRIES

blackberries	loganberries
boysenberries	strawberries
blueberries	youngberries
raspberries	

FRESH VEGETABLES

asparagus	tomatoes
avocados	zucchini
brussel sprouts	
kale	
lettuce and other greens	
mushrooms	

SEA FOOD

aba lone	oysters
clams	qahags
crab	shrimp
lobster	

LIVE ANIMALS

baby chicks
hatching eggs
beef catt1e
sheep

FISH (frozen and fresh)

halibut	tuna
whitefish	salmon
trout	

DAIRY PRODUCTS

milk (fresh and powdered)
eggs
cheese

MEAT AND POULTRY

Chickens and turkey (frozen and fresh)
fresh fryers
precut specialty meats (lamb, beef, pork)
bacon
sausage

MISCELLANEOUS

bread
jams and preserves
canned foods
kosher foods
nuts
yeast

TABLE 1 FOODSTUFF SHIPPED BY AIR

Hawaii's 1argest food chain, Food1and Super Market Ltd., regu1arly f1ies fresh poultry and pork (60,000 lbs. (27,200 kg.) weekly) from the United Hates mainland. The return shipment may be papayas and pineapple. Meat reaches the counter nine hours after leaving the packing plant, compared to seven days by ship. 20% of Trans World Airlines (TWA) cargo out of San Francisco is fresh fruits and vegetables. They expect to ship 35 to 40 million pounds of strawberries in 1967. Three-quarters of the tonnage sent by Pan American Airlines (PAA) from Seattle to Fairbanks, Alaska is foodstuff carried in the belly of passenger airplanes. One-third (600,000 lbs./ month) of this is fresh milk in cardboard containers selling at 50 to 55c a quart. Another third is perishables, lettuce, chives, tomatoes, greens and eggs and 10% is precut specialty meats, such as bacon and sausage. This represents 3 to 4 hours by air in contrast with 4 to 6 days surface route. PAA sends premium quality berries and fruit to Europe-strawberries to Frankfurt, Germany - Jumbo cherries sell for 90c a pound in Paris, France. North Africa exports by air to Europe and Mexico. Between January and March 1966, U.S. importers brought in from Venezuela by air, 505 tons of bananas and plantains, 202 tons of shellfish, 137 tons of fish in airtight containers. The Flying Tiger Line, with all cargo domestic service increased its ton mile cargo service from 219 million to 308 million this year. They served eleven states in the U.S.A. with 21 aircraft and had over 45 million dol1ars operating revenue in the 12 months ending with August 1966.

The International Red Cross and other relief agencies take advantage of the speed and mobility of aircraft to distribute food and other supplies to disaster areas. Their relief shipments flown to Florence, Italy from North America were mostly clothing, blankets and drugs. The American Red Cross now uses air drops from helicopters supplied by the military services to distribute food to disaster areas. In Alaska, the distances are too great to use helicopters. Air drops are made by small planes, flying low at slow speed. These planes are provided by the Civil Air Patrol, and Navy parachutes are used, to minimize damage to the air dropped packages.

<u>AIRPLANES AND ECONOMICS</u> Air transport has been and is a high-cost medium. Costs per ton / mile are “high” In comparison with surface transport, but the availability of surface links is not the same In any two areas. What may be true for the dense sea network of the North Atlantic or the road and rail networks of Western Europe and the United States is certainly not true for the Southern Continents, most of Asia, Alaska and northern Canada. It is necessary to consider what alternatives exist in each region and compare costs.

Many factors have produced the present rate of growth and will help or hinder the development of air cargo. The factors which effect all air cargo effect the shipment of food. The aircraft designer, the airlines, the airport operation, world geography, the politics of the country or countries Involved, all control the economics of air cargo.

Operating costs vary with the type of aircraft and the distance it flies, Some planes are more suited to short range than long range work. For each aircraft type there is a distance over which it can be most economically operated. If operated beyond this distance it must sacrifice cargo for fuel. Increased landing costs and a reduction in speed from runway to runway are the penalty of shorter flights. The costs involved in air transport may be divided into "fixed" costs which are incurred whether the machines operate or not and the "variable" or "operational" costs. Fixed costs include not only the costs of regular maintenance, ground installations, offices, crew and office salaries, insurance, advertising, etc.; but also the capital depreciation on the aircraft. This latter is a high one as the planes are normally written off in a short period e.g. 7-10 years in the U.S.A., sometimes longer in Europe. Operating costs depend on hours flown and involve fuel, additional maintenance (essential for a high utilization rate) and costs incurred at each takeoff and landing, such as landing fees. Landing fees can become very high where short distances are being flown. Maintenance alone is 10% of costs.

The manufacturer designs the aircraft to minimize all these costs. He must also work with the airlines to fulfill their needs. There is no use operating the aircraft if there is no market for its services. This may entail foreseeing the market and in many cases developing a market. Here the market analyst plays an important role. Earning capacity is based on revenue miles, therefore the faster one flies the greater revenue one can earn. This is why the fast jet can be successfully operated and implies a possible future in cargo transport for supersonic planes. Table 2 lists a representative group of cargo aircraft and some of their characteristics. They are now in operation or will be in the next decade.

United Airlines makes use of the Boeing 727QC, the quick change airplane, figure 2, to implement their overnight service to the East Coast. The 727QC was a joint development of United Airlines and the Boeing Company. Additional inputs came from Braniff Airlines. It can be changed from a first class passenger interior into a stripped metal -Flored cargo interior in 20 minutes. This is done by having the entire passenger interior, including seats, galley, etc. located on pallets similar to cargo pallets which are inserted on a specially designed low profile anti-rattle cargo transfer system. The QC type aircraft is expected to provide the operator with a potential profit increase of 30 to 40% over a similar plane in the passenger-only configuration. For short range routes as flown by the 727 this represents eight hours flown during the day in the basic passenger configuration supplemented by a three and one-half hour night cargo operation. Table 3, from United Airlines, illustrates shipping rates for seafood, fruits and berries, and is representative of overnight service to early-morning markets.

PACKAGING The facilities and associated supporting systems for the ground handling of air cargo are as important as the aircraft itself. While on the ground the large modern cargo transport incurs fixed costs at the rate of $300 to $400 an hour. In flight it has potential revenue of the order of $2500 an hour. Efficient storage and loading facilities and techniques are mandatory.

AIRCRAFT	Vertol 114 CH 47A Chinook	Prestwick Pioneer	De Havi11 and DH C-4A Caribou	Transall C-160	Boeing 727C
ENG I NES no.	2 shaft-turbine Lycoming (helicopter)	1 prop Leonidas	2 prop. P&W	2 turbo-prop RTY.22	3 turbo-fan P&W JT&D
Thrust /or PR / eng.	2650 shp	520/540 hp	1450 hp	6100 eshp	14,000 Ibs.
TAKEOFF GROSS WT. 1bs. kg.	33,000 14,970	5800 2630	28,500 12,930	90,400 41 ,000	170,000 77 ,000
CRUISE SPEED mph. kmph.	150 240	140 230	220 350	310 510	580 930
PAYLOAD (max) 1 bs. kg.	10,370 4700	1000 453	8740 3970	35,270 16,000	47 , 000 21 .300
RANGE m. km.	230 370	300 480	240 390	1070 1720	1725 2780
PAY LOAD(max) lbs. kg.	6290 2850			17.640 8000	35,000 15,900
RANGE m. km.	230 370			3020 4850	2880 4600
FIELD LENGTH at max. G. W. ft. m.	0 0	600 180	1200 360	2500 760	7000 2130
COMPARAT I VE DIRECT OPERATING COAST*					1.3

* Based on 1.0 for today's standard jet freighter 707 / DC-8

TABLE 2 CARGO AIRCRAFT

AI RCRAFT	LOCKHEED L-l00 (C-30)	BOEING 707-320C or DOUGLAS DC-8F	ANTONOV AN 22	LOCKHEED L- 500 (C-5A)	BOEING 747F
ENGINES no. Thrust /or PR / eng	4 turbo prop Allison 4900 eshp	4 turbo fan P& w JT 3D 18,000 lb	4 turbo Prop Kutnetsov 15,000 shp	4turbo fan G.E 41,000 lb	4 turbo fan P& W JT9D 42,000 lb
TAKE OFF GROSS Wt 1bs Kg	155,000 70,000	300,000 227,000	500,000 227,000	720,000 326,000	680,000 308,000
CRUISE SPEED mph kmph	350 560	560 900	400 640	510 820	600 970
PAYLOAD (max) 1 bs kg	45,000 20,400	90,000 41,000	175,000 79,000	220,000 99,800	220,000 99,800
RANGE mi km	2300 3700	3220 5180	1725 2780	3220 5180	2500 4025
PAYLAND 1bs Kg	35,000 15,900	60,000 27,000	75,000 34,000	140,000 63,500	120,000 54,000
RANGE mi km	2880 4600	5180 8300	5180 8300	5180 8300	5180 8300
FIELD LENGTH at max G.W ft m	6000 1800	10,500 3200	6000 1800	9500 2900	10,000 3000
COMPARATIVE DIRECT OPERATING COAST *	1.7	1.0	0.80	.63	.65

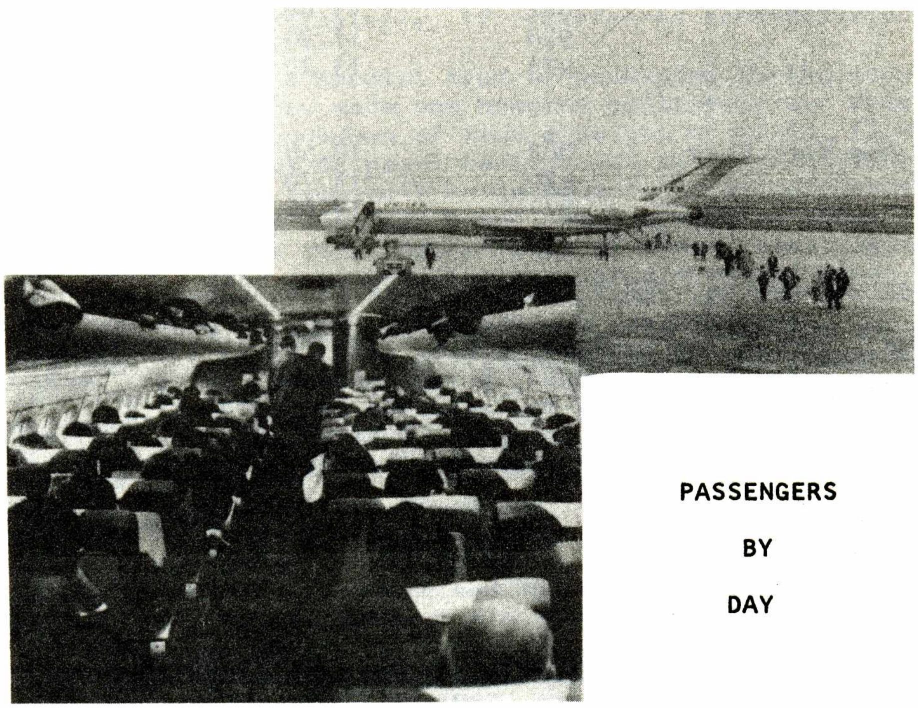
* Based on 1.0 for today's standard jet freighter 707 / DC-8

TABLE 2 (cont.) CARGO AIRCRAFT

CARGO

AT

NIGHT



PASSENGERS

BY

DAY

FIGURE 2 - BOEING 727 QC

From	To	COMMODITY GROUP	RATES IN U.S. DOLLARS PER 100 POUNDS 100	1000	2000
Seattle	Baltimore	802	11.10	11.10	9.60
		920	13.60	12.10	9.60
		921	15.00	15.00	12.00
	Boston	802	12.00	12.00	10.50
		920	14.50	13.00	10.50
		921	16.80	16.80	13.40
	Chicago	802	8.75	8.75	7.50
		920	9.60	8.90	7.50
		921	11.30	11.30	9.05
	Cleveland	802	13.00	11.50	9.00
		920	11.30	10. 20	8.25
		921	13.20	13.00	10.60
	New York City	802	10.50	10.50	9.00
		920	13.70	13.70	9.00
		921	15.B5	15.85	12.65

Group No. 802 --- Fruits, fresh, edible, namely: blackberries, boysenberries, raspberries, youngberries, figs, padayas and cherries.
Group No. 920 --- Fish and Seafood, N.E.S. (applies to fish in any form, and to canned, cooked, dried, pickled, salted, smoked, or otherwise preserved mollusks and crustaceans.).
Group No. 921 ---Clams, Crabs, Lobsters, Oysters, Shrimp, Scallops (applies to fresh or frozen clams, crabs, lobsters, oysters, shrimp and scallops.)

(from United Air1ines)

TABLE 3. TYPICAL SHIPPING RATES FOR PERISHABLES

Containerization and palletinization have been the cargo carriers answer to a part of the problem. Such packaging reduces terminal and ramp loading costs, and claims from damage and pilferage can be more easily controlled. The volume shipper can reduce his costs 10 to 15% when he does the loading.

The pallet is a portable platform of wood, metal or other material designed for handling, storage, or movement of materials and packages in warehouses, factories, or transport vehicles. Some perishables in the U.S.A. are shipped in containers referred to as "igloos" or "hula huts". The perishables are placed on flat fiberglass pallets and covered with dome-shaped tops, which can be loaded or unloaded mechanically. The average jet freighter can be fil1ed or emptied in about 20 minutes, using combination roller bed mechanized units, to handle the pallets.

Containers, generally made of corrugated and solid fiberboard, allow a substantial increase in the average weight of shipments, reduce packaging costs and allow the shipper to unitize individual packages into a single unit. Ground and aircraft handling for loading and unloading is minimized while the quantity of airline documentation is reduced. Containerized freight moves with greater speed, requires less labeling and packaging than shipments of individual packages, particularly, if transferred from one aircraft to another.

The Red Cross used a special type of packaging during recent floods in northern California. They made one hundred helicopter air drops of food to isolated families, by touchdown or from a height of 11 ft. (3.4 m.) or less. All food in glass bottles or paper cartons was put in plastic bags. Crumpled paper packed around the foodstuff in cardboard cartons prevented breakage. Each carton, weighing 30 Ibs. (13.6 kg), was bound with steel tape and placed in a burlap bag. A drop consisted of four of these boxes containing coffee, tea,-sugar, flour, tang (orange juice) powdered milk and other foods.

International Air Transport (IATA) first introduced a containerization program in 1963. More than 150 different types of air freight containers were authorized from 12 cu ft. (1/3 cu.m) to 180 cu. ft. (5 cu. m.) capacity, some are reusable, some incorporate a pallet as an integral part of the container, some are contoured to the aircraft shape, the majority are for general merchandise, others for specialized purposes. With larger jet freighters the IATA containers Board has introduced 12 standard sizes ranging from 61.75 cu. ft. (1.75 cu. m.) or more, to take maximum advantage of aircraft space. They range from 41 to 84 in. (105 to 259 cm.) in length, 41 to 119 in. (105 to 303 cm.) in width and 45 to 76 in. (115 to 193 cm.) in height. They have also established maximum floor loading requirements to be 200 pounds per sq. ft. (0. I kg. per sq. cm.) of floor bearing surface and dynamic and static compression test loading criteria for each size. These standards will become mandatory on September 1, 1967. Shippers receive a discount of 10 to 15% on normal freight, if they make use of containers registered under IATA.

Fruehauf has developed a new and versatile container system for speedy and efficient door to door delivery. Ca11ed “Couplable Container System”, it involves two containers 20 ft. x 8 ft. x 8 ft. (6.1 m. x 2.4 m. x 2.4 m.). They offer efficient shipment of goods via steamship, road, rail and air and can be operated over a road as 40 ft. (12.2 m.) highway trailers or loaded on flatcars or stacked for air transport In either 20 (6.1) or 40 ft. (12.2 m.) lengths.

Figure 3 illustrates three types of air cargo, the piece cargo, palletized cargo enclosed in nets and containerized cargo. Some of the latter may also be palletized. Plastic covers are often part of the loading and material handling system to keep shipments dry.

The design of warehouse and loading facilities must be linked to the aircraft to be serviced. Figure 4 shows various loading entrances for airplanes. At small terminals, fork lifts and tractors can readily service small jets. Figures 5 and 6 give a number of concepts suggested and In use for loading and unloading into a warehouse with transfer to truck or train. At airports near water, the cargo could be readily transferred to a ship. In the United States, the Flying Tiger (all cargo) line has integrated its cargo service into rail, truck and steamship transportation.

AIR TERMINALS Air terminals (ref. 9) are classified as 1. origination and destination terminals, 2. hub terminals , 3. transit terminals and 4. special purpose terminals. Origination and destination terminals in the U.S.A. are mainly located on the Eastern, Western and Gulf Seaboards and handle international trade as well as domestic cargo. They make provision for customs, quarantine and other necessary agencies. Abroad, London, Calcutta and Tokyo, and in the U.S.A., New York, Seattle, Anchorage and Honolulu are representative of this group.

Hub terminals are at the center of an industrial district and the flow of cargo moves to and from the terminal in all directions. Here will be found processed foodstuffs to be shipped and also the transshipment of perishables between aircraft of the same type or different types, or from the main compartment to the belly compartment of the airplane and vice versa. Procedures must be flexible in order to meet a11 these situations which may also involve international cargos. Paris, Cairo, Teheran and Chicago are good examples.

Transit terminals are the most numerous, and combine the services of the two previously discussed, but seldom engage in international operations. They are served by the large cargo transports on multi-stop runs and by smaller short range transports. The terminal handles less than plane load lot cargo which may not be unitized unless large shipments are made.

Special purpose terminals include seasonal terminals, single purpose or commodity terminals and knock-down transportable terminals. Seasonal terminals have been rarely used, but with increasing airborne distribution of fresh fruit and vegetables, the need for such facilities will grow. They will be located in agricultural areas from where their products can be airlifted to

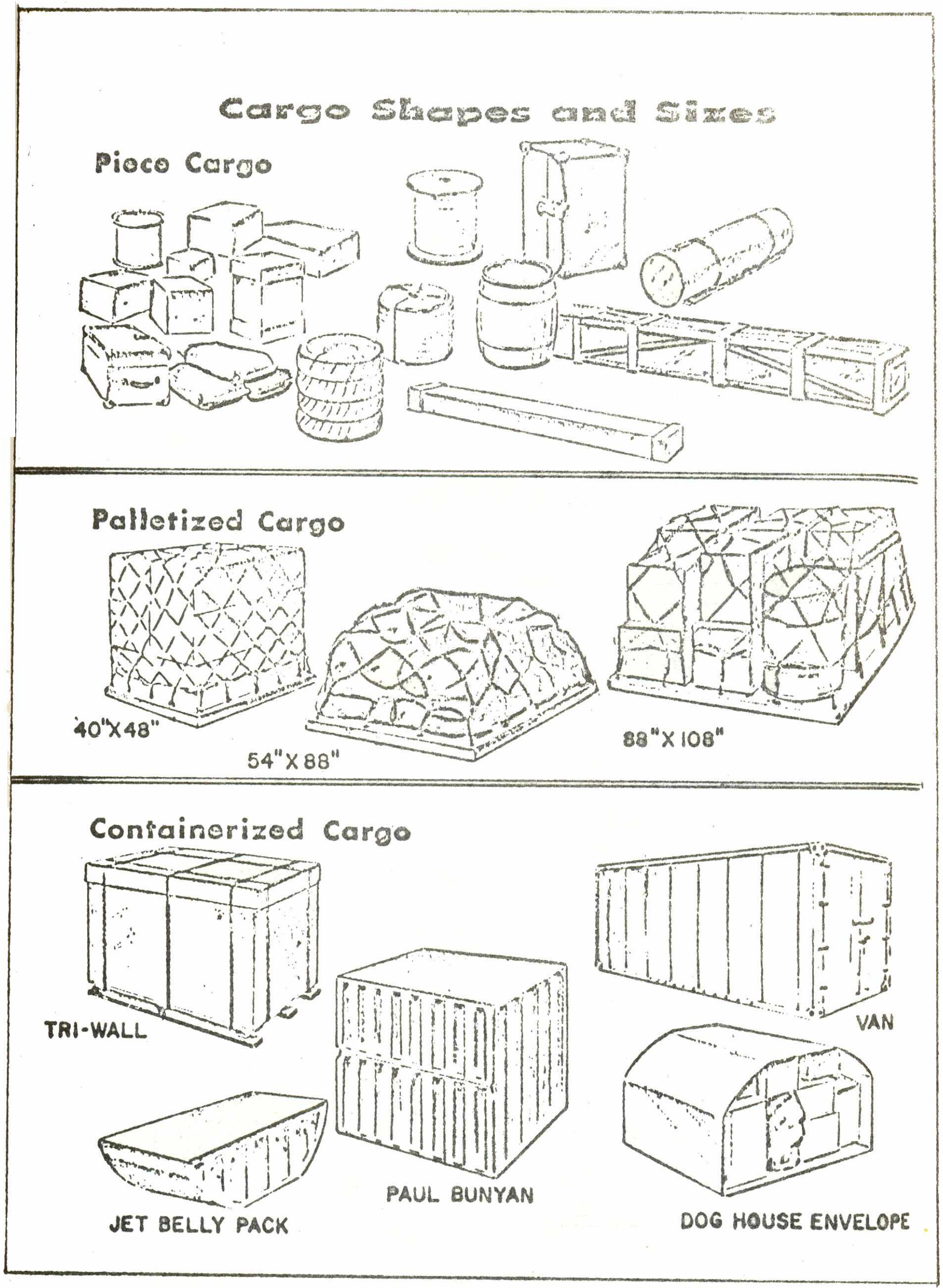


FIGURE 3 (From ref. 9.)

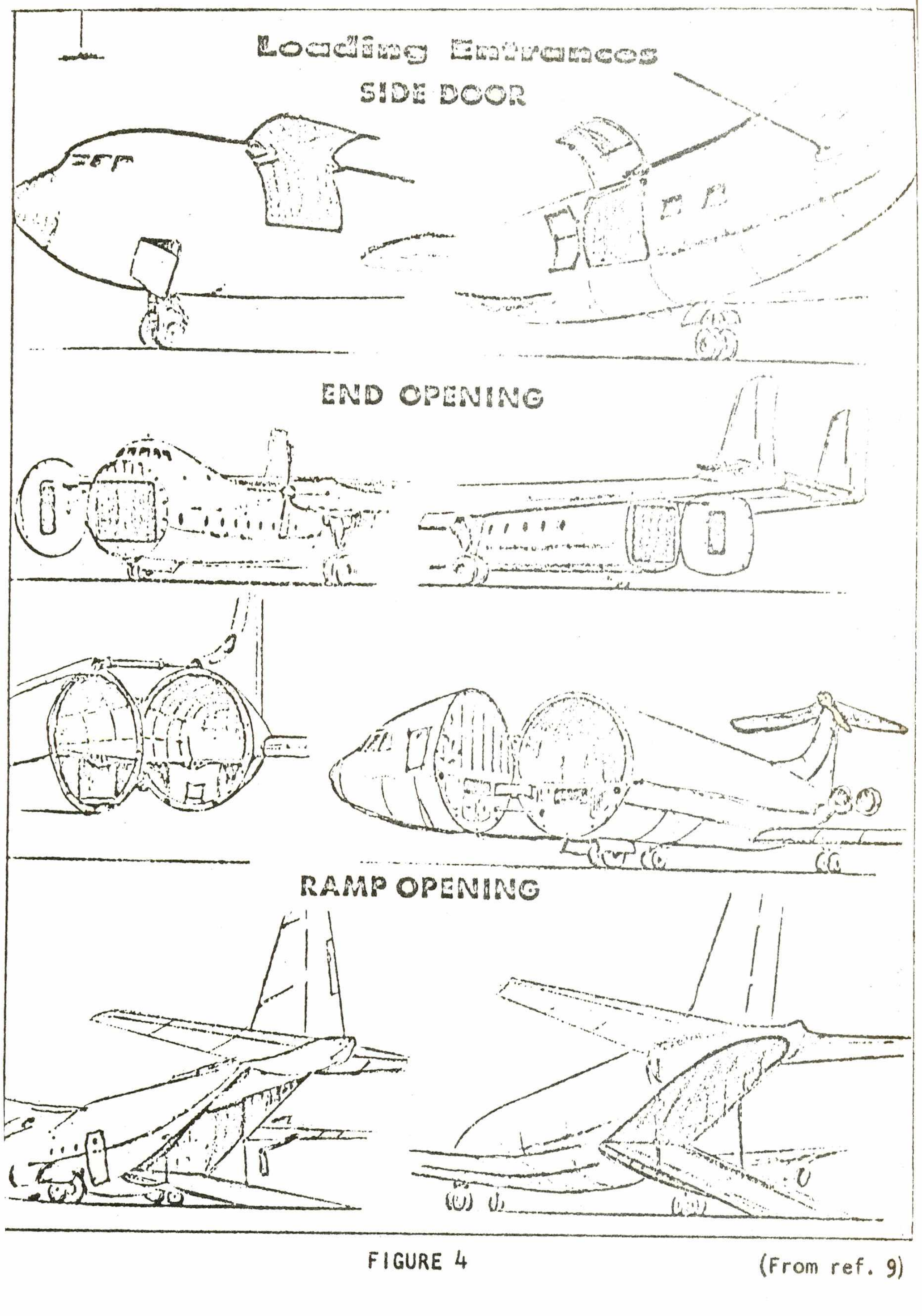


FIGURE 4 (From ref. 9)

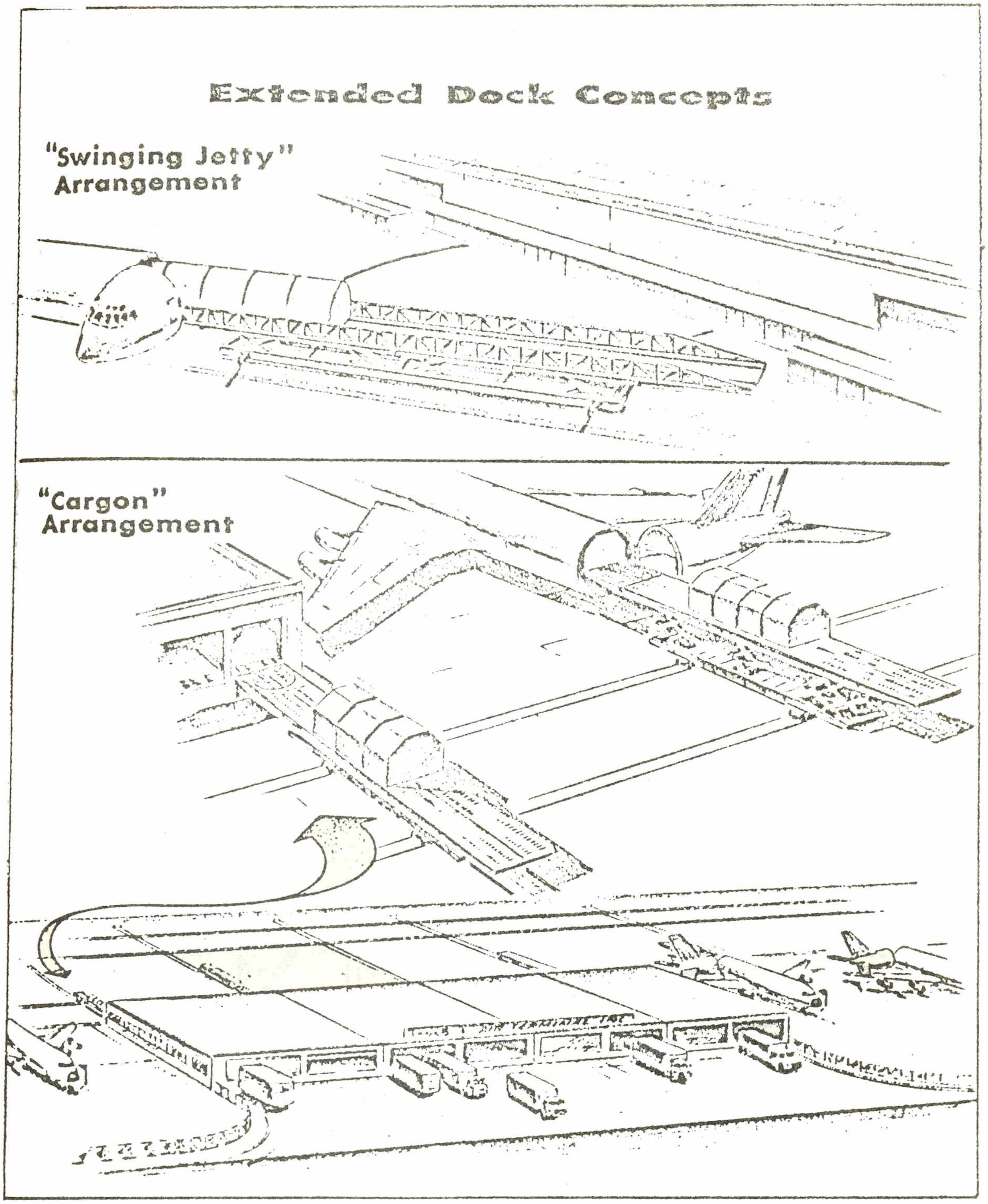


FIGURE 5 (From ref. 9)

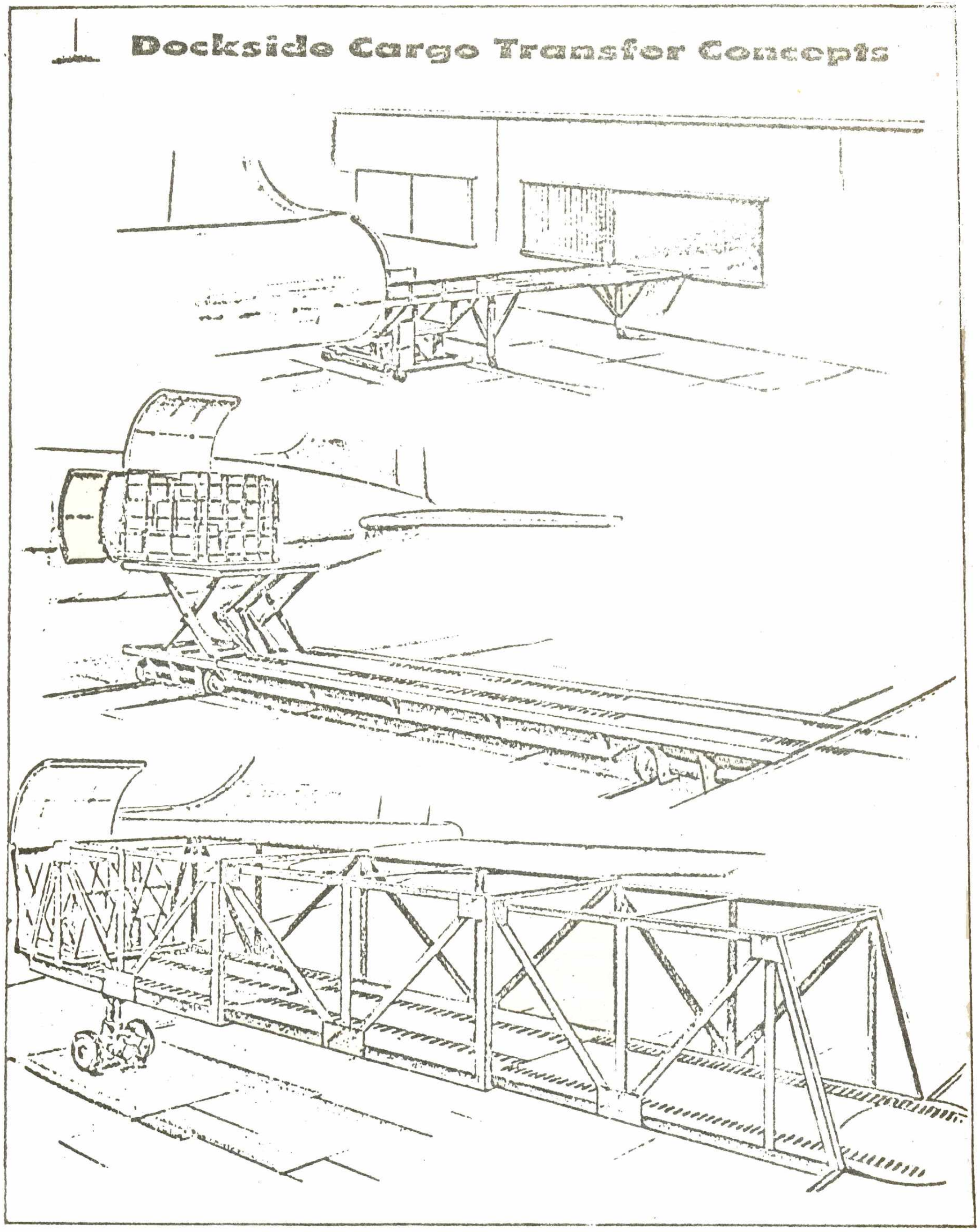


FIGURE 6 (From ref. 9)

appropriate markets within hours of harvesting. Airlifting of California fresh fruits and berries to the East Coast and also to European markets illustrates the success of this endeavor. Single purpose terminals have limited application. However, Australian National Airways airlifts processed beef from inland areas 300 miles to coastal points and Hawaii has an intraisland airlift system for distribution of its processed commodities.

Knock-down air transportab1e terminals are the answer to the needs of the developing territories of the world. During the early stages of opening up such areas, these terminals can be used until 1oca1 resources can be obtained for building permanent facilities. In the event that lower tariffs increase the number of foodstuffs with lower market value which can be carried by air, a new type of air cargo service to outlying areas could be inaugurated. It would then be convenient and profitable to carry a knock-down air transportable terminal as part of the cargo transport's auxi1iary equipment. It is also of value in temporari1y expanding the facilities of an existing terminal.

Figures 7 and 8 illustrate two extremes of the many types of air terminal. Figure 7 shows a highly automated termina1 used by the Flying Tiger Line in Chicago, which handles 140,000 pounds (63,500 kg.) of freight per hour. It also incorporates the two-level concept to minimize/on space. Figure 8 illustrates the modular terminal concept. Custom built structures for air terminals can be expensive. The Building industry has a large inventory of prefabricated building components, especially adaptable for warehouse and freight terminals. An air cargo terminal lends itself to this very well and also to the modular approach. Ten truck loading positions and five aircraft loading positions could be related to one module or building. As freight volume increased a second and third block could be included. A refrigerated area for foodstuffs could be incorporated into each module or shared between several depending upon the specific handling arrangement.

The logistics of cargo-handling has become very complex, particularly where there are one-way or only partial cargo loads available. Often it takes a longer time to clear the red tape and paperwork than the total air travel time. The use of computers, standardization of paperwork and containerization can considerably reduce freight costs.

GEOGRAPHIC SIGNIFICANCE The importance of location hinges on the unequal distribution of resources and population as well as the unequal development of knowledge among men on how to use material resources. Ideally, each area should produce what best it can. Trade will develop with other areas only if the price of the goods is sufficient to cover the cost of transport between them. Four vital assets of the airplane minimize this cost, 1. trans-shipment of cargo at coastal ports is avoided, 2. speed of travel implies a saving in time and also distance since the route is more direct, 3, air travel needs no road or track, in difficult terrain, roads and railways can be an almost prohibitive project, 4. special packaging by air is usually simple and less expensive .

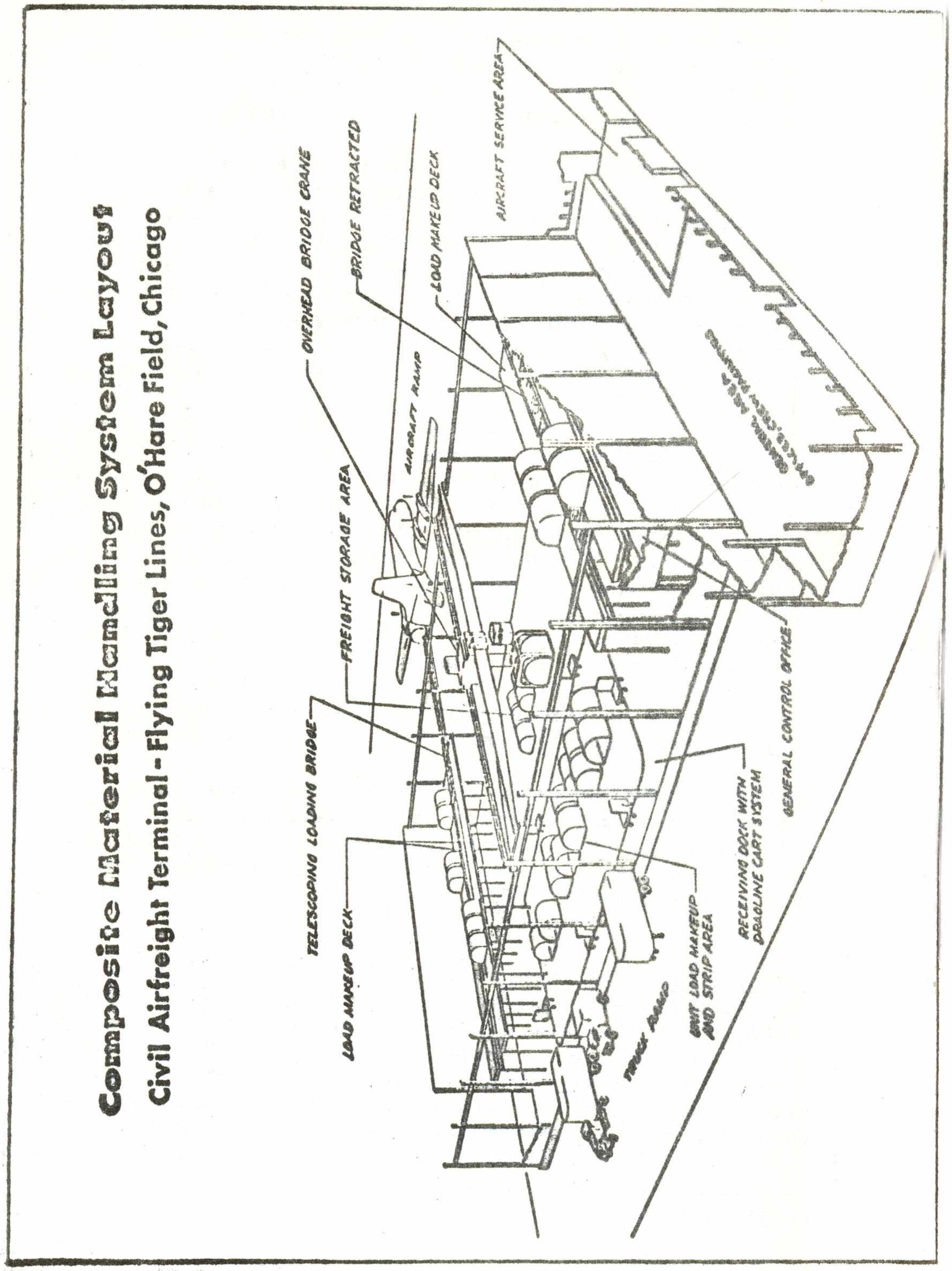


FIGURE 7

(From ref. 9)

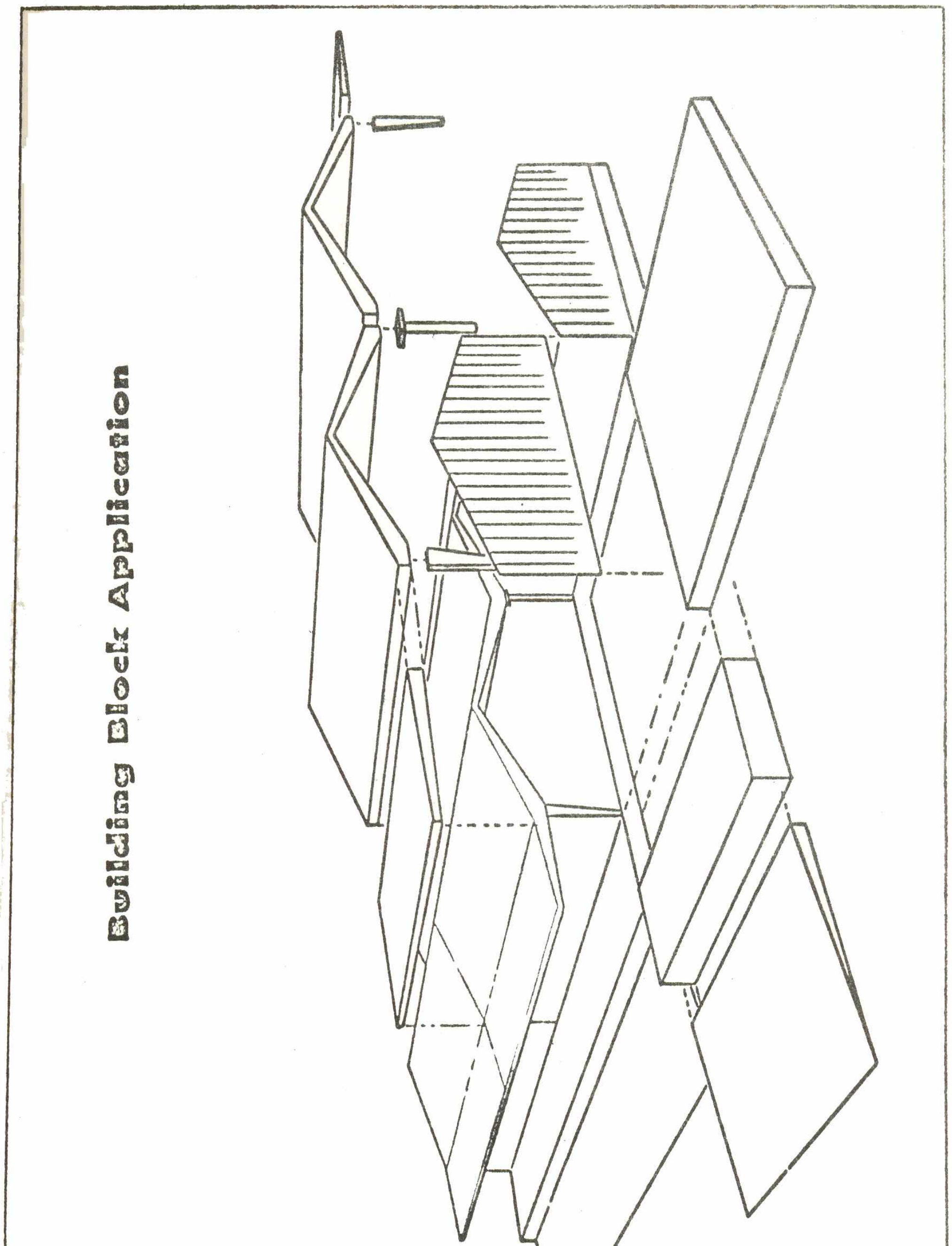


FIGURE 8 (From ref. 9)

The earth's surface features effect the airplane in the vicinity of airfields and during actual transit. Relief influences the high flying jet slightly. Very high mountains - the Himalayas- effect weather conditions and could be a deterrent. Altitude can influence the location of airports, and is an important consideration in the case of plateau sites as in East Africa. For airfields located at altitudes above approximately 200 feet above mean sea level, the fall-off in aircraft performance at take-off can mean a reduction in the possible load that can be carried.

Weather, for example, snow in Chicago this past winter and fog in London and Seattle, can close airports for hours or days and disrupt food shipment, particularly perishable foodstuff. Alternative airfields and routes may be necessary to off-set these conditions. In an emergency. helicopters, small planes with skis for snow, or air drops from larger planes may solve the problem. Blind landing aids and many more sophisticated electronic navigation and landing devices will reduce the number of air field closures. Visibility is more important near airports where traffic is concentrated. Take-off and landing are still the most vulnerable aspects of flight.

Weather influences the choice of route. It need not be considered a hazard. Routes may be chosen to take advantage of particular wind circulations and a longer traverse that makes use of pressure and wind conditions to aid the passage may be the most economical in the end. Temperature changes may also effect the range of aircraft. In one instance, a headwind component (50 knots) / on a long flight (1500 naut. mi.) reduced range by one or two hundred nautical miles, while an increase in temperature of l5ºC reduced range approximately 30 nautical miles. Storms must be avoided and the jets must bypass Clear Air Turbulence (CAT). In order to do this, weather reporting and devices to recognize CAT are being studied in the development of the supersonic planes, the Concorde, the Tupolev TU-144 and the United States Supersonic Transport (SST).

A thorough analysis of seasonal and daily climatic data relating to temperature, pressure and wind in order to predict total flying weather per year per given area, should be made for each airport and its alternate emergency field. In the future, weather satellites may be invaluable in both long range and hour by hour forecasting.

POLITICAL CONSIDERATIONS International air transport operates mainly through 295 bilateral agreements between political states. A nation's frontiers are now 3-dimensional and each state controls the air-space above it. How much longer national self-interest will hinder free air traffic remains to be seen. The joint operation of the Scandinavian Airlines System by Norway, Sweden and Denmark seems a step in the right direction. The Common Market can be an important factor. Such international bodies as the International Civil Aviation Organization (ICAO) and IATA can contribute much toward alleviating the situation, by the promotion of adequate, economic and efficient air cargo services at reasonable charges, and by the prolliotion of competition to the extent necessary to assure the sound development of the air transportation system.

Australia. Britain. Canada and India among others maintain public ownership of airlines. In the U.S.A., public ownership has never been seriously considered for the airline industry, but the National government has been very much concerned with the airlines' problems. As regulator of the air transport industry In the U.S.A., the Civil Aeronautics Board (CAB), has had to concern itself with route allocation, mergers, the shares of traffic carried by different classes of airlines, subsidies, quality of service, and the effects competition on the airlines and on the traveling public. This is done in an atmosphere of controversy generated by conflicting interest groups. Corresponding to the CAB, the regulatory authorities in Australia and Britain find their task more difficult because the industries they regulate are divided between public and private ownership. In Canada, the regulatory authority, the Air Transport Board, with a small staff, must hear, applications for domestic routes and assist in the preparation and presentation of Canada's case in negotiations with foreign countries over air traffic agreements. In India, the, Planning Department, with its head a member of the Board of Management, prepares material for the negotiation of air agreements with foreign countries and schedules the fleet for maximum aircraft utilization.

The regulatory authorities in Australia, Britain, Canada and the U.S.A. must determine how much and what kind of competition there should be in the air transport industry. The nature of the problem changes as the size of aircraft, their speed and cost increase. Competition in domestic aviation has advantages in terms of the public relations of the air lines, and political advantages in as much as it leads to the disclosure of information and promotes open policy discussion and debate. In negotiations with foreign countries, it has proven easier for a countries representatives to bargain for traffic rights for a single flag-carrier rather than for two or more. Again, if more ten one airline is competing in international aviation it is better from the negotiator's point of view, if the route pattern is neatly divided among the airlines without overlapping.

It bears repetition to say that a concerted effort by all regulatory bodies; national or international, to modernize customs clearance procedures and reduce tariffs, would give impetus to the air cargo market and expand the transport of foodstuffs with lower market value to the areas where they are most needed.

THE FUTURE The further growth of food transportation by air is Limited, only by the imagination and ingenuity of the men and women who design and operate the aircraft and air terminals. Jumbo jets, like the Boeing 747, figure 9, will lead to cheaper cargo rates and a capability of hand ling larger loads. The 747 in the combination convertible model, is designed to carry 490 passengers plus their baggage or 202,400 pounds (91,809 kg.) of cargo, as well as several different combinations of cargo and passenger arrangements. Special docking and terminal facilities, as shown in figure 9, will expedite load i n9 and un loading

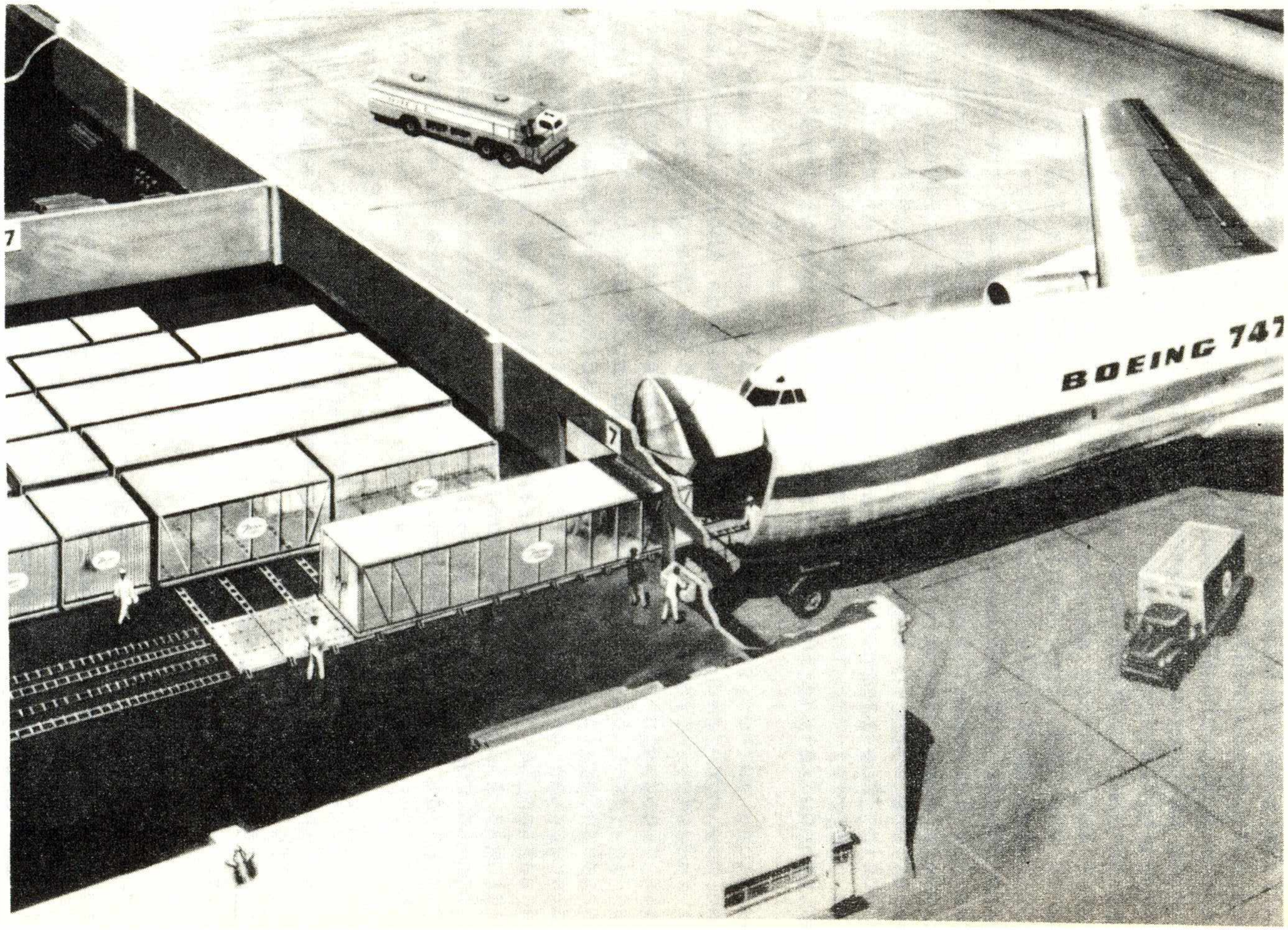


FIGURE 9 BOEING 747 LOADING

Expanding markets for perishables, canned goods and the use of techniques such as drying, powdering, freeze drying and irradiation of meats, grains, vegetables and fruits will produce food with less weight and bulk, which can be shipped by air economically. Figure 1, page 3, gives predictions of future cargo yields, which may be achievable in the time periods noted. These are averages based on a complex tariff structure. Can they be improved? If so, marked economic gains will take place in air transportation of food. Formerly inaccessible areas will be open to trade. People will be provided the food they need and in turn have markets for the goods they produce.

The sociological effects of rapidly expanding passenger air traffic has been apparent in the past twenty years. The world has shrunk, ignorance of our neighbors has become less likely, and with it misunderstandings and strife less probable. As air cargo grows, just as passenger traffic did in the past; this growth will be recognized as a force for world peace. This force will be most effective,in the transportation of food by air.

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The Application of Technology - Distribution

DISCUSSION

B. Özgüner (Turkey)

I am teaching some of our students packaging, and I would like to ask Miss Salembier whether she would recommend a short course on packaging and where I could write for more information on the subject.

O. Salembier (U.S.A.)

A short course in your University would be very much in line with what has been dons in the American Universities. It is only about four or five years since we had our first full packaging engineering course in any university in the USA, when the University of Michigan took this project on. We are now beginning to get packaging engineering in other universities, but engineers with a degree in packaging engineering are still quite new. In the last 15 to 20 years, our work in the training of packaging engineers has been primarily by short courses in cooperation with a university when industrial packaging people have come in and acted as lecturers. We started with a course at a new university where members of industry and government, who were interested in packaging, campussed at the university for about one month. This has now been out down to a shorter course of two weeks. Other universities have done the same thing. In our annual packaging and handling convention, we always work with the university in the city in which we are located and we have a one week short course, mornings only, during this time.

K. Chandrasekhar (India)

I am interested in the antiseptic method of packing milk referred to by the first speaker. Would the antiseptics used affect the quality of the milk and would it be safe to feed children such milk.

O. Salembier (U.S.A.)

I think we run into a language barrier. The antiseptic packing of milk that I was discussing is not performed by adding a physical antiseptic but by passing the milk through live steam, or by other meohanioa1 processes of this kind.. There is no introduction of a foreign substance into the milk, so it is perfectly safe.

M. Tanaka (Japan)

I would like to comment on the first paper about packaging. In Japan for freeze dried foodstuffs we have been using many packaging materials obtained from the USA, but as you know Japan has a very humid climate. We have been using a plastic coated paper that consists of aluminium film and paper and polyetheline but even the slightest hole in the aluminium foil causes deterioration of the food. People in the USA say that this packaging material is quite safe but they have dry weather all the year round. If we make the aluminium thicker this costs quite a lot, so have you any idea what can be used for very humid climates like Japan ?

O. Salembier (U.S.A.)

The problem is one of getting the exact humidity and working specifically with the product. It would be unsafe to make a statement that one the of material would work better than another. But in a lot of the quick-freeze materials that are coming into the USA from Japan the product is keeping very well. You are getting good results in Arizona which is a good dry place and also good results in California which is not a dry place. I think Japan will probably solve the problem by doing a little testing and experimentation because polyetheline manufactured in Japan is an excellent and much cheaper product than the USA polyetheline.

E. Jesse (Netherlands)

Miss Salembier said that the research and development for the product and the packaging should be integrated. One develops a product and makes a package that suits the product, I don't see how you can integrate because one thing is done before the other.

O. Salembier (U.S.A.)

This is the sort of question that makes me look at the clock and then at the calender. This is, of course, of primary concern to all packaging engineers. If you think of some product that you can squash into just about any shape like a piece of sponge maybe this would work, but integrating packaging design with the original formation of the product is often most important. May I give you an example I had occasion to spend some time on an airfield with a crew of carpenters and welding torch bearers cutting the legs of a piece of electronic equipment so that we could get it into the cargo hold of the aeroplane. Nobody had considered in the design what the package would be, and what the aircraft opening would be.. If they had consulted a packaging engineer, or the transport people, they would have known what size to make the product. So size is a factor. Another factor in these days of intricate equipment and miniaturization, is that we get a very delicate piece of equipment somewhere inside a package, all nicely sealed up so that we can't get it out again, and then find that it is almost impossible to control the amount of vibration and shock it is subject to. The packaging engineer needs to see inside before the covers are put on if he is to know where the weak points are for shock and vibration control. Some products could be dried, some made larger in volume depending on what would appeal to the public if, in developing the product, the packaging engineer and, perhaps, even the sales force and advertising people on a commercial product, were consulted from the beginning. This is what I mean by an integrated operation.

E. Jesse (Netherlands)

You mentioned in your paper that the package has to fulfil many requirements, being solid, having advertising qualities and so on. I have been thinking about another quality of design, the aesthetic. I think that this is of extreme importance, to me it is because I am one of those stupid housewives who go to a special shop to find a can of tinned milk which is more beautiful than one of the same quality, the same price, in another shop. I think it is very important to have nice things in my home, not only furniture but what is coming in for food. Is it considered in the same way in the packaging industry ?

O.Salembier (U. S .A.)

In the US they call that impulse buying. Of course with the on-the shelf product that is sold to the average house wife the matter of impulse buying is naturally very important. However, it so happens that a couple of packaging reports came in that gave statistics. The first said that the housewife would do as you do, buy the prettiest can of milk whether the liked the contents or not, and he quoted facts and figures to prove this. Two weeks later he said that people would not go for impulse buying, but that they needed practical industrial packaging ! So I guess it is a matter of choice. Packaging today is certainly based a good deal on the fact that the most attractive package will sell the product.

J. M. Scragg (U.K.)

As food stuffs vary in shape and size and the mechanisation for, say, refrigeration of packages varies, is there any chance of standardisation within the packages to keep the prices of transport down, because airfreight is very expensive. This would seem to be particularly important as packaged goods are supplied to so many countries.

O. Salembier (U.S.A.)

Yes, this is perhaps something that Miss Russell knows much more about and has some facts and figures on. Standardisation certainly is more prevalent in airfreight than in other forms of transport because of the containerisation programme, igloos as they call them, containers that can be loaded on the ground and fitted into the aeroplane so that all of the aeroplane is used. There is a cheaper freight rate for people who fill one complete set. One of the planes with which I am familiar takes 32 of these containers, 4 of them are smaller than the other 28, but any shipper who is shipping a large volume of goods gets charged volume rate. There is also a move towards lighter weight packages as this also saves cost on airfreight.

Packaging standardisation and movement has become one of the topics in the international packaging convention which is held annually in Germany or France. I believe this year some rapid strides were made towards the standardisation of collapsible containers which would go by ship. Standardisation of packaging is now becoming a matter of great importance internationally and I think you will find that in the next 3 or 4 years it will become possible to specify a container by letter or number; this aspect has developed more rapidly in the past two years than in the last 20 years together.

M. E. Russell (U.S.A.)

I might add to this that IATA, the International Airport Transport Association, has a packaging group which have determined definite size, shapes and forms of packages for air transportation and this is, in many cases, completely required. Also it means 15 percent less cost to the person transporting the package to use this type of container.

R. Shafer (U.S.A.)

There was also a conference a few years ago in which a gentleman proposed a unit cube which was based on space requirements on the decimal system. He suggested that we try to get world-wide co-operation to design hold space in ships and in aircraft and also, possibly, in submersibles, so that one size or another / of these oubes could fit into a standard space Without wastage.

A. Gunning (U.K.)

May I ask Miss Salembier if when designing food packages and using these new materials any consideration is given to the waste disposal problem after the package has been used.

O. Salembier (U.S.A.)

I know that we are going to have an enormous waste disposal problem particularly when it comes to the use of plastic packages. I think that people 2000 years hence are going to dig through a layer of plastic to find nothing underneath. As you know the eventual disposal of plastic containers is not the easiest thing in the world, and there have been some committees formed to give consideration to this.

M. M. Moody (U.K)

Air-conditioning on ships has usually one tremendous problem and that is the question of space. The space taken by plant and ductwork which is installed in the holds of ships have to be kept to a minimum so that the cargo can be greater. The size of this equipment can, of course, be reduced by adequacy of the ships insulation. Has Miss Shafer any thoughts on how the best balance can be struck between the insulation and the plant.

R. Shafer (U.S.A.)

The insulation in deep refrigerated cargo spaces must be thicker than the insulation for refrigerated cargo where you are holding chilled temperatures. The usual thickness of deep freeze is from 4 to 6 inches. The difference between 4 and 6 inches is very slight. Although the insulation factor is the same per inch, beyond a certain point it is not economical to continue with greater thicknesses of insulation. To answer your implied question, - how can we get more refrigerated cargoes on board ship - we now have refrigerated containers stacked on deck, as many as 40 to 80 on one particular ship. These are refrigerated units with their own refrigeration plants and the only thing you have to do after you place the container on deck is to plug them into the electricity supply of the ship. The 'Hawaiian Citizen' can also carry refrigerated containers below decks by plugging them into the chilled water system. Here there is no ductwork involved, except for the ventilation of air.

E. Jesse (Netherlands)

May I ask of Miss, Russell, could she please tell us something about the influence of clearing taxes, and similar barriers to importing food into a country by air.

M. E. Russell (U.S.A.)

I think that the USA problem with aeroplanes is the same as with any method of transporting goods across the borders of one country to another or one state to another. In my state of Washington, we are not allowed to import wines from the sate of California without an extra tax. It is things like this that are set up to protect the producer at home that make the difficulty. Somehow a compromise has to be made between countries, and between states, in order to get food to the people who need it and to bring other products to where they are wanted. For example, we fly meat to Hawaii, they send pineapples and other fruit back to us. If arrangements such as these can be made then the cost of sending products will be smaller.

K. Chandrasekhar (India)

I have a question for Miss Russell. Airlifting cargo is alright for countries like the USA; but could it possibly be made cheaper for countries like India where airlifting is not so easy because of economic difficulties.

M. E. Russell (U.S.A.)

Our hope for the future is that airlifting of food can be made cheaper by the use of larger aeroplanes, this is only one way of doing it. The 747 and the C5 type planes being built by Lockheed will carry such large amounts of cargo that it will be carried much less expensively. With the 747 they are talking of passenger air fares to Europe of only $50 and the cost of transporting food and other goods will be comparable. There are other aspects, food that can be freeze dried or irradiated has less weight and could be packaged. We are not going to send bulky items like wheat and potatoes by air but there are products like dried milk, soya bean products (being made because of their high protein value) and food-stuffs of this sort which can be airlifted economically in the future.

PROCEEDINGS OF THE
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Volume 3

THE WOMAN PROFESSIONAL ENGINEER

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In the Chair Jacqueline Juillard (Switzerland)

Opening address:

Science versus the humanities - a harmful dichotomy

Josephine R. Webb (USA)

Vote of thanks Phulporn Saengbangpla (Thailand)

Jacqueline Juillard (Feyler), Ingénieur-Chimiste EPUL-SIA

After graduating as a ohemica1 engineer from the Polytechnicum School of the University of Lausanne (EPUL) in 1947, Jacqueline Juillard was chief assistant of the Radium-Institute in Geneva. When she started having her children (three girls) she switched over to science writing for the lay people, since 1955, writing mainly on atomic energy, space and research problems; as such she has been invited to visit numerous research centres the world over, but she has also worked for 5 years as part-time literature scientist at the documentation service at the Battelle Memorial Institute, Geneva. She published a book in French and German on " The Atom: Source of Energy " and has just finished writing the tenth anniversary booklet for The International Atomic Energy Agency. She is member of the board of the Swiss Association for Atomic Energy and vice-president of the science section of the Swiss National Commission for UNESCO, and of numerous professional societies, namely the Swiss Society of Engineers and Architects (SIA) and the American Society of Women Engineers. She was furthermore named by the Swiss Government, Swiss delegate for science and technology at the last UNESCO General Conference.

SCIENCE VS. THE HUMANITIES: A HARMFUL DICHOTOMY

By Josephine R. Webb (Mrs. Herbert J.), BSEE, P.E.
Sr. Memb. IEEE, NSPE. SWE

Josephine Webb and her husband are consulting engineers in the Pacific northwest, specializing in industrial electronics, underwater acoustics and power and municipal planning.

Mrs. Webb was educated at Purdue University, with graduate work at the University of Pittsburgh and as a research assistant at Carnegie Institute of Technology. Next, she joined the Westinghouse Corp. as a design engineer. Later, she was a laboratory director for a firm manufacturing facsimile equipment, and also in New England she worked as a research engineer for the Foxboro Company.

Since moving to the northwest the Webbs have built their office and laboratory along with their home, on Lake Coeur d'Alene.

Summary Science and the humanities are not separate and unrelated, both are subclasses of philosophy. The roots of the division between the rational and the intuitive approaches to an understanding of life lie in ancient civilizations and can be traced through the ages to the present.

We have inherited attitudes about what is “cultural” that are harmful to the interaction among the various disciplines. This is especially damaging to modern man, who lives in technological societies, but often has little -understanding of his environment, thereby rendering him less able to identify himself and to respond to the needs of his society intelligently.

Changes in education are imperative, with emphasis on the unifying principles in all fields of knowledge. The importance of both axiomatic and intuitive modes of thinking should be stressed, together with the great need for, and satisfactions to be found in, social responsibility and professional commitment.

SCIENCE VS THE HUMANITIES: A HARMFUL DICHOTOMY

by Josephine R. Webb

1.

The Second International Conference of Women Engineers and Scientists has grown out of a desire on the part of many women from all over the world to engage in a continuing dialogue on the problems of the human race and how we may use our special skills and attributes to contribute to their solution. The Technological Sessions concentrated on some of humanity's most pressing problems. The Sociological Sessions will I think, crystallize our approach. For if we don't analyze our status and pinpoint our position as women professionals versed in science and engineering we may fail to recognize the directions of our best opportunities for service and innovation.

I would like to relate the previous inquiry into world problems and the implied limitations of our, as yet. Small group, to another problem: communication. Certainly. if all humanity could communicate meaningfully with one another and even if all groups within a given culture could understand each other, the physical problems would not seem so formidable. Therefore to contribute to this understanding might shorten many of the tasks which must be accomplished if we are even to survive as a species. Survival is going to require an informed approach. Additionally. We are looking for a great deal more than mere survival - we want to survive in meaningful ways, in dynamic societies which allow for the full development of the human personality.

The title of my address may indicate to you that I have in mind one of these problems of communication. It has been discussed before in many different and distinguished gatherings but perhaps another try won't be amiss. I don't think I will come up with any pat answers and that is probably good. I would like to quote the delightful Danish poet-engineer-artist, Piet Hein, who says, in his grook, On Problems:

Our choicest plans
have fallen thru,
Our airiest castles
tumbled over,
Because of lines
we neatly drew
And later neatly
stumbled over.

The first thing I should do is define my terms. What do I mean by the words, science and humanities? My Webstert's International. Dictionary defines science as follows: A branch of study concerned with the observation and classification of facts, and with the establishment of verifiable general laws chiefly by induction and hypothesis, tested by critical experiment; or as the 1891 Edition put it, loosely but with more of a flair: The knowledge of principles and causes, ascertained truths, Knowledge classified and made available in work, life, or the search for truth.

Next we come to humanities: Originally, the branches of "polite" learning - as language, rhetoric, poetry, the ancient classics and belles lettres; or, more generally, today: The branches of learning regarded as having a cultural character, usually including languages, literature, art, history, mathematics and philosophy.

Now, dichotomy means literally, "cut in two", or in logic: The division of a class into two subclasses, opposed to each other.

I discovered immediately that I needed to clarify what "class" it is that is "divided into the two subclasses" of science and the humanities. I concluded that it is the study of life as a whole, by all the means at our command. Perhaps, then, science and the humanities could be called subsets of philosophy. Let us see in what ways the subsets are separate and opposed, by going back and tracing their development.

2.

As described so well by Lewis Mumford, from the moment man made his appearance on this planet, we find evidence in his attitudes towards death, ancestral spirits, future existence, sun, sky, earth and water, of his consciousness that forces and beings, distant in space and time, may play a controlling part in his life. Man's excess of neural energy over that needed for purely physical survival, his creativity, so to speak, gave rise to ritual. Continuous elaboration of symbols for ritual and myth, hunting and food gathering, gave rise to language. Without man's capacity to give symbolic form to experience, to reflect on it, to refashion it and project it, he could not have postulated meanings for his universe.

The world, symbolically organized in language, became more significant to primitive man. No other art rivals speech in inviting a contribution from each member of the group, no other expresses individuality so definitely. The expressive and emotive functions of language were essential to the formation of a culture.

So, from the Pleistocene to the Neolithic, man is refining his language as well as his tools. By 8000 B.C., he has domesticated the dog and the horse, developed agriculture and animal husbandry. Mr. Mumford points out that the Neolithic tool maker first invented daily work - defining work as: the industrious devotion to a single task whose end product is socially useful, but whose immediate reward might be small to the worker. Can' t you see a group of Neolithic men in the village, bidding their mates goodbye, and absorbing the morning sun as they walk over to the stone pit where they will spend the day - far differently from the hunter grinding, boring and polishing granite or diorite, and knowing circular motion, using the potters wheel to grind pots and vases out of soft sandstones before baked clay pots were invented........How ancient is our concept of the "daily grind " and our synonym for the tedious, "boring" ....

Nevertheless, in the village culture of the Neolithic man had security for the first time. With the domestication of grain and the invention of bread man was assured of daily nourishment, provided he stayed rooted in one spot and worked steadily. The addition of meats and oils and greens gave man a balanced diet, rich in energy. This is the end of hand-to-mouth living, and capital accumulation begins here, and then came the development of the country town and the city.

3.

By 3000 B.C., industrial and military power were organized in the classic river valleys much as they are today. Communities were based on a political structure, an authoritarian, dominant minority dedicated to the expansion of power, from China, Cambodia, Mesopotamia, and Egypt to Peru and Mexico.

The cult of divine kingship enabled the powerful minority to have control over the group, bringing about the separation of classes, the lifetime division of labor, the mechanization of production and the enlargement of military power. The universal introduction of slavery and forced labor, for both industrial and military purposes, changed the whole scale of collective life to that of urban civilizations, cultures which produced vast works!

This mechanization of vast numbers of men required organization the organization of knowledge, the invention of writing reckoning in arithmetic, the division of labor into specialized skills, communications, economic intercourse, and invention.

King and bureaucracy were the coercive force, and men were separated into worker and idle consumer for the first time. With the increased division of labor, the field of the individual worker shrank - the city was often a place of confinement, daily drill, labor at its worst - out of which came the feeling that labor was inherently a curse!

War became an integral part of civilization. Pugnacity and slaughter for food are biological traits, but war is a cultural institution.. requiring a surplus of goods and manpower, and in turn providing the supply of additional wealth and slaves needed to maintain the culture. Populations concentrated, and the cycle of conquest, extermination and revenge became chronic only widening the collective anxiety so characteristic of civilized man. War also became a safety valve for discontented masses, allowing their rulers to postpone constructive measures to improve the human condition.

However, new cities rose, providing the environment for the sharpening of individual minds, expressions of order and beauty, common codes of law, and more freedom for some of its citizens. The great technical achievements of ancient civilizations were in the domains of architecture and the domestic arts - not only for the satisfaction of physical needs, but for the pursuit of significance. The endless flow of designs touched even the commonplace- pottery, textiles, musical instruments - generating the whole craft tradition. The mass of aesthetic inventions interacted with the mass of mechnical inventions, unlike the current tendency to separate art and technics.

4.

Greek culture resisted the cult of kingship at an early date and retained a measure of the village tradition even at the height of its urbanization until its overthrow by Alexander the Great. The Greeks accomplished the invention of the screw leading to water pumps - the watermill dates from the 3rd century B.C - the invention of the lathe , in turn producing shafts and wheels, pulleys and winches. They also learned the casting of bronze by the lost wax method and stamped metal coins.

The Greek view envisioned nature as drama, entailing the acceptance of the remorseless working of things, the decree of destiny. They proceeded from abstract principles - the theoretical rather than the empirical approach - the “real “ being always regarded as inferior to the "ideal".

In Athens, there was a deemphasis on the military and the appearance of the school as an institution and teaching as a profession, including the primary school, the gymnasium, and the ephebia, for students from 7 to 20 years of age.

The curricula of the primary school included athletics, drawing, music, leaning to count by rote, and literature, also by rote.The gymnasium taught, as abstract disciplines, geometry, arithmetric and the mathematics of music and astronomy. Take note that this mathematics was divorced from the actual calculations of surfaces and volumes, of geodesy or accounting. The latter were faught to surveyors, masons and clerks and did not form a part of liberal education.

As the Graeco-Roman period advanced, literature elbowed out the sciences and distorted their resentation, with far reaching consequences. Nothing is more characteristic of the classical tradition than the predominance of literature and the dislike of mathematics as a basis for general education. Mathematics lost its place in the culture. It continued to be respected and admired, but one did not have to learn it to be considered an educated man. Rhetoric was the queen of subjects.

5.

Ancient China surpassed the rest of the world in technology, predating Western cultures in the manufacture of pig iron, ceramics and textiles and in the study of geography, minerology and botany. In the 2nd century A.D., they had learned the control of plant pests. In the 6th century, they had printing and in the 11th century (Sung Dynasty), they produced along with the magnetic compass and elaborate astronomical clocks, an encyclopedia of over 11,000 volumes.

Before the dawn of the Christian era, sons of peasants in China were studying philosophy. From the 3rd century B.C., examinations for the highest offices in the land were competitive and were open to everybody. Not all could read the classics, but everyone was familiar with much of their content in the form of proverbs. The Chinese were fond of drama, and story-tellers abounded to recite episodes from plays in the market place. The “talker-of-books” presented in oral form the contents of works written by scholars at court. These things gave the whole Chinese people a remarkable homogeneity.

Confucius, who was born in 551 B.C., was one of those who have deeply influenced human history. He probably formed the first private school devoted to higher education in China, as contrasted to the tutors of the aristocrats, or apprentice training among the minor officials, with the express purpose of educating his students broadly, so as to take part in improving the government and to work out in the world and to struggle for principles. Furthermore, Confucius considered intellectual cultivation to be of little worth if it were not accompanied by emotional balance. He emphasized action animated by the ideal of justice and motivated by love for all men. Through the ensuing centuries, while the west was accelerating the application of science, the cultures of the east assumed a divergent path, with emphasis on classical thought and the arts. Religious and philosophical teachings were paramount in daily life.

6.

In Europe, Copernicus, the orthodox Christian, promulgated a heresy more consequential than any the church had yet struck down. It put man in his place in the cosmos. The social ferment of the Renaissance facilitated the acceptance of his innovations. Humanism, an ethical rather than a religious philosophy taught the perfect ability of man's nature without supernatural aid, an identification of spirit with the realities of nature, and regard for the interests of mankind.

Leonardo da Vinci is often thought of as one of the most complete expressions of the Renaissance personality. For Leonardo, the natural sciences, art philology, anthropology, were understood according to the universality of all things - all the arts and all the sciences, if they are to be learned deeply or touch the ideal are intertwined. He demonstrated a passionate dissatisfaction with limited knowledge, a desire to break down the barrier between theory and practise, thought and action.

Leonardo da Vinci worked on his scientific studies simultaneously with his art intermingling studies of whirlpools, designs of canals, research into phonetics and anatomy with sculptures, portraits such as St, Anne and Leda, and sketches of reliefs from ancient monuments with military designs and architecture.

In a very real sense, his age was freed from prejudice or arbitrary assumption. The philosophical quality of Leonardo da Vinci' s study of nature is brought out in his words: "For in truth, great love is born of great knowledge of the thing loved, and if you do not know it, you could not love it, or love it but little." Invention appears to Leonardo to be a step forward in creation - an a agreement with the <u>nature</u> of being, producing a <u>new</u> <u>value</u> which had not been in effect before.

Leonardo da Vinci realized the limitations of mechanical invention. He wrote about and painted terrible dreams and visions of disaster. He had forebodings of the total destruction of humanity through its misuse of the forces of nature. An allegorical drawing of his, dated 1516, when he was “engineer and architect for the King of France”, still eludes my understanding:

This drawing is of a boat, its mast a living plant thick with foliage. The sail is wind filled and the boat is also being driven by the strong current of the river. At the helm sits a shaggy bear looking at a compass which is illuminated by a shaft of light from the heart of a crowned eagle perched on the river bank on a globe.

It is said that Humanism was the most important intellectual movement of the Renaissance. The scholars who called themselves Humanists (from the Latin studia humanitatis, which the Romans had used in the sense of a literary education) venerated Latin and Greek classics and reintroduced them into the main stream of western thought. They broke away from the conformity arid logic, and other-worldliness of medieval education and stimulated the rebirth of man’s interest in the world and a belief in man’s individual worth and right to freedom of action.

By the 15th century an education in the humanities included the study of history, grammar, poetry~ rhetoric and moral philosophy and by 1550 the sciences were included as part of humanistic learning.

Throughout the Renaissance, the small towns and monasteries produced a surplus of goods while promoting the idea of work as a moral commitment. Progressive abolition of slavery was completed in Europe, and a nice balance between the rural and urban existed. The printing press eliminated the class monopoly of knowledge, and with the combination of handicraft skills and power machinery, material goods became available to a large part of the population.

Then, as wealth accumulated, the economic gaps grew. Capitalism tended to concentrate on profit, not on man. State capitalism fluorished before private capitalism, as exemplified by the Knights--Templars (the warrior-bankers of the middle ages), the merchant guilds, and the great trade associations of northern Europe. Landlords, merchant-adventurers and speculators emerged, with their concentration on power, profit and prestige altering the familiar hierarchy of noble, king,and church. There was in the air the great promise of material abundance through exploration, conquest and colonialization, invention and trade.

7.

When Francis Bacon's Novum Orlganum appeared in 1620, the scientific discoveries of Copernicus, Kepler, Galileo and Gilbert, Vesalius and Harvey had already been published. Along with his famous method of induction, and Descartes' mathematical method of induction, Bacon's idea was that knowledge ought to bear fruit in works and the improvement of man's lot. "The seal and legitimate goal of the sciences is the endowment of human life with new inventions and riches", he wrote. This often reduced inquiry to mere utility and materialism.

Here lay the beginnings of a deep split in western personality. A most important ethical problem was left out of the new world of science – man's responsibility for his works. This weakness disguised itself as "scientific purity". It went a step further at times to become "science for science's sake" - an idea to rival "art for art's sake".

However, as Lewis Mumford reminds us, even if this conceptual frame of science had no place for the full human personality, in its actual operation, it partly offset this lack. Scholastic philosophy had rested on authority. Scientific reasoning rested on a foundation of observations and interpretation, making it possible to correct error. Scientists themselves long failed to realize the implications of their method.

The scientific movement was at first confined to an intellectual minority - as contrasted with the popular involvement in the religious upheaval of the Reformation. Nevertheless, the quiet growth of science recolored the mind of western man, altering his approach to life. Alfred North Whitehead has said that men of philosophical temperament have always and all over the world been absorbed in weaving general principles, but it is the passionate interest in the union of principle and fact which forms the novelty of the "scientifically oriented" society.

Science had to become critical of its successes before we again began to question the nature and limitations of predictive knowledge. The physics of Newton and the geometry of Euclid were superceded. In the 19th and 20th centuries came the further development, in the sciences, of the tools of abstraction, the forte of the arts. With Darwin, Einstein and Planck, and the symbolic logic of Bertrand Russell and others, we are again beginning to understand the untapped philosophical potentialities in science Attaching to science the quality of beginning from a priori truths, men had overestimated its ability to offer ultimate answers, ultimate security, and they had become disillusioned.

8.

Dr. Jacob Bronowski, formerly of Cambridge University and now a Senior Fellow of the Salk Institute of Biological Studies in San Diego, California, spoke on this subject in his 1965 Phi Beta Kappa-Sigma Xi lecture, "The Logic of the Mind", delivered before the American Association for the Advancement of Science. It was one of a series of lectures entitled "Science and the Other Humanities". He clarifies the revolutionary change of approach that is reaching fruition among the scientists of today. It is an exciting time - we seem to be on the verge of new insights, perhaps valuable new avenues for action.

In exploring the modern theorems in mathematical logic, Dr. Bronowski describes the quality of thought common to both science and the arts. He starts with the important theorems in symbolic logic, dating from 1931. The first theorem says that any logical system which is not excessively simple (that is, which at least includes ordinary arithmetic) can express true assertions which nevertheless cannot be deduced from its axioms.

The second theorem says that the axioms in such a system cannot be shown in advance to be free from hidden contradictions. In short, a logical system which has any richness can never be complete, cannot even be guaranteed to be consistent! Next, mathematicians showed that no mechanical procedure can be devised which could test every assertion in a logical system and in a finite number of steps, show it to be either true or false.

These theorems can apply to any system of thought which attempts to set up fundamental axioms and then to match the world by making deductions from them in an exact language. At some points, there will be holes which cannot be filled in by deduction. In other words, there cannot be a universal description of nature in a single, closed, consistent language - the unwritten aim of the physical sciences since Newton.

This does not take away from us the concept that life does obey laws of her own - only that their formulation must be of some different kind from any that we know. Our formulations must be incomplete because of the logical insufficiency of our language. We have been humbled. We are again at the Renaissance!

Every scientific system is incomplete. It follows, therefore, that the system must be enlarged from time to time with new axioms, which cannot be foreseen nor proved to be free of contradictions. The steps by which new axioms are added cannot be mechanized.

It requires a free play of the mind outside the logical processes. This is the central act of imagination in science, as in literature. It begins in multiple meanings and overtones, made up of past metphors and analogies, links and conjunctions. In science, the aim is to disentagle each ambiguity and to decide between alternatives by critical experiments. In literature or in any of the arts, the ambiguities are not resolved - the emphasis is on self identification with the problem. Both approaches provide meaningfulness, a concern with wholes glimpses of unachieved goals and a variety of ways to approach them.

Furthermore, a basic difficulty lies in the fact that our symbolic languages can be used to describe not only parts of the world but also parts of themselves. Many problems and paradoxes grow from this root. "I am hungry" implies no self-reference, but “I am troubled" does. By their nature, all of the arts operate in the field of self-reference, whereas science does so only occasionally. Therefore, Dr. Bronowski suggests that psychology and other social sciences, which contain elements of both rational hypothesis and self-identification, will always lack the comparative rigor of the natural sciences - that these disciplines should not be put exclusively into axiomatic systems.

It also becomes clear that literature and art that is not merely factual involves our becoming part of it - a something made by a man to express how he sees himself in the world, and which asks us to see ourselves in it too, watching our own minds from the inside while watching someone else’s from the outside.

We can see that part of the richness of the human situation is brought about by the capacity of our language to refer to itself. The brain, therefore, is not merely a logical machine, for a machine (involving input - action - output - self regulation) must operate by means of a formal, closed symbolic language. No logical machine can reach outside the difficulties and paradoxes created by self-reference, to overcome and exploit them, so that they become instruments of the imagination, in great art and in great leaps forward in science!

That the rational and intuitive are not opposites and should be companions has also been brought out by Dr. R.G.H. Siu, an eminent biochemist and director of research in the United States of Chinese background. He is a student of both the scientific methods of the west and the eastern wisdom of "no-knowledge", as explained in his book “The Tao of Science”. He describes rational knowledge as using us as spectators and interpreters of nature, and intuitive knowledge – no - knowledge - as what remains of the undefinable whole, requiring us to attempt to be participants in nature, to be aesthetically sensitive - a quality we have long admired in the Oriental. Is this not similar to the position we have arrived at through an appreciation of the limitations of logic? through the realization that at the moment we create a new idea, we are outside logic? Pascal called the same two ways of thinking “geometric" and “finesse “.

9.

We have called ours a "scientific culture" by virtue of its application of the scientific method, even while our many anxieties and social problems have led to a gnawing disillusionment with science. Yet, the great majority of people, even in the most technologically advanced societies, in their thinking and in their motivation, are as yet nearly untouched by the spirit or understanding of science.

The gap between popular reverence and common lack of knowledge is filled with conventional beliefs that range from cliches to superstitions. The man of today thinks he sees science in every gadget he uses, while the significant achievements of engineering are accepted without any real conception of their workings or their beauty. In short, there is little interaction between man and his milieu. How do we explain the paradox of a literate society, bound by the methods of science using the ideas and products of science, yet withholding its mind from it, saying it lacks the talent to do anything but remain ignorant?

This state of affairs can, I think, be traced directly to education, education by indoctrination, still lacking the spirit of seeking the whys and wherefores through experiment and hypothesis still emphasizing a vast array of discreet subjects rather than the relatedness of the whole, and still accepting the idea that “culture” is not particularly connected with science, so that a man may even boast of his ignorance of science - and especially of technology to prove his cultural leanings.

This is a dangerous fallacy! Today we must face continuous change. Our children must be educated for an unknown future. We have few ethical standards to guide us outside those of the great religions which tend to depend upon fear, punishment or perpetual reward for motivation. We need not only a well rounded knowledge of the various disciplines of thought, but also a very real conception of the actual world in which we live, if we are to deal with that world and to interact with that world intelligently.

On the other hand, who hasn' t heard the scientist or engineer remark that he hasn't had time to read a book in months - the implication being that he was too busy with the really important work of the world to indulge in trivial things! Yet how often the best ideas come from people who stick their noses into everything. This quality of openness, almost childlike enthusiasm for all sorts of experiences, is characteristic of every great man or woman.

Additionally, the narrow attitude towards work also takes on, as above, the connotation of masculinity. And since science and engineering are somewhat under the cloud of not being "refined", it is easy to understand how the social climate has not been such as to encourage women to enter these fields naturally along with men. we must all realize too that there are deep seated and ancient psychological reasons why men have put women on a pedestal, where they were not expected to face the rigors of the world, or else they have demeaned women and considered them less able, mentally and physically, to take part in these demanding endeavors.

Irrational concepts about women' s place in the scheme of life were produced long ago by male hostility to female, and over the ages, these concepts have been refined and submerged and camouflaged, until we fail to realize their common roots in primitive man' s fear of women, his need for dominance, and the resulting beliefs, practices and mores in every society. Modern man, too, must be freed by knowledge from these ancient taboos, so that we may achieve a truly balanced male-female relationship appropriate to our times. It is a partnership worth working for!

10.
Therefore, as we are beginning to realize, we need to teach better interdisciplinary science coursesto everyone, from grade school on, stressing the methods of science, its strengths and its limitations and its relationship to the everyday world. We also need to teach everyone the meaning of professional commitment - the sense of social responsibility in one' s work which distinguishes the professional from the technician, as for example, the professional engineer. We need to convey a passion for utilizing new truths and the resources of nature for the benefit of mankind - the function of the engineer. At the same time, we need to deliniate more elegantly the different branches of the natural and social sciences, and to show their compatibility with the intuitive arts - with examples of the enrichment of each through knowledge of the other.

We need more hero worship, more information about the creative work of outstanding individuals throughout history, and including the present, to inspire our students. At present, much of this approach, when it exists, ceases at the High School level, and it is hard to pick it up again in College at the adult level. High School curricula need drastic change, both for the college bound and those who elect a trade or training in industry. Girls especially are given confusing, and often conflicting, guidelines for their futures at the High School level. Self identification becomes difficult!

In the United States, there are experimental courses being tried along these lines. For example, the High School student ordinarily only has the option of taking physics, chemistry or biology, and often he does not even elect these unless he has decided he wants to major in science later in college. Many students leave school with only the vaguest knowledge (from their grade-school science) of the physical principles behind their technological world - only 17% have taken physics. The National Science Foundation assisted a group of engineers and teachers in developing a course containing technical concepts relevant to the students world of radio, television, airplanes and automation - with laboratory devices that actually perform the functions discussed, including logic circuit boards the same as those used in computers.

I feel that a searching out of the human potential, not specialization, ought to mark the High School years especially. As it is, most students, at least in our country, haven' t caught fire by the time they graduate, and even then they really have little idea of what they hope to do as adults and whether they have taken the, right courses in preparation. An exposure, and possibly a resulting passion for many fields sequentially, should be encouraged - rather than the present “Don' t make up your mind too soon" climate, which actually does not result in the student's broad growth, but in apathy and alienation.

Another vital force for educational reform in the United States, is the National Committee for the Support of Public Schools. Founded only five years ago by Agnes –Meyer, who has been active in public affairs since 1921 and is the owner of the Washington Post Newspaper.This group consists of over 1300 members – educators, businessmen, parents and civic leaders from all over the country, who engage in continuous dialogues about the functions of education. They advocat e more civil involvement by the schools. They are suggesting the idea of "community schools" which will make a point of being open day and night, for recreation and study and for people of all ages to mingle. This is something we do piecemeal and in a self -conscious manner now.

11.

In conclusion, it seems to me that diversity and cross-fertilization are the best possible leavening agents for social problems and for individual human development. To survive - to adapt - and then to create: we must accomplish all three to live meaningfully, both as individuals and as societies.

Education is not “liberal”, is not “cultural “if - along with its distinguished contributions in teaching the arts and the discreet scientific disciplines - it does not contain these unifying ingredients.

Perhaps our Danish friend expressed our dilemma best in another of his poems:

The Miracle of spring

We glibly talk
of nature’ s laws,
But do things have
a natural cause?
Black earth becoming
yellow crocus
Is undiluted
hocus-pocus!

- over -

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The Woman Professional Engineer **7 July 1967**

Session I

In the Chair — Lydia I. Pickup (USA)

Canadian attitudes to the employment of women in the technical professions — Kathleen H. V. Booth (Canada) (presented by Winifred Hackett (UK))

Une femme peut-elle reussir une carrière d'ingenieur en France? — Janine Badoz, Josette de Bellefonds and Nicole Becarud (France)

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The key to the science womanpower pool: teacher education — Gladys S. Kleinman (USA)

Factors affecting sex differences in aptitude for, interest in and achievement in mathematical and scientific subjects — M. Dormer Ellis (Canada)

Lydia I. Pickup, Vice President, Society of Women Engineers

Lydia I. Pickup studied electrical engineering at the University of Wisconsin following her service in the U.S. Navy (WAVES) during World War II. She returned to active service from 1951 to 1953 and upon release joined The Boeing Company in Seattle, Washington. While there she designed mobile systems trainers and directed sub-contractor design of missile weapon control systems. In 1962, Lydia Pickup transferred to the newly formed Space Division in New Orleans, Louisiana, as a lead engineer in Configuration Management for the S-IC stage of the Saturn Launch Vehicle. She is currently a Design Specialist assigned as a lead engineer in Systems Engineering in Huntsville, Alabama, and responsible for performing operations analysis on the Saturn / Apollo vehicle, with particular emphasis on pre-launch operations including all testing and processing of the entire vehicle from on-dock at the launch site to lift-off.

CANADIAN ATTITUDES TOWARDS THE EMPLOYMENT OF WOMEN IN THE TECHNICAL PROFESSIONS.

By Kathleen H.V. Booth, B.Sc., Ph.D.

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Junior Scientific Officer, Royal Aircraft Establishment, Farnborough, 1944-46.

Research Student, King's College London, 1946-50

Research Assistant, Institute for Advanced Study, Princeton, USA. 1947

Research Fellow and Lecturer, Birkbeck College, London, 1951-62.

Research Fellow University of Saskatchewan, Canada, 1963-present

Books: Automatic Digital Calculators (with A.D. Booth) - Butterworths.
Programming for an Automatic Digital Calculator. - Butterworths.

Summary A survey was made, by questionnaire, of women with technical and scientific qualifications employed in Canadian universities and government establishments. Data was obtained on their qualifications, experience and opinions on employers attitudes to the employment of women. The results are presented in the paper.

CANADIAN ATTITUDES TO THE EMPLOYMENT OF WOMEN IN THE SCIENCES AND ENGINEERING

By K.H.V. Booth.

From a European viewpoint North America is often said to be a matriarchal society, and impressive figures are quoted to prove that women own more than 50% of invested wealth, in the U.S.A. at any rate. This statistic however, tells us very little about the position of women as employed working members of the community, as opposed to those who inherit money or marry wealthy husbands, and although it might be maintained that he or she who signs the chequebook rules the roost, one suspects that the management of much female-owned capital is left to men.

The author of this article, having worked in the mathematical field for nearly 20 years in a variety of posts in England, came to Canada nearly 5 years ago, and for most of the time since then has been employed in a teaching and research post in the University of Saskatchewan. This is not intended to be the autobiography of a Pioneer on the Prairies, but one must remark here on the extreme friendliness and co-operation of Canadians at all levels to the newcomer which makes the process of transplantation much more agreeable than might appear.

Although it may seem inappropriate for a Non-Canadian to be commenting on an essentially Canadian topic, perhaps the fact of having a different background may make critical observation easier. Thus, one feature of the Canadian scene which strikes the British emigrant is the Victorian flavour of several aspects of life, at any rate in the West. A similar comment was made about washington, D.C., a few years ago by a British reporter so the author is not alone in this impression. The particular manifestation of this which interests us here is, of course, the employment of women, and it did seem that particularly in the field of married, Women working, Canada is several years behind the U. K. It is not appropriate here to discuss the pros and cons of working wives and mothers but it does seem to be becoming recognised here that the country cannot afford to waste the potential of technically qualified women, especially, and from time to time newspaper leaders and articles proclaim this fact.

In order to get some data on the position of women as employees in the scientific field the author circulated a questionnaire, a copy of which is appended, to about 180 women. The majority of these were on the faculties of the universities, or employed in technical capacities as laboratory assistants etc. As far as known all Canadian universities were covered. A much smaller number were in government employment, chiefly in the National Research Council (N.R.C.) at Ottawa. It is regretted that the survey of Civil Service employees could not have been more complete, but as there is no Canadian publication equivalent to the British "Civil List" tracking down people is difficult. However, N.R.C. are almost certainly the largest government employers of scientists. The position with regard to industry is even more difficult, and here only a few women who happened to be known to the author were included in the survey.

Thus the results represent a fairly full survey of universities, less so of the Civil Service, and are probably rather incomplete for industry. 74 replies were received, and Figure 1 summarises the details of these replies.

As regards qualifications, everyone who replied had at least a first degree, 76% had further degrees and 45% had PhD's or higher doctorates. As a comparison, the qualifications of 440 faculty members of a Western Canadian University were analysed, and it was found that 31% had PhD's or higher doctorates and 73% further degrees of some sort. Thus, the members of our group were rather better qualified, on paper anyway, than a typical university faculty.

A comparison of the positions held indicates that women tend to gravitate to the middle and lower grades, holding only half as many Full Professorships proportionately as the University sample. Thus, of the 62 who worked or had worked in universities, only 7, or 11% had Full Professorships (corresponding to a British Professorship), 14 or 23% had Associate Professorships, (British Readership or Senior Lecturer) and 25 or 40%, Assistant Professorships (Lectureships). The corresponding figures for the University sample were:

Full professor	87	20%
Associate "	74	17%
Assistant "	132	30%

Of course this is a somewhat crude comparison, as no allowance has been made for age, length of service in the university or the fact that time may have been taken off for raising children.

On the last point it will be seen that about half of the group are married, and about half of these have families. Seven of the latter reported that they were allowed maternity leave, but this figure is not very significant since apparently leave was not always requested.

The employed married woman has the disadvantage that she is probably restricted to obtaining work in the same locality as her husband, and particularly in small towns this may be difficult. Often there will be only one major source of employment for graduates, such as a university, government establishment or business organization, and the attitude of employers towards joint husband / wife employees may be crucial. On this point 15, or about 25% of those who replied, reported that their organizations had an absolute ban on such an arrangement, and 8 reported that a limited ban existed so that, for example, husband and wife could not work in the same section, or wives were only allowed to hold inferior positions with inferior pay and pension rights. In both civil service and university, attitudes appeared to vary on this point. One shining example may be mentioned the New York University, Ontario, has announced that husband and wife teams are positively welcome.

The attitude of industry in this respect is difficult to assess. Informal enquiry among a group of top executives produced denials, with one exception, that any ban existed. The exception, who must remain nameless, reported with some pride that his organization had an absolute ban on employment of relatives, and that on one occasion a woman clerk at Calgary was dismissed because her cousin worked for one of the firm's Ontario branches. For the benefit of non-Canadians it may be explained that this would roughly be equivalent to the separation between London and Athens.

Provision for part-time working, so much desired by women with younger families, does not seem to be very general, and the point was made several times that where it does exist, as for example in universities, where people may be employed to teach specific courses, the pay is often much lower than the proportion of a full-time academic salary on a pro-rata basis.

It is the author's impression that qualified married Canadian women do not seek out employment as frequently as their British counterparts. Without circulating qualified non-working women (a difficult task) it is impossible to say whether this is through lack of desire or discouragement at inadequate opportunity. Possibly the fact that Canada had no conscription for women during World War II may have influenced this situation.

We come now to the more nebulous part of the questionnaire, dealing with discrimination in promotion, pay and pension. The percentages reporting discrimination under these headings were as follows:

Promotion	14%	(10)
Pay	22%	(16)
Pension	15%	(11)

Many made the point that it is difficult to assess these matters, particularly with regard to promotion. Two opposing reports, both concerning government employment may be quoted. One woman, who raised the question of unsatisfactory promotion was told that it was not her work which was at fault but the fact that she had the misfortune to have chosen the wrong sex! On the other hand, another employee (from a different establishment) reports that her superiors have “leaned over backwards” to accomodate her. In general the conclusion seems to be that apart from some restrictions on husband / wife employment there is little or no theoretical discrimination against women scientific and technical employees but that in practice much depends on the boss who is almost always a man!

A final point - one reply complained that women are not encouraged to work in Canada because of the tax structure which makes no allowance for housekeepers etc. One felt tempted to remark that some people do not appreciate their good fortune. In Canadian tax law husbands and wives may make separate declarations and are assessed separately so that the infamous British surtax system which assesses incomes jointly is happily unknown. There is no insurance contribution to be paid on domestic help and, of course, no employment tax. The latter must surely have been the last straw for many British working wives.

FIG. 1 SUMMARY OF QUESTIONNAIRE REPLIES

Total number of replies - 74

Qualifications

1st Degree	74	100%
Higher Degree (M.A., Ph.D. etc)	56	76%
Ph.D. or Higher Doctorate	33	45%
Other professional qualifications	22	30%

Working Experience (present and past)

University	62	84%
Civil Service	12	16%
Industry	13	18%
Other	16	22%

Marital State

Married	41	55%
Children	24	59 %(of married women)
Maternity leave granted	7	

University Position Held (Percentage of total at university)

Full Professor	7	11% (this included 3 Heads of Dep't)
Associate Professor	14	23%
Assistant Professor	25	40%
Instructors	14	23%
Research Assistant	2	3%

Discrimination

Promotion	10	14%
Pay	16	22%
Pension	11	15%

Husband / wife Ban (Percentage of the 59 replies received)

Absolute	15	25%
Partial	8	14%

UNE FEMME PEUT- ELLE REUSSIR UNE CARRIERE D' INGENIEUR EN FRANCE?

Par Jaine BADOZ (ing. E.S.P.C.I.), **Josette de BELLEFONDS** (ing. E.C.P.) et
Nicole BECARUD (ing. E.N.S.C.P.)

Janine BADOZ (née LAMBLING). Ingénieur chimiste diplômée de 1'Ecole supérieure de Physique et Chimie industrielles de Paris, en 1948 - Licenciée es-Sciences (1950). Docteur es-Sciences Physiques (1951) - A fait sa carrière au Centre national de la Recherche scientifique où elle est entrée comme stagiaire en 1948. Successivement Attachée de Recherche (1949), Chargée (1953), Maitre (1959) et Directeur de Recherche (1967). Spécialité : chimie et électrochimie des solutions. Présidente du Cercle d'études des ingénieurs de l' A.F.D.U. de 1961 à 1963.

Josette de BELLEFONDS (née GARAIX). Ingénieur des Arts et Manufactures (Ecole centrale Paris - 1938). Spécialité : métallurgiste. A été ingénieur à la HYDRONITRU (S.A.) à Paris, puis `a la Section des métaux non ferreux de l'O.C.R.P.I. Entree en 1945 au Centre technique des industries de la Fonderie, elle est actuellement Chef du Département des Informations techniques et directrice de la revue FONDERIE. Vice-présidente de l'Association technique de Fonderie. Présidente du Carcle d'études des ingénieurs de l'A.F.D.U. de 1958 à 1963.

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Résumé Pour obtenir le diplôme d 'une Grande Ecole d' ingénieurs, il est nécessaire dans notre Pays de poursuivre des études difficiles pendant cinq ou six ans après le baccalaurént. L'entrée dans ces Ecoles se fait par voie de concours, ce qui conduit à une sélection sévère. Presque toutes les Ecoles sont ouvertes aux femmes; toutefois, l' élément féminin varie de 0 à 40 % suivant la vocation de l'Ecole; au total 3 % environ de l'effectif de la profession.

Cette minorité féminine a éprouvé le besoin de se grouper pour définir et résoudre ses problèmes spécifiques : informer l'opinion et les jeunes, aider et orienter les ingénieurs récemment diplômées. D'ou la création, en juin 1958, du Cercle d 'Etudes des Ingénieurs au sein de l' Association des Françaises diplômées des Universités.

En effet, les possibilités offertes aux femmes qui doivent tout mettre en oeuvre pour concilier leur vie professionnelle avec les exigences de leur vie familiale, varient considérablement, d'une part, suivant les branches, d'autre part, suivant la nature de l'établissement employeur. Elle doit, pour exercer son métier, vaincre des préjugés qui, s'ils sont moins enracinés qu'autrefois, sont tout de même tenaces et sont le fait à la fois de son entourage et de son employeur. Dans sa vie professionnelle, comme dans sa vie familiale, elle ne peut se permettre la médiocrite et c'est seulement à la condition de réussir les deux qu'on l'acceptera comme l'égale de son collègue masculin.

UNE FEMME PEUT- ELLE REUSSIR UNE CARRIERE D'INGENIEUR EN FRANCE ?

par Janine BADOZ
Josette de BELLEFONDS
Nicole BECARUD

"En période de péril national, les fenunes ont servi avec distinction dans des catégories d’ emplois extrêmement variées, mais, une fois le péril passé, elles ont été traitées comme un groupe marginal dont les capacités sont sous-utilisées" .

Président KENNEDY

Alors qu’ il est couramment admis qu’ une femme peut faire en France une brillante carrière dans la Médecine, la Magistrature ou la Politique, on en est encore à se demander s'il est opportun d’ orjenter les jeunes filles vers les carrières scientifiques et plus particulièrement vers le "métier d' ingénieur". A l’ occasion de ce IIème Congrès international des Femmes Ingénieurs, qu'il nous soit permis de faire le point. Comment le problème se pose-t-il en France? Dans quelle mesure a-t-il été résolu ?

I - <u>DEFINITION DE L' INGENIEUR</u> Le mot "ingénieur" dérivé de l' ancien français "engeigneur" de engin: machine de guerre, désignait à l'origine l'homme qui conduisait des travaux ou des ouvrages pour attaquer ou défendre une place forte. Par extension il s’ applicque maintenant "à tous ceux qui se sont spécia1isés dans la mise en oeuvre de certaines applications de la science" (1).

En France, "cette désignation fait appel à la notion de "cadre" (éxécutive) qui fait elle-même appe1 à la notion de catégorie socio-professionnelle. Ce dernier terme, introduit depuis 1946 dans la codification des recensements de population, essaie de tenir compte, à la fois de la catégorie professionnelle et de la catégorie socia1e" (2).

Pour définir les "cadres supérieurs", on se réfère pratiquement "à la notion de "salarié", jointe à celle de niveau "hiérarchique supérieur" avec souvent l'idée complémentaire de "technicité supérieur" (2). L'Ingénieur fait partie des cadres supérieurs. Cependant, "en France, la dénomination Ingénieur recouvre à la fois, mais pas nécessairement en même temps, un titre et une fonction. Le titre d’ lngénieur s'attache aux diplômes énumérés dans la loi du 10 juillet 1934, dite loi sur la protection du titre d’ Ingénieur" (2). En ce qui concerne la fonction d'ingénieur nous aurons recours aux définitions proposées par I’ E.U.S.E.C. dans son rapport sur la formation de l’ ingénieur dans les pays de l'E.U.S.E.C. et de l'O.E.C.E. (3). L’ E.U.S.E.C. propose de définir deux niveaux d’ ingénieurs : l'ingénieur professionnel ou (de conception), "Professional engineer" et 1'Ingénieur technicien (ou d'exécution); “Engineering Technician “ .Nous reproduisons ci-des-sous les définitions adoptées.

"Un ingénieur de conception est, par son instruction et sa fornation de base, compétent pour appliquer la méthode scientifique à. l’analyse et à la solution des problèmes de l’art de l'ingénieur. Il est capable d'assumer personnellement la responsabilité du développement et de l’application de la science et de la technique de l' ingénieur notamment dans la recherche, la conception des projets, la construction, la fabrication, le contrôle, la direction et l’éducation de l’ingénieur.

Son activité met principalement en jeu l'esprit dans des orientations diverses et n'a pas le caractére d’un travail courant, Intellectuel ou physique, Elle exige la mise en oeuvre d'une certaine pensée créatrice et de jugement personnel, et, si nécessaire, la compétence pour la surveillance des travaux tech-nicques et administratifs d' autrui ... Son Instruction et sa formation auront été telles qu'il aura acquis une connaissance étendue et générale des sciences de l'ingénieur et des connaissances plus approfondies dans sa propre spécialité ..,".

"Un ingénieur technicien ou d' exécution est celui qui est cupable d' appliquer avec compétence des procédés ayant fait leurs preuves et généralement connus des spécialistes d'une branche de l'art de l'ingénieur, ou des procédés spécialement ordonnés par l'ingénieur de conception.

Sous la direction générale de l'ingénieur de conception, ou en suivant les techniques établies, il est capable de remplir des fonctiuns, dont certaines impliquent la surveillance compétente du travail d'ouvriers spécialisés. Ce rô1e exige une connaissance et une expérience acquises dans une branche particuliére de l'art de l'ingénieur ainsi que la capacité d'ordonner les détails d'un travail, à la lumière de procédés bien établis. Un ingénieur technicien devra donc posséder une éducation et une formation suffisantes pour lui permettre de comprendre les raisons et les buts des activités dont il a la responsabilité".

Enfin, avant d'examiner dans le chapitre suivant les diverses formations correspondant à l'une et l'autre catégories, formations sanctionnées par un diplôme d'études supérieures, mentionnons le cas des ingénieurs autodidactes dits "maison". Ceux-ci, généralement du niveau "exécution", mais parfois aussi du niveau "conception", n'ont en principe pas de diplômes d'études supérieures, mais ont passe un certain nombre d'années dans une même entreprise au niveau "technicien". Ayant alors acquis une grande compétence dans leur spécialité, parfois sanctionnée par un diplôme du conservatoire des Arts et Métiers (réservé aux travailleurs), ils deviennent "cadres", en général dans cette même entreprise et sont assimilés à des ingénieurs diplômés, tant du point de vue rémunération que sur 1e plan activités.

Ce cas particulier mis à part, mais relativement fréquent dans l'industrie, quelles études préparent donc en France à la carriére d' ingénieur ?

II - LES ETUDES MENAUT A LA CARRIERE D' INGENIEUR Il convient tout d' abord de situer l'enseignement scientifique dans l'ensemble du systéme d'Enseignement en France, ensuite d'y placer la formation des Ingénieurs.

La figure 1.(*) donne un schéma de ce que sera l'Enseignement français en 1973, c'est-à-dire lorsque toutes les réformes actuellement en cours seront entrées en vigueur. On peut voir qu' il est prévu de lancer dans la vie active au niveau "cadre supérieur", 8% des jeunes d'une classe d' âge à savoir,5% à 22 ans titulaires d'une Maitrise et 3% à 24 ans munis d'un diplôme du Troisième Cycle. Parmi ces cadres, dont la fonction sera véritablement d'encadrer la Nation, citons les médecins, magistrats, économistes, professeurs de 1'enseignement secondaire et supérieur, chercheurs, ingénieurs, etc.

La figure 2 (*) montre l'organisation des études supérieures scientifiques. On voit que trois voies s'ouvrent au jeune ayant obtenu, à 18 ans, le Baccalauréat Mathématiques.

a) Il peut entrer dans un Institut universitaire de technologie (IUT), dépendant des universités, mais où l'enseignement est partiellement assuré par des ingénieurs professionnels exerçant leur profession dans l'industrie. En deuxans il obtient son diplôme qui lui permet d'entrer à 20 ans dans la vie active au niveau technicien. Une année supplémentaire et il accède au niveau ingénieur technicien.

b) II s'inscrit dans une Faculté ; il peut la quitter à divers niveaux : soit à 20 ans où il a à peu près le même niveau que s'il sortait d'un IUT; mais sa formation est davantage orientée vers la Recherche que vers la technologie. Il peut ensuite obteriir en deux ans le grade de Maitre-ès-Sciences, puis préparer un Doctorat de 3ème Cycle (en deux ans) ou d'Etat (en cinq ou six ans). Les titulaires de ces derniers diplômes seront des cadres supérieurs ayant la culture et la technicité d'un ingénieur d'une grande école.

c) Il prépare une école d'ingénieur. D'une manière générale, on peut dire que ce qui différencie la formation dispensée en Faculté dea Sciences et dans une Ecole est de trois ordres :

- Selection sévère à l'entrée de l'Ecole.
- Encadrement plus important dans les Ecoles.
- L'aspect expérimental des sciences est auasi développé que l'aspect théorique.

(*) Les figures sont rassemblées à la fin du mémoire.

Une liste des écoles d' ingénieurs publiée en mai 1963 par le Ministre de l'Education nationale permet de dénombrer :

- 90 écoles publiques délivrant un titre d'ingénieur;
- 25 écoles techniques privées reconnues par l'Etat délivrant un titre d'ingénieur;
- 11 écoles techniques privées délivrant un titre d' ingénieur reconnu par la Commission des ti tres d' ingénieurs.

La valeur des titres délivrés est difficilement comparable. Pratiquement, le titre d' ingénieur est défini par la désignation de l' école qui l' a décerne. On peut cependant tenter de le faire en tenant compte par exemple de la longueur de la scolarité après le baccalauréat. C'est ainsi que dans les grandes Ecoles d'Etat: Ecoles normales supérieures, Ecole centrale des Arts et Manufactures, Ecole nationale supérieure de Chimie de Paris, Ecole supérieure de Physique et Chimie industrielles de Paris, Ecole supérieure d'Electricité (Malakoff), Ecole nationale supérieure des Télécommunications..., la durée des études est d' au moins six ans, comport ant au minimum deux années préparatoires dans une classe de préparation généralement implantées dans les lycées ; puis un concours difficile (environ un reçu sur 10 présentés) et enfin trois ou quatre années de scolarité. Ces années de scolarité peuvent se décomposer de la façon suivante : deux années d’ enseignement scientifique général de haut ni veau et une ou deux années de spécialisation. Ces dernières peuvent être accomplies dans des écoles d'application qui n'admettent que sur titre: Ecole nationale supérieure du Pétrole et des moteurs à combustion interne, Institut national des Sciences et Techniques nucléaires (génie atomique), Ecole supérieure d'Application des corps gras, Institut français du caoutchouc, Institut français du Textile ....

Il existe par ailleurs d'autres établissements, souvent privés, qui ne nécessitent qu'un an de préparation et quatre années de scolaritv: Ecole Bréguet, Ecole Violet, Ecole française de Radio-électricité, Ecole nationale supérieure des Arts et Industries textiles, Ecole superieure de Chimie organique et minérale (Institut catholique), Ecole de Chimie de Marseille, Ecole technique supérieure du Laboratoire, Ecole supérieure de Physique de Marseille, Institut supérieur d'Electronique du Nord, Ecole de Chime de Mulhouse ..., Ecole polytechnique féminine. Parfois même l'année préparatoire se fait non pas dans une classe extérieure, mais est partie intégrante de l’ enseignement de l'école ; ce qui signifie que le recrutement se fait au niveau du Baccalauréat Mathématiques (Polytechnique féminine, ISEP, ...).

Toutes ces écoles sont ouvertes aux filles à l'exception des écoles militaires telle 1'Ecole polytechnique et des Ecoles des Mines. L'une d' elles, parmi les écoles privées formant des ingénieurs d'exécution et recrutant à la sortie de Baccalauréat Mathématiques est strictement réservée aux jeunea filles. C'eat la seule de ce type et en fait il n'est pas souhaitable que ce système qui tend à accentuer un cloisonnement par sexe déjà regrettable, soit étendu. Il est bien préférable d'encourager les filles à obtenir les mêmes diplômes que les garçons.

Si l' on examine par contre le nombre effectif d'étudiantes admises dans les écoles d'ingénieurs, en s'en tenant aux grandes Ecoles d'Etat, on constate qu'elles ne les attirent pas toutes également. C'est ainsi que l'on ne compte pas actuellement d'anciennes élèeves des écoles d'Arts et Métiers, et c'est en 1959 que pour la première fois une femme est entrée à l'Ecole supérieure des Ponts et Chaussées, et en 1961, par voie de concours, à l'Ecole des Télécommunications.

Une statistique un peu ancienne donne, réparti sur dix ans (1947-1957), le nombre de jeunes filles diplômées de quelques grandes Ecoles de formation diverses (4).

Ecoles	Hommes	Femmes	Pourcentage
E.N.S. d' Aéronautique .... ………	331	3	1 environ
E.Centrale des Arts et Manufactures ... ……	3 130	17	0,57
E.N.S. des Telecommunications .... …..	433	0	0
E.N.S. d'Electricité .... …………	2 616	25	1 environ
E.N. de Physique et Chimie industrielles ...	418	53	12,6
Institut national agronomique .... ……	1 312	17	1,3
E.N.S. de Chimie de Paris .... ………	588	114	près de 20
	8 828	229	2,6 (*)

(*) Nous insistons bien sur le fait que ce tableau est incomplet et ne veut représenter qu'un sondage puisque, en particulier, n'y figurent pas les écoles nationales supérieures de chimie de province, ni les écoles d'agriculture autres que l' I.N. Agronomique.

La figure 3 (*) précise par ailleurs le nombre de jeunes filles, entrées depuis la date à laquelle elles ont été autorisées à se présenter, à l'Ecole supérieure de Physique et Chimie de la ville de Paris et à l'Ecole centrale des Arts et Manufactures.

La lecture de ces chiffres nous oblige constater que la proportion de jeunes filles diplômées ingénieurs par ces écoles est bien faible comparativement au nombre de celles qui, chaque année, sont reçues au baccalauréat de mathématiques élémentaires (25% environ du total) et l' on ne peut que regretter que, pour diverses raisons, on n'oriente pas plus de femmes vers ces grandes Ecoles.

(*) Les figures sont rassemblées à la fin du mémoire.

Des préjugés toujours tenaces et le manque d'informations sur les dé-bouchés offerts aux jeunes diplômées entretiennent cet état de choses. C'est donc avec la conviction qu'il était nécessaire de remédier à cette situation que les ingénieurs françaises, à l'image de ce qui existait dans certains pays étrangers, se sont groupées en juin 1958 au sein de l'A.F.D.U. (*) pour former le Cercle d'études des Ingénieurs.

Le Cercle s'est donné pour tâche de faire connaitre aux jeunes filles terminant leurs études secondaires avec l'option mathématiques élémentaires, les débouchés que leur offrent les études scientifiques, les carrières et les traitements auxquelles elles peuvent, prétendre, une fois diplômées.

Une action parallèle, menée auprès des professeurs des classes terminales des établissements secondaires à l'occasion de colloques entre ingénieurs et enseignants, complète cette information en faveur d'un recrutement plus important.

La recherche d'une situation ou une simple orientation pose aux femmes ingénieurs, tout au moins à certaines, des problèmes spécifiques. C'est ce qui a amené le cercle à envisager également cette question (5).

III - <u>EXERCICE DE LA PROFESSION</u> Les annuaires d'écoles montrent que la proportion de diplômes délivrés a des femnles est à peu près constante depuis un certain nombre d'années et égale à 4 % du total. Or, nous constatons que ce chiffre, déjà faible est encore optimiste par rapport au taux de femmes ingénieurs que l'on peut obtenir, par exemple, grâce a l'exploitation statistique des déclarations souscrites par les employeurs (6).

En effet, on trouve en 1964, sur un total de 85 457 ingénieurs du secteur privé et semi-public 1 831 femmes, soit 2,14% du nombre total.Ces chiffres excluent toutefois lea organismes publics, tel l'Enseignement supérieur et le C.N.R.S.,où le nombre de femmes pourvues d'un diplôme d'ingénieur est nettement plus élevé. Si l'on compte ces secteurs d'activité importants, on arrive à une proportion de 3,28%.Ce rapport est de toute façon très faible, surtout si on le compare à celui obtenu dans d'autres pays, en U.R.S.S., par exemple où le tiers des ingénieurs en fonction est constitué par des femmes. Rappelons qu'en France même, dans d'autres professions on atteint des pourcentages beaucoup plus élevés, puisque un avocat sur quatre est une femme, ainsi qu'un pharmacien sur trois et un médecin sur dix.

Il convient de noter pourtant que si l'on s'en tient aux statistiques elles-mêmes, 80% des diplômées exercent leurs métiers.Ceci rejoint l'observation générale suivant laquelle plus les femmes ont une formation supérieure moins elles ont tendance à cesser leurs activités professionnelles.

(*) A.F.D.U. Association des Fran9aises dipl8mees des Universitas.

Par ailleurs, certaines branches de l'activité de l'ingénieur attirent davantage les femmes que d'autres. C' est ainsi que la Recherche tant publique que privée en emploie un nombre supérieur à la moyenne nationale. Une enquête de la Délégation générale à la Recherche scientifique et technique, effectuée en 1965 sur les moyens de Recherche et Développement dans l'Industrie française en 1964, indique une proportion de 6 % de femmes pour le secteur privé et semipublic; dans le secteur public la proportion monte, suivant la même source à 19%. Cet écart s'explique aisément, pour une large part, par le fait que dans la fonction publique, il n'existe pratiquement pas de disparité entre salaires et chances de promotion masculins et féminins, disparité qui existe bel et bien dans le secteur privé (pas seulement pour les ingénieurs d' ailleurs).

En effet, pour l'ensemble des cadres supérieurs du secteur privé et semi-public (dont font partie les ingénieurs), le rapport entre le salaire moyen des hommes et le salaire moyen des femmes est de 1,57. On peut même considérer que les ingénieurs femmes sont, en moyerme moins défavorisées que les autres categories de cadres supérieures puisque le même rapport n'est dans leur cas que de 1,2 environ (6). Si par contre on examine l'évolution des salaires en fonction de l' âge, on constate une discrimination plus nette encore comme le montre la figure 4(*). On voit sur ce graphique qu'une femme ne peut espérer atteindre: au moment de la retraite un salarire équivalent à celui d'un homme du même âge, bien que l'égalité des salaires soit inscrite dans la loi et que la France ait ratifié des 1952, la Convention internationale de Genève du , 29 juin 1951, sur l' égalité de rémunération entre la main-d' oeuvre masculine , et féminine.

Les chiffres statistiques officiels sont éloquents : ils montrent qu' à des postes identiques, munies des mêmes diplômes les femmes sont en général moins payées que leurs collègues masculins. Ces chiffres traduisent d'ailleurs en partie l'attitude des employeurs vis-à-vis des ingénieurs femmes et aussi celles de ces dernières.

Attitude des employeurs S'i1 est vrai que le chef d'entreprise se fonde, lors de ses décisions sur des faits objectifs (diplômes, curriculum vitae, test psychotechniques, etc.), il se réfère souvent aussi à des valeurs subjectives, qui dans le cas des femmes prennent souvent forme de préjugés, lesquels bien qu'en régression n'en sont pas moins tenaces.

On peut citer parmi les objections formulées :

a) Les femmes ont peur des responsabilités; on ne peut leur confier la direction d' un service, associée à la suivante,

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(*) Les figures sont rassemblées à la fin du mémoire.

b) Les femmes n'ont pas d'aptitude au commandement.

c) Les femmes manquent d'ambition professionnelle.

En fait, il s'agit là de traits de caractère individuels qui ne sont, à notre avis ni spécifiquement féminins, ni spécifiquement masculins, certains hommes n'etant guères aptes à occuper des postes de responsabilité. En ce qui concerne le manque d'ambition, il semble là encore qu'une femme bien intégrée dans son métier ait légitimement les mêmes ambitions que les collègues masculins. Ce préjugé ne paraît justifié que par les hésitations de la jeune diplômée qui cherche sa. voie; mais n'est-ce pas aussi le cas des jeunes hommes ? si les employeurs craignent que leurs collaborateurs féminins ne lea quittent après deux ou trois ans de maison en début de carrière, c' est-à-dire lorsqu' ils commencent à être rentables du point de vue de l' entreprise, il serait juste de noter que bien dos jeunes ingénieurs masculins le font aussi. Les jeunes quelque soit leur sexe, cherchent leur voie, on ne peut leur en vouloir.

d) Un reproche plus sérieux est l'absentéisme des femmes dû à la difficulté de concilier obligations professionnelles et rôle familial.

Si l'on examine les choses de plus près, il convient de noter que près de la moitié des femmes-cadres sont des femmes soules (célibataires, veuves ou divorcées), souvent chargées de famille (ascendants ou descendants) ou encore les épouses de couples sans enfants. Pour les premières qui sont tenues de travailler exactement au même titre que les hommes, il n'y a aucune raison valable de leur faire grief, dans leurs activités professionnelles, de leur condition de femme. Pour les secondes il n'y a pas lieu de craindre un absentéisme lié aux charges familiales. (Les statistiques montrent d'ailleurs que leur courbe d'activité est la même que pour les hommes).

En ce qui concerne les épousos mères de famille, le reproche le plus fréquent des employeurs est que les maternités avec les trois mois de rapos obligatoires dèsorganisent les services. Il convient de remarquer, cependant que dans la plupart des cas les enfants naissent lorsque la mère a entre 25 et 35 ans - âge auquel des postes de responsabilité sont rarement confiés `a des ingénieurs. La désorganisation du service n'est alors guère plus importante que lors de l'arrêt d'un ingénieur homme obligé de subir une grave opération chirurgicale, avec la différence cependant que l'absence pour maternité est prévisible six mois à l'avance.

Par contre, aucours des 25 années d'activité suivantes où les charges familiales deviennent plus morales que matérielles, l'absentéisme des femmes n'est guère plus élevé que celui des hommes.

Quant au sérieux des femmes et à leur stabilité dans leur emploi les statistiques montrent (6, p. 33) un indice de stabilité légèrement en faveur des femmes: 90,4% contre 85,7 %.

L'attitude des femmes justifie parfois les reproches des chefs d'entreprise. C'est ainsi que bien des jeunes filles qui n'ont pas été habituées à envisager avec suffisamment de sérieux leur avenir professionnel et gardent plus ou moins consciemment la nostalgie d 'une époque où faire des études constituait un plaisir et non une nécessité se voicnt accusécs de dilettantisme. C'est à elles qu' il appartient de prouver qu'elles sont aussi attachées que les hommes à leur métier, faute de quoi leur abandon de la profession constituera une perte incontestable pour la Société qui a contribué à les former.

Il faut reconnaitre que si certaines causes d'abandon restent valables : naissances rapprochées, maladies, changement de domicile il en est de moins acceptables telle l'attitude réticente du mari qui amène parfois la capitulation de l'ingénieur (e) devant l' épouse.

Félicitons-nous cependant qu'un tel état d'esprit tende à disparaître chez les jeunes, plus conscients que leurs ainés de la nécessité qu'ont leur épouse d'épanouir leur personnalité par d'autres moyens que ceux offerts à la femme au foyer.

Debouchès Examinons maintenant quels débouchés s'offrent plus spécifiquement à une femme munie d 'un diplôme d' ingénieur et qui a la volonté de faire carrière.

La recherche - Le développement considérable de la recherche depuis la fin de la dernière guerre a ouvert awe ingénieurs, et notamment aux femmes, des débouchés nombreux. Qu'il s'agisse de recherche fondamentale ou de recherche appliquée, le diplôme d'une grande école, auquel s'ajoutent parfois des titres Universitaires (licence, doctorat), confère au candidat une autorité certaine.

Les qualités exigées du chercheur : l'intelligence et les connaissances scientifiques, la persévérance, l'intuition et la curiosité scientifique, peuvent se trouver aussi bien développées chez la jeune fille que chez le garçon, et peut-être même davantage lorsqu'il s'agit d'intuition et de curiosité.

Les conditions matérielles de travail sont ici compatibles avec le tempérament féminin, contrairement à ce qui peut se produire parfois dans l'industrie.

Rien ne s'oppose donc, si elle en a le goût, à ce qu'une jeune fille sortant d'une grande école s'oriente vers la recherche.

Une enquête a montré que, dans les organismes de recherche fondamentale (l'Enseignement supérieur et le C.N.R.S. notament), à valeur professionnelle égale, l'embauche et la promotion sont identiques pour les chercheurs femmes et leurs collègues masculins. Il en est généralement de même dans les centres techniques industriels, organisme de recherche collective au bénéfice d'une profession.

Par contre, dans les services de recherche des grandes compagnies industrielles axés sur des études intéressant directement l'industrie en cause, et où les facteurs temps et rentabilité jouent un rôle prépondérant, on note une certaine réticence à donner aux femmes des "postes de responsabilité". Il s'agit bien entendu de cas particuliers, car il est bien connu que certaines grandes entreprises sont peu favorables au travail féminin, alors que d'autres, non moins importantes, comptent plusieurs ingénieurs femmes parmi leurs cadres. Une lente évolution semble se faire plus généralement dans ce sens, et c'est aux intéressées qu'il appartient de convaincre leurs employeurs de leur capacité à tenir ces postes.

L'industrie - Si donc, d'une manière générale, la recherche semble un domaine particulièrement favorable aux femmes, il en va un peu différemment de l'industrie, de certaines industries tout au moins (sidérurgie, fonderie, grosse industrie chimique)où, du fait même des conditions de travail qu'ils impliquent, certains postes de fabrication leur sont encore interdits.

Mais nombreuses sont les autres industries (hydraulique, optique, transports et télécommunications, électronique, matières plastiques, céramiques et produits réfractaires, industries alimentaires, etc.) qui sont en plein essor et qui emploient dans leurs ateliers un nombre croissant d'ingénieurs parmi lesquels on compte déjà un certain nombre de femmes.

L'industrie ne se limite d'ailleurs pas aux ateliers, et les bureaux d'études, les services de contrôle et de mise au point, ainsi que la partie technico-commerciale offrent aux femmes ingénieurs des débouchés certains.

Aux femmes que l'industrie proprement dite effraie, le diplôme d'ingénieur ouvre encore d'autres portes telles que la documentation - auxiliaire indispensable de la recherche - les services de brevets et de normalisation, la presse technique. Là encore, les mêmes qualités que dans l'industrie sont à déployer surtout s'il s'agit de diriger un service.

IV - INCIDENCE SUR LA VIE FAMILIALE L' exercice par une femme mariée d 'une profession à temps plein ne peut manquer d' avoir une incidence sur la vie familiale. Dans un article paru en 1964 dans IMPACT, rewe publiée par l'UNESCO, nous avons essayé de cerner le problème (5). Nous reprendrons ici les mêmes arguments.

Il ne faut pas se faire d'illusion, il est souvent difficile à une femme de concilier ses devoirs professionnels et familiaux, surtout si elle a plusieurs enfants. Elle devra mettre tous les atouts dans son jeu, se faire aider à la maison (son salaire le lui permet) pour qu'en aucune façon son entreprise n'ait à souffrir de sa qualité de femme, et, dans la mesure du possible, travailler non loin de son domicile.

Un schéma retraçant les différertes étapes de la vie familiale d' tune femme et leur incidence sur Sa vie professionnelle, dans le cas particulier de l'ingénieur,est reproduit ci-après, accompagné de commentaires qui visent à exprimer le caractère varié et nuancé d 'une réalite qu'il aurait quelque peu tendance à simplifier.

Notons tout d'abord que la forme seule, avec ou sans enfants, ne se pose pas la question de savoir si elle doit ou non travailler. A de rares exceptions près, elle est "dans l' obligation de le faire" tout comme l'homme (ici encore, à de rares exceptions près).

Seule la femme mariée et dont le Mari a un salaire décent peut se permettre d'avoir des cas de conscience : mon rôle se limite-t-il à mon foyer, puis-je, au dois-je travailler à l' extérieur et dans cette hypothèse comment m'est-il possible de concilier ces deux activités?

C' est ce cas particulier, mais relativement frequent que no us examinerons ici.

Différentes étapes de la vie familliale et professionnelle d'une femme (cas particulier de l'in génieur)

	Vie familiele	Vie professionnelle
1 re étape ↓	Célibataire	Sortie de l' école
25 ans	Mariage	Débutante dans la Profession
2^{e} étape ↓	*Ménage sans enfant*	
27 ans	Naissance du premier enfant	
3^{e} étape ↓	*Jeunes enfants* : charges familiales très lourdes	Chox de l' orientation Soumission a un horaire Strict.Peu de liberté du point de vue professional
35 ans	Dernière naissance	
4^{e} étape ↓	Allégement progressif des charges familiales.Passage des responsabilitiés d,ordre intellectual et psychologique	Augmentation progressive de I,activé professionnelle Accè à des postes de responsabilité.Déplacements fréquents.Nécessité d' étre << disponible>>, mais plus grande liberté d' action
45 ans	Enfants adolescents	
5^{e} étape ↓		
55 ans	Enfants élévés ou mariés	
6^{e} é tape ↓	Ménage sans enfant	Stabilité
65 ans	Retraite	Retraite

Deux choix sont alors possibles :

Essayer : a) d'adapter les exigences de la vie professionnelle aux impératifs des différentes étapes de la vie familiale; b) tenter d'adapter les exigences de la vie familiale aux impératifs de la vie professionnelle.

Nous nous placerons dans la première hypothèse, ce qui n'exclut pas la possibilité d'un planning d'ordre familial, bien au contraire.

Première étape (célibat.). Aucun problème spécifiquement féminin : adaptation à la vie professionnelle.

Deuxième étape (couple sans enfant). Une légère surcharge se manifeste sur le plan domestique par rapport à un homme placé dans les mêmes conditions. Cette surcharge peut être également répartie entre les époux, si le mari est coopératif. Par contre, elle peut devenir un handicap sur le plan professionnel si le mari : a) souhaite une vie sociale et mondaine très intense et n'accepte pas les charges correspondantes; b) fait passer sa réussite profesoionnelle avant tout et estime que sa femme est là pour lui mettre le pied à l'étrier.

L'importance de ces deux étapes doit être soulignée; elles permettent à la femme de s'adapter à la fois à sa vie professionnelle et à sa vie conjugale.

Il paraît souhaitable qu'elles s'étendent sur un minimum de trois ans, la première période pouvant être réduite à zéro.

Troisième étape (couple avec jeunes enfants). C'est sans aucun doute la période critique, les charges familiales étant alors très lourdes et difficilement conciliables avec la vie professionnelle. Il faut, à ce moment, éviter deux écueils : a) accorder la priorité a la vie professionnelle en sacrifiant le climat familial à créer; donner aux enfants l'impression qu'ils sont une gêne tant pour la vie professionnelle de la mére que les activités-loisirs que le couple pratiquait avant leur naissance; b) se laisser envahir par les problèmes domestiques, subir son travail professionnel d'une façon de plus en plus pénible, pour aboutir à l'abandon brutal ou au bâclage.

Solutions proposées. Consacrer une part importante, sinon la totalité, de son salaire à l'obtention d'une aide domestique efficace (au moins una personne ayant des qualités d'éducatrice). Ne pas accepter de nouvelles reaponsabi1ités professionnelles sans en mesurer 1a répercussion sur 1a vie familiale. Au besoin, réduire temporairement son activité professionnelle (temps partiel, choix d'une entreprise plus proche de son domicile ou à horaires plus souples). Sacrifier beaucoup de loisirs pour assurer aux enfant une présence "disponible" (dimanches, jours fériés, soirées).

Certains facteurs favorables encouragent la jeune femme à poursuivre : a) le mari souhaite que sa femme travaille et accepte les inconvénients inévitables que cette situation entraî ne pour son confort personnel; b) le ménage dispose d'un logement assez grand et proche du lieu de travail de la femme; c) la jeune mère dispose d'une aide domestique efficace; d) la jeune femme, le mari et les enfants ont une bonne santé; e) le ménage a établi un planning d'ordre familial et défini les tâches qui peuvent être confiées à des tiers; f) la jeune femme est intéressée par son travail et a de bonnes perspectives d' avenir dans l'entreprise qui l'emploie.

Ajoutons que certaines nécessités financières (aide aux parents, achat d'un appartement) rendent fréquemment les deux salaires nécessaires. Ce facteur, bien que négatif, oblige souvent la jeune femme à persévérer et à. surmonter les difficultés passagères. Le choix "accepté" ou "subi" à cette période de la vie d'une jeune femme pése très lourd sur son orientation professionnelle ultérieure.

Quatrième et cinquième étapes (enfant d'abord plus grands, puis adolescents).On constate une augmentation progressive de l'activité professionnelle. Les charges familiales sont peut-être aussi lourdes (transfert des préoccupations du plan matériel sur le plan psychologique, nécessité de recevoir, d'organiser les loisirs des enfants, leurs voyages et surtout de suivre leurs études), mais mieux supportées, souvent mieux réparties entre les époux (dans le cas d'un ménage équilibré).

L'équilibre financier est très amélioré.

L'accès à des postes de responsabilité entraî ne souvent un travail plus lourd et implique une plus grande disponibilité, mais laisse la femme plus libre dans l'organisation de son temps, ce qui se traduit par une meilleure utilisation de celui-ci.

L'effort psychologique d'adaptation à la vie familiale est moindre. Une organisation équilibrée de la vie est plus aisée.

A noter toutefois que souvent de nouvelles préoccupations surgissent, dues à la santé des grands-parents, qui deviennent quelquefois une charge pour certains.

Sixième étape. Il semble que les problemes qui se posent à cette période de l' existence sont assez voisins pour l'homme et la femme exergant une activite. Dans leurs dix dernières années de vie professionnelle, les couples voient en général leurs enfants se marier ou subvenir eux-mêmes à leurs besoins. Leur vie redevient celle d'un ménage sans enfants avec, toutefois - mais aucune de nous n'en a encore l'expérience - l'obligation de s'occuper de petits-enfants.

Tel est, brossé de façon très schématique, le tableau de la vie d'une feme qui a choisi de faire carrière. si les difficultés à surmonter sont loin d'être nég1igeables, elles sont largement compensées par l'expérience passionnante et sans cesse renouvelée qu'est l'exercice d'une profession.

Les femmes - reconnaissons-le - ont une grande faculté d'adaptation ; quand une tâclle les intéresse, elles s'y consacrent totalement et il ne fait aucun doute qu'elles peuvent réussir si elles ont les qualités requises et une volonté suffisante pour tenir bon.

V -<u>PERSPECTIVES D'AVENIR</u> Après avoir exposé la situation telle qu'elle se présente en france à l' heure actuelle pour la femme-ingénieur essayons d'imaginer l'avenir qui attend nos jeunes camarades récemment diplômées, nos filles.

Il est certain qu'i1 se produit actuellemont une évolution irréversible vers la formation et l'emploi en nombre égal de cadres supérieurs féminins et masculins - et en particulier des ingénicurs - Cette évolution est d'ailleurs conforme à l'intérêt de tous ainsi que le soulignait Yvette MENISSEZ au colloque de Royaumont en octobre 1966 organisé par "le Centre d' Information des Cadres Féminins et de la promotion Féminine" (C.I.C.F.) (5).

Dans le cas particulier des femmes-ingénieurs un certain nombre d' éléments supplémentaires sont favorables. Tout d'abord, le <u>dévelopmement de l'automatisation</u> de bien des opératios industrielles, l'utilisation massive d' ordinateurs et calculateurs électroniques entraî nera une diminution de plus en plus importante du travil physique de l'home au profit des travaux de conception et de mise au point convenant particulièrement aux ingénieurs-femmes.

Par ailleurs le fait qu'un ingénieur ne peut vivre désormais toute sa carrière professionnelle sur les connaissances qu'il a acquises à l'école a mis à l'ordre du jour <u>ce perfectionnement permanent</u> appelé "recyclage" qui peut constituer pour les femmes contraintes d'abandonner leur métier pendant quelques arnées (25-35 ans) une façon de rentrer dans le circuit de l'emploi.

D'autre part la réforme en cours de l'Enseignement Supérieur qui tend à former en Faculté des éléments (Docteurs 3éme cycle ou d'Etat) de même niveau scientifique qu'un ingénieur d'une grande école, est favorable aux femmes sil'on admet qu'une certaine "misogynie" règne parfois dans les jurys appelés à juger les concours d'entrée aux grandes écoles.et qu'un tel état d'esprit n'existe pratiquement pas en Faculté. Des filles en plus grand nornbre pourront accéder aux diplômes les plus élevés décernés par la Faculté et par la suite si elles le désirent briguer des postes d'Ingénieurs. Il va de soit que cette possibilité de tourner le "malthusianisme masculin" devra s'accompagner d'une évolution parallèle de la mentalité moyenne concernant le travail des femmes.

Les femmes qui travaillent et qui tiennent à leur métier ne doivent plus être considérées comme des exceptions surprenantes, voire choquantes, au regard de certains. Il est, et il sera de mieux en mieux admis qu'une femme pourvue de diplômes doit les exploiter et ne pas les laisser se dévaloriser.

Les femmes en place actuellement appartiennent à une génération charière entre leur mère et leurs filles et petites-filles. Les premières vivaient au foyer; travailler au dehors constituait souvent pour elle une tare, voir un déshonneur; les secondes se considèrent comme l'égale de leur maxi dont elles partagent ou partageront les responsabilités familiales et professionnelles.

Souhaitons égalemcnt que se développent les initiatives tendant à implifier, à dépersonnaliser et à organiser le travail domestique. D'une part, la création dans les les grands ensembles de super-marchés, de blanchisseries automatiques ouverts en dehors des heures normales de bureau, le fonctionnement d'entreprises collectives de ménage, de distribution de plats cuisinés à domicile qui permettraient de rendre plus rationnel et plus efficace le travail ménager. D'autre part, des services commodes et efficaces de garde d'enfants : crêches, garderies, organisation des loisirs, aides familiales en cas de maladie d'un nfant, toutes mesures qui permettruient de pallier ce fameux absentéisme des femmes en les soulageant de leurs tâches matérielles.

Conclusions - Il ne fait pas de doute que l'avenir des jeunes filles embrassant a carriére d'ingéieur se présente sous des abords moins sévères - tant du ,point de vue familial que du point de vue professionnel - que pour les généraions précédentes.

Des difficultés subsistent cependant que nos associations féminines devront s'employer à surmonter, nous les avons évoquées au cours de cet exposé et les résumons ci-dessous en guise de conclusion, pour essayer de dégager "les remèdes" .

a) A formation identique, plus grandes difficultés d'embauche pour les filles que pour les garçons.

b) Information insuffisante sur les carrières auxquelles clles peuvent prétendre, d'où hésitation à entreprendre des études longues et difficiles.

c) Préjugés inconscients des parents qui consentiront volontiers des sacrifices financiers pour les études des garçons, mais négligeront celles des filles.

d) Problème psychologique également chez les jeunes filles qui, souvent par sens de ce qu'elles croient être leur devoir, mais quelquefois aussi par commodité, préfèrent se consacrer uniquement à un futur foyer que de choisir une orientation.

Que pouvons-nous faire en contrepartie, nous les anciennes, pour faciliter et accélérer. l'intégration des jeunes femmes dans notre Profession?

a) Persévérer dans notre effort d'information objective vis-à-vis des jeunes filles des classes terminales. Leur faire savoir avec precision quelles études elles doivent entre prendre pour devenir ingénieur; ne pas leur dissimuler les efforts qu'elles auront à faire, mais aussi leur montrer l'intérêt qu'elles trouveront ensuite dans l'exercice d'un métier qui les mettra aU niveau de leurs collègues masculins;

b) Infonner parallèlement les parents, les éducateurs et les employeurs;

c) Encourager et aider l'action entreprise pour le développement des structures collectives (garderies, aides familiales, services ménagers) destinéea à alléger la tâche des mères de famille (7),

d) Attirer par tous les moyens (presse, radio, télévision, interventions parlementaires) l'attention des femmes cadres sur le danger que représentent pour elle ces lois à allure protectrice qui tendenta à généraliser le travail à temps partiel, à créer des horaires spéciaux pour les femmes, à prolonger les congés de maternité et qui n'aboutissent qu'à dévaloriser le travail féminin (8);

e) Enfin réclamer l'application de la loi "à travail égal, salaire égal".

C'est un lourd programne que nous devons nous efforcer à mener à bien dans les années à venire.

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FIG.1. Entrées et sorties dans le système scolaire français en 1973

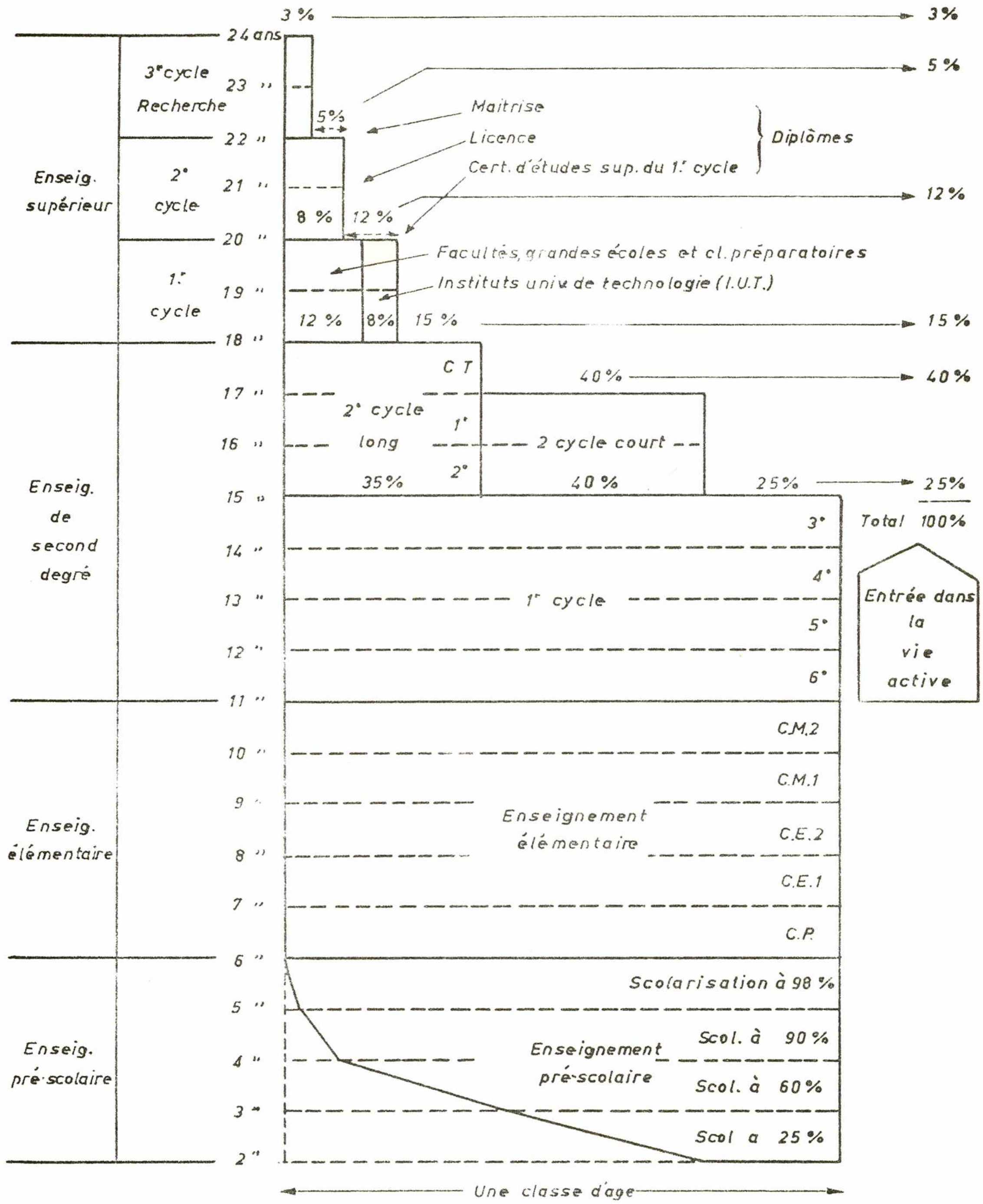


FIG. 2. Le nouveau régime des Etudes Supérieures Scientifiques

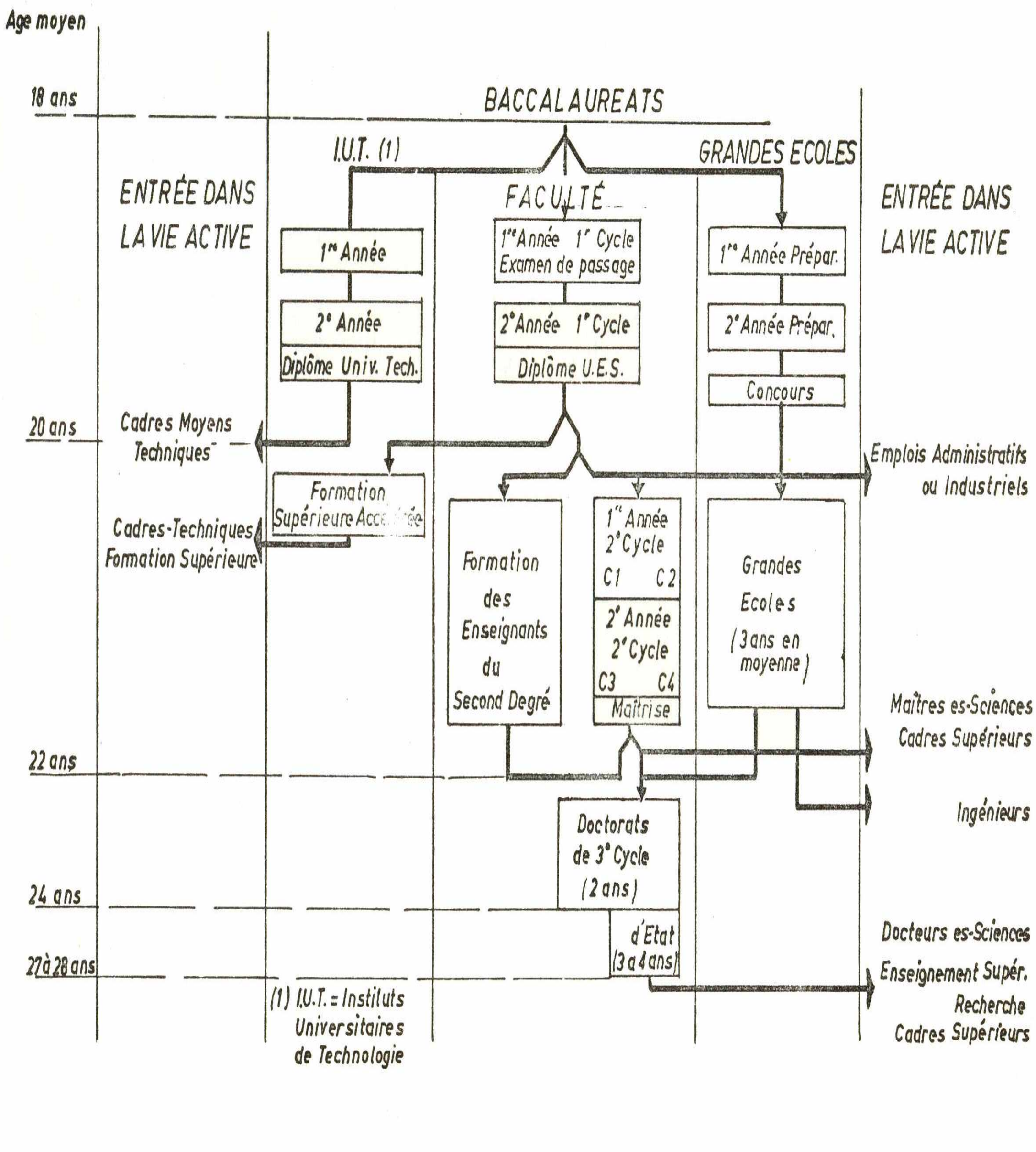


FIG. 3. Nombre de jeunes filles entrées chaque année à l'Ecole Supérieure de Physique et Chimie de Paris et à l'Ecole Centrale des Arts et Manufactures.

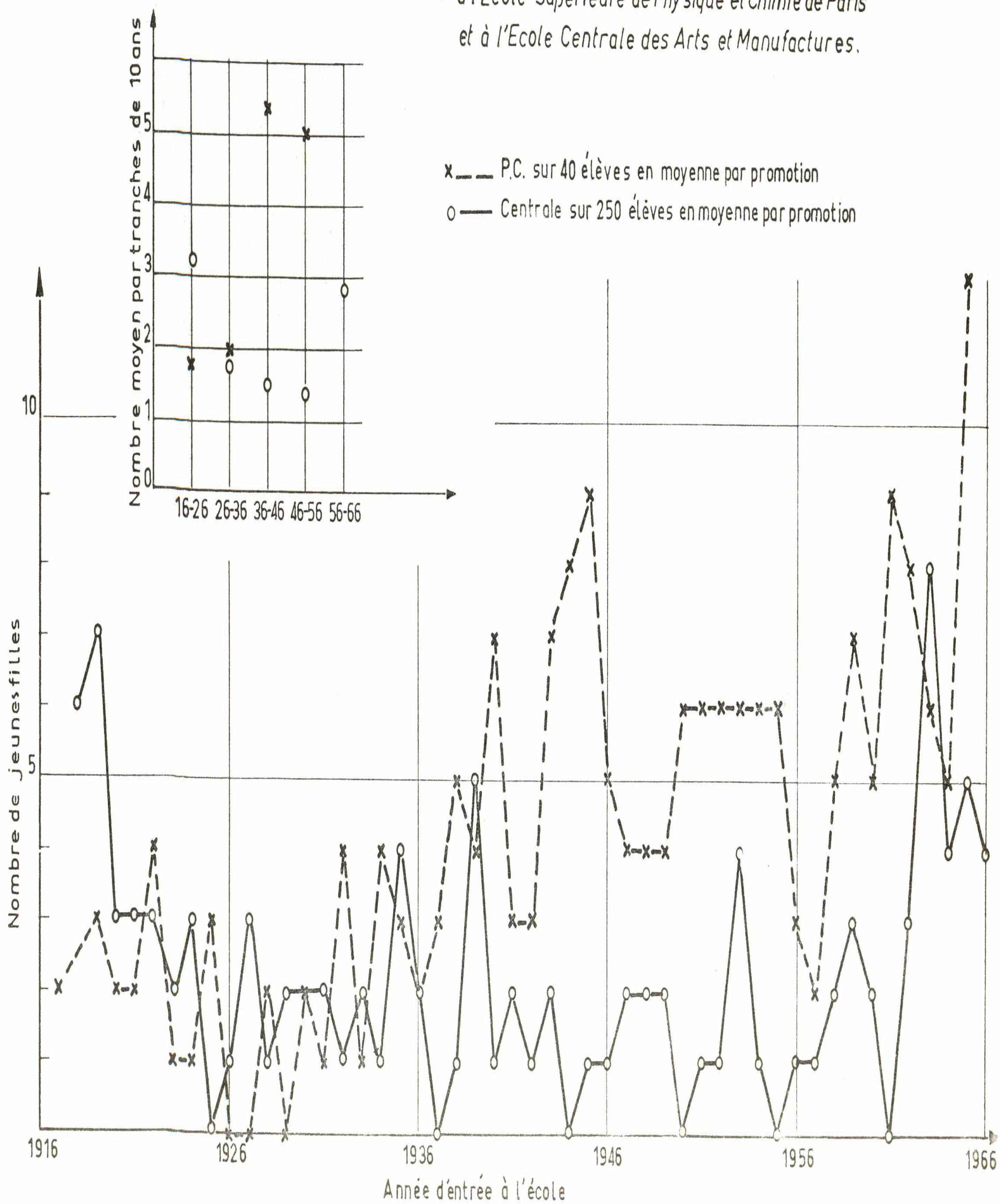
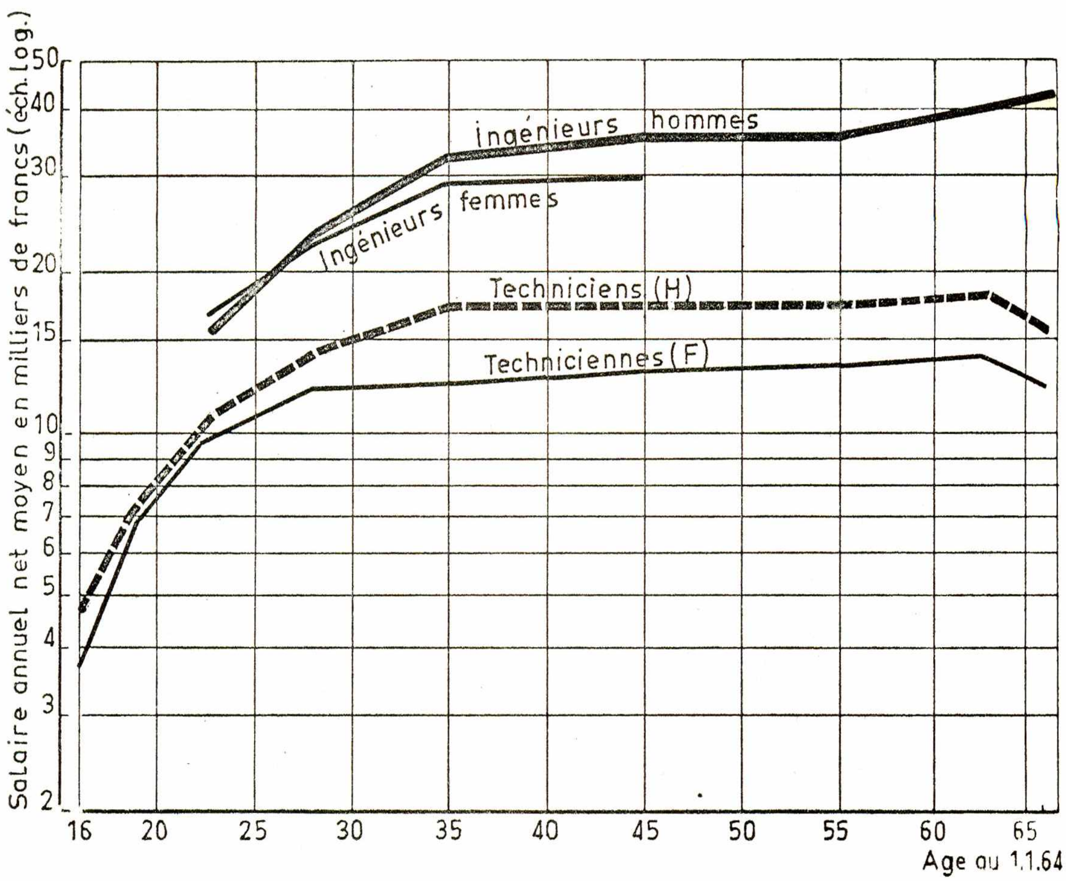


FIG. 4 - Salaires en fonction de l'age, du sexe et de la qualification professionnelle



WOMEN ENGINEERS TODAY IN GERMANY

By H. Brocher, Ingineer (grad.), textile engineer

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Publications: Methoden zum Nachweis der heute gebräuchlichen Textilfasern (1955), Nachweis von Farbstoffklassen auf Textilfasern (1963), Textile wet processing in Germany (1964), Das Identifizieren von Farbstoffklassen aus der Substanz (1966), Ingenieurinnen, Partner der Ingenieure - Berufsaussichten und Erfahrungen in der Textilindustrie (1964), Frau und Technik - heute (1966).

Summary In the Federal Republic of Germany woman is guaranteed equal rights by law which, however, does not mean that she actually has them in the field of technology. For years the Verein Deutscher Ingenieure (German Society of Engineers) has stood up for the cause of the woman and

created in 1965 the Ausschuß "Frauen im Ingenieurberuf" (Committee on Women in Engineering). The initial endeavours of the VDI have been to compile the professional problems of women in engineering in order to establish a clear conception for further activity. It has become apparent that the main reason for the infinitesimal small number of active women engineers is not a lack of technical abilities but the conventional attitude of society, which even today still prefers men to women in professional life and which grants the unemployed house-wife the highest level of social recognition and which, last not least, believes for a girl to plan her life is not obvious. As a result of that the education of girls, especially in mathematics and science, is not similar to that of boys. Furthermore a woman lacks security in a technical world created by men in which she has not yet found a successful example for her to follow 1966 the leaflet "Women Engineers in Industry and Administration" appeared. It should not be considered as an unscrupulous and eager advertisement for the engineering profession, but it is meant to give parents and girls reasonable assistance in choosing a profession. It gives information about the requirements for this profession, about the course of study at Technische Hochschulen (technical universities) and Ingenieurschulen (engineering colleges),about suitable fields of activity for women engineers, about possibilities for resuming practice after a temporary interruption and about the chances of further education in order to keep pace with the rapid progress of technology.

WOMEN ENGINEERS TODAY IN GERMANY

By H. Brocher

We all know that a modern industrial company determined to carry out its task cannot do without the professional collaboration of women. In the Federal Republic of Germany women's work has reached an extent that can hardly be increased. The majority of these women however work on the lower or at most on the medium level and we should there fore endeavour to raise the standard of female work. We have already a considerable shortage of qualified persons and - which is for us of particular interest - according to statistical prediction, in a few years time it will no longer be possible to occupy all the necessary engineering positions. Sensible considerations lead to the conclusion that we cannot afford it to leave abilities unutilized. In the opinion of experts a lot more women can be won to take up engineering.

At the present time about 1100 = 2, 9 % women study engineering at Technische Hocbschulen (technical universities) in the Federal Republic of Germany and only 800 = 1, 3 % at Ingenieurschulen (engineering colleges). About 80 female university students per year graduate in engineering and about 160 female students per year pass the examination at engineering colleges. The estimate is that in our country not more than approximately 2000 - 3000 women engineers are practising at present, which is an infinitesimal number on the labour market.

At the "Deutscher Ingenieurtag 1960" in Hamburg, the Verein Deutscher Ingenieure (German Society of Engineers) for the first time gave the floor to women engineers. Their problems were treated comprehensi vely in round-table discussions. A journal with a large edition published a summary under the concise heading “They won't let us". A very vivid discussion had shown the amount of prejudices against the woman engineer in industry and administration.

At the "Deutscher Ingenieurtag 1962" in Karlsruhe the discussion was continued subsequent to a number of papers on professional possibilities for women engineers. In München 1964 women engineers reported on their experiences in the fields of electrical and communication engineering, of chemical and textile engineering.

These special sessions held in conjunction with a "Deutscher Ingenieurtag" are gradually taken seriously by male engineers too. They began to realize that the summary judgement, namely "women Lack technical abilities and physical strength", remains on the surface of a real problem. It was felt that it is not enough just to discuss the matter every second year. It was admitted that intensive work should have to follow the suggestions.

At a conference of the VDI Department on Questions of Professional and Social status in 1965 the Ausschuß "Frauen im Ingenieurberuf "(Cammitte on Women in Engineering) was established. In this Committee the women engineers are not on their own with their problems and troubles, but they work together with engineers and they are supported by female and male representatives of the Federal Institute for Labour Exchange and Unemployment Insurance, Nürnberg, of industry, of the Trade Unions, of Technische Hochschulen (technical universities) and of Ingenieurschulen (Engineering Colleges).

The initial object has been to determine the possibilities which the engineering profession offers to girls and women. Among other aims it is planned to work out proposals for supplementary education for women engineers, which is meant to make it possible for them to resume their professional career after a longer interruption.

The work began by compiling the results of former discussions on the activities of women in engineering. The image of the woman of today in engineering was put together and shown at the "Deutscher Ingenieurtag 1966" in Berlin. Al though the German woman has equal rights she has, in the field of technology, not the same starting conditions as the man. The rising facilities offered to her are not the same as they are offered to the engineer. Equal position does not mean that she always gets equal salary, and real leading positions are out of reach for her. If you try to find the reasons for these facts you will see that most of her biggest difficulties come from the attitude of society. It begins already with bringing up and educating boys and girls differently, which need by no means be considered as basically wrong, but which nevertheless can easily be the cause for leaving certain gifts of girls undeveloped. when parents choose a profession for their daughter they usually look for a "feminine" profession and shrink from technical jobs. Particular difficulties arise for women when they take up engineering, because they have to work in surroundings coined entirely by man. Furthermore / in that new world a woman is not sure of herself because she lacks an example crowned with success. This picture clearly indicates that there are problems which have to be tackled in order to make it easier for her-to find and to make her way in professional life. Already at school one should start by laying better foundations for girls education in technology. This means that also girls should be taught mathematics, physics, and chemistry in such a way, that in an eventual later course of study they are on the same level as their male fellow students. Home, school and vocational guidance should be informed about the possibilities and limits girls have in engineering in order to give them advice according to their specific aptitudes. Courses at technical universities and colleges should be more adapted to the concerns of woman without however granting her an exceptional position. The required practical training should be better prepared and more suitably arranged. Attempts should be made to make industry more responsive to accepting women. Furthermore women in industry should also be paid and promoted on their merits. Engineers must change their thoughts and regard a woman engineer as an equal colleague. The situation of a woman is such that she might want a part-time job, and a temporary interruption for family reasons might become necessary.

All these problems of women engineers provided more than one approach to solving them in further committee work.

At first the summary judgement of society, namely that woman has no technical gifts, has been studied. Dr. Amthauer, who is a graduate psychologist and in charge of the education department of Farbwerke Hoechst AG, reported at the "Deutscher Ingenieurtag 1966" on the results of his experiments dealing with the differences in the structure of intelligence *the* sexes,. On a broad basis and well prepared he started testing boys and girls in their early childhood and he came to the conclusion that there are fundamental differences in the nature of male and female aptitudes. Technical understanding, mathematical abilities and a sense of space are much more frequent in boys than in girls. Girls on the other hand have a much better memory and have more talent for languages. In order to judge the skills of both sexes objectively, it would only be fair to establish different standards. If you assume that only specific engineering abilities can be prerequisite to a position in accordance with the education and to a permanent success, then women come off rather badly to begin with. On the other hand, tests have shown that women are more talented for compensatory attainments than men, and this faculty can make up for a lot. Balancing one gift against the other, psychologists have come to the conclusion that 5- 10% of girls are very well suited for a thoroughbred engineer and that 30 - 50 % can easily assume the responsibilities of an assistent. These figures show that a much higher percentage of girls have a gift for a profession in engineering than there are actually employed. Dr. Amthauer however explicitly pointed out that woman who want to take up engineering need very careful vocational guidance. If a woman has been educated in scientific and technical professions, then Dr. Amthauer strongly recommends that rising facilities should be improved and that their further education should be promoted.

Frau Dr. König who is on the Administrative Board of the Federal Institute for Labour Exchange and Unemployment Insurance in Nürnberg, read a paper and examined the attitude of authorities and industry toward female bosses and senior employees and discussed the possibilities women have in order to advance in their profession. Actually the group of qualified personnel of higher rank is much smaller than generally thought and the number of female seniors is exceedingly low. There is hardly anything from what experiences can be derived. (Due to the fact that specially for women there are certain fields of activity without possibilities of gradation, there is no point in looking for rising facilities, on the contrary, it is surprising that there have ever been chances for women to advance at all).

In industry and administration the possibilities for women to advance are almost exclusively on an internal basis, Chances for women in big firms or companies are exclusively on a medium level and only a few ever reach leading positions. The situation is more favourable in small firms or commercial enterprises. Regarding government positions only the female teacher is taken for granted, but if it comes to the post as headmaster, man is given preference. Social aspects are given as a reason, because it is felt that the position as headmaster with a higher salary should be left to a family man rather than to an unmarried woman. Only 2,8 % women are in superior government positions. In 1960, out of 2727 professors chairs 18 were held by women and only 6 of them were full professors. One might conclude that the opinion of industry and government were principally negative. But on the other hand certain realities which give women a worse starting point than men should not be overlooked. Regular senior positions can only be attained after many years of practice and long experience. This is what men have much more than women who often resign at a time when men have gained the necessary experience. Then employers have ample means of choosing a man and need not take any risks with a woman whose suitability is not yet based on experience. Industry and administration still consider that only male professional tradition and male leadership are possible which makes things difficult for a woman. It is however interesting to know that young and modern companies which have grown very fast offer good rising facilities to efficient women. If we look for the reasons we can see that these companies have democratic management, which is very much in line with the natural disposition of women. There it is much easier for them to reach leading positions. Here they can even be found in key positions. This development seems to justify a well founded optimism.

Frau Verwaltungsoberrätin Böckling commented on the possibilities for women to resume their professional practice. The structure of the whole professional life has changed. On one hand the trend to marry early has necessarily led to a reduction of the number of unmarried women in employment and on the other hand the percentage of married employed women between 40 and 60 years of age is continuously increasing. The idea of the "only housewife" society had in the 19th century can no longer be realized. There are branches of industry with more than 50% of married women. For a woman the alternative between marriage and family on one hand and the carreer on the other hand is no longer valid.It is felt that both should be sensibly combined. Sociology has developed a three-phase-theory according to which it is assumed that nowadays only one third of the adult life of a woman is devoted to household duties. At the first phase a young girl will get her vocational training and gather experience in her profession until she gets married or until she has her first child. The second phase should ,be devoted to the family. During the third phase her duties as a housewife decrease and she can again take up her professional life either in part or in full. A number of women, at that stage, are interested in serious work in senior positions. But in most cases they find out that they have lost track. Thus they do not find full satisfaction in their work, unless they put up with gradually struggling their way into the job. Others want only a part-time job with simple routine work. But such activities are less and less available in the course of the technical progress up to automation and rationalization. There is already a considerable lack of qualified personnel in the field of technology and after an interruption of profession a woman is hardly in a position to recover so qualified an education. A way out of this problem would be to provide an intermediate level for women practicing engineering, which takes account of their situation in life. 1965 the "Bundesminister für Arbeit und Sozialordnung" issued regulations pertaining to a programme for induvidual promotion. This provides financial assistance for women to participate in courses with a view to facilitating re-entry in professional life. Not many women make use. of this possibility. Probably the reason is that women in their forties to some extent have been poorly educated due to war and post war times and have gone through the toils of building up again their existence. They rarely longfor new activities. One can therefore say that the behaviour according to the three-phase-theory is recognizable in its initial stages; but that a conscious attitude to that course of life is still missing. This will probably change with the young generation. With better general knowledge, better professional education and with simplified domestic work for young women, their interest in resuming professional work in the third phase of life increases. Women of today in their second phase should in time be made familiar with a conscious attitude toward the mode of life in the third phase. Engineering organisations should help to keep them in touch with their profession, just as reading technical journals, attending meetings and short courses, replacing staff on leave and part-time work. In this connection it should also be pointed out that women in the third phase are more reliable, more conscientious .and trustworthy than younger women, so that not only their technical knowledge should be considered. In the Federal Republic of Germany the regulations of the labour and social law make things easier for women who resume their profession, whereas the civil servants law needs to be reexamined in this respect. Nothing can be said at this stage about the aims of women engineers in the third phase, because their number is extremely low and cannot be determined. Considerations in this connection can only serve as a guide. If the number of girls taking up engineering should increase we have reason to believe that they will deal with the problem of the duality of women in marriage and professional life.

The problems discussed so far always include one or the other point which should be brought to the attention of either society in general or to the attention of parents or of the girls.

It has been clearly stated that the image of the career woman, especially of the woman engineer, is changing, even if perhaps still unconsciously. The Committee on "Women in engineering" came to the conclusion that this development can or even most be promoted through publicity in order to help assimilating the requirements and expectations of technology to those of women engineers.

At the "Deutscher Ingenieurtag 1966" in Berlin, the Verein Deutscher Ingenieure presented a leaflet entitled “Women engineers in industry and administration - education and profession “. The contents is partly based on the aforementioned statements. It is intended to distribute the leaflet via vocational guidance departments of labour offices and also in schools with a view to objectively advising parents and pupils in the choice of profession, but this leaflet is by no means meant to advertise unscrupulously and eagerly for the engineering profession. In the leaflet it is said that people have realized that the engineering profession is not a pure man's profession. Apart from the fact that girls too have a talent for engineering, the technical and industrial development has greatly increased the field of activity of the engineer and has also opened new and promising roads. The risks for women engineers decrease with the gradually decreasing prejudices which men had established. It is particularly stressed that real propensity for science and a special gift for mathematics as well as a practical and technical inclination would be requisite for taking up engineering. The potential engineer must be physically fit. More girls than one would normally think meet all these prerequisites, but in most cases they just lack self confidence. During the studies girls and boys have of course to meet the same requirements. Experience has shown that girls are quite capable to do so without being physically overexerted.

In the Federal Republic of Germany "Diplom-Ingenieure" have been educated at Technische Hochschulen (technical universities) and “Ingenieure (grad.) “ at Ingenieurschulen (engineering colleges). The fields of activity of both types of engineers are in pricipal not different, but on account of the diverse requirements for admission to both educational institutions there are naturally certain typical possibilities of employment and work. Diplom-Ingenieure preferably have technical and scientific tasks in research and learning, in constructive and productive development as well as in technical and scientific management and administration areas. More "Ingenieure (grad.)" are found wherever in construction, development, production and sales there are problems of a practical rather than theoretical kind to be solved.

A woman engineer can principally assume the same responsibilities as an engineer. Specialization follows according to the individual inclination and interest. The woman engineer is particularly suited for research and development, laboratory work, documentation, patent matters, electronic computers and programming, market research, statistics, teaching, construction, precision mechanics, planning and sales. She can be placed on the same level and parallel to the man. She can resume her work after a longer interruption and she has the same chances as offered to an engineer who returns to his job after a longer sejourn abroad and she will be granted a certain period to bet into work again. Lectures and meetings offer possibilities for further education. A part-time job can keep her in touch with professional life even if, for family reasons, she cannot work full time.

These last sentences picture dreams of the future to which the Committee feels entitled. The bad situation of the labour market in Germany these last years has made it easier for women to go in for engineering, but I hope that I have pointed out at least some aspects which show that it is by all means feasible to make a virtue of necessity.

SOCIAL AND EDUCATIONAL ATTITUDES TO WOMEN IN PROFESSIONAL ENGINEERING WITH PARTICULAR REFERENCE TO INDIAN ENVIRONMENTS

By K.K.Khubchandani, B.E. (Elec.)

Miss K.K.Khubchandani did her B.E. in Electrical Engineering from the University of Bombay in 1963. She worked as Assistant Lecturer at Women's Polytechnic, Delhi for two and half years. Since June 1966 she is engaged in research work in High Voltage Engineering at Indian Institute of Science, Bangalore.

Summary: Women in India have started invading the field of engineering very recently. To date there are only about 275 women engineers in a total of 93,000.

The socio-economic conditions are such that more encouragement is forthcoming for women to take up a career and a career in engineering profession is a challenge to them. The favourable attitude of the family members is a big step towards meeting this challenge. The prejudices and narrow outlook towards career women in general were more prevalent twenty years back. This attitude also proved detrimental in securing proper employment.

It is a happy sign that this attitude is showing a change for the better. Women are proving as efficient as their men counter parts and the engineering community has accepted them at par with men.

Women engineers are mainly employed in teaching, design, development and research. The unfavourable psychological attitude of the labour prevents them from taking outdoor duties. Also they face the same difficulties in fulfilling their social role as women, as other career women do.

Women in India have just started harnessing their talents to the field of engineering; the future outlook appears to be brighter than what it was in the past.

SOCIAL AND EDUCATIONAL ATTITUDES TO WOMEN IN PROFESSIONAL ENGINEERING WITH PARTICULAR REFERENCE TO INDIAN ENVIRONMENTS.

By K.K.Khubchandani

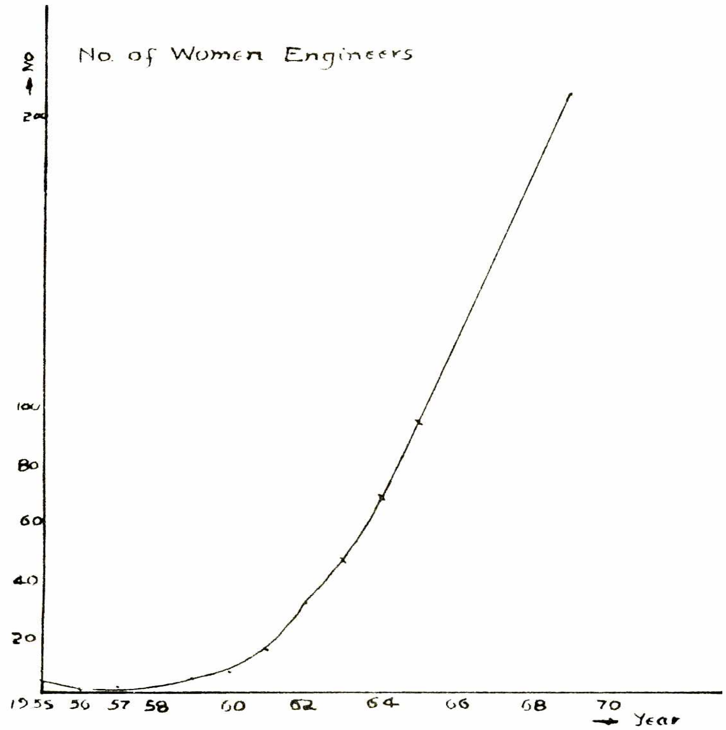
Time today demands more of women than the fulfilment of their traditional role as women and their biological role in continuation of human race. Human race can no longer afford to waste the enormous potential of man power of half of the world is population, not fully tapped yet. In developing countries like India, material and intellectual output of this potential would result in the acceleration of rate of social and economic progress.

With the turn of the century, women have realised this responsibility and have started participating more actively, in economic life, but their intrusion into the field of engineering is very recent. Very little information is available on a subject like social and educational attitudes to women in professional engineering and hence it is difficult to generalise.

This paper is based on a survey conducted by past. It would have been ideal to have measured the attitudes of every section of society towards women engineers, but since this was difficult, I confined myself to a few groups closely associated with her. The questionnaires were mailed to four groups of people (i) Women engineers (ii) Gentlemen engineers (iii) Heads of the Engineering Institutes (iv) Employers of engineers. Out of 160 questionnaires mailed 96 were replied.

Statistical Data

1. Number of women engineers: The first woman engineer in India took her degree in 1943. To date there are only about 275 women engineers amount a total of 93,000 engineers. (From "Demand and Supply of Manpower 1961-75" Report on Engineering Manpower I.A.M.R.1965). The above number of women engineers is estimated by interpolation of the following graph: The number of women engineers who qualified each year during 1955-62 period was obtained from Engineering Examination Results, Ministry of Education. This curve was extrapolated.from the graph.



No. of women graduating in	1963	-	46
	1964	-	68
	1965	-	94
till	1962	-	67
			275

Also University enrolement of women during 1964-65 in the faculty of engineering technology in all the universities throughout India is 878. Assuming the results as 75% each year (which is the average % of passing in Engineering courses) and a five year course, no.of women graduating in 1969 = $(.75)^5$ x 878 = 208. This point lies on the extrapolated graph.

The proportion of women engineers in total engineers in different countries in the year 1965 is given below:

Proportion of women engineers in different countries:

	Country	No. of women engineers in total engineers		
a)	U.S.S.R.	1	in	3
b)	France	1	in	50
c)	U.S.A.	1	in	100
d)	India	1	in	400

Note: Data a), b) and c) from 'Women no longer weaker sex' by Tatyana Baturina of U.S.S.R., Sept. 1965. Data d) computed.

2. The number of women engineers who qualified on the different branches of engineering is given below:

Distribution of women engineers branch-wise.

Branch	No. of women qualified	During years
Civil	24	1955 - 1962
Electrical	15	-do-
Telecommunication	13	-do-
B. Tech.& B.Sc. Tech	5	-do-
Mechanical	4	-do-
Chemical	3	-do-
Textile	3	-do-
	Total 67	

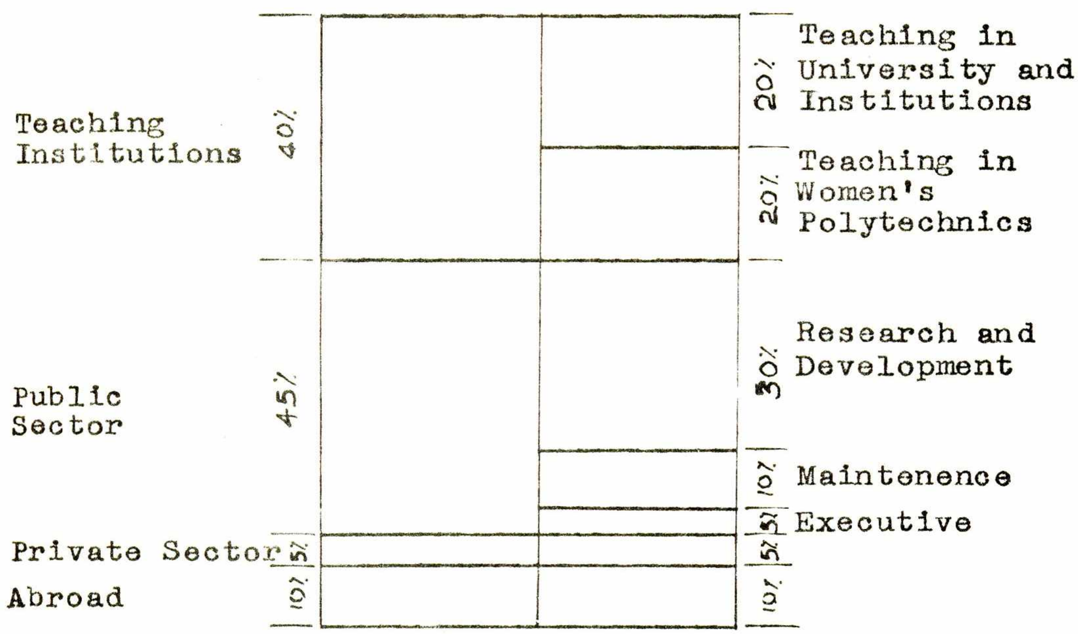
Data from University results, Ministry of Education.

The distribution branch wise at present is not determined exactly, but the number of Electrical and Telecommunication engineers is much greater than civil engineers. Mechanical, Chemical and Textile engineers are also less on number. I have got the following data of no. of women engineers who qualified in various engineering branches from Indian Institute of Science, Bangalore.

No. of women engineers who qualified in various engineering branches from Indian Institute of Science, Bangalore.

Civil	1
Electrical	1
Telecommunication	20
Mechanical	-
Chemical	1
Aeronautical	-

3. The places and the type of work women engineers are employed in.



Data by survey

Appendix I to IV give the questions put forth to above mentioned four groups of people and their answers. The answers that could not be accommodated in the tables are excluded.

Social and economic background of women taking up engineering.

The socio-economic conditions encourage women to take up careers, and a profession in engineering is a challenge to them. The present technical developments that fascinate them at a young age, encourage them to take up the challenge. Seeing the your female is attitude and inclination, the family members react favourably to her taking up the engineering profession. The women engineers generally belong to that class of society which is conscious of the technological progress and the change that is taking place in the country and in the world as regards the place of women in society. A woman taking up engineering is a big step towards strengthening the belief that she should take part in every sphere of life.

Social and Educational Attitudes:

1. Attitude of Parents: Most of the women engineers have reported that their parents permitted them to take up engineering course without hesitation.

2. Getting technical education: About two decades back many engineering institutes hesitated to admit women because of their prejudices and narrow outlook on the role of women. In 1933-34, one girl was actually refused admission in an Engineering College just because she was a girl. Admissions to engineering courses are strictly on the basis of merit i.e. through open competition. Women students being few, become quite conscious of their performance and reputation and till now they have established that they are more serious about their studies than men students. Though the majority did not find the courses difficult, to some the workshop and other practical work was strenuous.

In the beginning the male student community could not adjust itself to the idea of women becoming engineers. Hence their response was slow and watchful. The attitude of fellow students was not encouraging in the case of those who took up this career before 1960's. Most of them doubted whether women would be successful. This is also reflected in the attitude of their parents who hesitated to send them to engineering institutes. However, women engineers who have passed after 1960's did not find it difficult to get along with their fellow students and also their parents welcomed and encouraged their joining the profession. This definitely indicates a favourable change in the social attitude. Now that in many engineering institutes there are women students, and in every branch of engineering, there are women engineers, at least this class of society consisting of members associated with the engineering profession has accepted them at par with male engineers. Here I must point out that in every technical field, it is the man who is the yard stick for comparison.

3. Problem of getting a proper job: While the public enterprise has welcomed women engineers, the private employer still maintains his orthodox attitude. One of the employers has said that he would hesitate to employ a woman engineer because she will be a distraction to all the male engineers and workers around her.

Though there is some initial resistance in employing women engineers, there is a different attitude towards them once they are employed. The male colleagues as well as subordinates do not show any particular reluctance to accept them. A majority of the engineers feel that research, design and teaching are more suited to women engineers. The general feeling of the people about working women is that they get on easily in the jobs which are monotonous in nature. Are these two opinions not contradictory? Research, design and teaching need original thinking and planning on the part of the engineer.

Most of the women engineers are employed in design and development, teaching and research. Most of the members of the engineering profession have recommended these fields of work for women engineers. The psychological climate in this country is not yet ready for women to take up outdoor duties like construction projects, supervision and maintenance work in factories. This type of work needs dealings with unskilled and semiskilled labour force which is generally male, (labour force in heavy engineering factories consists or all men, in light engineering factories mixed, and for delicate and monotonous work mostly women), and at present juncture, the mental attitude of this class or people is not such as to accept a woman engineer to work with them be supervised by her.

4. Social attitude and social role: The social attitudes play a major role in an individuals life in India, that is, the individual is very much conscious of social status. For a long time the individual's behaviour was strictly directed by the rules prescribed by the society, especially that of women to whom the society was particularly unkind and neglected the need or change or her place in society with changing times.

A few decades back, woman was asked to play only the role of a homemaker. Ever since a girl was born in a family, the parents' main concern was to find her a husband end a home. The wakening of woman to the fact that she was to play a more active role came with the separation of the family from the joint family system which called for sharing the economic burden of the small family and with the influx of the foreign influence and modern education. Soon she entered those professions which offered scope far her earlier established capabilities to be made use of. Thus teaching, medical and arts fields were the first to attract women. The profession of engineering, hitherto understood to be 'man's field' also attracted her in the light of her chugged status in society.

The less informed female members of the society are amazed when they learn that one of them is an engineer. As such women who have careers others than engineering exclaim that they could also have taken this profession if the idea had occurred to them. This attitude is same as that of non career but conscious women towards career, who think that if they were properly qualified they could also contribute to the economic life. As the number of career women is increasing, women are invading all fields including that of engineering.

The majority of women engineers report that their profession interferes with their social responsibilities. This is perhaps a problem common all career women. We have not yet been able to organise the day to day life so that the career woman is freed from some of the responsibilities of household work. Before women started participating actively in economic life, all her time and attention was given to her role as home maker and mother. Now that she has to give a substantial part of her time to the profession, how is it possible to perform the same duties the same way? It is necessary not only to cut down the time and labour required for household work by bringing in mechanisation and automation but also that this work be shared by other members of the house and society. This calls for a sharing of the household jobs by husband provision of day care centres for children, and other such facilities.

India is undergoing a transit state in socio-economic progress and this change of , mode of duties of women is very slow. But the social climate is certainly favourable to her. We advise the younger female generation to opt for a profession in engineering.

APPENDIX I

Questions put to woman engineers and answers.

Total no. of women engineers - 25

Q. No.	Questions	Answers	Frequencies
1	Did your parents oppose, hesitate, permit or encourage your taking up Engineering profession?	Oppose Hesitate Permit Encourage	0 5 5 15
2	If you are married, what is your husbands attitude towards your profession?	Helpful Neutral Not helpful	10 2 0
3	If you are unmarried, are you looking for an engineer life partner? If yes why?	Yes Not necessarily an engineer	7 5
4	Is your husband an engineer? If not do you come up with any problem because he is in a different profession?	Yes No	8 4
5	Was it difficult for you to get admission in engineering institute?	Yes No	2 23
6	Were you ever refused admission in any college because of your being a woman?	Yes No	2 23
7	Do you believe that engineering course is more difficult than any other course for women?	Yes No More strenous	2 21 2
8	Did you like your subjects? Give reasons for the answer.	Yes No	25 0

Q. No.	Questions	Answers	Frequencies
9	Did your fellow male Students accept you at par with them?	Yes No Made them do so.	15 3 7
10	How did the teaching staff reaot to you?	Helpful Not helpful	21 4
11	Did you have difficulties in finding a job? If yes what difficulties did you encounter?	Yes No	12 13
12	Have you found a job to your liking?	Yes No	19 2
13	Do you like your work?	Yes No	20 1
14	Do you think you are paid for your work? As for instance a male engineer would be paid in your place?	Yes No	17 2
15	Does your employer accept you as an engineer or as a female engineer?	As an Engineer As a female engineer.	12 11
16	Do your male colleagues accept you at par with them?	Yes No	18 4
17	Do you get ready co-operation from them?	Yes No	18 4
18	Is your authority accepted by your subordinates?	Yes Yes, but with reluctance. No	17 4 0
19	Do you prefer indoor work of field work?	Indoor Field Both	9 1 11

Q.No.	Questions	Answers	Frequencies
20	As a woman, what handicaps do you face on the field?	Physical strain. Managing the labourers. None. No opinion Dress	8 2 2 1 1
21	Would you like to go into defence services?	Yes No	10 14
22	How long do you think you will be able to persue this profession?	Till retirement. Till conditions permit.	17 8
23	What is the reaction of the members of your own sex, towards you in society?	Surprise and appreciation Normal Un favourable &: jealous	18 3 3
24	What is the reaction of the members of your opposite sex, towards you in society?	Surprise & appreciation Normal Unfavourable	13 8 1
25	Do you feel by taking up the profession of engineering, your status in society has been raised?	Yes No	13 12
26	Would you advise your younger generation (women) to go in to the profession at engineering?	Yes No	23 2
27	If yes, which branches of engineering would you recommend and why?	Any Civil Electrical Telecommunication Mechanical Chemical Textile	9 0 6 12 2 0 0

Q.No	Questions	Answers	Frequencies
28	Do you think that your profession conflicts with your social role as a women? Please comment.	Yes No	5 9
29	Please furnish the following data (i) name of the institution where you qualified. (ii) Number of women engineers passed out till 1965 from this Institution		
30	Names and addresses of women engineers you know		

APPENDIX II

Questions put to 'Gentlemen engineers' and Answers

Total no. of engineers - 22

Q.No	Questions	Answers	Frequencies
1	What do you think about women taking up engineering profession.	For Against	20 2
2	Do you think women can make competent engineers	Yes No Doubtful	20 0 1
3	Do you have women engineer colleages at your work place? If yes what do you think about their work ?	Good Not Good	13 2

Q.No.	Questions	Answers	Frequencies
4	Do you think a woman engineer has any natural advantages or disadvantages over male engineer by virtue of her sex?	Yes No	13 6
5	Do women engineers co-operate readily?	Yes No	17 2
6	Out of the following which type of work do you think is suited to woman engineer i) teaching ii) research iii) industry iv) office v) field	Field work not Suited In order of preference i) teaching ii) research iii) office iv) industry v) field	4 18
7	In your opinion is it proper to reserve some seats for women on engineering institutes?	Yes No	1 21
8	Are you a bachelor? If yes, how would you like to marry a woman engineer?	Yes Profession is no bar No	6 3 3
9	If you are married, would You encourage your daughter (or young female member) to take up engineering profession profession?	Yes No	12 4

APPENTIX III.

Questions put to 'Heads of the Engineering Institutes' and their answers.

Total no. of answers - 13.

Q. No.	Questions	Answers	Frequencies
1	What do you think about women taking up engineering profession?	For Against	1 0

Q.No.	Questions	Answers	Frequencies
2	Are there women undertaking engineering courses in your institute? If yes, how is their performance in comparison with male students?	Equally good Better Inferior	10 2 0
3	Have you noticed any difference between women and men students in studiousness?	More studious Less studious No points	7 0 6
4	Do you have women on teaching staff or doing research? If yes, how do you evaluate their performance in comparison with men in the corresponding fields?	Equally good. Better Inferior	8 2 0
5	Do you think women should be encouraged to take up engineering profession?	Yes No	12 1
6	Would you recommend any specific branches of engineering for women?	Civil Electrical Telecommunication Mechanical Textile Chemical Light Engg.	4 6 10 2 2 4 12
7	Out of the following, which type of work do you think, is more suited to a woman engineer. i) teaching ii) research iii) industry iv) office v) field	Field work not suited.	12
8	In your opinion is it proper to reserve some seats for women in engineering institutes?	Yes No	0 13

APPENTIX IV

Questions put to Employers of Engineers and their answers.

Total no. of answers – 39

Q.No.	Questions	Answers	Frequencies
1	Do you have women engineers working in your establish-ment? It yes now many, in what branch of engineering?	Yes No	21 18
2	If no, would you hesitate to give employment to a woman engineer? If yes, why?	Yes No	5 13
3	If you have women engineers working in your establish-ment do you encouter any special difficulties? If yes, what?	Yes No	6 15
4	Do you consider her as competent as a male engineer? If not, please comment.	Yes No	19 2
5	Would you prefer a male engineer in per place? If yes, why?	Yes No	7 14
6	Do you think a woman engineer is accepted by her colleagues and subordinates?	Yes No Yes but with reluctance	16 3
7	Out of the following which type of work do you think is more suited to women engineers. i)teaching ii)research iii)industry iv)office v)field	In order of preference i) teaching ii) research iii) office iv) industry v) field	30

THE FILIPINO WOMAN PROFESSIONAL ENGINEER IN THE 60' S

By Zenaida Gonzales Gordon, BSChE, MSChE

Zenaida Gonzales Gordon completed her Bachelor of Science in Chemical Engineering degree from the University of Santo Tomas, Manila, Philippines in 1959 and passed the government examinations for professional chemical engineers in the same year. She graduated with a Master of Science in Chemical Engineering degree from the Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A. in June, 1961. Two months later, she joined Inhelder Laboratories, Inc., a Philippine pharmaceutical firm as Head of the Chemical Laboratory, in-charge of quality control. In 1962, she was appointed chemical engineer of the Research & Development Department of The San Miguel Corporation, the largest Philippine corporation, and was promoted to Senior Chemical Engineer in 1965.

Summary With a large part of Asia in political turmoil, due mainly to social inequities and economic imbalance, the Filipino people are conscious of the urgent need to promote our national growth. Fortunately, there is a current re-awakening to harness all human resources more purposefully to bring us out from the shadow of social and economic backwardness. To meet these problems of nation building, we are making all efforts to expand our technical and scientific manpower as a means of increasing the tempo of our industrial development. In growing numbers, our women have penetrated the technical fields and other areas of human endeavor previously dominated by men. Our women professional engineers, numbering about 3% of the total lot of registered professional engineers have performed and are performing their functions with imagination and versatility. Her employability, working conditions and wages have improved considerably; her continuing search for knowledge to attain professional efficiency and dedication to her particular line of endeavor has enhanced her image in the 60' s. The Filipino woman professional engineer aspires to build her own image of leadership in the national effort to make her country a good place to live in.

<u>THE FILIPINO WOMAN PROFESSIONAL ENGINEER IN THE 60 ' S</u>

By **Zenaida Gonzales Gordon**

The Philippines, a developing nation emerging from centuries of a feudal economy, is a country of 33 million people. A mixture of several races like the Chinese, Hindu, Spanish-Mexican, and American, the Filipinos are, however, predominantly of Malayan strain.

At the time of the Spanish conquest (circa 1571), the country had a population of 500, 000 and did not have any contact or external relations with the rest of the outside world. Spain's greatest contribution was the Christianization of the Filipinos. She introduced European culture but actually did very little to educate the masses and to improve their economic and social condition. For more than 300 years the Filipinos lived, existed and survived under an agrarian economy unbelievably feudal in character that kept the peasantry in perpetual poverty with practically no hope for a full and satisfying life. The Filipino woman was a housekeeper, and no more; her hush-and was a farmer from sunrise to sunset four months of the year, and the rest of the time he was nursing a revolt to extricate and free himself from economic and political bondage.

England, perhaps, lost an opportunity and a challenge when Admiral Samuel Cornish took Manila in 1762, for she could have changed the pages of history by introducing and planting the seeds of industrialization amongst our people. But after three years of occupation, she felt that possibly the prize was not worth the trouble and she decided to let others do it. America, later did her part and to her everlasting credit, she introduced mass education and eventually developed an export market solely dependent upon her as the market. She taught the people the meaning of freedom which has been denied them for so many years. She trained the Filipinos in the art of government and sowed the seeds of democracy.

During these years of American tutelage , the Filipino woman, by nature, shy, reserved and conscious only of her primordial role as a housewife, began to emerge from her eggshell and started to discover slowly but surely that she was capable of undertaking other occupations outside the home. Bravely, and in increasing numbers, our women invaded the teaching and medical professions, and timidly at first, but with confidence and courage, she ventured into commercial enterprises and business management. In many instances, armed with intuition and a delicate sense of balance, she achieved remarkable success, surpassing even men in their efforts to pilot small or large businesses.

World War II had brought dynamic changes in the lives of nations and their peoples; it had created political upheavals, revolutionized social and economic thinking; it had advanced and is advancing the frontiers of science and technology to make this world a better and happier place to live in. In the universal effort to gain knowledge and promote technological skills in the professions, women have become and are common partners with men in human enterprise, for women had more than demonstrated their capacity to acquire and use knowledge for the benefit of mankind, as intelligently and effectively as men.

In the 1950's, the Philippines, struggling to overcome the ravages of war, went through a financial crisis. She was compelled to impose financial and economic controls to survive. It was a time for a reexamination of national objectives and economic thinking; a time for reviewing the directions of national growth; and a rethinking of the multifarious business and professional activities of Filipino men and women to accelerate the industrialization of the country. With our population increasing at a staggering rate of 3.2% per year, we were faced with the stark reality that the development and advancement of our country can not be achieved without industrializing our economy. And industry needs technical and scientific manpower, of both sexes.

The Philippines, today, just like her Asian neighbors, cannot afford to ignore half her population, the women, who want to be responsible participants in the betterment of social and economic order. Educational advances have re-shaped the woman's role in the new social structure. The modern Filipino women can not stand still, sit by, or be oblivious to the technical, economic, political, and social changes now taking place in our country. She is conscious of her capabilities and the role she must play in nation building; she is willing to meet this challenge and to establish her own image in the advancement of education, business and the professions. Her progress in the various professions can be seen from an over-all count of registered professionals and non-professionals* in the scientific and technical fields from 1902 to 19660 Appendix Table 1 shows that the males exceeded the females only by 2.32%.

What about Filipino women professional engineers? As of 1966, women

* Those who have passed government examinations given by the Civil Service Commission and are duly licensed to practice in their respective fields.

accounted for about 3% of the total number of registered professional engineers. This paper aims to present the current status of the Filipino women professional engineer- her employability and job opportunities, her working conditions and wages, her maintenance of professional growth and acquisition of new knowledge, and her awareness of the role of technology in the national effort to industrialize the country. The basic material used in this study was a compilation of submitted data and information through letters and interviews of 200 working women chemical engineers*, roughly 55% of the total number of members of the Women Chemical Engineers of the Philippines, an association of 361 members. Of these 200 women engineers, 45% were employed by the government, 17% were in industry. About 29% were in education, teaching in the grade high school or university level, 8.5% were out of the country either as postgraduate students or employees and only 0.5% were working without permanent designations. The types of work being performed by these women professional engineers can be divided into the following categories:

Executive, Management Positions	- 2.0%
Research and Development	- 25.0%
Design, Production and Application	- 28.0%
Information, Technical Writing, Technical Librarian	- 3.0%
Teaching, Grade High School level	- 13.0%
Teaching, University level	- 16.0%
Others, Technical level	- 3.0%
Miscellaneous, Non-technical	- 1.0%

Current statistical data show that our women professional engineers are applying their technical knowledge, have performed and are performing their functions with imagination and versatility. Her employability, working conditions and wages have improved considerably, as shown by the following data.

Table 1
Gross Annual Earnings of the Filipino Woman
Professional Engineer by Placement, 1966

	Gross Annual Earnings, 1966 (in Philippine pesos**)		
Employment	High	Low	Average
Government	12,000	1,800	4,442
Private firm	36,000	2,160	6,764

* 79.86% of the total registered women professional engineers are chemical engineers
** One Philippine peso is equal to £.09 British pounds

Teaching	High	Low	Average
Grade / High School level	4,000	21500	2,957
University level	9,600	3,360	5,902

The 1966 over-all average earning of the Filipino woman professional engineer was ₱4,920, as compared to the 1963* average of ₱4,068 an increase of almost 21.0%.

Further, the woman professional engineer of the 60's are well aware of the many technological advances in science. She has maintained her professional growth through refresher courses; acquired new skills through training in other disciplines. Amongst the fields chosen by them in the pursuit of new knowledge are: Business Administration, Economics, Industrial Management, Nuclear Technology, Pulp and Paper Technology, Biochemistry, Statistics, Law , Actuarial Science , Paint and Leather Technology , etc. Of the 200 women engineers included in this survey, 15% had one or two degrees aside from their basic Bachelor of Science in Chemical Engineering degree; 20% had special studies in selected fields or are studying courses leading to other advanced degrees. This continuing search for knowledge to attain professional efficiency and dedication to her particular line of endeavor, has enhanced the image of the woman professional engineer and, consequently, augmented her income potential.

Table 2
Comparative Earnings of the Woman Professional Engineer, 1966

	Gross Annual Earnings, 1966 (in Philippine pesos)		
Woman Professional	High	Low	Average
Engineer with 1 or 2 degrees aside from BS Ch E	36,000	3,748	7,729
Woman Professional Engineer with special studies or other studies leading to a degree	10,800	2,256	5,595

Considering that the minimum annual income of a Filipino in 1966 is

*Result of the 1963 Salary Profile Survey conduced by the Women Chemical Engineers of the Philippines

₱1, 800, it can be concluded that the woman professional engineer is indeed receiving a favorable return for her efforts.

Conclusion With a large Part of Asia in political turmoil, due mainly to social inequities and economic imbalance, the Filipino people are conscious of the urgent need to promote our national growth. Fortunately, there is a current re-awakening to harness all human resources more purposefully to bring us out from the shadow of social and economic backwardness. To meet these problems of nation building, we are making all efforts to expand our technical and scientific manpower as a means of increasing the tempo of our industrial development.

In growing numbers, our women have penetrated the technical fields and other areas of human endeavor previously dominated by men. We have made an auspicious beginning; achieved some measure of success in the past and look forward to continuing progress in the engineering profession. Let it not be said that at this time when we find ourselves at the threshold of a new surge of growth, the women professional engineers of the 60's did not contribute their share in the economic development of the Philippines. Let it not be said that in times of stress she did not respond to the call of duty, for she is as much a part of the nation as their men, and shares in common with them the product of their joint endeavors. Imbued with this spirit, the Filipino woman professional engineer aspires to build her own image of leadership in the national effort to make her country a good place to live in.

A P P E N D I X

Table 1
Registered Professionals & Non – Professionals in Scientific & Technical Fields, Philippines, 1902-1966

Registered professionals & Non –Professional	**NUMBER**			**PER CENT**		
	Total	Male	Female	Total	Male	Female
Total	120041	61414	58627	100.00	51.16	48.84
A Medical & Related Fields	83014	27130	55884	69.15	22.60	46.55
Dentists	11234	6248	4986	9.36	5.20	4.16
Dieticians	543	-	543	.45	-	.45
Nurses	27234	1029	26205	22.69	.86	21.83
Optometrists	2045	718	1327	1.70	.60	1.10
Pharmacists	17553	1747	15806	14.62	1.46	13.16
Physicians	23773	16781	6992	19.80	13.97	5.83
Veterinarians	632	607	25	.53	.51	0.02
B. Chemists	2577	870	1707	2.15	.72	1.43
C. Engineers	25928	24950	978	21.60	20.78	.82
Chemical Engineers	2969	2188	781	2.47	1.82	.65
Civil Engineers	8169	8034	135	6.81	6.69	.12
Electrical Engineers	2713	2721	10	2.28	2.27	.01
Professional	529	528	1	.44	.44	-
Associate	559	558	1	.47	.46	.01
Assistant	1643	1635	8	1.37	1.36	.01
Mechanical Engineers	9172	9168	4	7.64	7.64	-
Professional	1325	1325	-	1.10	1.10	-
Mechanical Plant	1970	1970	-	1.64	1.64	-
Junior	5877	5873	4	4.90	4.89	.01
Mining Engineers	738	736	2	.61	.61	-
Sanitary Engineers	258	247	11	.21	.20	.01
Agricultural Engineers	164	161	3	.14	.13	.01
Geodetic Engineers	1724	1692	32	1.44	1.41	.03
Geologist	3	3	-	-	-	-
D. Surveying	2693	2665	28	2.24	2.22	.02
Private Land Surveyors	2346	2318	28	1.95	1.93	.02
Cadastral Land Surveyors	158	158	-	.13	.13	-
Mineral Land Surveyors	189	189	-	.16	.16	-
E. Other Technical & Related Fields	5829	5799	30	4.86	40.84	.02
Chemical Technicians	164	152	12	.14	.13	.01
Certified Plant Mech.	3693	3693	-	3.08	3.08	-
Master Electricians	1265	1265	-	1.05	1.05	-
Master Plumbers	399	381	18	.33	.32	.01
Mill Foremen	82	82	-	.07	.07	-
Mine Foremen	217	217	-	.18	.18	-
Quarry Foremen	9	9	-	.01	.01	-

THE SOCIAL AND EDUCATIONAL ATTITUDES TO WOMEN IN PROFESSIONAL ENGINEERING IN SWEDEN

By Ragnhild Wallin

Ragnhild Wallin graduated from the Royal Technical University in Stockholm in chemical engineering. Active as the first woman examiner at the National Swedish Patent and Registration Office, then working at the Boliden Mining Co in wood impregnation research and as patent engineer, later also as principal librarian. Now active at the Patent and Licensee department of the Sandvik Steel Mills. Member of the Association of Swedish Inventors Club, of the Society of Patent Engineers of the Swedish Industry, of the Swedish Association of Engineers and Architects / of the editorial board of Corrosion Abstracts issued by the Swedish Corrosion Institute.

Summary

In Sweden today there are about 100.000 engineers of all educational degrees, 2 % of which are women. According to the latest official population census in 1960 there were 84.592 male and 1610 woman engineers, among them 16.849 men and 284 women with master degrees.

In the year 1920 women were admitted as regular students at the Royal Technical University in Stockholm. The majority of woman engineers are architects and about one third of them are in chemical branches. Only half a percent of engineers with master degrees working in privately owned industry are women.

In 1960 we had 81.152 university graduated persons in Sweden. 21% of them were women and 70 % of these women were economically active, the woman engineers among them also having an activity rate of 70 %. The economical activity rate for all Swedish women in the actual ages 25 - 64 is 38 %.

Due to financial study help from the government the number of highly educated people is growing and it is supposed that the portion of women among the engineers will increase more than the portion of women of university graduates altogether. Equality is, fully accepted except for a small reduction in salary.

THE SOCIAL AND EDUCATIONAL ATTITUDES TO WOMEN IN PROFESSIONAL ENGINEERING IN SWEDEN

Ragnhild Wallin

In 1842 it was decided in a Swedish law that every boy and girl had to go to school and learn to read and write. Last year a new form of compulsory education started. When 7 years old the children begin a nine year comprehensive school divided into three stages:

1. The lower stage, classes 1 - 3
2. The intermediate stage, classes 4 - 6
3. The high stage, classes 7 - 9

This is intended to give about the same education as the former junior high school which is now disappearing.

After the compulsory school the teenagers go of their own free will either to vocational training institutes or to senior high school for 3 - 4 years. There are different sides in the latter some of them mainly intended as a preparation for university studies. One of them gives in 4 years a certificate in engineering in either of 4 different branches: chemical, mechanical, electrical and building engineering. It is of course possible to continue at a suitable kind of university. we have two complete Technical universities with 10 sections in Sweden, the Royal Technical Institute of Technology in stockholm, which started 1877, and Chalmers Institute of Technology in Gothenburg. The main sections are the architectural, mechanical, electrical, civil engineering, chemical, metallurgical, surveying, physical, shipbuilding and aeronautical. As the government plans for the future to educate twice as many engineers a year as now, two more Technical Universities are being built. After 4 - 5 years of studies a master degree is achieved usually at an age of 24 - 25. There are also possibilities to continue the studies for doctor degrees.

There are also other kinds of engineering certificates, a very common one is attained in 3 years after the previous junior high school comprising about 25 different branches. Another certificate is available in 2 years after compulsory school and those studies are often arranged as evening courses for wage earners.

According to the latest complete population census 1960 Sweden had 7.4 millions inhabitants. About 80.000 people held university degrees and 21% of then were women. This is about 3 % of the total male population of the age 24 - 65 years and less than 1% of the female population of the same ages. Due to financial study help from the government this rate is rapidly increasing. Most women at universities go to the faculty of arts and sciencics, studying languages and history of literature; and after the examination many become teachers.

As for engineers the total number with certificate of any degree was 84952. Of these 1610 were women, which is less than 2% of the total number. There were about 300 women and 16850 men with master degree in engineering. That is about the same female rate as for all degrees of engineers. It is expected that the percentage of women among technology students will soon increase faster than among students in other faculties. The most optimistic forecast says it might become 12%. The relative number of women in the engineering, now being only 2% of all engineers, is remarkably low in comparison with the relative number of women in the academic professions as a whole, where it is 21% .In 1901 the first women studied at the Royal University of Technology and become an architect but could not get a formal examination certificate ,as women were not admitted as regular students until 1921.Among the women engineers one third are in chemistry ,the majority being architects, but women are also educated in the electrical ,mechanical, physical, metallurgical sections and exceptionally also in other sections ,as for instance civil engineering.

In engineering as in other academical professions women make use of their education in wage earning to 70%. of course there is a clear tendency to a higher tendency to a higher frequency for more profitable employments requiring a higher education .In 1965 only about 30 women with master degrees in engineering were employed in the private sector of industry which is less than half a percent of men with the same degree. About 30 % of the women engineers are working in government service. Some of them also are independent enterprisers. But it is very astonishing that we are so few, considering the rather long time we have been free to study technology. Engineers are well paid and esteemed in society and there has been much discussion about what to do to increase the number of them.

The principal of equality between sexes is quite accepted in Sweden, a woman can choose any profession if she only has the education. We get as much work and responsibility as we want when we have proved our ambition but as equality is not yet quite accepted practically we get less paid than men for the same job. Of course it is not valid every where but about the same reduction rate of salary is to be found on all levels of education and responsibility. This rate varies from 80 to 90 % in private owned industry. In governmental employment the salary is equal for both sexes regarding the same situation but the low relative number of women in higher positions seems to indicate there is not equality in advancement. In Sweden there is never made a sincere official calculation of the loss for the society depending on unexploi ted or not fully exploited capacity of well educated women, though there has been very much talk about shortage of personnel, especially engineers. In our industry women have earlier usually been employed only in such work which does not require high physical strength or mechanical skill. During the last 10 - 15 years the number of women labour in industry has, however, grown and very interesting attempts have been made to arrange suitable working hours and education for advanced technical work requiring relatively high skill and responsibility.

The Swedes have lived in peace during the last 150 years and hence nothing has forced women into technical work. The increasing education which followed equality of sexes has occurred in the first place in such professions where the prejudice against women is least pronounced. As to the fast development of equality it is interesting to note what happened in 1950 when the competition had increased the admission requirements to the Royal Technical Universities very much and hence there was a trend towards' more female students because girls often are more ambitious at the high school stage preceding the university. The headmaster in Stockholm then proposed not to admit female students at all because they in his opinion had great difficulties after marriage in combining professional work and home-work, and after an absence from their work their education would be obsolete and worthless. We have a club of woman engineers and engineering students which this spring celebrates its 40 years anniversary, which then made statistics of all woman engineers and demonstrated that 86 % of them (the corresponding rate for the men is 92 %) still were professional and almost everyone married. We heard nothing more about the proposal. Of course some of the headmaster's ideas were intelligent as an absence is a very serious disadvantage in the carrier of a professional woman engineer. The fast development in technology which she misses during her absence is a real reason for a somewhat smaller salary compared to the men working all the time. But the said evaluation of a woman engineer after some years absence is very unfair. In Sweden as in other countries there is a need of complementary courses for engineers, especially elder ones, because of the fast development in technology. As long as this necessity is not generally recognized for all engineers it is not fair to make a special point of it with regard to women. A substantial part of the wage increase is due to general maturing and it is obviously unfair never to consider that a woman developes very useful qualities in her work at home with her small children. Sense of responsibility, power of initiative, ability to organize and decide and to delegate work, patience in teaching others, persistency, self-control, consideration for others and objectiveness - those are positive properties, aren't they? I think a new evaluation of merits which counts also general human maturing -not only the one that is successively recognized in the salary envelope - would be an efficient weapon against prejudice.

It will probably take two more generations or more to overbridge the deep cleft between the theoretical and practical equality between sexes. An average manager in Sweden is about 53 - 58 years old and many persons in key positions in labour market organizations, authorities; legislative and investigating committees are about the same age, a fact which serves to strengthen the General conservative attitude. Women politicians are badly needed for dealing with problems with which they have a practical and direct contact. They are needed because in general people have too little interest in and knowledge about the living and behavior of other individual and groups. 1966 the percentage of women in the Swedish Parliament was about 15 and the figure in local government in towns was 20% which is about the same rate as women in university education. Most of what up to now is done to make it easier for women working outside their homes aims to the benefit of the majority of then, namely in the first place a small tax relief and a very steep graduated system of taxation and have had joint taxation for married couples . In order to stimulate educated married women to go back to work the joint taxation has recently become optional. But there are still considered practical problems for instance regarding shop opening hours which are stated by law to be almost the same as office working times. To get a responsible job it is at the same time, an indispensable condition that you never mention any problems with your home work

Young people think there will be no difficulties in their professional life and of course their optimistic confidence in cooperation between man and women is a true way to development.

But it might work faster in a society which was interested in making use of all their human resources in the most efficient degree.

THE WOMEN'S ENGINEERING SOCIETY' S CONTRIBUTION TO CHANGING ATTITUDES

By E. Laverick, B.Sc., Ph. D., F.I.E.E., A.Inst.P., S.M.I.E.E.E.

Dr. E. Laverick read Physics at the University of Durham and was awarded her Ph.D. for work on dielectric measurements using voltage step methods. In 1951 she joined G.E.C. working on microwave aerials. In 1953 she moved to Elliott Brothers as a microwave engineer. She now runs the Radar Research Laboratory of Elliott-Automation Radar Systems Ltd. She became the fifth lady Fellow of the I.E.E. She is a Governor of the Boreham Wood College of Further Education, Senior Vice-President of the Women's Engineering Society and Chairman of the Careers. Advisory Committee of the W.E.S.

Summary A description is given of the various ways in which the Women's Engineering Society has contributed to changing attitudes, through Public Relations, and through Careers Work. A brief comparison is made of the present position compared with that of ten years ago, and it is concluded that through its various activities the Society is making its presence felt more and more, as both the government and the public realise the need to exploit our technological manpower, to the full.

THE WOMEN'S ENGINEERING SOCIETY 'S CONTRIBUTION TO CHANGING

ATTITUDES

By E. Laverick

Introduction Although in Great Britain we pride ourselves on the equality of the sexes, although women obtained the vote in 1918 and in spite of two world wars, the percentage of women among professional engineers in this country remains lower apparently than anywhere else in the civilised world. To improve this situation it is necessary to overcome the prejudice which exists in industry, the schools and the home. This of course takes time and effort. A certain amount can be achieved by the individual - far more by grouping together, as in fact the members of the Women's Engineering Society have shown.

In what ways then has the Society contributed to the changing attitude towards women engineers?

Historically, as many of you may know, the Society was founded in 1919 as a direct result of the 1914/18 war, with two main aims in view.

i) to promote the study and practice of engineering among women, and

ii) to enable technical women to meet and correspond and to facilitate the exchange of ideas respecting the interests, training and employment of technical women and the publication and communication of information on such subjects.

Between the 1914-18 and 1939-45 wars, engineering as a profession for women was practised only by individuals accepted as exceptional. The world slump and the application of the marriage bar did not encourage any increase in the number of women engineers.

The 1939-45 war brought more members to, the Society and a greater acceptance of women in engineering by the country as a whole, in a time of emergency, but, as is often the case there was a tendency for the situation to revert somewhat once the emergency was over.

Ten Years Ago In 1956 the shortage of engineers and scientists in this country compared with the demand led to the recommendation by the Government that more women should be trained and employed. In response to this the Society organised a Conference on "Careers for Girls in Engineering" which was held in Coventry in 1957. The Report on this conference makes very interesting reading today.

From the Report it would appear that the situation ten years ago was as follows. Firstly there was a shortage of girls interested in taking up an engineering or scientific training. Secondly, there was a shortage of places at University. Thirdly, there were considerable difficulties associated with the practical training of girls - far too few firms were able or willing to undertake this. Fourthly, industry had yet to demonstrate that properly qualified women engineers would find proper scope for their abilities in progressive careers, The Conference concluded with an address by the Rt. Hon Iain Macleod, then Minister of Labour and National Service, in which he appealed for "a change of outlook, not only among the girls themselves, but among their parents, their teachers, and last but by no means least, in industry itself", in fact, “a change of public opinion on a wide front “.

The Women's Engineering Society's Contribution Gradually attitudes are changing and in support of these changes the WES has been active in several fields.

Public Relations Firstly, the Society has made a point of good public relations by participating wherever possible in the work of associated Committees and Societies. In this way more and more people come to accept the existence and influence of the woman engineer. For example, for some years we have had representatives associated with the Electrical Association for Women, and the Advisory Council for the W.V.S., the British Women Pilot’s Association and the Caroline Haslett Memorial Trust.

Indeed the Electrical Association for Women was founded in 1925 as a result of the efforts of the W.E.S. with a view to encouraging the domestic use of electricity and to interest women with regard to developments in the electrical field.

This work takes the form of providing for the education and training of women with regard to electrical energy and its uses in domestic science and the home, promoting research relating to the use of electrical energy in connection with matters of particular interest to women, organising lectures and demonstrations and providing advice and instruction with regard to the use of electrical energy in connection with the home, domestic science, hygiene, social welfare and so on.

The Caroline Haslett Memorial Trust, whose trustees are the E.A.W. is a charitable body whose aims are to provide scholarships, travelling exhibitions and other educational opportunities for women who are seeking or already pursuing careers in the electrical industry or in other fields requining, qualifications in science, engineering or domestic science. Typical of its work, the Trust has awarded a travelling exhibition enabling two women engineers to visit the U.S.S.R. in order to study the training, employment and prospects of women engineers in that country, a bursary to the " home mother "of the Vocational Training School for girls refugees at Ramallah in Jordan for a six months' study of institutional management in Britain, a bursary to enable two British women engineers to attend the 1st International Conference of Women Engineers in New York in 1964 and bursaries to attend <u>this</u> conference.

The Trust has also awarded scholarships in domestic science - for example, one recent scholar was a young woman from Uganda who successfully completed a two-year training in Britain and then returned to Africalto work with the Uganda Electricity Board. Also the Trust awards university scholarships in science, engineering and mathematics. One scholar with a successful career at Cambridge became a graduate apprentice with A.E.I. Rugby; another Cambridge graduate who has married is teaching physics in a girls' school.

This association with other bodies can work two ways of course - and we are fortunate in having representatives of the major Engineering Institutions and the Royal Aeronautical Social on our Council. In addition; the President and Honarary Officers of our Society attend a variety of functions in association with the Engineering Institutions, various Government Departments etc.

Wherever possible the Society endeavours to publicise the achievements of its members in the press, on radio and on T.V. and to provide speakers and authors on request to describe the work of women engineers, and associated subjects.

The 'inhouse' functions of the Society also contribute indirectly to the changing attitudes of today.

The Journal, which is published quarterly and which publicises news of members and technical articles often written by members, finds its way into industrial libraries and elsewhere. The Society now has four branches, in London, Manchester, the Midlands and Wales, the last being formed only last year. Details of the Branch Meetings, which are held monthly and are generally of a technical nature, appear in the technical press and non members are welcomed at these Meetings and on the technical visits arranged by the Branches.

The Society holds an Annual Conference, sometimes in London, sometimes in other parts of the country, at which members from all the branches get together and exchange views on some theme which is of general technical interest. Last year for example, we met at Cardiff, capital of Wales, and, our theme "Education for a Technological Society" aroused great interest both within and outside the Society.

This International Conference of Women Engineers and Scientists - only the second of its kind to date - is yet another example of the Society's work in encouraging both the public and the technical world to recognise that the woman engineer is here to stay and has an important contribution to make.

Careers Work But perhaps the Society's greatest impact has been and is, in the field of Careers work. Only by increasing the quantity and maintaining the quality of our women engineers are we going finally, to achieve the recognition we seek. Then and only then will this country be in a position to exploit to the full its technological manpower and capability.

For some years the Society has been actively engaged in careers work, taking part in Conferences and Exhibitions, contributing to Careers Conventions, giving talks at schools, answering careers enquiries and giving advice and information on request to parents, careers mistresses, Youth Employment Officers, etc.

Two years ago, at the request of the Engineering Institutions' Joint Board (now the Council of Engineering Institutions) the Society produced a memorandum "On increasing the Number of Women Engineers and Technologists". This

Memorandum was presented to the Government's Inter-departmental Working Party for publicising Technology, and circulated to various Government Departments, the B. B. C. and other interested bodies. This was followed by a second publication "Careers Advice on Professional Engineering for Girls". As a result of the increased government and public interest in this problem, the Society set up a Careers Advisory Committee as a Working Party to co-ordinate the Society's interests and activities in the fields of education, training and careers advice.

The terms of reference of this working party are first " to promote the study and practice of engineering among women" - as you will remember, this was one of the main principles on which the Society was founded - and second " to liaise, with all appropriate bodies for this purpose and to take all steps to implement this object, in particular

1. To arrange careers meetings in areas remote from the branches and to attempt to interest local industry in the recruitment of women for technical work.

2. To liaise with the branches so that branch careers meetings can be co-ordinated, into the Society's Programme.

3. To participate in careers meetings and conventions with other organisations, e.g. Department of Education and Science, Council of Engineering Institutions, Confederation of British Industries, British Association and the Careers Research Advisory Centre.

4. To prepare such publicity and literature as may be deemed advisable.

5. To produce a short list of easily available published information on engineering careers, to be available at H.Q., at the Branches, at Careers Conventions and Meetings.

6. To draw up and brief a panel of people covering areas and subjects to give specialized advice to parents, industrial undertakings etc., who write in for information and also to give talks at schools, careers conventions etc., the efforts of the panel to be co-ordinated throughout the Committee".

This entails quite a formidable programme of work particularly in that it requires the voluntary efforts of a large number of our members who, by virtue of their own achievements in industry, the civil service, and the academic fields, have little spare time anyway.

Firstly, with regard to activities in areas remote from our branches, I have already mentioned the very sucessful Annual Conference held by the Society last September at Cardiff. This created considerable interest among the University and Technical Colleges and the local branches of other engineering Institutions. In addition a handful of enthusiastic members carried out a survey of local industrial training schemes in the area. This work led, among other things, to the formation of our Wales and S.West Region Branch.

As far as careers meetings and exhibitions are concerned, in addition to the work of the branches, the Society has taken part in several events arranged schools and by the Youth Employment Service in various parts of the, country. By participating in these events members are able to inform parents, children and teachers of the opportunities for girls in engineering, with the added advantage that they speak with the voice of experience. Gradually the Society is getting together posters, pamphlets, photographs and other display material to help with this work. In addition the Society has been co-operating with the Department of Education and Science in the provision of speakers in support of the Department's Travelling Exhibition " Technology Today ". This Exhibition is but one activity of the DES Publicity working Party on Technology and Engineering, on which our Society is actively represented. It has been planned by the Department of Education and Science, and produced by the Central Office of Information and consists of two 22 ft. caravans which are towed singly by a Land Rover, then linked end to end on site to form a self-contained unit. The caravans are visiting schools and technical colleges throughout the British Isles to interest and inform children, in the 14 to 17 age group, on the scope and prospects of engineering careers. The Land Rover carries a generating unit so that the exhibition has its own power supply.

The display material ranges from the Europa 1 Rocket Moter to minute printed circuits containing complicated electronic systems within the dimensions of a postage stamp. It further illustrates developments in new materials and in medical engineering such as an ultra sonic-acid for the blind. Many sectors of industry and government departments have contributed exhibits and photographs.

In conjunction with the exhibition, lectures are given by professional engineers and the W.E.S. have provided some of these speakers. A number of up-to-date films are carried with the caravans and a selection shown at each venue.

The Working Party has also been responsible for the publication of a Careers Booklet, "Engineering - a creative career", and for the initiation of a thrice-yearly careers publication for Schools called " Project " to which several of our members have contributed articles. Another event on a national scale in which we have participated recently is the Ministry of Technology's Exhibition "The Engineer's Day" held at the Science Museum. Its purpose was to arouse the interest of young people, girls as well as boys, who are still at school and considering their future careers, to make them aware of the importance of engineers and to encourage more of the ablest to choose professional engineering as a career.

In a way never before attempted, the exhibition showed the daily events in the lives of engineers of all kinds: mechanical engineers, electrical engineers, civil and transport engineers and all the many kinds of engineer who contribute to our complete modern society. It set out to answer a question continually being asked by youngsters when faced with the choice of a career – ' If I become an engineer, how will I spend my working day, what exactly will I do and what will be my rewards? '.

On the ground floor of the Science Museum in London, over 7000 square feet was given over to this exhibition. It was designed so that the visitor could see a developing story of the importance of engineering in our lives and of the range of careers available within the profession.

An introductory animated display showed the educational routes to an engineering career. This was followed by further displays including such subjects as the new Severn Bridge; the Olympus gas turbine being developed for marine propulsion for the Royal Navy a day in the life of a nuclear engineer; the opportunities which the Army provides for its professional engineers in research, development, repair and maintenance of equipment; and microwave communication links with the GPO Tower and the Goonhilly installation in Cornwall. Research projects show how youthful interest in model aircraft and playing with water can lead to a useful career. Other presentations were designed around the relief of suffering by the design of brain controlled artificial limbs; testing Concord; the development of rocket missiles for defence ; developments in electricity supply; an electronically controlled automatic ticket gate for

London's Underground railway; coal mining without miners; and help to developing countries (illustrations included work on the Mangla Dam in Pakistan). Models of the Deltic, Britain's most powerful diesel engine; the AL6 electric locomotive; and the latest British radio telescope were on show.

In some cases the engineers shown in, the displays were on hand to talk about their work and this included one of our members, Major Sergeant working with R.E.M.E.

The lecture hall at the Science Museum was the focal point of great deal of important activity during the period of the exhibition. Programmes of films were shown , interspread with occasional short lectures given by practising professional engineers; here again the young visitors to the exhibition could see what it means to be an engineer and the exciting possibilities the profession opens up to them. Several half day conferences were arranged, some for headmasters, careers masters and others who could influence the choice of a career, and others for fifth-and-sixth-formers. Here, through the auspices of the British Association for the Advancement of Science, the Society contributed to the afternoon Session devoted especially to girls, which was chaired by our President and for which we provided several speakers, who presented their own picture of engineering for women in various spheres.

Yet another aspect of our work is concerned with Careers Enquiries. A panel of members has been set up to help with this work, covering between them just about every aspect of engineering. In this way we ensure that almost every enquiry receives attention from someone with first hand knowledge of the woman engineer's point of view. About 150 enquiries were dealt with last year and the number of enquiries are growing slowly but steadily.

Conclusions To summarise then, the Society through its various activities is making its presence felt in at least some homes and some schools as well as in more public spheres. Our advice is often sought by Ministry Departments and by the Engineering Institutions on matters relevant to girls and women in engineering. The barriers are beginning to disappear are plenty of places available in engineering at the Universities, and there the barrier is effectively non-existent to girls with adequate school qualifications. However, the shortage of teachers in science and maths and a general lack of knowledge of what engineering is about, means that both girls and boys are slow in coming forward to take up those places.

On the other hand industry has on the whole not yet succeeded in demonstrating its willingness to employ qualified women engineers in positions commensurate with their abilities. However, this is undoubtedly partly due to the small numbers available. To achieve a radical change of outlook here, particularly with the smaller firms and in the older industries with their deeply-rooted traditions and prejudices it is very much a matter of "making haste slowly". Only in the due course of time will industry accept the woman engineer for what she is.

This raises an important point and one which tends to be overlooked at times, that is, the importance of the contribution of the individual woman engineer to changing attitudes today, particularly as far as industry is concerned.

Whilst there are so few women engineers in this country each and everyone pf them has an added responsibility, in that their performance can so vitally affect the country's attitude towards the woman engineer of the future. Success as an engineer is not only a matter of technical achievement. To be a successful engineer one must, be a diplomat, a psychologist, a good mixer, a good administrator and a bit of an economist as well as having a knowledge and understanding of the fundamental principles of science.

I have endeavoured to describe the contribution of the women's Engineering Society to changing attitudes, but it must be remembered that in the long run this is made up of the contributions of the individual members. At the same time it is undoubtedly true that by joining together in our endeavours the women engineers of this country can have the maximum impact on the widest possible front. Much has been achieved, but much remains to be done.

WOMEN ENGINEERS IN TRAINING

By J.A. Shercliff, Ph.D., M.A., S.M.

Professor Shercliff read engineering at Cambridge University before taking a master's degree at Harvard. In 1949 he joined A.V. Roe and Co., Ltd., in Manchester and in 1951 returned to Cambridge to work on magnetohydrodynamics for a Ph.D. degree. In 1954 he joined the staff of the Cambridge Engineering Department, and in 1960-1 spent a year at Massachusetts Institute of Technology. In 1964 he became Professor of Engineering Science in the new University of Warwick at Coventry.

Summary. The paper discusses the three stages, pre-university, undergraduate and postgraduate, of the training of a woman engineer, examining the barriers which still remain, although they are lessening, and how they may be overcome. New trends in the engineering profession, many of them favourable to the increase in the number of women engineers, are explored.

WOMEN ENGINEERS IN TRAINING

By J.A. Shercliff

Introduction These are exciting times to be involved in education and particularly in engineering education at a new University, where the scope for reappraising educational practice and undertaking pioneer ventures is great. The nature of engineering is evolving so rapidly that reappraisal is continually necessary, and, for the woman engineer, the news is wholly good; the trends seem to be in her favour. These trends include the slow but sure erosion of prejudice in schools and industry, the changes in industry itself with the emergence of totally new products and professions where no anti-female tradition exists, and the great shortage of talented engineers which guarantees a welcome in industry for any good graduate engineer, irrespective of sex.

For convenience, this paper divides up the process of training women engineers into the three stages, the pre-university stage, the student stage and the postgraduate stage. Since much has already been said and written on the subject, I do not attempt a comprehensive treatment but merely present a collection of reflections on aspects of the situation.

Before the University There is no denying that at the pre-university stage there are many obstacles in the way of the potential girl engineer, often due just to prejudice or ignorance of the work of the modern professional engineer. But the girl who has sufficient spirit and imagination to make an engineer should not be deterred by these. In any case, it is not necessary to decide finally while at school to be an engineer.

All that is needed is to keep open the possibility of being one amongst other things, and this, for all practical purposes, just means pursuing A-level mathematics to a good standard. Though in some girls' schools the staff tends to discourage pupils from taking up engineering careers, they can hardly object to A-level mathematics. In all fairness I should also recognise that there are many schools that do promote engineering for girls.

A much more serious barrier is the increasing difficulty that many girls' schools have in mounting adequate, let alone stimulating, science and mathematics teaching. Published statistics have shown many times that the so-called "drift from the sciences" in schools in recent years is almost entirely confined to girls. This is very regrettable and is the major influence which impedes our efforts to get more girls into engineering. It also impedes the production of lady physicists and mathematicians. No quick solution to this problem is in prospect, though it is helpful if universities do not insist on A-level physics as a prerequisite for engineering in all cases. If women engineers are produced in significantly larger numbers in future, some may go in for teaching (a trend much to be welcomed), perhaps on a part-time basis after a career in industry and the starting of a family. This could be a very fruitful development as such teachers should be able to present mathematics and science as exciting and rewarding activities related to the needs of society. Some universities collaborate with schools in the vicinity over the use of scientific equipment to broaden and enrich the sixth formers' work, and this is particularly likely to benefit girls' schools.

Though a girl of high intelligence and imagination can make just as good an engineer as can a boy of comparable ability, she usually starts with a considerable handicap, because in childhood and at school her experience of material phenomena, mechanical and scientific toys and the operation and maintenance of devices is much less rich than that of the average boy. This makes it harder to produce girl engineers just as it makes it harder to produce engineers in underdeveloped countries where instructive "play-experience" in childhood is lacking. In this sense the female sex is also an underprivileged race. One could say that the biggest saboteur of the women's engineering profession is the gallant male, who all too readily insulates his womenfolk from opportunities to be educated by themselves coping with mechanical and electrical crises that occur. The determined girl should cultivate independence and as a result continually enrich her experience, resisting the more normal female temptation to exploit the compliant male. This is one of the ways in which a girl, if she is to compete in a man's world, must surrender the traditional female role.

Another barrier to girl engineers is lack of information. It is probably still true that most girls' schools do not point out to their pupils the existence of the possibility of engineering as a career. This is far more deleterious than providing opposition after a girl has got the idea of doing engineering. (Opposition is more likely to generate the determination a girl needs in her engineering career among men. The answer to the problem is propaganda for engineering as a profession, and in recent years this had been considerably intensified by the professional institutions, government departments and agencies, universities themselves and other influences such as the various projects for applied science in schools. A certain amount of this propaganda is specifically aimed at promoting engineering for girls. For instance the magazine, "Project", produced by the Department of Education and Science and circulated widely to schools, is an excellent publication which loses no opportunity to remind girls of the openings in the profession for them. The Engineering Industry Training Board proclaims in its publications its desire to see more women in engineering, and to support their training alongside men. Television, radio and the press play their part too.

The movement towards applied science in the sixth form, either as a time-tabled and examined activity or as an extra "appetiser" to enliven the science teaching, seems to be gathering strength, but so far hardly impinges on girls' schools. At Warwick University we are cooperating with the Schools Council Midlands Pilot Project, which is exploring the scope in girls' schools for using "applied science" to promote the idea of engineering as a career. There are obvious difficulties, such as lack of equipment and practical experience among the staff, and it is generally agreed that badly done applied science is far more harmful than none at all. Nevertheless there is some feeling in the Project that what matters is developing an attitude of mind, an enterprising "do-it- yourself" approach to scientific knowledge and practice, together with a certain irreverence for prevailing folklore and unsubstantiated allegation. This approach can be developed from quite an early stage, perhaps from entry to secondary school, in the context of many school activities, not least the often-scorned domestic science. For instance, a "which" type of approach to devices and appliances can generate projects to develop independent and rational habits of thought. From such beginnings more sophisticated projects could evolve, particularly if the help of local industry and other educational institutions were sought.

In the past, the majority of professional engineers emerged from apprenticeships with evening and day release education for HNC and associate membership of the Institutions. Under these conditions a, girl in industry was unlikely to advance to professional level. However, this particular sex handicap is disappearing because the trend is now entirely over to the situation where the university or college degree will be the norm for professional engineers and the girl engineer can spend her earlier stages in an environment more sympathetic to her.

Sandwich courses, either "thick" or "thin", are widely accepted as giving a good training for those students who are quite definite that they intend a career in a particular kind of engineering. At Warwick, for instance, we encourage students to spend a pre-university year in industry, but I feel it is unlikely at the present time that many girls will adopt this practice. Until the day is completely won for women engineers, it will be better for girls to develop towards engineering in a sympathetic educational environment before plunging into the industrial hurly-burly. This is a pity, nevertheless, because a period in industry is just what a girl often needs to make up for being deprived of experience of mechanical things and practices in childhood.

At the University Girls are more likely than boys to be still uncertain on entering university which career they should finally adopt. It is my opinion that even for most boys it is unreasonable to demand that they should decide irretrievably at the outset between physics, mathematics and engineering on a basis of no experience of these subjects at university level or of their professional implications. Experience at school is often misleading. Even less reasonable is a requirement that fresh men and women specify the kind of engineer they want to be at the start. Thus girls who think they may wish to be engineers or to pursue other, related industrial careers will tend to enter those universities where these crucial decisions can be delayed until they can be taken rationally. This may be one reason why new universities, like my own, tend to have more than their fair share of girl engineers.

It is a very desirable thing that girls in training for engineering careers, whether at university or gaining industrial experience, should be concentrated in groups rather than spread singly everywhere. Their morale and confidence in the face of uniformed opposition will be much higher and they are much more likely to be treated as normal participants in all the activities than if they are solitary curiosities, worthy of remark. Moreover, a university which is used to handling the education of girl engineers in fairly large numbers is much better placed to build up good relations with firms sympathetic to the training and employment of women engineers, so that the girl students may benefit. When students are placed in industry for summer vacation experience, it is obviously preferable to find firms that will take a group of girls rather than isolated individuals.

It is my impression that all universities and colleges nowadays welcome able girl applicants into their engineering schools, and that no preference in favour of male applicants operates. Indeed it may often be that a university is more ready to make allowances for shortcomings of secondary education for girls than for boys, in recognizing the difficulties that afflict many girls' schools over science staffing.

Universities would appear to be more convincingly in favour of girl engineers if they had more - or indeed any - women engineers on their staff, but this particular failing will take at least a generation to rectify.

Two years of running undergraduate engineering courses at Warwick with a significant number of girl students has not thrown up any particular problems. There is no evidence that the girls are not the equals of the boys in tackling the university level engineering science course, with its laboratories, projects and other activities. Very soon after the University opened I was delighted to come upon a girl explaining to a group of men students how a sectioned model demonstrated the operation of a petrol engine! We find the men accept their female colleagues as equals and there is little tendency for the girls to adopt either an excessively feminine or subservient role or a fiercely, feminist, "we'll prove we're better" attitude. From the point of view of the staff, mixed audiences are much to be welcomed (and a novel experience for most of us). Female students are less consciously blasé than many men. It is also possible gently to exploit the war of the sexes as a spur to effort!

It is noticeable that many of our leading women engineers of to-day did not in fact study engineering at university, but took mathematics or physics courses. This merely indicates the difficulties facing women engineers in the past. Though nowadays girls who wish to become engineers ultimately are often still advised to study mathematics or physics, I consider this to be a mistake. The point is that engineering is so much more than mere science - it is cost-consciousness, it is ease of manufacture, it is customer research, it is public safety, it is efficient management, it is leadership, it is compromise and decision-making. So engineering courses must part company with the sciences and begin to inject the true entrepreneurial and incredibly diverse flavour of engineering as soon as possible. The student of pure science or mathematics is insulated from too many realities.

After the University the normal pattern of training for engineers after university is still some two years of practical experience, but the situation is in a state of rapid flux and evolution. One factor is the emergence of new industrial professions allied to engineering, such as systems engineering. These are not encompassed by the traditional approaches, and it is in many of these newer, less hidebound areas that some of the best careers for girls may lie. The attitudes and requirements of the Institutions, now grouped in the CEI, have evolved considerably in recent years. There is a clear trend towards greater formalisation of the postgraduate training of the engineer, evidenced in the programmes being recommended by the Engineering Industry Training Board and also foreshadowed in such documents as the Bosworth Report. It seems that the engineers' postgraduate industrial training will now cease to be the haphazard affair it has so often been in the past, varying enormously in educative quality and efficiency from firm to firm, and will become instead a clearly defined and orientated programme, often incorporating periods of formal training in particular product technologies, management, etc., in nearby colleges and universities. Smaller firms are being encouraged to embark on joint schemes so as to pool their expertise and make the groups of trainees large enough to justify proper handling.

All these developments should smooth the path of the woman engineer, who will continue to find her training handled sympathetically by educationally-minded people after leaving the university, whereas the old "sink or swim" on the shop floor could have been less satisfactory. The principle that women engineers should be trained in groups rather than in isolation applies again at this first postgraduate stage.

I seek the attitude of industrial employers to girl graduates whenever I can and have been impressed by the readiness of most industries to employ and train them. Of course there will always be fields where the woman engineer may not prosper, but generally few prejudices still survive. Few employers have actually had girl engineers yet, but most are prepared to try. The often cited difficulty that women soon start families and withdraw from employment is recognised as not disastrous, since most firms find that male graduates also usually move on with in a few years. There is a growing realisation that industrial training is a contribution to the national - not the individual firm's - pool of skills, and indeed the Engineering Industry Training Board's job is largely to foster this attitude by subsidizing those firms that take more than their share of the burden.

One extra difficulty is that after marriage, a woman is likely to move if her husband moves, and indeed to select the next job more from convenience than appropriateness to her skills. Such factors do remind us that female emancipation is still far from complete, and that, for an employer, a girl graduate is more of a gamble than a man. It is bound to be the case that as long as the majority of women are home-makers, their professional continuity is slightly suspect and their advance to positions of high responsibility in industry will usually be somewhat hampered in comparison with their male contemporaries. But this should not deter women from industrial careers and the engineering profession.

Another minor barrier to women that is worth mentioning is that careers involving overseas responsibility may sometimes be closed, simply because some countries take a more traditional view of the place of women in society.

It is sometimes suggested that industries like the textiles and food industries which use female labour intensively are particularly appropriate for women engineers to enter, but there could be a danger that such firms would find it hard to adjust to the idea of women as decision makers rather than shop-floor personnel. On the other hand, a newer industry like the semi-conductor industry is one where feminine meticulousness is equally welcome on the shop-floor and in the professional ranks.

There is one newly-emerging variety of engineering which is perhaps peculiarly appropriate for women engineers, since it provides an outlet for the sex's undoubted capacity for compassion and desire to alleviate suffering. I have in mind the broad class of activities now known as bioengineering, which includes medical engineering and instrumentation, aids for the disabled, engineering of life-support systems in novel environments, and indeed any problem of matching man with his tasks and circumstances, i.e. ergonomics. There are also many fascinating research aspects to bioengineering, such as cybernetics and the mechanics of physiology, where women can make a big contribution. It is significant that it was a woman engineer, Miss A.R. Chamney, who in 1966 won the first Clayton Bequest fellowship for medical engineering, awarded by the Institution of Mechanical Engineers.

H. M. The Queen devoted her 1966 Christmas message to the special contribution that women have made and continue to make in our society. Although she was thinking primarily of women as homemakers, teachers, nurses and social reformers, it should be remembered that engineering, like medicine, has as its aim the application of intellect and science to ministering to the needs of society. So the women engineer can feel that she too is fulfilling her proper role as a female member of the community and guardian of its welfare.

ROLE PLAYED BY WOMEN ENGINEERS AND SCIBNTISTS IN THE USSR

By **The Soviet Women's Committee**

Summary The paper reviews the changes that have taken place over the last 50 years in the status of women in the USSR and in the role they play in society and the family. After giving general statistics relating to the employment of women, their position in the field of engineering is considered in greater detail with examples of the careers of a number of women engineers and technologists. The position of women scientists is reviewed in a similar way. The paper emphasises the dual role of women as professional engineers and mothers.

ROLE PLAYED BY WOMEN ENGINEERS AND SCIENTISTS IN THE U.S.S.R.

By **The Soviet Women's Committee**

The year 1967 is a no ordinary one for Soviet people: it marks the fiftieth anniversary of the Great October Socialist Revolution. In this jubilee year the half-century during which the Soviet State has been in existence is reviewed, Soviet people's gains and achievements, as well as problems that await solution, are analysed, and the ways and means of overcoming difficulties and of coping with the tasks facing Soviet society are discussed.

This survey registers, among other things, how far the women's problem has been solved, what changes have taken place in women's status and what role they are playing in society and the family.

But before embarking on the description of the role played by women engineers and scientists in the USSR, a short excursion into the past may be in place here, as it will show the road travelled by women in the Soviet country and what the Soviet State has done to enable them to take a fitting place in society.

The history of all social and economic formations that went before Socialism in our country offers countless examples of women's oppression and utter subjection.

Women were carrying a double yoke: in the process of material production working women were deprived of every right by the State laws providing for inequality, while at the same time they were in an age-old state of "domestic slavery".

In tsarist Russia 82.5 per cent of women were illiterate*. Not many women could receive a secondary education, while the number of women with a higher education was exceedingly small. Women had neither political nor economic rights. "The Code of the Russian Empire" stated that "females are not to be included in voters' lists for the State Duma".

* N. Popova, The Role of Women in Socialist Society, 1967, p.9

Domestic servant, farm hand or day labourer - that was all a working woman could aspire to be; 80 per cent of all women in employment were engaged on such jobs, whereas there were a mere 13 per cent of women industrial workers. Their working day was from 10 to 12 hours and their pay half that received by men.

In outlying regions, particularly in Asia, the lot of women was unbearable: there, even the living quarters for women were prison-like, and they had to wrap themselves from head to foot in the "paranja", a black veil of horsehair.

That is why one of the first legislative acts of Soviet Government was the Law Granting Women a Full Equality with Men, a decree putting an end to women's inequality for the first time in our country.

But equality before the law was merely a condition for achieving full equality in practical life.

Vladimir Lenin, the founder of the Soviet State, held that it was necessary to draw women into socially-useful productive work, into governing the state, he considered it imperative to free women from the "domestic slavery", from the kitchen, and to create conditions helping mothers, both the parents, to bring up their children.

In drawing women into social labour the Soviet State was wittingly taking a measure that was unprofitable from the economic viewpoint. That was done with a view to ensure the speediest liberation of women. For instance, in Central Asia and in the Transcaucasian Republics where women were taking no part in social labour, such branches of industry were being set up as allowed of employing Moslem women. There were even factories staffed exclusively by women, although the cost of production at such factories was much higher.

In addition to measures of a general character to raise the cultural level of the population at large, special steps were taken to improve the professional training of women.

The Soviet State set apart additional sums to prepare women for higher and secondary technical schools. A definite percentage of vacancies were reserved for women at universities, secondary technical, trade and vocational schools. In the first years of the tempestuous development of Soviet industry and agriculture the Soviet Government provided for the enrolment of at least 20 per cent women in industrial institutes, at least 30 per cent in agricultural and at least 35 per cent in economic institutes.

Now that the principles of women's equality has become part and parcel of the country's day-to-day life, with some institutions of higher learning, for instance, medical and pedagogic, having predominantly female student bodies, reserving vacancies and establishing a definite percentage of women students are no longer necessary. But at the time all these measures were implemented they resulted in a speedy increase in the number of women participating in our country's economic life.

Persistent ,work and constant study, the desire to master all and every trade and profession, to take part in the most complex fields of human activity on a par with men and, last but not least, the unflagging concern and assistance by the State have ensured Soviet women an equal status with men both de jure and de facto.

Today, this is what we read in Article 122 of the Soviet Constitution:"Women in the USSR are accorded equal rights with men in all spheres of economic, government, cultural, political and other public activity". Further, the Fundamental Law states that the possibility to exercise the rights granted by this Article is ensured by women being accorded an equal right with men to work, payment for work, social insurance and education, and by State protection of the interests of mother and child, State aid to mothers of large families, maternity leave with full pay, and the provision of a wide network of maternity homes, nurseries and kindergartens.

Thus the Soviet Constitution not only proclaims women's equal rights with men, but ensures their realisation through creating adequate conditions for a true equality.

Today, 47,900,000 women are employed in social production, which makes up 50 per cent of the total number of workers*.

The following table shows the percentage of women workers and employees in various spheres of the national economy;

* According to the data supplied by the Central Statistical Board.

Industry	46	per cent
Construction	29	" "
state farms and ancillary agricultural enterprises	44	" "
Transport	24	" "
Communications	65	" "
Trade and catering establishments (including various auxiliary enterprises)	72	" "
Public health	86	" "
Education	71	" "
Science and auxiliary services	44	" "
State machinery and economic, co-operative and other administrative bodies	55	" " *

It should be borne in mind that among the women active in socially-useful work, nearly 7,000,000 are specialists with a higher or secondary special education, which is 58 per cent of the total number of specialists employed in the national economy**. This high figure is due to the fact that women in the USSR have every opportunity or receiving an education.

In the 1965-66 academic year women made up 44 per cent of the total student body at universities and other institutions of higher learning. The following shows the percentage of women students in the different institutions:

* Courier of Statistics, No.1, 1967, p.86.
** Ibid., p.47.

Industrial, construction, transport and communications	31	per cent
Agricultural	26	" "
Economics and law	54	" "
Public health, sports and physical culture	54	" "
Education, art and cinematography	66	" " *

There are 50 per cent of women students at the secondary special schools (colleges).

No woman in tsarist Russia could as much as dream of taking a hand in organising and governing production. According to data for 1963, nearly 34 per cent of leading managerial and engineering posts at industrial enterprises were filled by women.

Nearly half a million women engineers are working in the country's national economy, each third engineer being a woman. There are 1,056,000 (or 37 per cent) women technicians with a secondary special education; 39 per cent of specialists with a higher education working in agriculture are women **.

Eighteen thousand women (of whom about 6,000 are engineers and over 12,000 technicians) out of 28,000 certified specialists are working at specialised assembling organisations and enterprises, designing bureaus and research institutions of the USSR Ministry of Assembling and Specialised Construction Operations, engaged on mounting complex equipment, pipe-lines, checking and measuring apparatus and automatic devices in key industries and on unique construction projects, such as the TV tower in Ostankino, the production and assembling of the metal elements of the Kremlin Palace of Congresses and so on ***.

Soviet women are busy in planning the national economy 60 per cent of economists with a higher education are women.

* National Economy of the USSR, 1965, p.700

** Courier of Statistics, No.1, 1967, p.88

*** These data have been supplied by the Personnel Department of the USSR Ministry of Assembling and Specialised Construction Operations.

Now that a new system of economic planning has been introduced, with emphasis on the drawing up of plans on the spot, the work of economists at the enterprises and offices has acquired particular importance. Women constitute a high percentage of these workers. There are many women working in the country's central planning bodies such as the economic planning administrations of the various Ministries and the USSR State Planning Committee, the organisation for economic planning of the USSR Council of Ministers, which draws up the unified plans for the development of the country's national economy as a whole. It is noteworthy that women made up 36.6 per cent of the economists with a higher education at the USSR State Planning Committee.

The broad opportunities for receiving any type of education and also for systematically improving their skills without discontinuing work enable women to hold posts demanding the greatest efficiency.

Serafima Kotova started as a weaver at the Kalinin Factory in Moscow. She graduated with honours from a technical college and was appointed a foreman. While working, she received a higher education and is at present a shop manager. For her signal labour achievements she has been awarded the title of Heroine of Socialist Labour.

Anna Grinenko has for many years successfully headed the "Red October" chocolate factory. A peasant's daughter, she graduated from the Institute of Food Technology; first, she worked as a shift manager, then shop manager and finally was promoted to the directorship. She is one of many women economic leaders possessing initiative and a talent for organisation.

Anastasia Makarova has been director of the major biscuit factory, the "Bolshevik", for over twenty years. She began her career at this Moscow factory as a rank-and-file worker and has gone all the way to becoming its head.

Many more similar examples could be cited here.

At present, six per cent of directors of industrial enterprises of the USSR are women; of chief engineers 16 per cent are women; of shop managers and acting shop managers 12 percent; of shift managers, managers of sectors, installations, chiefs of laboratories and their assistants 22 per cent; of senior foremen and foremen 20 per cent; of engineer and technician rate-fixers 62 per cent, and of economists, engineer-economists, planners and statisticians 79 per cent ***.**

* Data for 1963 supplied by the Central Statistical Board.

Women are making a sizable contribution towards improving the technology of production: out of the engineers and technicians active at designing and construction organisations women make up 35 and 71 per cent respectively. Forty-six per cent of the engineers and 71 per cent of the technicians working in technology are women *.

Recently a glass-works has begun operating at Ponievezes, Lithuanian SSR, using a new progressive method of making plate glass, which not only reduces the time but also ensures high quality of the product. Its chief engineer, Julia Lugauskaite, said in an interview that there was in the Soviet Union only one factory - the glass-works at Lvov - that had been using this method prior to the Ponievezes works, and it was there that Lithuanian glass-makers were taught the new techniques. Its director, Tamara Perederienko, chief technologist Olga Zaporozhtseva, chief of the laboratory Irina Talanova and expert glass-makers readily shared their experience with their colleagues from Lithuania.

Incidentally, this readiness to share experience, to help one's colleagues and to impart to them all the "secrets of the trade" is not merely an outstanding feature of socialist emulation but its strongest point.

There is a Russian woman, Tatiana Matveyeva, who heads the designing office of the Metal Parts Works in Chelyabinsk. She is full of initiative, and the working drawings made under her guidance always contain new and progressive types of groups and structural elements. Many major construction projects have been erected after the drawings elaborated under Tatiana Matveyeva's direction: the converter shop in Nizhni Tagil, the blast and open-hearth furnaces of the Chelyabinsk, Karaganda, Cherepovets and Novo Lipetsk iron and steel works, the electrical-welding shop turning out tubing with a diameter of 1020 millimetres, and many others.

Nina Bant spent many years in the Extreme North where she designed homes for Tixi Bay, the Isle of Dixon and the town of Petropavlovsk in Kamchatka. Today she is chief architect of the Yakut Research Institute in Mirny, the centre of Siberian diamond industry. Jointly with a group of collaborators she has worked out the project for a city in which people will cease to be at the mercy of the severe northern climate. In this city, houses several storeys high will be connected by glass-covered galleries and passages

* Data for 1963 supplied by the Central Statistical Board.

leading to shops, post-office, cinema, kindergarten and sports grounds. This city will be built on the site of Aikhal, just now a small settlement of wooden houses.

The Metal Works in Leningrad has made a major contribution to Soviet turbine construction by building a giant steam turbine of unheard-of capacity. The constructors of this turbine have received congratulations on their achievement from the Soviet Government. This message was addressed, among others, to Nina Samusenko, an outstanding turbine constructor.

Nina Samusenko goes farther than drawings and calculations: she works in a close contact with the workers of the steam-turbine shop and particularly, of the regulation sector, where the most complex operation of assembling turbine heart is performed. She has earned the nick-name of "Turbine Regulation Goddess" because she spares no effort in teaching the foremen and workers, because she is always ready with advice and eager for their suggestions. And it often happens that together they arrive at happier constructive solutions.

Miranda Shirashenidze at 33 is chief engineer of the Institute of Industrial Electric Design inGeorgia. She has taken part in, and directed, the construction of concentration mills of the Chiaturmanganese Trust and Rustavi foundry, of several big compressor stations and some other projects.

Asked if she could live without her work, A. Balashova, a constructing engineer and mother of twelve (she has been awarded the Mother Heroine Order) said: "No, I can't. And it is not only because I love my work, but because my work lends meaning to my life and draws together the whole of my big-family”.

Tens of thousands of women occupying managerial posts in the national economy have become prominent leaders in production.

Quite a few women hold leading posts in state administration as Ministers and Deputy Ministers.

In the Soviet Union there are seven women Chairmen of the Presidiums of the Supreme Soviets of Union or Autonomous Republics, 28 women Ministers, 56 women Deputy Ministers (of the USSR and Republic Ministries), all of whom have to solve grave state problems as part of their daily work.

Soviet women playa no less important part in science. During the Soviet years a whole galaxy of outstanding women scientists have come to the fore. At present the Soviet Union has 6,646,000 scientific workers - a quarter of the world's scientific force - of whom 254,800 are women (38 per cent) ***.**

Out of the 390,000 scientific workers in the country's scientific institutions 154,800 are women ***.**

Out of the 221,800 scientific workers on the staff of the country's institutions of higher learning 82,400 are women ***.**

There are 1,100 women academicians and professors, 9,500 docents (associate-professors), 8,300 senior scientific workers, and 25,000 junior scientific workers and assistants.

Ten per cent of Doctors of Science are women, while the percentage of Candidates of Science is 25. ******

Nearly 800 women bear the titles of Lenin Prize and State Prize Laureates for outstanding achievements in science, technology and culture.***

Soviet women have refuted by their work the erroneous views of opponents of women's equality, who hold them incapable of scientific work, particularly in the sphere of exact sciences. The following examples - a few out of many will illustrate this.

Pelageya Kochina, member of the USSR Academy of Sciences, is an outstanding specialist in the field of hydromechanics and theory of filtration. One of her major contributions is the successful solution of the problem of simultaneous filtration of two liquids with different densities and application of methods of the analytical theory of differential equations to problems connected with the movement of subsoil waters. Pelageya Kochina is the author of over 80 scientific works. One of them deals with the irrigation of arid lands. Looking deep underground with the assistance of geologists and geophysicists, she discovered mighty rivers flowing from the Altai towards the Arctic Ocean at an immense depth under the permanently arid Kulunda Steppe. And now, under the direction of Pelageya Kochina and other scientists, wells of tremendous depth are being bored, powerful pumps are working as part of

* National Economy of the USSR, 1965, pp.709-7l0.

****** Ibid.

******* The Soviet Woman magazine, No.2, 1966.

the study programme aimed at turning the arid Kulunda Steppe into a land of flowering gardens and green fields.

Physicist Olga Bazilevskaya is a scientific worker at the Kurchatov Atomic Energy Institute. For her contribution to science she has been awarded a Lenin Prize. It should be noted that she has brought up four children, two of whom have followed their mother's example in becoming physicists.

Professor Lyudmila Keldysh is a senior scientific worker at the Steklov Institute of Mathematics. She is the author of very valuable works on the descriptive theory of multiplicities and topology and a capable tutor. A prominent mathematician, she is the mother of five, three of her sons being successful scientists. Lyudmila Keldysh has been awarded the Red Banner of Labour Order and the Maternity Medal.

Professor Maria Klyonova is an indefatigable student of sea and ocean beds, the founder of a new school of marine geology and author of 150 works. She has taken part in the writing of The World's Geology, the only work of this kind in the world. She has done much to set up oil extraction from the bottom of the Kaspian. Doctor of Geological and Mineralogical Sciences, Maria Klyonova has braved storms on the seas and oceans of the five continents and is the first woman to set foot on the Antarctic ice.

Olga Oleinik is Professor of Moscow University. Her works on the theory of non-lineal equations with particular derivatives and solution of a number of physical and mechanical problems have brought her world fame.

For her contribution to the development of a new engine fuel Maria Nadirova, senior scientific worker of the Oil Chemical Processes Institute in Azerbaijan, has been awarded a State Prize.

Among the physicists who were awarded a Lenin Prize for research into exiton in crystals in 1966 was one woman Academician Antonina Prikhodko, director of the Physics Institute of the Ukrainian Academy of Sciences, author of more than 60 scientific works.

Doctor of Physics and Mathematics Valeria Troitskaya is justly called "the most profound woman in the world", for she has descended in a bathysphere to a depth of 2,500 metres. She is the Scientific Secretary of the National Soviet Committee of the International Geophysical Year, Chairman of the Soviet Section on Geomagnetism and Geocurrents, the first and only woman member of the Bureau, Executive Committee of the International Geodetic and Geophysical Union.

The name of Professor Zinaida Yermolyeva, the microbiologist, occupies a place of honour in the list of the scientists who have conquered the scourge of cholera. Jointly with Professor Lydia Yakobson she has elaborated the cholera bacteriophage which has made it possible to eliminate this dire disease in the Soviet Union. Professor Yermolayeva has obtained a new anti-virus preparation, interferon, which inhibits the proliferation of poliomyelitis, measles, smallpox and other viruses. She takes part in theoretical research and the introduction of fresh antibiotics.

Professor of Leningrad University Nadezhda Nikolayeva, the daughter of a peasant, has made a sizable contribution to economic geography: she has spent many years on a marine atlas and has written a number of important works in the field of economic geography.

Her colleague in Leningrad University is Olga Ladyzhinskaya who is deservedly called a second Sophia Kovalevskaya. She has astonished the world by her works in mathematics: she has discovered methods for solving the most complex mathematical problems which have long defied the efforts of scientists throughout the world.

If there is the slightest tremor of the soil in any part of the globe, no matter what the longitude and latitude, it will immediately be registered at the seismic station in Pulkovo, headed by Albina Lazareva. This woman scientist is bending all her efforts on studying earthquakes and discovering methods of predicting them.

The world's first woman cosmonaut, Valentina NikolayevaTereshkova is a glaring example of the wide possibilities open to Soviet women. She has successfully mastered the hitherto unknown profession of cosmonaut, one requiring most varied knowledge and technical skills, unflagging courage, persistence and endurance. Valentina Nikolayeva-Tereshkova combines her work and studies with manifold social activities, including the post of Deputy Chairman of the Soviet Women's Committee. Her grave and numerous duties do not prevent her from being a fascinating woman and devoted mother.

As has been noted before, these are only a few examples out of many. As regards skill, scientific and technical maturity and prestige Soviet women engineers and scientists are in no way inferior to their male colleagues. Soviet people are justly proud of their achievements.

For their attainments in all spheres of the national economy and culture and for the feats of valour displayed during the Great Patriotic Wart 885,000 women (32 per cent of the total number of recipients) have received more than 1,180,000 Orders and Medals for their valorous labour; 2,931 women have been granted the highest honour - the title of Heroine of Socialist Labour *.

In a short article like this, one naturally cannot touch upon all the aspects of the important work carried out by women in the country's economics, science and life in general. The figures and examples cited here will, we hope, give a correct idea of the part played by women engineers and scientists in the USSR.

The question that easily arises is: could women take such a prominent place in the life of our country if the State limited itself to proclaiming women's equality with men without guaranteeing its realisation?

The answer is an emphatic NO, they certainly could not.

The Programme of the Communist Party of the Soviet Union envisages the total elimination of the remnants of the unequal position of women in domestic life and the provision of social and living conditions enabling women to combine happy motherhood with increasingly active and creative participation in social labour and social activities, and in scientific and artistic pursuits.

This will be facilitated by the fulfilment of the new Five-Year Plan whose main economic task is to secure - through the utmost application of the achievements of science and technology, the industrial development of the whole of social production, and the enhancement of its efficiency and higher labour productivity - a considerable growth of industry and stable high rates of agricultural development, thereby achieving a substantial rise of living standards and fuller satisfaction of the material and cultural requirements of all Soviet people.

Under the Five-Year Plan particular attention will be paid to measures for improving Soviet people's working and living conditions, expanding the construction of houses and children's institutions, and extending the social services and public catering.

* Women in the USSR, Statistical Materials, Statistics Publishing House, 1967, p.3.

During the five years, ten-year secondary education will be made compulsory, and a five-day working week (with two days off) will be introduced.

Scientific research opens up bra ad vistas before Soviet people, bringing within their reach vast natural resources and arming them with methods far achieving progress in all spheres of social life.

It would be out of the question to try to salve the tremendous tasks of further developing Soviet economics, science and technology without an active participation of women, without involving them in productive work on an increasing scale.

The creation of the material and technical basis of Communism, the improved cultural and technical level of women better living conditions and the extension of mother and child care an the part of the State - these are factors that will further enhance the role of women in Soviet society.

FUTURE ROLE OF WOMEN IN U. S. SCIENCE AND ENGINEERING

By John B. Parrish, B.A., Ph.D., Professor of Economics

Dr. John B. Parrish received the Ph.D. degree in economics at the University of Illinois. In 1941-42 he served as economist for the War Manpower Commission and. from 1942-44 was principal economist for the National War Labor Board. From 1944 until 1947 he served as regional director of the U. S. Bureau of Labor Statistics. In 1947 he returned to academic life as associate professor and since 1955 as professor of economics, University of Illinois. He currently serves as a member of various federal manpower committees, including the National Defense Executive Reserve and University Consultants to the U. S. Employment Service. Principal published works include Labor Problems of American Society (co-author with Carroll R. Daugherty) and papers on manpower topics in American Economic Review, Monthly Labor Review, Journal of Chemical Education, Research and Development, Science, etc.

Summary Views of a very limited future role for women in science and engineering based on the past are subject to serious doubts. Talented women are now in quite a new environment of Big Science in which for the first time demand will exceed supply and permit long term career planning. The ongoing revolution in information technology will further reduce many of the inhibiting factors of the past and facilitate extension of pluralistic living patterns to include high level professional as well as low level nonprofessional work. The advances in information technology should also serve to accelerate participation of talented women in science and engineering the world over, particularly in underdeveloped countries.

FUTURE ROLE OF WOMEN IN U. S. SCIENCE AND ENGINEERING

By **John B. Parrish**

I. Introduction

The participation of women in U. S. science and engineering has not only been quite limited in the past in absolute terms but appears to have declined relative to men in recent decades. Some very pessimistic conclusions about women's future role have been drawn from this record by knowledgeable observers both private and governmental.

This paper will raise serious doubts about this widespread pessimism. It will find that a significant role for women is probably just beginning, not only in the United States, but in many other countries with similar records of low past participation.

II. The Prevailing View of a Limited Future Role

The view that women are apt to have a very limited role in future science and technology is found among almost all sectors of the scientific community. A distinguished woman sociologist after an exhaustive study of women's career patterns in an affluent society concluded that most talented women admire high level science careers for other women but have no interest in pursuing such careers for themselves. [1] Labor economists have noted the very rapid rise in women's labor force participation rates, especially since 1940, but point to the almost complete concentration of this work in the low level occupations. Women want "jobs not careers" which precludes much progress in science and engineering.[2].

A leading engineering journal headlines a report: "Science Not Likely to Attract Many Women,,[3], and a distinguished science editor says we don't seem to have the right "social policies" to encourage women in the sciences.[4] The nation's top federal science agency after reviewing all the evidence concludes that many negative forces "militate against the hope for heavy commitment to science on the part of women". [5] The literature is voluminous. The pessimism is almost unanimous.

III. The Statistical Basis for Pessimism

The basis for pessimism can be found in a number of commonly used statistical measures.

In the broad professional and technical occupational group the decennial Census reported that women as percent of total personnel declined from 45 in 1930 to 40 in 1950 and to 38 in 1960.[6]

The decade of the 1950's was considered unusually favorable to the employment of women in all occupational categories yet in almost all the specific science classifications for which data are available, the Census reported women declining relative to men. To illustrate: women as a per cent of all chemists declined from 10.2 to 8.8 ; of physicists from 6.5 to 4.3; mathematicians from 38.1 to 26.6 and engineers from 1.3 to 0.6. [6]

The decline of women as a proportion of employed science personnel might be expected from their declining participation in higher education. In the 1920's and 1930's women comprised between 45 and 50 percent of all college enrollments. [7] In recent years this percent has been around 38. In the 1930's, women earned about 40 percent of all first level academic degrees. This percent declined to a low of around 34 in the mid-1950's, has since recovered to no higher than 38 percent. Women's share of second level degrees reached a peak of 40 percent in 1930, has since declined to about 32. [7]

Of particular concern to scientific societies has been women's declining participation in third level doctorate training. Thirty years ago Women earned 15 percent of all doctorates and in many individual science fields accounted for 20 and 30 percent of annual awards. Since then, women's share has declined to about ten percent overall and declined even more rapidly in selected sciences. For example in mathematics women at one time earned one out of five doctorates. Recently they have earned just one out of 20. In engineering women's share of doctorates declined from a low 1.2 percent in the years 1920-24 to the even lower 0.5 percent in 1960-64. [8]

In summary, every well known statistical measure seems to tell the same story: declining relative participation in professional training and employment in general and in science and engineering in particular for the last three decades.

IV. A Second Look at the Statistics

Before drawing pessimistic conclusions about the future outlook for women from the statistics of the past, it might be well to take a second and very close look at just what the statistics really mean.

From 1900 to 1930, women's share of total professional and technical personnel, as reported by Census, rose from 35.2 to 45.0 percent. This occurred because at this time women dominated teaching and teaching was the largest (30 times larger than engineering) and most rapidly growing of all professions. Women's relative decline since 1930 arose largely from two structural changes. First, several male dominated professions, especially engineering, grew more rapidly than education, thus lowering women's overall share. Secondly, the upper levels of the educational establishment grew more rapidly than the lower grades dominated by women. Men were attracted to secondary school teaching in large numbers, for the first time, thus lowering women's share. It is doubtful if these structural changes properly serve as indicators of women's declining interest in professional life, per se.

Within the professional occupations women never made any real rising commitment to science and engineering except for one decade. The Census did report a sharp rise for the ten year period of 1940 to 1950. Women as a percent of total professional personnel rose from 3.1 to 10.2 in chemistry, from 0.3 to 1.3 percent in engineering, from 24.1 to 26.3 percent in the natural and social sciences.[10]

There was great rejoicing among ardent feminists when the 1950 Census data became available. The rejoicing may have been somewhat premature. This may be illustrated in the case of engineering. In 1940 the Census reported 945 women engineers. In 1950 it reported 6,700. This spectacular rise came as quite a surprise to engineering educators who awarded, at most, only about 800 engineering degrees to women during the entire decade and who estimated not more than half of these were employed in engineering in 1950. Where did the other 5,350 bright and shiny new women engineers come from? A checkback revealed several disquieting facts. Nearly half of the 5,350 new women engineers hadn't even graduated from secondary schoo1.It and most of those who had graduated with college degrees had never been inside an engineering school. It soon became abundantly clear what had happened. In an effort to induce women into jobs vacated by men during the war years, and perhaps to circumvent the rigidities of wartime wage controls, industry had grossly over classified women on a very big scale. [12] Glamorized titles were added to glamorized pay. By 1960 most of the WWW's (wartime women wonders) had left employment. Over c1assification had ceased. The exhilarating relative rise 1940 to 1950 was followed by a disconcerting relative decline 1950 to 1960. In reality, both the relative rise and relative decline comprised a statistical illusion.

How does one explain women's declining share of academic degrees since 1930? Here again it is important to note that from 1900 to 1930 women's share was rising. This rise resulted from the fact that teaching was dominated by women, it was the fastest growing profession and it led the way in requiring more formal academic education for entrance. Women's relative decline since 1930 has risen from two influences. The first is long run in nature. The nonteaching professions, particularly the natural sciences and engineering, have followed teaching in requiring more formal classroom training. Men have been forced into the colleges by rising standards of the scientific community. This is hardly cause for deploration.

The second influence is of a short run, temporary nature. It stems directly from World War II and postwar military developments. During the 1940's, as was just noted, women entered industry on an unprecedented scale, postponed marriage and cut education short. Then came the "make up" years of 1945 to 1955 with very high marriage rates, high birth rates and abnormally depressed education rates. On the other hand, men's education rates were abnormally accelerated by subsidization of higher education for all men with military service. In 1940 the percent of 18 and 19 year olds enrolled in school was 31 for men and 27 for women. They were thus fairly close. In 1950 the percentages were 35 for men, 24 for women, a widening gap unfavorable to women. In 1956 the enrollment rate for men reached a peak of 45 for men but for women declined to a low of 2.7 percent only a little more than one half that for men. Since then women have been rising up out of this postwar valley. In 1964 the education enrollment rate for men was 51 percent and for women was 34 percent.[13]

It is very doubtful if one should conclude that the results of women's outstanding contributions to wartime mobilization and the postwar educational subsidization of demobilized men, should be interpreted as reflecting declining intellectual interest or vigor on the part of women. Lamentation hardly seems in order. One need only keep in mind that except for this early post war period, the percent of women 18 and 19 years of age enrolling in higher education has risen irregularly for the last six decades and there is every reason to expect this upward trend will continue on into the future.

Statistics on women's declining share of doctorates, 1930-60, appear offhand to represent a serious lessening of interest in top level professional careers and a considerable deterioration from what was once a relatively strong position. This is hardly the case.

The percent of total doctorates earned by women rose from eight percent in 1900 to a peak of 15 percent in the early 1930's. This rise is largely a distortion of small numbers. For example when women earned one fifth of doctorates in mathematics, 1920-24, the total annual number of women recipients was four.[14] During the years 1900 to 1930 only a few women moved into the doctorate program. Even fewer men did so, giving rise to some sharp percentage gains. The record shows that the early doctorate was used by these few women, at the height of the feminist movement, to escape from the drudgeries of homemaking and the lack of attractive alternative employment opportunities. Almost all the early Ph.D. women remained single, entered college teaching, primarily in the growing women's clleges.[15] Their research productivity was relatively low.[16]

Women's declining share 1930-60 resulted in part from the more rapid movement of men into the program as the Ph.D. became desirable in nonacademic employment and as the scientific community raised its standards. In part it resulted from structural changes. Some of the science and engineering doctoral programs in which women had low representation grew much more rapidly than those in which they had higher as in English literature, education and psychology. To illustrate: engineering accounted for just 1.3 percent of total doctorates in 1920 but 13 percent in 1965.17

In summary, the statistics on the rise and decline of women's share of top level academic degrees have been widely misinterpreted. The rise and subsequent decline occurred because of changes in the interest and response of men, not women. Women never made a strong numerical commitment to top level training in science and engineering.

Parenthetically it may be noted the overall decline in women's share levelled off about ten years ago and that after decades of very slow absolute growth the annual awards to women recently have turned sharply upward in some science fields. For example, in mathematics, the number of Ph.D.'s earned by women was stabilized at around 10 degrees for nearly 30 years, 1930 to 1960. In 1960 the number increased to 18, then moved up sharply to 36 in 1963 and up sharply again to 60 in 1965. It is of course too early to tell if this marks the beginning of a strong long term absolute rise but it very well may - a possibility that will be considered later.

V. Explaining Women's Limited Role in the Past

A. The Falling Barriers to Marriage and Low Level Work

The explanation for this relatively limited role of women in engineering and science in the past is to be found, ironically enough, in the effects of advancing technology. On one hand it made marriage and family life more attractive and low level work more feasible. On the other it left high level careers relatively inaccessible and more difficult to sustain. These differential effects warrant brief discussion.

The changes in technology making for the greater attractiveness of homemaking may be summarized as follows:[18]

1. Mechanization of housekeeping tasks. In 1900 less than five percent of U. S. families had automatic cooking, washing, cleaning equipment. In 1920 the percent had

risen to 20, by 1950 to 50 and by 1965 to about 75 percent, thus drastically reducing the drudgery of housekeeping tasks.[18]

2. Mechanization of individual transportation. In 1900 less than five percent of households had automobiles. By 1920 the percent was 15, by 1935 the percent was 50 and By 1965 about 80 percent of all U. S. families owned at least one automobiles thus reducing the isolation and immobility of home life.

3. Mechanization of individual communication. In 1900 telephones were enjoyed by less than four percent of families. In 1935 they were owned by 35 percent, in 1950 by 62 percent and by 1965 slightly over 80 percent had telephones, thus providing convenience, freedom from isolation, access to emergency help. In 1940 television was a laboratory toy, in 1950 about 12 percent of families owned TV sets and by 1965 about 93 percent, thus providing information, entertainment at low cost.[18] .

4. Advances in medical techniques and facilities. In 1910 only ten percent of women had children born in hospitals. By 1965 the percent was 98. In 1920 the maternal death rate per 1,000 live births was eight. In 1965 it was less than one third of one percent, thus reducing the risks and discomforts of childbearing.[19]

5 The Diffusion of Discretionary Income. In 1910 only about one third of all U. S. families had discretionary income. Using a more generous yardstick the percent rose to 45 in 1920, to 65 in 1950 and to 82 percent in 1965 Poverty had become so rare ,as to become conspicuous.[20]

The response of women to the mechanization of homemaking is well known. They responded with greatly intensified interest and participation in marriage and children. This may be briefly summarized as follows:

1. An extremely high rate of marriage. In 1900 spinsterhood was very common especially among highly educated women. Nearly ten percent of all women never married. Today about 97 percent of all women marry - at least once.[2l]

2. Early age of marriage. In 1890 marriage was long delayed. Only 48 percent of all young women 20 to 24 years of age were married. Since then the trend toward earlier marriage has been strong. In 1940 the percent of this age group married had risen to 53, by 1950 it was up to 68 and by 1965 it had risen to 71. The median age at first marriage is now 21, considerably lower than in most industrial countries. 22

3. At least one child per family. At the turn of the century, childlessness was very widespread. As recently as 1940 only 77 percent of women ever married in the age group 30 to 34 had had one or more children. By 1950 this percent had risen to 83 and by 1960 to 93. Before the present cohort in this age group completes childbearing around 96 or 97 percent will have had at least one child - a status symbol of an affluent society.23

4. Control of the number and timing of children. It is estimated over 95 percent of professional families, 90 percent of white collar families and 80 percent of all families utilize contraceptive technology to control family size and timing. One result of control is a trend toward having children earlier except for the college going population which is characterized by increasing postponement.

It requires no further delineation to support the conclusion that marriage and family life have since 1900 become a much more attractive and popular institution to the entire population including women with high educational attainment.

Advanced technology not only made marriage and family life more attractive it made work for women at low to medium levels much more accessible.

In 1900 working women were almost entirely confined to just two occupational categories, school teaching and manual labor within a narrow occupational structure containing probably less than 1,000 identifiable jobs.

In just six decades advances in science and engineering created an occupational structure containing 22,000 identifiable occupations, almost all of them open to women. This opening up process was accomplished by proliferation and divisionalization of the white collar sub professional: managerial, clerical, sales, service jobs and by the mechanization and dilution of manufacturing tasks.[26] .

The response of women to this opening up process is well known. Their overall participation rate rose from 17 percent in 1900 to nearly 40 percent in 1965. The work profile by age groups underwent revolutionary change. In 1900 labor force participation reached a peak of 29 percent before age 25, then declined steadily at successive ages. In 1965 participation rates reached an early peak of nearly 50 percent, declined to age 35, then rose to a second peak of 50 percent at age 45 to 54.[27] The work rate of college educated women in the latter age group in 1965 was 85 percent.

Rising access to marriage and to work has been accompanied by greater access to education. Once again the response has been positive. In 1900 only four percent of women 19 and 20 years of age enrolled in college. The percent reached 32 in 1960 and is probably about 34 percent currently.[29]

Finally we may note there has been a strong trend toward combining all three activities, marriage, employment and education. In 1890 married women didn't work. Less than five percent were in the labor force. In 1960 the percent was 3l and in 1965 it was up to 35. In 1900 women enrolled in college didn't work. Today 25 percent of all women students 18 and 19 years of age, nearly 40 percent of those 20 to 24 years of age are also working.[30] As recently as 1940 combining marriage and college attendance was unheard of for women. Currently about ten percent of college women students age 20 and 21, about 30 percent of those 22 to 24 years of age and 65 percent of those 25 to 29 years of age are married.[3l] As one might expect the combination of study, marriage, work, has led to a fourth dimension - children. Maternity wards and kindergartens on college campuses with graduate schools are no longer unknown or even luxuries, they are becoming necessities.

These statistics on marriage, work and education rates have been cited in order to support two observations of very great importance for the future. First, the record shows that wherever and whenever technology has lowered the barriers to employment and education, women have responded positively and strongly. And, secondly, under the impact of advancing technology women's lives have become highly pluralistic.

B. The High and Rising Barriers to Top Level Work

The very same forces of advancing science and technology which increased women's access to marriage and low level work 1900 to 1950 did not have similar effects on women's access to high level work in science and engineering. In some respects they worked in the opposite direction.

The demand for women at high professional levels never opened up during this period as it did at lower levels. There is no evidence of chronic shortage of scientific and engineering personnel. Instead the evidence points to an adequate and at times, more than adequate, supply of men, until very recently. [32] It would have been unwise for large numbers of women to have trained for nonexistent jobs.

Although characterized recently by rapid growth it must be kept in mind the size of the scientific force has been relatively quite small. It has been estimated the percent of the population engaged in professional work in science and technology was 0.03 in 1870, increased only to 0.2 percent in 1910 and to 0.7 percent in 1950.[33] As a percent of the labor force, personnel in science, engineering and technology were less than 1.0 percent in 1900, were 1.5 percent in 1940, 2.2 percent in 1950 and were still only 3.2 percent in 1960. [34] The time and expense required to acquire minimum professional competence has steadily lengthened. In 1910 most engineers required no formal specialized training. They were trained on the job. By 1930 a formal four year academic degree was desirable if not necessary. By 1950 it had become a necessity. Now five and six years of college training is standard.[35] And the Ph.D. is rising rapidly as a percent of total engineering degrees awarded annually.

Not only have academic degrees, and higher level degrees, become necessary but the time required to get the same degree has been stretching out; Women obtained Ph.D. 's in 1910 in about two, at the most, three years after the baccalaureate. Today it takes five and six years.[36]

The years of professional training now almost completely overlap the primary child-bearing years. The average age of women Ph.D. recipients in 1910 was about 25. The average age of individuals earning science Ph.D.'s in recent years has been 31.[37]

The task of professional re-entry has become ever more difficult as the rate of professional obsolescence has risen with the explosion of scientific knowledge. It is estimated that if a woman scientist or engineer is away from her profession for seven to ten years the literature in her field will have doubled.[38]

In the light of these high and rising barriers, the decision of most talented women not to pursue high level careers in the sciences in the past makes a great deal of good sense. It reflects considered and realistic appraisal of the scientific world as it existed from 1900 down to around 1950.

C. In Recapitulation of 1900-1950

Recapitulating we may now bring the past record of women's work into some degree of focus. Advancing science and engineering have made family life ever more attractive and low level work ever more possible. Women have responded positively. Pluralism is now characteristic of women's life patterns. Advancing technology has made longer term high level careers more difficult. Women's participation has remained low. The statistics reporting a rise in women's share of top level degrees and work from 1900 to 1930 or 1940 and then subsequent decline are misleading and to a considerable extent a statistical illusion. Women have never made a strong commitment to science and engineering. In the light of existing opportunities in the past, this record is cause for commendation, not lamentation or pessimism. The past record provides strong support for the view that should the three major barriers to high level careers cited above be lowered, talented women will respond positively.

VI. The Basis for a New and Significant Role

A. The New Environment of Big Science: an Emerging Demand for Women

The years before 1960 have little predictive value for the future role of women in engineering and science. Events of the last ten years, particularly the last five, suggest that in many ways the scientific world is in a new environment. Using Derek J. de Solla Price's dichotomy, it may be said we have moved from an era of Little Science in existence up to about World War II into an era of Big Science since then.[39] We now appear to be high on an exponential curve of expanding scientific development.

In this new environment of Big Science, demand for engineers and scientists tends to outrun supply. For the first time in history, women who undertake advanced training in the sciences, may reasonably expect to find abundant, attractive and challenging employment opportunities. This strong and rising overall demand is being reinforced importantly from women's view by the proliferation in the number of science occupations the divisionalization of these tasks and their geographical diffusion.[41]

All available evidence points to the continuance of this demand supply relationship favorable to women in the future. A major barrier to women in engineering and science has come down. It is likely to stay down.

B. Continuation Study: The Revolution in Information Technology

The principal remaining barriers to women's pursuit of high level science careers, are as noted earlier, the difficulties of combining marriage and family life with the long years of training required for entry and the difficulties of re-entry professionally after years out for children. These two barriers rest primarily on the inability to engage in continuation study. The severe limitations of the educational process Dave prevented pluralism at high levels. It now appears reasonable to suggest that these two remaining barriers are now being lowered by advances in the science of information.

The nature of the current revolution in information technology is well known but it may be useful to summarize briefly, selected aspects as follows: [42]

1. Micro information storage and retrieval. The micro revolution includes micro photography, printing on film, fiche or tape, retrieval and display and transmission. These new techniques permit thousands of books, drawings, images to be stored in a few cubic inches or feet of space. A small library can now be sent through the mail.

2. Rapid reproduction of words, images. Advances in reprography using both wet and dry copier methods now permit rapid reproduction of words, images at very low cost and in great quantity.

3. Computerized information storage, retrieval and analysis. Millions of items can now be electronically stored and retrieved in seconds. As an instrument for analysis computer capability increased from 10,000 calculations per second in 1952 to 3,000,000 calculations per second in 1964 and will rise to 1,000,000,000 per second by 1969. Equally significant the computer may be used by off-site personnel within countries or between countries.

4. Telecommunication systems. Two way closed circuit television systems or televue phone systems now provide instant place to place visual as well as audio communication.

5. Automatic literature search and transmission. Much progress has been made in automatic literature search, bibliographic compilation, retrieval, printout or transmission of information to distant inquirers. Breakthroughs in automatic indexing, cross referencing, abstracting would make for revolutionary advances in this area.

6. Mechanical language translation. Optical reading and translating machines already do a fair job. They should do an even better job in the near future in providing complete international access to the world's exploding literature.

7. Facsimile transmission. It is now possible to transmit through ordinary telephone lines both printed words and images at relatively low cost.

8. Computerized reprography. Combining advances cited above it is now possible to store and retrieve both data and images and automatically obtain unlimited quantities of printouts. For example one machine introduced in 1966 can store 2.5 million blueprints or images on microfilm, retrieve and print a copy of anyone in less than five seconds. The printout may be at (1) a local station, (2) a distant location or (3) the printout may be made locally and unlimited copies sent to different distant locations by facsimile transmission.

Substantial and even revolutionary though these recent advances have been they are likely to prove just a beginning. A very large volume of investigation, demonstration and research is going on at a rapid pace around the world. In the United States alone there are under way such projects as COSATI, EDUCOM, HSIC, MARC, SDIEX, PIRS, NSRDC, CFSTI, INTREX, ACAT, MEDLARS, MVIS, ASCA and NCIS.[43] Other countries have similar projects. Out of them is certain to come giant strides in the next few years.[44]

The implications of the ongoing revolution in information technology for talented women are many. It should provide for the first time individualized access to all aspects of the learning process. It will provide at-home instant access to the literature, to ongoing research experiments, to lectures, consultation with faculty, etc.

It should enable women to combine marriage, advanced study, probably children, while acquiring professional status and the maintenance of professional competence during later time out years for child raising. Continuation study in the comfort of residence will be substituted for the discomforts and limited accessibility of libraries, classrooms.

These developments will represent nothing really new, merely upgrading of pluralism which is now widespread but principally limited to study, marriage and to work at low levels.

VII. Summary and Conclusions

There is widespread view, based on the record of the past, that women will have a very limited future role in engineering and science. This pessimistic view is subject to serious doubts. The past is apt to have limited relevance for the future.

Women's relatively low participation in engineering and science in the past was based on (1) lack of demand, (2) increasing difficulties of combining family life and long years of professional training, (3) increasing difficulties of re-entry after years out for family responsibilities, (4) greater attractiveness of and access to early marriage and low level employment.

The traditional barriers are now coming down. In the new environment of Big Science demand for both men and women exceeds supply for the first time. This relationship will likely continue on in the foreseeable future. An ongoing revolution in information technology will make it possible for women to participate simultaneously in marriage, family life, higher training, professional practice. Automated electronic continuation study techniques should facilitate both entry and re-entry into long-term, high level work. Advancing technology together with increased educational subsidization will permit women to enlarge and upgrade the pluralistic living patterns which have emerged since 1900.

In the first half of this century, engineering and science made notable contributions to the lives of Women. In the second half women will make notable contributions to engineering and science to a much larger extent than before.

In the light of the evidence from both the past, the present and the prospective future, it appears reasonable to conclude a significant role for women in engineering and science is not ending. It is just beginning.

VIII. A Prospectus: The Woman Engineer of the Future

The woman engineer of the future will marry a professional man before or shortly after getting her first degree. She will earn a second level and perhaps a third level degree. She may have children before leaving the university campus, or she may obtain the degrees, work for three to five years and then drop out for child raising. In either case she will acquire or maintain professional competence by means of an automatic study carrel. Through telecommunication she will attend engineering classes, observe research projects, discuss problems with teachers and engineers on the job. The turn of a dial on a console will give access to all engineering literature, including search, retrieval and display of any desired volume, article, report, blueprint. If convenience requires she can retransmit the display to panels in other rooms - to the kitchen while making coffee, to the nursery while tending the children. Another console dial will give access to a computer network for analytical tasks.

If enrolled in formal course work, examinations will be written in her study carrel, transmitted to a mechanical grader, the grade transmitted back to the carrel, to faculty and to academic administrative personnel. If unable to travel she will attend the 12th Annual Meeting of the Society of Women Engineers and Scientists via her carrel. This air-conditioned automatic information carrel will be made available at low subsidized cost through a federal government scientific manpower agency. She will insist it be in colors to match the decor of the other rooms in the house or apartment.

If she takes time out from professional practice while children are small she will return to part time or full time practice fully updated, in fact, probably more so than her male colleagues undergoing professional obsolescence through narrow specialization. Her professional husband will need to have frequent recourse to this information carrel to keep up professionally with his wife - the new pluralistic and continuous engineer.

IX. An International Footnote

It has not been possible in this brief paper to explore the many international implications of the revolution in information technology. Yet the subject deserves at least mention. Talented women in underdeveloped countries have particularly difficult problems in acquiring professional status. Training resources at home are scarce, opportunities limited. Study in advanced countries is very expensive and time consulting. The new technology of microform will permit the largest of engineering libraries to be sent in one airmail package to the most remote corners of the world in a few hours. Telecommunication technology can provide access in seconds. These and related information technologies should soon bring a new freedom and a new access to professional status for talented Women the world over. And in return these women should contribute importantly to scientific knowledge and thereby participate in the task of enriching and broadening life everywhere.

X Footnotes

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EDUCOM: Interuniversity Communication Council, established to devise ways of increasing and automating information exchange between institutions.

HSIC Health Sciences Information Center. Proposal for an automated medical information center being studied by EDUCOM.

MARC Machine Readable Cataloging Study being made by the National Aeronautics and Space Administration.

SDIEX Selective Dissemination of Information Experiment being ,. conducted by Chemical Abstracts Service.

PIRS Photo Image Retrieval System, announced by International Business Machines company for distribution in 1966.

NSRDC National Standard Reference Data Center being developed by the National Bureau of Standards for the U. S. Office of Science and Technology.

CFSTI Clearinghouse for Federal Scientific and Technical Information, in operation as separate federal agency to collect, store, disseminate research reports, domestic and foreign, to all inquirers at low cost on standard form & or micro-forms.

INTREX Information Transfer Experiment at Massachusetts Institute of Technology to give faculty and students remote access to computer controlled magnetic memory store. Sometimes referred to as MAC (Multiple Access Computer).

ACAT Automatic Cataloging and Transmission. An experiment in which the U. S. Library of Congress began in Fall of 1966 to transmit machine readable catalog data to computers in, cooperating libraries.

MEDLARS Medical Literature Analysis and Retrieval System in use since 1962 at National Library of Medicine, Bethesda, Maryland, for mechanical search and bibliographic compilation.

MVIS: Micro-Vue Information Systems, pilot project sponsored by the Council on Library Resources.

ASCA: Automatic Subject Citation Alert. Weekly publication listing articles from any of 1500 scientific journals to meet the citation, author or other index criteria of the user. Developed by Institute for Scientific Information.

NCIS: National Chemical Information System, design project begun in late 1966 by Information Management Inc., under contract with National Science Foundation to develop automated system of chemical information indexing, abstracting, search, transmission.

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THE KEY TO THE SCIENCE WOMANPOWER POOL: TEACHER EDUCATION

By **Gladys S. Kleinman,** B.A., M.Ed., Ed.D.

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Summary The number of women who ultimately go on to major in science or engineering is a function of the attitude of our western culture toward women in science. A negative attitude toward science as early as kindergarten has repercussions in the size of the science womanpower pool a generation later. Attitudes of children are formed early by mothers and school teachers who are non-science oriented models of femininity.

The adolescent culture discourages scholarship--those girls who admit to an interest in these "masculine" studies are considered odd. These who are very aggressive "'buck the culture" and we see them practicing science today. The more compliant girls go on to major in social sciences and humanities, often winding up teaching elementary school. By this time they fit the mold; they are poorly prepared to teach science and tend to teach science reluctantly.

In an effort to break this cycle, several groups of scientists, teachers, and psychologists, are developing teaching materials to enable even the most insecure teacher to teach science. Hopefully favorable attitudes toward science will be developed among all children and the cultural bias against women "doing" science will be overcome.

THE KEY TO THE SCIENCE WOMANPOWER POOL: TEACHER EDUCATION

By **Gladys S. Kleinman**

An American high school junior recently reported in the New York Times, "Maths and sciences seemed very important to the Russians and were always stressed. Girls were treated the same as boys (1)." Since this student had attended schools in London, West Berlin, Hong Kong, Taiwan, Bonn and the United States, as well as Russia, one infers that boys and girls are not treated the same in these other places! Is there any relationship between this perceptive observation and the fact that half of the semi-professionals and professionals in the Russian labor force in 1959 were women (2) as compared to thirty-seven percent in the United States in 1965 (3)?

Early Sex Differences: Inborn or Learned? The question arises: Are boys and girls treated differently because they are different or are they different because they are treated differently? Even before birth there are differences between boys and / girls. Although more boys are conceived, the prenatal mortality rate is higher for boys and about an equal number of boys and girls are born (4). In comparing boys and girls in elementary school we find that girls mature earlier (5), have fewer reading, learning and behavior problems, stutter less, have fewer language disorders, are less vulnerable to stress, and are less likely to be retained in the same grade for more than one year (4).

One investigator found that 9 year old boys and girls even have different thinking styles. Girls are more introspective, open, people-oriented, and relate well to teachers and school. Boys are more self-confident, resistent to school, happier to be boys, and organized around power, competition, and mastery (6).

Erikson correlated the differences between boys and girls with the morphology of their genital organs. When asked to construct a moving picture with models, boys and girls used space differently. Girls showed an interior scene. They placed people and animals in an enclosure in static positions, with low walls and peaceful surroundings. Boys, on the other hand, depicted exterior scenes in which people, animals, and vehicles were moving. The walls were high and accidents and policemen were frequently present (7).

What are the sources of the differences between the sexes? Basically there are three: biological, societal, and parental (8). The biological differences are obvious as far as anatomy is concerned, but did the differences in behavior that Erikson identified arise "by nature", culture, or parental influence?

Societal differences are based on the concepts and mores of each society. One example that comes to mind was brought to my attention when I visited Poland a couple of years ago. In the course of a conversation about women professionals, my informant mentioned that 80 percent of the dentists in Poland were women. When I expressed surprise, the mater-of-fact response was, "Well, dentistry is a woman's profession!"

Parental differences are tied in with societal differences in major respects but vary somewhat in degree. In most primitive societies, the female's duties are to nurture and care for children, while the male's responsibility is to provide protection and food. These rules are clearly differentiated and it is easy for children to learn the appropriate behavior. In modern society, especially in the United States, there are many cultures and children may be confused (8).

In fact, it isn't only children who are confused. Psychologists and sociologists would be the first to admit that it is all but impossible to distinguish between biological, societal, and parental influences. In one study, elementary school children were encouraged to join after school clubs. Boys selected tumbling and girls cooking. In the crafts club, the boys worked with wood and metals; the girls sewed, and embroidered (5). What influence was strongest here? Though creativity and curiosity are considered native talents in which boys surpass girls, Torrance found that after a year in a special curriculum girls were as creative as boys (9). In another study of teacher interactions, both male and female teachers reported acting differently to boys and girls (10). It is not uncommon to find kindergarten teachers removing little boys from doll houses and firmly suggesting that they play with trucks instead.

Both behavior and attitudes are thought to be learned by imitation prior to the age of eight (11, 12). This is probably why, as early as the elementary school years, girls sublimate their desires, aggression, and creativity, conforming to the socially accepted pattern of behavior that gains approval. In other words, they learn to do what pays off. If they haven't learned their traditional roles at home, teachers' expectations and stereotypes shape them into the "mold" in school.

<u>The Adolescent Culture</u> In a study by Rowe, it appeared that <u>scientists</u> have four characteristics in common: high intellectual ability, persistence in work, extreme independence, social aloofness (13). Brandwein's findings, in a study of scienceprone high school students were similar (14). Apparently these characteristics are developed early in life. What likelihood is there that the adolescent girl will have these characteristics?

According to Coleman, author of The Adolescent Society, among girls, scholastic success rates lower than good looks and nice clothes. Beauty is more important than brains in being popular. The best scholars had the least good feelings about themselves. The brightest girls hid their intelligence because grades help less in popularity than activities like cheerleading (15). Even at home, girls are discouraged from solitary pursuits, and urged to cultivate popularity. At home, too, father presents the masculine model of independence and persistence while mother, the feminine model, is compliant and socially-oriented. The middle class, highly sophisticated adolescent boy is not interested in the studious girl. In working class areas girls date older boys and often leave school to marry (15). As long as status and recognition in high school are synonymous with popularity, girls are not likely to develop the characteristics of scientists.

Education of Women At high school graduation the attrition of bright girls begins. While 60 percent of the boys in the upper third of their high school graduating class go to college, only 46 percent of the girls in the upper third of their high school go to college. In 1965, 40 percent of the bachelor's degrees were earned by women. Of male college seniors in the upper third of their class 50 percent go to graduate school; only 45 percent of women college seniors with similar standing enroll in graduate school (18). A decreasing proportion of the women in graduate school complete their master's. In 1930, 40 percent of the master's were earned by women; in 1965 the proportion dropped to one-third. In 1930, women earned 15 percent of the doctor's degrees; this dropped to 11 percent in 1965 (3).

Women in the Labor Force Vocational choices are manifested as early as the ninth grade (16). Girls interests in marriage and family rank progressively higher in the eighth, tenth and twelfth grades. Boys are primarily interested in salary in eighth and tenth grades and in the twelfth grade rank marriage and family just below salary. The greatest difference in careers between boys and girls is orientation towards economic forces for boys and homemaking for girls (17).

The amount of education a woman has directly influences her employment pattern: 72 percent of women with 5 or more years of college are working 53 percent of women with 4 years of college are working, 45 percent of women with high school education are working, 31 percent of women with 8th grade education are working (3). It would seem then, if we need more women in the labor force, we must encourage them to continue their education, Age, too, influences a woman's pattern of employment. There are two peaks: the early twenties, before marriage, and after 40, when children are grown. More than one-half of women between the ages of 45-54 are working or seeking work (3).

Table 1 shows an increase in the proportion of women in the labor force from 26 percent in 1940, to 29 percent in 1950, to 35 percent in 1965. At the same time, there has been a proportionate decrease in the number of women in professional or technical employment from 45 percent in 1940, to 42 percent in 1950, to 37 percent in 1965.

Women non-college teachers number 1.4 million. This is 42 percent of the women in the professional-technical category, and 69 percent of all non-college teachers. This group comprises 90 percent of all elementary teachers and 50 percent of all secondary teachers. Yet non-college teachers account for only 5.5 percent of all women employed ,of 125,000 college teachers, 23,000 or 18 percent are women (3).

Table 1. Employment of women .percentage given of total personnel.

Employment	1965	1950	1940
Men	46 million	41 million	34 million
Women	25 million	17 million	12 million
Professional Technical –	3.3 million (37%)	1.9 million (47%)	1.6 million (45%)
Non-College Teachers	1.4 million		

What is the situation in science? Only 17,000 or 8 percent of science personnel are women. This is 0.5 percent of all women in professional – technical employment and 0.08 percent of all women employed! But there is another dimension to women's employment as can be seen from table 2. Withdrawal from the labor force between the two peaks of employment is particularly high for women in the 24-44 age group (19).

Table 2. Voluntary withdrawal from labor force* in selected professions, by age and sex expressed in percentages.

Profession and sex	Age 25 to 44	Age 45 to 64	Age 65 or older
Natural scientists			
Women	51%	13%	61%
Men	2	1	57
Engineers			
Women	31	13	42
Men	1	4	58
Secondary school teachers			
Women	34	13	65
Men	2	2	54
Physicians-surgeons			
Women	19	10	31
Men	2	2	25

* The labor force is defined as all persons, whethere currently employed or not, who have worked in the stated capacity during the last 10 years .The figures are as of 1960.

The critical need for women in professional and technical occupations in recent years has led to the development of centers for the retraining and counseling of middle-aged women whose careers have been interrupted. Women who have not worked for many years are updated and in some cases may get initial training for teaching or working in industry.

Not only is there a need for women to fill jobs, there is a need for jobs to fulfill women! In a recent study of almost 500 women, ages 37 to 47, it was found that although marital status was the single most important influence on the state of happiness, women who are best adjusted are married and working at a high level in a feminine profession or voluntary activity. Low morale was attributed to widowhood or divorce, and a low level job or little or no voluntary activity. In each case, education was the most important determinant of career. Since married women tended to have less education than single women, the folly of too early marriage was indicated (20),

<u>The Importance of Science Education for Elementary Teachers Psychologists believe</u> that attitudes are formed early in life. Thus little girls of elementary school age have already learned the acceptable feminine mode of behavior -- compliant, dependent and non-science oriented. Elementary teachers, mostly women themselves, shaped by similar experiences, reinforce the stereotype. The adolescent society, in junior and senior high schools, stresses popularity and school activities other than scholarship. Girls who go on to college seldom major in science. Those who are more aggressive buck the culture and become science teachers, doctors, scientists or engineers. The more conforming girls major in humanities or social sciences and become elementary teachers. With inadequate backgrounds they are reluctant to teach science, and the cycle perpetuates itself (21).

If indeed the number of women in the science pool is a function of negative attitudes towards science inculcated early, then the way to increase the number of women in science is to introduce favorable attitudes towards science early. This can be done by improved science education for elementary teachers. If elementary teachers can be assisted to teach science with some degree of satisfaction and pleasure two important purposes will be accomplished: 1) favorable attitudes will be developed among all children toward science and 1) the cultural bias against women “messing around “ with science will be overcome.

In the United States a number of nationally known groups of psychologists, scientists and elementary teachers, financed by government agencies, have pooled their efforts to develop experimental science curricula that even the most insecure elementary teacher can handle. These courses are based on direct, concrete experiences involving observation, manipulation of simple equipment, hypothesizing, collecting data, and drawing conclusions. By carrying out investigations himself the child learns the satisfaction of testing his own hypotheses. Not only does he understand better the methods of science but he gains independence in setting up experiments and persistence in trying various hypotheses. The child may work by himself, with a buddy, or a small group.

Three of the best known experimental elementary curricula are those developed by the American Association for the Advancement of Science; the Science Curriculum Improvement Study, based at the University of California-Berkeley; and the Elementary School Science Project sponsored by a non-profit group in Watertown, Massachusetts.

Interestingly, each of these three groups has pursued the same goals by three different approaches. The AAAS curriculum is based on the processes of science, the SCIS on scientific literacy as opposed to common sense, and the ESS on discrete experiences.

The AAAS Teachers Guide explains that the philosophy of this course is based on the assumption that science is more than facts, that science is concerned with processes as well. The objectives state the expected behaviors, followed by the rationale which relates the exercise to the instructional scheme. An exercise entitled "Observations on Rolling Balls" for grade 2 begins with this statement:

"At the end of this exercise, the children should be able to describe the rolling of balls down an inclined plane with particular attention to relative rates of rolling. They should also be able to distinguish between a solid and a hollow ball by watching their relative rates or rolling when someone else rolls them down an inclined plane."

The rationale points out that similar behavior in falling doesn't necessarily mean similar behavior on an incline, a closely related behavior. Vocabulary, instructional procedures and appraisal follow (22).

To reach the objective of scientific literacy, the SCIS provides pupils with experiences different from their usual ones, via a student manual and kit, a teachers manual containing background material and instructions for using the kit and audiovisual teaching aids which complete the package. The student manuals contain suggestive questions and data sheets, but no information. The only information is derived from observation. For example, the following four systems are considered: brickscale; magnet-steel toy car; dry cell-wire-light bulb; and vinegar-water-bromthymol blue. The manuals alert the teacher to the common characteristic: they each evidence interaction. Teachers are cautioned to listen to pupil's remarks, not to ascertain whether the child is reading the teacher's mind, but to determine what the child observes. (23).

In the ESS units, the children explore materials and equipment freely, in an unstructured situation. For example, a fifth grade class was given a frame for each pair of students, string and several weights. After several weeks of "messing about" they came up with most of the questions designed for the unit on pendulums (24).

These three curricula are unique in that 1) they were developed by groups of scientists, teachers and psychologists, 2) they were supported by government funds and 3) they were developed experimentally. Each of these curricula was tried with small groups of typical elementary teachers in typical classes, rewritten and tried again with larger groups. They have all undergone extensive revisions. They are all predicated on science as "doing". Hopefully, as these curricula influence elementary science on a wider scale, we will witness a scientifically literate citizenry and an increased pool of science man and womanpower.

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FACTORS AFFECTING SEX DIFFERENCES IN APTITUDE FOR, INTEREST IN AND ACHIEVEMENT IN

MATHEMATICAL AND SCIENTIFIC SUBJECTS

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Summary Attention is focussed on the extent to which sex differences in aptitude for, interest in, and academic, achievement in mathematical and scientific subjects are culturally determined rather than innate. The data originated from scholastic aptitude and achievement testing programmes involving tens of thousands of students in the secondary schools of the Province of Ontario, Canada. Although the data are specific to Ontario, the findings are presented against a background of Canadian and American educational and sociological research studies. Factors affecting the divergence of academic interests of boys and girls in early adolescence and the career consequences thereof are discussed. Some methods are suggested whereby the rate of change in attitude of students, teachers, parents and employers towards women scientists and engineers may be increased.

FACTORS AFFECTING SEX DIFFERENCES IN APTITUDE FOR, INTEREST IN, AND ACHIEVEMENT IN MATHEMATICAL AND SCIENTIFIC SUBJECTS

By **M. Dormer Ellis**

Canada is the second largest country in the world. Ontario, the second in size among the ten provinces of Canada, has an area larger than France, Germany and the Netherlands combined. More than a third of Canada's twenty million people live in Ontario. The northern regions of the province are sparsely settled; the population is concentrated near the waterways of the Great Lakes and the St. Lawrence River. With abundant raw materials and water power, southern Ontario is one of the foremost industrial regions of Canada. There are twenty-five thousand professional engineers in Ontario, only forty of whom are women.

In order to practise as a professional engineer in Ontario, one must be licensed by the Association of Professional Engineers of the Province of Ontario. Since 1937, the designation ' professional engineer' has been restricted by law to members of the A.P.E.O.; other persons identifying themselves as professional engineers are prosecuted. However, the term 'engineer' is not legally defined and is commonly applied to operators of railway engines or steam plants. Occupational titles such as 'physicist', 'mathematician', 'scientist' and 'chemist' do not have legal status but are customarily used to describe persons having university graduation or equivalent qualifications in these fields. Although there are Canadian associations of physicists, statisticians, chemists, etc., membership is voluntary as these are not licensing bodies. The numbers of people in each of the scientific and mathematical professions and the percentages of women are not as readily ascertained as in the case of professional engineers. The A.P.E.O. publishes annually a list of registered professional engineers, their university degrees, branches of engineering, and present employers. The sex of the professional engineer is not stated but it is usually apparent from the given names. When searching for women's names in the A.P.E.O. list, one is not only impressed by their scarcity but also by the fact that such a high proportion of the women who are licensed to practise the profession of engineering in Ontario obtained their university education outside Canada.

Both academic achievement and practical experience are prerequisite to registration as a professional engineer in Ontario. The usual route is graduation from the engineering faculty of one of the universities in the province followed by a couple of years of appropriate employment in industry. Immigrants to the province may be licensed to practise professional engineering if the A.P.E.O. deems their university education and employment experience to be comparable to those of Ontario applicants. Although it is possible for persons who are not university graduates to become professional engineers, it is not common. The A.P.E.O. provides examinations at the technical level of final examinations of four-year university courses in engineering and candidates may prepare for these examinations by private study. A few men have become members of the A.P.E.O. by this means but no woman has done so.

Why are there so few women among Ontario's professional engineers? Does the A.P.E.O. have admission regulations that discriminate against women? No, it does not. From its inception, the association has always accepted women members on the same basis as men. Do Ontario universities dissuade girls from enrolling in engineering courses or even prohibit them from doing so? At one time, some of them did. But that time is long past. The early feminists fighting for the removal of artificial barriers against their sex claimed that if women were given equal opportunities, their career accomplishments would equal those of men. Nowadays, there are no restrictive clauses in the admission criteria of engineering courses in Ontario universities. Nevertheless, some engineering courses have no co-eds at all, and the others have very few. The first woman to enrol in an engineering course at the University of Toronto was Elsie Gregory MacGill. She graduated in 1927 and has become highly respected as a consultant in aeronautical engineering. But in her footsteps have followed only a few, for the woman professional engineer is still a rarity in Canada.

It is not that the Canadian girl decides against preparing for a career in engineering; the possibility of doing so is unlikely to even enter her mind. Present-day Canadians, like the vast majority of people in every period of history and in every country, accept as unquestionably right and universally valid the particular customs and mores that happen to be current in their own society. Canadians do not try to explain why engineering is an almost-exclusively masculine profession; both men and women just take it for granted that this is a natural reflection of innate sex differences.

As well as the obvious bodily differences related to the complementary roles of men and women in reproduction, there are physical differences which give one sex an advantage over the other in certain occupations. Some people who are not conversant with the professional responsibilities of engineers, scientists and technologists have the mistaken idea that physical strength is required. The observation that technical work is almost always done by men lends credibility to this notion. The professional engineer may direct the activities of persons engaged in manual labour but his own contribution is primarily mental. Although the average man surpasses the average woman in brute strength, this difference is as unimportant in professional engineering as differences in hair colour or handedness. Good health and vitality are assets in any occupation but physical strength per se is no more necessary in the profession of engineering than it is in the predominantly feminine professions of nursing and elementary-school teaching.

The preponderance of men in occupations requiring mathematical skill and knowledge of scientific principles seems inevitable to those who believe that the ability to think logically is a masculine prerogative. Jean Jacques Rousseau, an influential eighteenth century writer, maintained that there is an inborn characteristic of the feminine mind that prevents women from comprehending abstractions. That it is woman's nature to be inferior in aptitude for mathematical and scientific studies was held to be self-evident until it was inadvertently disproved in the present century as a result of the administration of scholastic aptitude tests to thousands of schoolchildren of both sexes. Statistical analyses of the results of testing programmes carried out in Canada, the United States of America and elsewhere have demonstrated repeatedly that the younger the pupils tested, the more nearly equal are the 'average boy' and the 'average girl' in the ability to recognize relationships, manipulate symbols, and Understand numerical principles. Even in the upper grades of elementary school, where the 'average boy' is somewhat superior to the 'average girl' in such traits as mechanical aptitude and interest in science, there is considerable overlapping of the score distributions of boys and girls; many girls surpass the 'average boy'. The evidence from the field of psychological measurement dissipates the theory that the reason Ontario girls do not become technologists and professional engineers is that they are inherently incapable of mastering the necessary academic and technical subjects.

About thirty years ago, anthropologist Margaret Mead carried out a scholarly analysis of the mores of certain New Guinea tribes; in Sex and Temperament in Three Primitive Societies she revealed her startling conclusion that the mental characteristics and behaviour patterns typical of each sex vary greatly from one culture to another and hence are not biologically determined. Mead observed how the growing child is gradually moulded by daily experience of social expectations into the personality type considered by members of the tribal group to be natural for an adult of that sex. Desirable traits are those which enable the individual to adapt to the unique combination of social, religious and economic factors characteristic of a particular society at a particular period in its history. They are neither universal nor permanent. Although her anthropological studies were based on extant primitive societies, Mead's work raised questions about the effects of subtle social pressures on the developing personalities of boys and girls in modern societies. Perhaps sex differences in career choices reflect differences in social expectations experienced during childhood and adolescence. Is the school system in which Ontario children receive their formal education a source of the sex differences in the mathematical, scientific and technical interests and achievements of adults?

In Canada, education is a provincial responsibility. Ontario is justly proud of its educational system. There is no illiteracy. Both elementary and secondary education are free. Attendance at school is obligatory for all children and a large and increasing percentage of young people remain in school after reaching the legal school-leaving age of sixteen. There are eight elementary grades and five secondary grades; most children proceed through the grades at the rate of one grade per year. Graduation from Grade 13 is required for admission to Ontario universities. Each municipality taxes local real estate to finance the building and operation of its own schools. To equalize the educational opportunities of children living in different parts of the province, the Ontario government supplements the local financing of schools by a system of grants. The Department of Education of the Ontario government maintains high academic standards in the schools by training and certificating the teachers, approving courses of study, authorizing textbooks, inspecting classroom activities and conducting province-wide examinations in the subject matter of Grades 12 and 13. One looks in vain for overt sex-discrimination in the Ontario educational system. Boys and girls attend the same schools, are taught in the same classrooms by the same teachers, and write the same examinations. But it has not always been so.

Canada is a fairly young nation. This year, 1967, Canadians are celebrating the one hundredth anniversary of their country's birth. Even before the region that is now known as Ontario changed" its status from that of an English colony to that of a Canadian province, it provided free elementary education for children of both sexes. By modern standards, instruction was rudimentary, but almost all boys and girls did learn to read, write, and do simple calculations. Secondary education was not common. The fore-runners of Ontario's secondary schools were fee-charging institutions intended solely for the sons of the wealthier families. The curriculum of Latin, Greek and Euclid was designed to prepare the young men for their future roles in government and the professions. Their sisters received a very different type of secondary education. As the only respectable vocation for a woman was that of wife and mother, the primary goal in the education of a daughter was the acquisition of a suitable husband. An attractive appearance, untarnished virtue, and a modest demeanour were regarded as a young lady's greatest assets. Both in the home and in the few schools for the privileged classes, girls accomplishments were limited to a little embroidery to employ a dainty hand, a little poetry for its refining influence on the soul, and a little music to amuse a husband during an idle hour. Very few Canadians regretted the lack of real educational opportunities for girls; the majority of women, as well as men, believed that the existing situation was only right and proper.

The resistance encountered by pioneer advocates of academic and professional education for girls can only be understood in the context of entrenched social custom and traditional belief about the feminine role of During the last quarter of the nineteenth century there was a gradual relaxation of the exclusiveness that had previously characterized secondary education in Ontario. But even when secondary schools opened their doors to students of both sexes, many parents were reluctant to permit their daughters to enrol. Not only was an academic education considered unnecessary for a young lady but her anxious relatives feared that too much book-learning would make her unattractive to prospective suitors. It is interesting to note that during the 1880's, the per-student grants made by the Ontario government to the secondary schools in the province were computed according to the principle that two female scholars are equivalent to one male scholar '. It was not until the closing years of the century that it became commonplace for girls to continue their education beyond the elementary grades.

Co-education in Ontario universities and the acceptance of women in the learned professions met with even greater opposition than the extension to girls of a secondary education. There were women patients in the hospitals but no women physicians to attend them; there were women prisoners in the docks but no women lawyers to defend them. Business, government and industry were all considered to be outside woman's proper sphere of interest. It is difficult for the professional woman of today to fully appreciate the ambition, determination and courage of the first women who obtained post-secondary education. When no medical college in Canada would accept a woman student, a group of intelligent and idealistic women established their own college to provide girls with full medical training. This brave enterprise overcame tremendous prejudice as it evolved into the present, internationally-recognized Women's College Hospital of Toronto. The first woman student to attend lectures at the University of Toronto was Helen Gregory. In spite of attempts to embarrass and intimidate her, she would not abandon her goal of earning a degree. In 1888, she graduated with high honours. Throughout her lifetime, she continued to overcome what most people would consider to be insurmountable difficulties and she eventually became Mrs. Helen Gregory MacGill, B.A., M.A., Mus.Bac., LL.D., Canada's first woman Judge! Until her death in 1947, she worked diligently towards improving the treatment of women and children who came before the courts.

Without intending to disparage the personal achievements of the ladies who first demonstrated that members of their sex could become doctors, lawyers, chemists, pharmacists, physicists -- even professional engineers, one must acknowledge that the great advances in career opportunities for women that have been made in the twentieth century did not take place in a social vacuum. Woman's gradual emergence from domestic seclusion into the political and economic life of the nation was influenced by and itself influenced the evolution of Canadian society. The growth of manufacturing industries, improvements in transportation and communications, the invention and development of home appliances and the increased availability of electrical power all tended to reduce the workload of the women and girls of the household and thus to increase their availability for remunerative employment. However, the country's participation in two World Wars was probably the most influential factor in altering the socio-economic status of Canadian women. The manpower shortage during the war years drew attention to the almost untapped womanpower reserve of the nation. Single women, childless wives, mothers of grown families, widows -- all were urged to devote their time and labour to the war effort. It became not only socially acceptable but a patriotic duty for women of all social backgrounds to earn their living by working in offices, stores and factories. Many Canadian women experienced financial independence for the first time and some were reluctant to return to the housekeeping routine when their brothers, fathers and husbands returned from overseas. Although it is twenty years since wartime industries closed down, the level of female employment in Canada remains high. It is now taken for granted that a spinster will be self-supporting throughout her lifetime. Young girls expect to earn their own living from the time they leave school until they have husbands to support them. In the past ten years it has become unusual for a girl to resign from her job when she becomes engaged or even when she marries; increasing numbers of young wives are continuing to work until they become expectant mothers. An even more recent phenomenon is the return to the labour market of mothers who no longer have small children at home.

The Canadian working woman of the 1960's bears little resemblance to her feminist counterpart of half a century ago. Oddly enough, the term 'feminism' is used to describe a rejection of all that was traditionally associated with the female's passive, dependent status. Membership in the feminist movement demanded an aggressive determination to establish oneself in a masculine profession. These women glorified the goals and privileges of men and were determined to make them their own. Their philosophy produced both a militant hostility towards men and a disparagement of the housewife. The ardent feminist belittled the married woman and gloried in her own battle for recognition in a man's world. The career woman had to be aggressive and competitive. When she deliberately chose 'career' in place of 'marriage', the decision was very likely to be irrevocable. The spiritual cost must have been enormous. Today, the Canadian girl has no need to be aggressive in order to enter any profession -- even engineering. She needs only the same academic qualifications and interests as the men who choose that profession. Young women no longer have to decide between participating in the economic life of the country and becoming housewives; most girls are confident that they will fulfil both roles -- serially, if not simultaneously.

In terms of numbers, women are well-represented in the labour force of Canada. But in terms of occupational status and the accompanying financial rewards and personal fulfilment, they are not. Almost all clerks and typists are women but few women hold senior management or executive positions in Canadian business enterprises. Although more women than men are teachers, men greatly outnumber women in the ranks of principals, school inspectors and educational administrators. In the medical professions, women predominate in nursing and occupational therapy but the majority of surgeons, physicians, dentists, optometrists and veterinarians are men. In industry, professional engineers, physicists, chemists, technologists and technicians are almost always men but women are employed on assembly lines and as machine operators in Canadian factories. As women's occupations are not limited by law, and as educational institutions are open to both sexes, and as psychological tests of academic aptitude taken by thousands of students do not indicate any superiority of the masculine mind, one is led to suspect that women, by the decisions they make as schoolgirls, inadvertently limit themselves to occupations of relatively lowly socio-economic status.

The first step in any attempt to reduce the gap between women's actual and potential participation in the scientific and technical professions is to ascertain at what age and grade level consequential career decisions are made. Numerical data accumulated for other purposes by the Department of Education of the Province of Ontario, The Ontario Institute for Studies in Education, the Metropolitan Toronto Educational Research Council, and other educational organizations have been carefully analysed for information on this matter. The transition from elementary to secondary school and graduation from Grade 12 mark the the periods at which girls elect to cut themselves off from paths leading to careers in mathematics, science and technology.

Throughout the eight elementary grades, boys and girls follow the same curriculum. Sex differences in elementary-school achievement are not great but such differences as are found are in the direction of superior performance of girls. More girls than boys are eligible for the enriched or accelerated programmes provided by some communities for their more successful pupils and fewer girls than boys have to spend a second year on the work of a grade. Comparisons of marks earned in Grade 8 mathematics and science provide no justification for the great difference in the proportions of boys and girls who continue to study these subjects in the higher grades. Most secondary schools in Ontario offer more than one programme. Unlike the practice in some countries, pupils are not assigned to one or another of these programmes on the basis of their previous academic performance or scholastic aptitude scores. The choice of secondary programme is made by the pupil and his or her parents. Educators may suggest that a certain programme is the most appropriate for a particular pupil but parents can -- and frequently do -- ignore this advice. Although secondary programmes have diversified in the last five years, the basic Ontario pattern has been three types of secondary education namely, commercial, technical, and academic. Boys and girls are not equally-likely to enrol in these programmes. Almost a hundred per cent of technical students are boys but among commercial students, girls outnumber boys by a ratio of fifty to one.

As well as general education in English and social studies, the commercial programme provides training in such immediately-salable skills as typewriting and shorthand. Foreign languages, algebra, geometry, physics and chemistry are not taught to commercial classes. Why are girls -- even girls having high marks in Grade 8 mathematics and science -- attracted to this type of secondary education? It is conventional for an adolescent girl to take a short-term view of her educational needs. The responses that thirteen- and fourteen-year-old girls give on school questionnaires about career plans reveal an appalling lack of long-term ambitions. Such glamorous positions as fashion model, airline stewardess, and private secretary to a handsome bachelor can hardly be considered as realistic, lifetime career goals. The socially-accepted myth is that a girl will work for only a few years before marrying and living happily ever after as a contented housewife and mother. This is no longer a realistic expectation. It is probable that the Ontario girl who begins her secondary education in 1967 will bear her last child before reaching the age of thirty, will have about half her life ahead of her when her youngest child starts school, and will outlive her husband by several years. It is highly likely that she will be in the labour force for thirty or more years. Will her working life be a monotonous routine? Will her contribution to society be commensurate with her intellectual potential? Will she enjoy an absorbing and rewarding career? The answers to these questions are not unrelated to the educational decisions made by and for girls as they move from the elementary grades into the more specialized programmes of the secondary schools.

Greater care is exercised in the selection of an appropriate secondary programme for a son than for a daughter. The boys who enrol in the technical programme receive an education that is somewhat comparable to that afforded by apprenticeship schemes in European countries. For four years the students divide their time between studying applied mathematics, practical science, English and social studies and gaining practical experience in the school's shops and laboratories. In the final year, each student chooses a speciality such as architectural draughting, applied electricity, or woodworking. With few exceptions, the boys who choose the technical programmes in Ontario secondary schools are those who would be unlikely to succeed in the more intellectually-demanding academic programme. It is very unusual for a girl to enrol in a technical programme and no attempt has been made to encourage girls to do so.

The academic secondary programme is the most popular for both boys arid girls and has the highest social prestige. Certain subjects are compulsory for all academic students but there are also optional subjects.

Algebra, geometry, physics and chemistry are optional subjects in Grades 11 and 12; girls are less likely than boys to choose these subjects. Ontariowide tests of Grade 12 achievement show no significant differences between the sexes. However, the pervasive influence of socially-approved sex roles is evident from the educational choices made by Grade 12 graduates. A graduate of the academic programme may enrol in Grade 13 to prepare for university admission or may enter a post-secondary educational institution such as a teachers' college, school of nursing, or institute of technology. Teachers' colleges (which train elementary-school teachers) attract five times as many girls as boys. No social disapproval accrues to a girl -however high her Grade 12 standing -- when she decides to teach in an elementary school but a boy whose Grade 12 work is satisfactory and who aspires to be a teacher is encouraged by his friends, parents, and school guidance counsellor to take an honour course in university and then teach his major subject in a secondary or post-secondary school. Similarly, no one criticizes a girl -- even a brilliant scholar -- for becoming a nurse; a bright boy who wants a medical career is expected to graduate from university in medicine or dentistry. Boys who have an interest in science or engineering but whose Grade 12 marks do not predict success, in university studies may enrol in Ontario's institutes of technology and prepare for careers as engineering technologists. Girls are eligible for courses in engineering technology but almost all the girls currently attending institutes of technology are taking home economics, fashion design, or secretarial subjects. From the point of view of the maximum utilization of Canada's human resources, it is unfortunate that the socially-expected occupations of elementary-school teaching, nursing, and office work attract not only the Grade 12 girls for whom these occupations are the most appropriate but also girls who -- had they been of the opposite sex -- might have become professors of mathematics, brain surgeons, and business executives.

Who can induce girls to raise their aspirations? Who can aware of the opportunities for self-fulfilment? Who can point lifetime consequences of educational choices made after Grade 8 or Grade 12? The woman who is practising a profession, managing a household, a family is particularly well-qualified to say, "It <u>can</u> be done and it <u>is</u> worth doing".

Canadian women in the mathematical and scientific professions have a social obligation to advise and assist girls whose aptitudes are similar to their own. How can they go about it? In spite of their busy schedules, they should welcome invitations to address groups of adolescents and / or their parents. Associations of parents and teachers, teen-age clubs, and church groups are chronically short of qualified speakers. Of course, it would be inappropriate for a speaker to solicit recruits for microbiology or nuclear physics but a general discussion about career opportunities in the field of science would be both interesting and enlightening. There is no need for such a lecturer to stress the fact that one does not have to be a man to be a scientist; her presence on the platform is proof enough. Grade 12 students are especially receptive to career information and school guidance counsellors regularly arrange career days during which students are addressed by visitors representing various professions. A married couple -- such as a professional engineer and a mathematician, or a zoologist and a professor of geology -- who discuss realistically the demands and rewards of their professional lives and who give frank answers to the students' queries about how they cope with household responsibilities can provide an instructive and inspirational experience for students of both sexes.

Writers are also urgently needed. School libraries and the youth sections of public libraries contain many books -- fiction as well as nonfiction -- about careers in science. But girls seldom borrow books that have titles like "A Boy's Book of Electricity", "Charles Black, M.D.", or "Great Men of Science". There should be more books whose titles and illustrations arouse girls' interests in mathematics and science. Articles in the newspapers and magazines that cater to young people can also be an effective means of directing girls' attention to the possibility of a career in electronics, computer technology, or metallurgy.

Is it desirable to have mass media dissemination of news items about individual women scientists? Publicity about a woman's genuine professional accomplishments should be encouraged but one must be on guard against interviewers and reporters who treat such a woman as a freak.

Women professional engineers, mathematicians and scientists are too few for effective group action but they can work with women in other professions to encourage career-mindedness among Canadian women and girls. There are Business and Professional Women's Clubs throughout Canada. These are actively engaged in trying to effect changes in the laws and customs which make it difficult for women to participate fully in all aspects of Canadian society. The income tax structure, the dearth of trained domestic assistants, the need for adequately-staffed nursery schools, the scarcity of part-time employment and the difficulties of staying abreast of one's field during periods of full-time homemaking, are all matters of concern to women scientists as well as to women in other professions.

Canadian women have good reason -to be optimistic about the future. Royal Commission on the Status of Women in Canada has recently been appointed. All members of the commission have demonstrated their ability to combine harmoniously personal career, family life, and public duty. The implementation of their recommendations to the Canadian government can be expected to make it possible for more women to utilize their intellectual potential. The members of the Royal Commission represent a wide variety of professional interests; there is even one of those rare Canadian women -- a professional engineer!

<u>The Woman Professional Engineer</u> **7 July 1961**

Session II

In the Chair Freda H. Gwilliam (UK)

Discussion

Freda H. Gwilliam, C.B.E., M.A.

Freda Gwilliam was educated at one of the schools of the Girls Public Day School Trust and Girton College, Cambridge & M.A. in History; taught children of all ages in schools in Britain then trained teachers specialising in History and Social Studies; Principal of Brighton Teacher Training College during the war; experience of social work in South London; of youth work in the Red Cross and the Girls Training Corps, also, during war; Chairman of Diocesan Youth Council and Justice of the Peace until 1941. Adviser on education in non-self governing Commonwealth countries specialising in the education of teachers and in everything affecting opportunities for women and girls; closely associated with the major women's international non-governmental organisations, consultant to UNESCO and the South Pacific Commission; co-Chairman of the Department of Co-operation of Men and Women in Church, Family and Society of the World Council of Churches; now Woman Educational Adviser to the Ministry of Overseas Development.

The Woman Professional Engineer

DISCUSSION

Sir Hamish MacLaren (U.K.)

I am rather overcome to be asked to speak first but I realise that this is a ladies show and that women must have the last word so by being allowed to come in now I may be allowed to speak for perhaps a couple of minutes. First, may I perhaps quite out of order, express the tremendous privilege that my wife and I have enjoyed at being invited to attend your Conference as representatives of the CEI. If any of you still do not know what the Council of Engineering Institutions means, do ask me before we break up. One other general word - I do want to congratulate you women on the tremendous organisation behind this Conference, it is beyond my words to express my appreciation, I know a little of what these things mean but to think this has all been done by voluntary effort. Take yesterday and all the things that were done - I feel rather like the Queen of Sheba after being shown all the glories of King Solomon she had no spirit left in her! However, as my few remarks are going to show I still have a little.

The subjects of your Conference were grouped under the headings of technological and sociological. Now looking back, and I admit that this is partly to get an opening to the one word that I want to say at the end, I felt that there were a few questions earlier on that were not quite adequately answered. The delegate from Austria asked why it was that a country like the Argentine which used to export enormous quantities of meat were recently reduced to having meatless days. The answer to that is in two words - bad Government - leading to rapid inflation and a disruption of their economy. The delegate from Ghana asked what was going to happen, how were they going to absorb the labour which would be released by the application of technology to agriculture in a country such as Ghana. The answer is, of course, that simultaneously with the release of such labour the secondary industries must be developed. Beginning with the simpler industries, for instance, making pots and pans from the aluminium produced by the new scheme, with the ample power there is, the secondary industries must be developed to make Ghana more and more self-sustaining as a country and so enhance the standard of life of the whole population. That means good Government, because the development of these industries requires the provision of capital, and capital can only be provided by the Government of the country or by giving confidence to people abroad who have capital to spare to invest. That brings me now to the real point I want to make. The professional engineer is one who applies science to technology. Engineers must accept the social consequences of applying science and technology and to do that they must go beyond the second heading of our Conference, namely sociology, and be prepared to apply sociology, which means they must be prepared to go into politics. Now here we do not have a very happy record in this country, today there are two electrical engineers in our Parliament and one in our House of Lords, Lord Jackson of Burnley better known to most of you as Willis Jackson. That is a pretty poor show, if compared with the number of teachers and lawyers in our House of Commons, people whose profession gives them adequate practise in talking but who compared with engineers are in many cases deficient in the experience of practical life which is the very realm in which engineers live and work. Here, therefore, men have failed and here is an opportunity for you women as you come more and more into the field of science and technology.

D. F. Jackson (U.K.)

I would like to comment on a point made by Mrs. Webb at the end of her paper. Interdisciplinary courses, of the type Mrs. Webb proposed, are in operation at several universities in the United Kingdom. I take part in the teaching of such a course, a degree course in Human and Physical Sciences, at the University of Surrey, and find participation in this type of course very stimulating. It is interesting that this course attracts a high proportion of girls.

Concern about the dichotomy between humanities and Sciences and about over-specialisation within the sciences and engineering has already given rise to changes and new developments in education, both in schools and universities. These developments will be of little use, however, unless there is a corresponding change of attitude among employers, particularly in industry.

Z. Szentgyorgyi (Hungary)

After the Second World War the position of women in Hungary changed radically. The former semi-feudal system greatly restricted the rights of women both in the political and in the economic sphere. For example before 1945 women were denied admission to the legal and agricultural universities. The mechanical engineering faculty took in hardly any women and very few women were able to become chemists or mechanical engineers. After liberation, following the Second World War and the introduction of new laws and regulations, women in our country got full independence, but it was impossible to remove the prejudices over night. In any case, in the last 20 - 22 years the social position, rights and prospects of women have changed considerably, this being also reflected by the fact that the proportion of women working has grown by leaps and bounds. This has brought us to roughly the same level as the developed industrial countries in the field of professional women. Compared with the pre-war period the percentage of women working in the technical and other intellectual professions grew more than any other and at the moment they represent about 40% of the total intellectual labour force. It should be said that this relatively high percentage is due to the fact that the intellectual professions include a number of expressly feminine professions such as teaching, pharmacy and medicine. For example 22% of our doctors and half our pharmacists are women. On the other hand the number of women engineers amounts to only 7% of the total number of graduate engineers and among them there will be few engineers in leading positions or professors, university lecturers, directors and heads of departments. Of the total number of chief engineers there are only about 60 - 70 women out of a total of 1,000. The question is being asked in Hungary, as elsewhere, whether women are in fact suitable for following technical and scientific professions. Although the ways are becoming open for women in a whole series of scientific subjects and professions there are some subjects, like my own electrical engineering, where there is a constant struggle for recognition. Doubts are raised whether women engineers are up to research jobs or executive jobs, whether perhaps their attention is not too much diverted by family problems. In many cases these doubts are rooted in prejudice, but they are not entirely unjustified and therefore must not be neglected. For this reason the National Association of Hungarian women has decided to take measures to increase the standing and recognition of women engineers. Similar measures were adopted in October 1964 in the Massachusetts Institute of Technology and a symposium on the subject resulted. We hope that on the occasion of the Third International Conference of Women Engineers we will be in a position to report in detail on positive results.

L. M. Guillerault-Danel (France)

For 40 years I have been concerned with Societies of women engineers, and I am struck by the similarity of the problems raised by today's speakers to those of 40 years ago. I would like to pick out the principal achievements made in France during these 40 years. First, excepting only the Military Schools, access to the Grandes Ecoles for engineers is now open to all. Secondly, openings for employment are equally available to men and women engineers and women have the same opportunities of choice Then, also, there is equal pay for equal work, although there is still the difficulty of gaining genuinely equal work, and women do not yet have an equal chance of promotion. The civil service, information work and scientific research most readily provide careers for women, whilst career.

in private industry call for greater ability and persistence to combat the greater obstacles. On the debit side of the balance, I observe today a greater tendency for women to abandon their careers either on marriage or at the birth of a child, though this is less common among established engineers except where their posts carry no responsibility. The main reasons for this are early marriage, economic prosperity, the difficulties of finding homes close to work, the need to care for young children, the need for a married woman to find work in the area where her husband is employed, and French legislation which has gradually increased the length of maternity leave without regard to the post occupied by the mother. These are problems which our Associations must work at if they wish to help. Finally, there is always the struggle against prejudice and lack of information.

M. L. Watkins (U.K.)

First of all I would like to thank Professor Shercliff for the most able contribution of a male on the education of women. Secondly, I would like to disagree with him on two points which he made. The difficulty of placing women in British Universities on engineering courses seems to me non-existent. Warwick, the City University and the University of London are only too happy to accept women provided that they have the required 'A' level mathematics and some other 'A' levels. In fact the City University, which only takes industry sponsored students, will find industrial sponsors for women, a privilege which they do not award to men. The second point which I would like to make is that I am not in favour of bunching women into one or two Universities in this country. I do not think that most women who take up engineering or applied science would like this or benefit from it. From my experience these women would prefer male company as a rule, although I realise that this Conference is made up almost entirely of such women. Secondly I think that this would not be very good preparation for life in industry. We mostly find ourselves the sole woman in male society and one might as well get used to it in early life. And finally I should loath to deprive the other Universities of the civilising influence which female students have on male company.

A. Azmaz (Turkey) (Written Contribution)

No paper giving a comparison between the role of women in developed and developing countries was given at the Conference and my intention in making such a contribution now is to arouse interest, although this is by no means a scientific study.

My understanding of the papers and my experience and knowledge of women engineers in Turkey lead me to believe that in the course of the next fifty years women in the developing countries will be holding a greater number and more senior positions in the professions than women in the countries which are at present more advanced.

I deduce this from the papers presented by Dr. John Parrish of the USA and Miss K. K. Khubchandani of India. Let me make four statements and give these authors' responses to them.

1. MARRIAGE IS MORE ATTRACTIVE IN DEVELOPED COUNTRIES

In the USA the marriage rate is extremely high being about 97% of all women. The median age of marriage, 21, is lower than in most other industrial countries.

In India on the other hand the situation is very different, and only recently the Indian government fixed the minimum legal age for marriage at 20. Although the purpose of this is to inhibit population increase, its long term effect will be to lead young girls towards university education and careers in the professions.

2. PROFESSIONAL WORK IS M0RE IMPORTANT IN DEVELOPING COUNTRIES

In the USA today life demands more of women than their traditional role of wife and mother. Socio-economic conditions encourage women to take up careers and a career in engineering is a challenge to them, whilst their families react favourably in the belief that a woman who makes engineering her profession is fit to take an active part in all other aspects of life.

In India social attitudes play a major part in an individual's life and the individual is very conscious of status. The country is going through a state of socio-economic progress and the role of woman is slow to change, though the present day climate of opinion favours her freedom from the ties of the home.

3. TECHNOLOGICAL DEVELOPMENT AFFECTS CHOICE OF MARRIAGE OR A CAREER

In the USA the 1950's were considered unusually favourable to the employment of women, yet in almost all science classifications for which data are available there is a declining percentage of women relative to men. For example, women chemists declined from 10.2% of the total number to 8.8%, physicists from 6.5 to 4.3%, mathematicians from 38.1 to 26.6% and engineers from 1.3 to 0.6%. In the 1920's and 30's women formed between 45 and 50% of- all college enrolments; in recent years this figure has dropped to around 38%. Thirty years ago women earned 15% of all doctorates and, in some fields, accounted for 20 to 30% of annual awards. Since then, women's share has dwindled to about 10% overall and in some spheres considerably less.

The explanation of this relatively limited role of women in engineering and science is to be found, ironically in the advance of technology which has, on the one hand, made marriage and family life more attractive and low level work more feasible, and on the other, left high level careers relatively inaccessible and more difficult to sustain.

4. FAMILY LIFE IS IN GREATER DANGER IN THE DEVELOPED COUNTRIES

There are more broken homes in the USA and children deprived of the steadying influence of family life create problems for relatives, parents, and society.

Since independence is the major characteristic of an American family, parents, grandparents and children all having their own homes, a young housewife will have no help from relatives and must do everything herself yet she has to combine marriage with other social and professional duties. The result must surely be to lead her to comparatively easy non-professional work.

In India because of the interdependent nature of the family, the young housewife will have much less difficulty in raising her children. Grandparents will help take care of the children and an extended family life will provide the young professional woman with the help she needs to fulfil her career successfully. It is more important for her to do this since it enables her to make a greater contribution both financially and socially.

I conclude therefore that the process of development forces women into professional life whereas in countries of greater advancement there is professional relaxation.

R. Winslade (U.K.) (Written Contribution)

Miss Azmaz refers throughout to a fifty year period and bases all her arguments on this period. It is perhaps significant that 'professional relaxation' is beginning in the USSR if recently available data are true indications of trends. For about fifty years women have played a very important part indeed in science and engineering and, until a year or two ago, represented well over 3510 of the profession of engineering in that country. There is now beginning a perceptible decline, which decline seems to coincide with a betterment of the standard of living and the improving economy of the country. A second point worth considering is whether, (with technological development gathering pace almost daily), in fifty years time, significant numbers of either sex will be needed as professional engineers.

A. Asmaz (Turkey)

I am sorry to say that I am a little sceptical about the future of women engineers for two reasons. For the last few days that I have been here I have observed that even in England, which I consider as a developed country, there are schools separate for women and men, I am surprised to see that this is the case. Now consider students having education in those separate schools and trying to graduate as engineers: they are claiming to work together and be equally efficient at their professional work, but if they have their education separate and ideas separate how can they be equally efficient when they start their professional life? The other reason is that in this audience we claim to be efficient and yet we are trying to have an international Conference of women engineers. Why cannot we have men engineers as well and try to compete with them through our ideas?

The third point I want to make is purely a comment. It is about the point raised by the delegate from the U.K. She said that an engineer should have many qualifications, not purely academic. I completely agree with that and would like to give an example to illustrate the point. This may be familiar to the delegate from the U.K. but it may be something new to the other delegates. Though I am from Turkey the example is from Pakistan. In Pakistan, engineers are at the key posts of the Government. A civil engineer can come to the key post of land development and the department head of foreign aid. This constitutes a prime example that engineers have to have many qualifications and be equally efficient in other social sciences.

R. Winslade (U.K.)

I assure Miss Azmaz that as far as we are concerned most professional women in this country deplore the idea of segregated schools because we think that in this way you get an inequality in the standard of teaching but I can also tell you that it is not general allover the country and certainly north of the border, in Scotland, it is non-existent. Regarding the differences in attitudes between the developing and developed countries I like to think of developing and developed as being related almost entirely to industry. The reason why the developed countries seem to be rather slower in making use of their female brains is that because of their long tradition of industry, industry founded at a time when a woman's place was very much in the home, and because of the differing social standards, there seems to be a block in believing that it is necessary for women to make this sort of contribution. In countries that are only just developing industrially, if they are going to catch up with the long industrial history of some other countries they have got to use 100% of their potential brains. That I think is the real answer.

D. E. Ajakaiye (Nigeria)

I come from an underdeveloped country although we like to be called developed. As far as underdeveloped countries are concerned, I think that any lady scientist or engineer would say that in these countries marriage is very important and profession is next. Single women, unlike in the developed countries, are seldom really accepted in society. Not that people do not respect you for what you are, but they view you with some suspicion and wonder why you are all by yourself and not settled. I would say to increase the number of lady scientists and engineers in underdeveloped countries those of us who are engineers and scientists must get married and convince the girls that you can be both an engineer and a mother, I think this would be a very good campaign in underdeveloped countries.

J. Knott-ter-Meer (Germany)

I am an engineer and have two grown up sons. I would like to say that the word 'profession' in German is derived from the word for vocation and if you have it in you to be an engineer then you will become an engineer and you will always be able to combine a profession with the position of wife and mother. In technology there are all kinds of openings suitable for women engineers which do not take up full time if they are not able to work full time in industry.

D. J. Shawe (U.K.)

I agree very much with what the last two speakers have been saying and I would suggest that it is a fairly quick way to increase the numbers of engineers and scientists. For example, everyone appreciates how impressionable young children are and they ask quite technical questions at quite young ages, they tell me its much younger than it used to be. Now, if a mother has some technical knowledge and she is able to give a simple but correct answer to the child she will be able to further its enthusiasm for science and engineering. I advocate that in many families where the woman is an educated woman, the family as a whole would be happier with the wife working, so long as suitable domestic arrangements can be made. She will no longer be frustrated and the time the families have together they will enjoy to the full. Now may I just say a few more words about the training of engineers. Mrs. Watkins from City University said they would find industrial sponsors for would-be women engineers. In many cases this is not necessary.

Just a few weeks ago I was talking to a high level engineer who is responsible for offering training places to students, and who has offered one to a girl taking her **'A'** levels this summer. He was a bit worried as to the effect on the apprentice training school when she goes in, so he asked a colleague in another organisation, in mechanical engineering, who said 'Welcome her with open arms: I always try to have one in my apprentice training school because just one seems to raise the level of all the males, the trade apprentices, student apprentices, etc. They all come looking smarter, they all work harder and behave better.' Talking of applied science projects in schools, they are certainly doing a marvellous job. I have heard more than one University lecturer say 'What are we going to teach the students in their first year, they have done it all at school'. When one is combining a profession and a home, with or without a family, I think one has to acknowledge the people who help on the backstage at home, who do their share of domestic work and arrangements. So I would like to put in a thank you to the men at the back who help us all to continue with our profession.

E. Adegbohungbe (Nigeria)

In underdeveloped countries it is true that we are short of women engineers and scientists, in fact we are short of all scientists in all fields. In theory women are encouraged to take to any career they want but in practise the attitude of the men in Nigeria is no different from that of men here many years ago. We have just had a student woman engineer who will be completing her course next year. I would have been the first woman engineer many years ago but the Government refused absolutely to give a scholarship for a woman to study engineering so I was advised to change to physics. This shows what sort of attitude they have although at the same time they realise they need the brains of both men and women.

K. Chandrasekhar (India)

I would like to add that being basically a zoologist, I can say that genetically there is no difference between the capabilities of a man or a woman. There is no such thing as a woman being not capable of taking up engineering or any of the either professional degrees. In our history we have on record women engineers who have planned cities and built great castles and so on. So it is the development of society, the environment, which has blocked the progress of women, and in modern society we know that men are more selfish, they would like to take all the important posts and however qualified a woman is they would not like her to take the top posts. I feel that this has been the cause of women not taking engineering and other professions and not that they are genetically unfit to do so.

J. R. Webb (U.S.A.)

I think that these comments about our social climate and the attitudes of men are well taken but I think we are missing a very important point and that is the attitudes of other women. This is very evident, and

I have seen it in my daughter's high school. Other women feel threatened and we must change the whole attitude from grade school on so that women welcome this progress for others than themselves.

J. Hamilton (U.S.A.)

I think it is not only prejudices of other women but perhaps our own feelings that we also have to be careful of. I notice that in some of the papers today, there was a mention that women, even when they get into the professions, often do not get to the top and although I can attribute this to the prejudice of men, I wonder how much of it is perhaps our own fault in that we accept it as being a fact of life. For instance, if a man is not getting ahead in his job, he will often quit or go to another position where he can get the type of work he is looking for, but I think a woman has a much greater tendency just to stay on and stick with her own job. Really, I think we women put up with an awful lot of stuff that we do not have to and if we would say 'I' m not going to put up with it any more' perhaps we would find out that we would not have to. I would like to propose that we should paraphrase the proverb that goes 'the hand that rocks the cradle rules the world' and perhaps change it to 'the hand that rocks the boat rules the world'.

H. Popper (U.S.A.)

I would like to ask the panel a question. According to some figures that Dr. Parrish quoted at the end of his paper, in the U.S., at least, there seems to be no reluctance on the part of employers to hire girls, in fact they seem to be competing rather vigorously for girls and I think that this is true in some other countries and if it is not now, it probably will be a little later. I would like to ask what can individual technical managers in industry do to attract more girls to the profession.

J. R. Webb (U.S.A.)

One quick thing occurs to me and that is the message must get through to girls at the junior high and high school level at the very latest. Industries, I know, prepare pamphlets on careers and so do engineering societies, but we need more of them and we need them written for the lower level.We need counsellors who want girls, they must be enthusiastic about engineering and I think you in industry can help enormously.

H. Brocher (Germany)

Efforts to get more girls to study engineering have convinced us that you must get the girls interested very early in their school career and that was included in the pamphlet I mentioned today. As regards the contribution by Miss Hamilton saying it was the women fault, too, we asked women teachers if they would be prepared to become headmistresses, and only 5% of the women teachers were prepared to take on the responsibility of a really leading top job.

G. S. Kleinman (U.S.A.)

There were several suggestions made that maybe women engineers should marry men engineers and have little baby engineers so that, perhaps, in twenty years or so we will have a surplus of engineers. This does not always work - sometimes it backfires. I have 3 children and when they were young and asked me questions I would try to answer to the best of my ability. In time however they would finish a question by saying 'Mother, I don't want a lecture, just answer the question'. In regard to Mr.Popper's question about what industry can do to help, I would like to say that in the U.S.A. industry is doing a marvellous job co-operating with schools, missing their top level scientists available to speak to school children at the elementary, junior school and senior high school levels.They are inviting classes to visit industry and so on. I think the fault lies probably with the schools, which are not taking advantage of the facilities that are available. I would also like to see son thing done in the way of improving the image of the woman scientist. I think perhaps instead of the lovely articles the Women's Engineering Society had written about this meeting this last week a couple of picture of some young girls with their short skirts and long hair would probably have been the best kind of publicity.

M. M. Moody (U.K.)

The Women's Engineering Society were stimulated by the request from Mrs. Webb for statistics about women to make our own investigation on the position of women engineers in Gt. Britain. I certainly do not propose to inflict all the data we obtained from it on you, we have published it in a booklet and if it is of any interest it is available. There were one or two features in it which I think might be of interest to the meeting.One of them related to the question of marriage. We found that the wastage among women engineers due to marriage was of the order of 15% and of that 15% three percent were hoping to return to engineering after they had been relieved of their domestic duties. I do think, incidentally, that one of the things we might give a lot of attention to is this problem of re-integrating women after they have had this gap away at home. The second point was a little more gratifying, we did find that quite a percentage of women were in fact holding high responsible positions, we also found that salaries could be reasonable, we had two or three who in fact topped the £5,000 mark. For these higher salaries the work had to be in administration, the next highest salaries came in research, and after that, education, and the general range of normal working for women engineers in all ranges of work was about £1,000 £2,000. Discrimination was another question on which we had some very enlightening data. We had an agreeable surprise that 56.6% in our replies said they had no discrimination. We did take this with a little pinch of salt wondering whether by any chance they had not appreciated some of the fringe benefits which they were losing. Of those who indicated there was discrimination most related to pension schemes, in one way or another either due to an earlier retiring age, a later starting age, unequal benefits and so on; the second group related to salaries; the third to restricted promotion and the last to lower status. We had a lot of individual comments which were enlightening and which we have printed, however, there was one which I think is very important 'It is not recognised that a woman might have dependants.' There was also one which I found was rather charming from a lady who said that in view of the fact that her firm could not allow her to earn a higher salary than her husband, when they promoted her they increased his salary to equal hers.

M. Tuck (U.K.)

About a century ago a well known Socialist leader was asked whether he would support the suffragette movement and he said ' Why should I support you in something which I can' t have myself. I can't have the vote because I don't own property and you want the vote but it will only be upper and middle class women.'. I think we should consider this even at the present day. We say only a small percentage of women become engineers, only a small percentage of women become professional people at all but similarly only a small percentage of men in Britain become anything like professional people. We are not only wasting women we are wasting men.

J. Juillard (Switzerland)

I do not think it is absolutely necessary for women to become engineers, but what I do think is useful for the economy of all countries be they developed, very highly industrialised, or simply on the way to development, is that all brains capable of becoming good engineers should be able to become engineers. There are feminine brains which are not fully used for the benefit of the country and I would like to emphasise the fact that there is a question of imparting information to girls schools where girls schools are separate from boys schools, especially secondary schools between the years of 15 and 18 and above. At the last general UNESCO Conference the Australian delegate said 'I don't understand why most women study biology or chemistry when in our country in particular what we need are geologists and engineers.' and I answered that it was quite simply a matter of lack of information in girls secondary schools. In Switzerland, in Geneva, we are starting to give this information to girls schools. I think this is a unique case in French Switzerland and I hope the Architects and Engineers Association will also give the other cantons of our country this information. In my view there is another way of giving information that we have not mentioned at all today, and that is to have scientific competitions. I know that in the U.S.A. they have them for young people and they have been very well organised for a number of years. This year we had a scientific competition in Switzerland for the first time called Science calls Young People and there were a number of candidates of both sexes. I had a chance of talking to the people who picked out the prize winners and they were most surprised that both among girls and boys there was a remarkably high standard of work done. Finally I would like to support what was said by a gentleman earlier on the subject of politics. Obviously both women and men who have the potential should be given opportunities because it is important for a Government to have people knowledgeable in these matters.

M. D. Lum (U.S.A.)

In regard to the gap when women leave to have children and come back later, I wish to suggest a possible solution which is, in fact, being done at an Airforce Base under the civil service system. I am not sure whether it is being done country-wide or not, it was started last year. The idea is two women for one job. what they do is pay exactly half of a full time work, they give exactly half time sick leave and thus a woman is able to work 20 hours a week instead of 40. This is not only technical women it is other types of women, secretarial etc. Incidentally this not only applies to women it may be a solution for the older, retired people who do not have the energy to carry a full time job. The second comment I wish to make is that one possibility for a woman to go high is to specialise in a field which is new. One example is the high speed computer. The high speed computer has become popular in the U.S.A., I believe only in the past twenty years, and now the computers are multiplying allover the place, they have uses in categorising information, in research, in business. Now the computer is not a brain, it is a brainless thing, and someone has to man them, someone has to programme them, and someone has to head the computing laboratory. I have found many young ladies who have gone straight to the top because of their ability to work with computers. I am sure this could be so in other fields like operations research, and communications.

A. Royle (U.K.)

How much do the delegates and speakers agree with me that schools tend to be reflections of the society in which we live rather than places where new trends begin? I think that although it seems important that we provide schools with information about careers, personal examples have much more impact on people who are choosing their job.

A. M. Anthony (France)

I would like to emphasise, as a number of people have done, the importance of information. The women engineers who are meeting here have deliberately chosen this career knowing the risks in it. In France we have tried passing out information to schools with the help of the Women's Engineering Association and we have come to the following conclusions: one should not approach the young girl, it is very easy to make her enthusiastic, but above all one should approach the parent because if the parents want to make the girl a lab. assistant and she comes home and says 'Father, I want to be an engineer' he will probably say 'What on earth put that into your head'. We must also bear in mind that at 15 or 16 adolescent girls are usually at loggerheads with their parents. If the parents tell the girl she is going to be an engineer she will say 'No I'm not, I'll be a pilot'. The best results we have had were by getting the children and the parents together and if they attend the same discussion or talk they both get different things out of it and I think it is the best way of imparting information efficiently.

J. R. G. Finch (U.K.)

I want to raise the point of co-education. I heard it blamed for the lack of women engineers in this country but I do not think co-education has anything to do with it, though I am not necessarily speaking in favour of any other form of education. There is a general shortage of science masters and maths masters in this country and I think it is true that girls schools come at the end of the queue, but in France I am told that most science teaching is done by women teachers. There must, therefore, be a lot of latent talent available in this country which could be turned on to teaching the girls schools and I would have thought that the segregated girls schools should be better taught in science than the boys schools.

F. H. Gwilliam (U.K.), Chairman

I am very sorry that there is no opportunity to continue with this, but we have already overrun by 25 minutes. Thank you very much for a most absorbingly interesting discussion which I am sure will be continued in the corridors.

A. David (France) (Written contribution)

The papers presented during the sociological sessions show common viewpoints and common pre-occupations. The majority are in accordance with the UNESCO programme concerned with women engineers and scientists.

Two aspects appear to me particularly importants:

1. Women's scientific potential is today insufficiently or badly utilised. Research into making better use of it is a social necessity and must cover both women themselves and their employers.
2. The development of education for girls must take account of the need to give them an interest in scientific problems and techniques, and a solid grounding in these subjects. This applies particularly in countries where girls' education is inadequate. Women engineers and scientists must co-operate in these educational programmes.

I would like to suggest that the theme of the sociological sessions of the next Conference is chosen within the UNESCO programme, for example, one of the subjects I have already mentioned.

<u>SECOND INTERNATIONAL C0NFERENCE</u>

<u>OF WOMEN ENGINEER' S AND SCIENTISTS</u>

Cambridge', England, 1-9 July, 1967

Comparative Statistics

Relating to

Women Professional Engineers

Hon. Statistics Editor: Mrs. Josephine Webb, P.E.

Foreword

Amongst professionally qualified engineers, women are in a striking minority in every country of the world. Even in the USSR, where the proportion is highest , it is still only 1 in 3, in highly industrialised countries such as the USA and Western Europe it is between 1 in 1000 and l in 100, although in countries where the total number of engineers is small it may be as high as I in 10.

Figures from several countries were recorded at the First International Conference of Women Engineers and Scientists, but comparisons were difficult because of different classification methods used and varying dates for the information quoted.

An attempt has been made in the data recorded here, to collect information on a common basis and, as far as possible, simultaneously. It must be acknowledged that due to the difficulties of obtaining statistics the record is not as complete as had been hoped, and differences in interpretation, as well as differences in educational requirements and methods of working render the common basis applicable only in a broad sense.

The Conference Executive Committee wish to express their sincere gratitude to Mrs. Josephine Webb, P.E. (U.S.A.), Hon. Statistics Editor, who has undertaken the task of compiling, and issuing questionnaires and collating the resulting figures to form this report, and to the Conference representatives and others who supplied information.

Introduction and Notes on Tables

The statistics given in the following tables were obtained by asking 29 Conference representatives and 5 other persons to complete and return the questionnaire shown in Appendix 1. The list of countries to which the questionnaire was sent is given below together with the response from each country including the source and date of the information, where it is known.

Response from countries receiving questionnaire

* questionnaire returned.

Australia

See Appendix 2.

Belgium *

Information relating to students refers to 1965.

Brazil

See Appendix 2.

Canada *

Numbers of engineers relate to 1961, numbers of students to 1962-23 and schools of engineering to 1965-66.

Colombia *

Questionnaire returned with data.

Finland

No return.

France

Numbers of engineers extrapolated to 1961 from data in the Proceedings of the First International Conference of Women Engineers and Scientists, 1964, using studies sent by J. Badoz.

Ghana

No return.

Hong Kong

No return.

India *

Total number of engineers relates to 1965, and the number of women engineers is extrapolated to 1965 from a survey made in 1964. The number of engineering schools relates to 1962.

Iran *

Questionnaire returned with data.

Irish Republic *

Questionnaire returned with data.

Italy

See Appendix 2.

Japan

No return. Data relates to 1962 and is taken from the Proceedings of the First International Conference of Women Engineers and Scientists, 1964.

Mexico *

Questionnaire returned with data.

Mozambique *

Questionnaire returned with data.

Netherlands *

Questionnaire returned with data based on 1960 census.

Nigeria

No return.

Philippines *

Numbers of engineers are taken from the Proceedings of the First International Conference of Women Engineers and Scientists, 1964.

Poland

No return.

Portugal *

Questionnaire returned with data.

Repub1ic of South Africa

Data on students relates to 1964, all other data refers to 1960 census.

Sweden *

Questionnaire returned with data referring to 1960.

Switzerland *

Questionnaire returned with data.

Turkey

See Appendix 2.

Uganda

No return.

United Kingdom *

Questionnaire returned. Data based on Institution membership, 1964 / 5, report of UCCA, 1965-6, direct circulation of women engineers, 1966, and "Statistics of Science and Teohno1ogy".

U.S.S.R.

No return.

U.S.A. *

Questionnaire returned with information relating to 1966 based on detailed study of data published by the Engineers Joint Council and Society of Women Engineers,1964-1966.

Uruguay *

Data relates to 1966.

Venezuela

No return. Data taken from Proceedings of First International Conference of Women Engineers and Scientists, 1964.

West Germany

See Appendix 2.

Notes on Tables

Key to symbols

t - Total
m - Men
w - Women

In all tables a blank signifies either "no information" or "category not used". The number zero is signified by a dash (-).

Table 1. Fields of Engineering

Key to classifications:

Aeronautical - includes Astronautical and Space

Architectural - includes Naval and Marine

Chemical - includes Ceramic, Materials, Metallurgical, Petroleum, Textile

Civil - includes Sanitary and Structural

Electrical - includes Electronic and Nuclear

Industrial - includes Business Administration

Mechanical - includes Packaging and Welding

Mining - includes Geological, Geophysical

General - includes Engineering Mathematics, Physics, Science, Education, Law, Data Processing, and Information Science

Table 3. Professional Qualifications etc.

1. Bachelor degree - equivalent to 4 years full-time study.

2. Advanced degree - equivalent to 5 years or more full-time study

3. Differences in status - this column records the answers to the question "Are there differences in pay, pension, or job security between men and women?"

Table 1.Fields of Engineering

Country and Population		Total	Aeronautical	Agricultural	Architectural	Chemica1
Belgium	t	17,000		853	289	3,707
(9,464,000)	m	16,890		850	284	3,645
	w	110		3	5	62
Canada	t	43,066				2,996
(19,604,000)	m	42,950				2,982
	w	116				14
Colombia	t	5, 338		187		264
(18,080,000)	m	5,290		180		245
	w	48		7		19
France	t	110,000	3,430	6,775		16,220
(48,922,000)	m	107,600	3,400	6,760		15,420
	w	2 ,400	30	15		800
India	t	93,000				11,050
(471,624,000)	m	92,750				11,020
	w	250				30
Iran	t	4500		520		1,018
(23,428,000)	m	4,425		520		977
	w	75		-		41
Irish Republic	t	2,933		15		60
(2,855,000)	m	2,932		15		60
	w	1		-		-

Table 1. Fields of Engineering cont.

Country		Civil	Electrical	Industrial	Mechanical	Mining	General or Unclassified
Belgium (9,464,000)	t	2,056	1,907	32	3,806	3,035	265
	m	2,048	1,894	32	3,790	3,034	264
	w	8	13		16	1	1
Canada (19,604,000)	t	11,917	8,763	3,962	8,137	2,349	4,942
	m	11,888	8,723	3,960	8,122	2,347	4,928
	w	29	40	2	15	2	14
Colombia (18,080,000)	t	3,837	390	80	300	250	
	m	3,820	385	80	300	250	
	w	17	5	-			
France (48,922,000)	t	2,430	30,440	275	13,165	3,465	33,800
	m	2,430	30,180	275	13,110	3,465	32,560
	w	-	260	-	55	-	1,240
India (471,624,000)	t	32,820	21,610		19,640	1,450	6,430
	m	32,760	21,505		19,620	1,450	6,395
	w	60	105	20	-	30	
Iran (23,428,000)	t	1,181	850	24	577	330	
	m	1,172	842	12	572	330	
	w	9	8	12	5	-	
Irish Republic (2,855,000)	t	1,753	550		555		
	m	1,752	550		555		
	w	1	-		-		

Table 1.Fields of Engineering cont.

Country and Population		Total	Aeronautical	Agricultural	Architectural	Chemica1
Japan (97,960,000)	t	79,527			19,757	
	m	79,353			19,607	
	w	174			150	
Mexico (40,913,000)	t	14,521	15	881		2,005
	m	14,445	15	881		1,964
	w	76	-	-		41
Mozambique (6,593,000)	t	465		107		24
	m	456		103		21
	w	9		4		3
Netherlands (12,292,000)	t	14,500		2,175	7 28	2,297
	m	14,144		2,081	684	2,121
	w	356		94	44	176
Philippines (32,345,000)	t	16,927			1,351	1,287
	m	16,459			1,244	1,001
	w	468			107	286
Portugal (9,167,000)	t	5,873		1,032		453
	m	5,718		973		392
	w	155		59		61
Republic of South Africa (17,867,000)	t	7,618				400
	m	7,602				395
	w	16				5

Table 1.Fields of Engineering cont.

Country		Civil	Electrical	Industrial	Mechanical	Mining	General or Unclassified
Japan	t	1,600	21,170		37,000		
	m	1,598	21,153		36,995		
	w	2	17		5		
Mexico	t	6,534	1,698	3,	1,859	202	1,324
	m	6,499	1,698	3,	1,859	202	1, 324
	w	35	-	-	-	-	-
Mozambique	t	171	47		31	39	46
	m	170	46		31	39	46
	w	1	1		-	-	-
Netherlands	t	2,541	2,173		3,661		566
	m	2,536	2,157		3,656		556
	w	5	16		5		10
Philippines	t	6,116	1,927		5,790	456	
	m	6,043	1,925		5,790	456	
	w	73	2		-	30	
Portugal	t	2,243	1,171		614	180	
	m	2,392	1,168		613	180	
	w	31	3		1		
Republic of South Africa	t	1,925	1,105		938	484	2,766
	m	1,924	1,103		937	484	2,759
	w	1	2		1	-	7

Table 1.Fields of Engineering cont.

Country and Population		Total	Aeronautical	Agricultural	Architectural	Chemica1
Sweden (7,734,000)	t	13,569			1,775	1,967
	m	13,374			1,660	1,905
	w	195			115	62
Switzerland (5,945,000)	t	6,087			1,934	
	m	6,043			1,894	
	w	44			40	
United Kingdom (47,762,800)	t	179,900	6,763			3,485
	m	179,500	6,725			3,465
	w	400*	39			20
United States of America (198,000,000)	t	755,200	19,052	9,016	9,978	124,930
	m	750,000	18,750	9,000	9,750	123,750
	w	5,200	302	16	228	1,180
Uruguay (2,715,000)	t	1,723		656		1
	m	1,656		622		1
	w	67		34		-
Venezuela (9,167,000)	t					
	m					
	w	94		5	6	7

* estimated

Table 1.Fields of Engineering cont.

Country		Civil	Electrical	Industrial	Mechanical	Mining	General or Unclassified
Sweden	t	3,011	2,965		3,851		
	m	3,010	2,953		3,846		
	w	1	12		5		
Switzerland	t						4,153
	m						4, 149
	w						4
United Kingdom	t	27,659	38,077		50,691		
	m	27,640	38,000		50,642		
	w	19	77	23	49	1	171
United States of America	t	123,592	162,780	39,916	144,750	15,047	106,139
	m	123,000	162,000	39,750	144,000	15,000	105,000
	w	592	780	166	750	47	1,139
Uruguay	t	715	8	336	6		
	m	691	8	327	6		
	w	24	-	9	-		
Venezuela	t						
	m						
	w	70	1			5	

Table 2.Types of Work

Country		Administration & Management	Research	Design	Development
Belgium	m				
	w	1	13		
Irish Repub1io	m	140	94	709	777
	w				
Mozambique	m	133	16	148	57
	w	2	-	-	1
Philippines	m				
	w				
United Kingdom	m				
	w	51	36	37	4
U.S.A.	m	157,500	45,000		157,500
	w	156	1,144		1,456
Uruguay	m	1	13		10
	w				
U.S.S.R.	m				
	w				

Table 2.Types of Work cont.

Country		Information Technology	Teaching	Supervision (Production)	Technician level
Belgium	m				
	w		8		2
Irish Republic	m		102	1,172	
	w				
Mozambique	m	20	28		54
	w	3	3		
Philippines	m		57		
	w		9		
United Kingdom	m				75,000 *
	w	17	15	-	1,700 *
U.S.A.	m	45,000	30,000	97,500	22,500
	w	156	520	156	520
Uruguay	m	6	218		719
		-	3		24
U.S.S.R.	m		- in addition to those		2,670,000
	w		listed as engineers :		1,014,000

* estimated

Table 1.Professional Qualifications and Status of Practising Engineers

Country		Bachelor Degree(l)	Advanced Degree (2)	Registration	Differences in status(3)
Belgium	m	-	15,785	no	no
	w	-	60		
Canada	m			33,135	no
	w			-	
Colombia	m			no	yes
	w				
India	m			no	no
	w	90%	10%		
Iran	m	20%	80%	no	no
	w				
Irish Republic	m	2,743	92	no	some
	w	1	-		
Mexico	m	14,521	109	13,362	no
	w	54	10		
Mozambique	m			100	no
	w				

Table 3. Professional Qualifications and status of Practising Engineers cont.

Country		Bachelor Degree(l)	Advanced Degree(2)	Registration	Differences in status(3)
Netherlands	m	709	12,419)	no	some
	w	51	305)		
Portugal	m		5,720	5,720	some
	w		153	153	
Republic of	m	4,970	455)	yes	
South Africa	w	3	4)		
Switzerland	m	10,000	6,043	6,043	
	w	-	44	44	
United Kingdom	m	179,000 *	2,000 $\neq$)		
	w	360 *	50 $\neq$)	no	some
U.S.A.	m	472,500	165,000	228,000	no
		4,100	320	60	
U.S.S.R.	m	1,024,000			
	w	460,000			
Uruguay	m	-	1,034	1,034	no
	w	-	33	33	

* estimated and includes professional qualifications equivalent to first degree
$\neq$ estimated

Table 4. Engineering Education – Students

country		No. of Engineering Schools	No. studying for Bachelor degree in engineering	No. studying for Advanced degree in engineering
Belgium	m	) (5)	-	1,919
	w	)		16
Canada	m	) (22)	14,269	1,582
	w	)	100	3
Colombia		(17)		
India	m	) (114)	78,114	
	w	)	878	
Iran	m	) (7)	1,800	
	w	)	110	
Irish Republic	m	(4)	695	
	w		1	
Mexico	m	(50)	11,451	143
	w		614	55
Mozambique	m	-		237
	w			47
Netherlands		(5)		
Philippines	m	(1)	1,281	-

Table 4. Engineering Education - Students contd.

		No. of Engineering Schools	No. studying for Bachelor degree in engineering	No. studying for Advanced degree in engineering
Portugal	m	(3)		4,386
	w			444
Republic of South Africa	m	(5)	2,813	265
	w		4	-
Sweden	m		14,273	1,009
	w		200	7
Switzerland	m	(2)		6,123
	w			201
Syria	m		900	
	w		130	
Turkey	m		3,600	
	w		400	
United Kingdom	m		23,000 *	930 ≠
			300 *	47≠
U.S.A.	m	(255)	255,000	60,000
	w		2,000	400
U.S.S.R.	m		1,742,000	
	w		540,000	
Uruguay	m	(1)	460	
	w		40	

* estimated on three year basis, but excluding technical colleges.

≠ 1966

Table 5. Places of Employment

Country		Private Industry	Public Industry or Utilities	Government Local to National	Education Schools	Consulting or Research Groups	Agriculture
Belgium	m						
	w			2	14	15	3
Canada	m	35,737		4,858	137	5 ,818	
	w	93		13	1	9	
Irish Republic	m	402	454	849	73	170	
	w	-	-	1	-	-	
Mozambique	m	118	60	139	28	30	81
	w	-	-	2	3	3	1
Netherlands	m			2,778			994
	w			33			16
Philippines	m				57		
	w				9		
Portugal	m				229		
	w				17		
Republic of South Africa	m	4,885	1,313	1,404			51
	w	8	5	2			-
Sweden	m	8,510		7,867			
	w	112		83			
United Kingdom	m						
	w	103	23	21	21	33	
United States of America	m	497,250		111,000	31,500	48,000	
	w	2,340	728	416	520	312	
Uruguay	m	379	804	10	296	23	
	w	8	35	-	7	-	

Table 6.   Age, and work status of women engineers

Country	No. working							
	Full time				Part time			
	Up to 25y	26-35Y	36-45Y	Over 45y	Up to 25Y	26-35Y	36-45Y	Over 45Y
India		Rest	10 approx	2 / 3				
Iran	------------- 100 % -----------			-	-	-	-	-
Irish Republic.	-	-	1					
(retired)				(3)				
Netherlands	-	36	11	83				
Sweden	9	80	80	39				
United kingdom	13%	19%	11%	16%	<1%	1%	3%	5%
(retired or unemployed)	(1%)	(6%)	(3%)	(14%)				
U.S.A.	6%	19%	25%	25%	-	-	1%	3%
(retired or unemployed)	(1%)	(4%)	(6%)	(10%)				
Uruguay		9	4	10				
(retired or unemployed)				(5)				

Table 7. Material status of women engineers

Country	Married				Unmarried				Widowed or divorced			
	Up to 25y	26-35y	36-45y	over 45y	Up to 25y	26-35y	36-45y	over 45y	Up to 25y	26-35y	36-45y	over 45y
Belgium	9	8	9	4	4	2	3	15				
Canada	------------ 41 -----------				------------ 69 -----------				------------ 6 -----------			
Irish Republic				1				2			1	
Netherlands	-	13	7	17								
United Kingdom	7%	13%	14%	11%	8%	11%	9%	19%	-	1%	2%	5%
U.S.A	3%	14%	20%	13%	5%	8%	10%	18%	-	1%	2%	7%
Uruguay		6	1	12		3	3	3	-	-	-	-

APPENDIX 1
QUESTIONNAIRE
STATISTICS ON WOMEN PROFESSIONAL ENGINEERS

To be prepared for the: Second International Conference of
Women Engineers & Scientists
Cambridge, England 1-9 July, 1967

To be returned to:
Mrs. Josephine R. Webb, Conference Statistics Editor
Rockford Bay, Coeur d'Alene, Idaho 83814 U.S.A.

Please return not later than:
31 May, 1966

COUNTRY ______________ Total No. of Engineers: ______________
Population: ______________ No. of Women Engineers: ______________

Please gather as many of the following statistics as possible, about professional engineers ,both men and women ,in your country :

FIELDS OF ENGINEERING	No. of Men	No.of Women
1. Electrical		
2. Mechanical		
3. Civil		
4. Chemical		
5. Industrial		
Your Categories: 6		
7		
8		
9		
10		
11		
12		
PLACES OF EMPLOYMENT		
1. Private IndustrY		
2 Public Industry		
3. Government (Civil or Militarv, Local to National)		
4. Schools		
5. Consulting or Research Groups		
6. Agriculture		
Your categories: 7		
8.		
9		
10		
11		
12.		
TYPE OF WORK		
1. Administrative- Manaeement		
2. Research		
3. Design		
4. Development		
5. Information Technology - Planning		
6. Teaching		
7. Technician level only (i.e. drafting, testmg, mamt.)		
Your Categories: 8		
9.		
10.		
11.		
12.		

PAY: Are there differences in pay, pension or job security between men and women?
Yes-------------- No ---------- Please elaborate, if possible:

- over –

PROFESSIONAL QUALIFICATIONS	*No. of Men*	*No of Women*
1. Bachelor level Degrees (equiv. to 4yr.full-time study)		
2. Advanced Degrees (l or more post-graduate years)		
3. Equivalent Professional Background (several years of responsible engineering work)		
Your Categories: 4.		
5.		
6.		
STUDENTS OF ENGINEERING		
No. of schools offering university degrees in engineering in your country : ______________ Students studying for:		
1.Bachelor Degrees in engineering		
2.Advanced Degrees in engineering		
Your Categories: 3.		
4.		
5.		

Does your country have registration or licensing laws governing professional engineers practising directly for the general public? Yes _______ No ________.
Is the law uniform throughout the nation ? Yes _______ No _________.
How many engineers are so registered or licensed? Men _______ Women _____.
Please enclose a copy of the statute or required qualifications, if available.
List the various engineering and technical societies in your country:

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

AGE / WORK / MARITAL STATUS OF WOMEN ENGINEERS

Age	No. Working		Unemployed Or *Retired*	Unmarried	Married	W idowed or *Divorced*
	Full Time	*Part Time*				
1. Thru 25 years						
2. 26-35 years				.		
3. 36-45 years						
4. Over 45 years						

WOMEN SCIENTISTS

In addition to women engineers, please list the no. of women scientists in your country actively engaged in scientific work or teaching. If possible, classify them by their fields. i.e. physics, chemistry. Mathematics, astronomy, biology, ecology, etc.:

your Categories	No.of Women
1.	
2.	
3.	
4.	
5.	

Your Categories	No.of Women
6.	
7.	
8	
9.	
10.	

This questionnaire completed by:
Name ______________________________
Title ______________________________
Address ______________________________
____
____

Conference Representative for
2nd International Conference, WES:
Yes ______ No ______

Comments or Questions:

Appendix 2.

Additional Data for countries from whom only limited information was available:

Country & Population	No. of Women Engineers	Country & Population	No. of Women Engineers	No. of Men Engineers
Argentina (22,353,000)	150 *	Syria (5,389,000)	80 *	1,120 *
Australia (11,360,000)	8 *	Turkey (32,005,000)	150 *	
Austria (7,255,000)	30 *	U.S.S.R. (230,600,000)	460,000	1,024,000
Bo1ivia (3,710,000)	100 *			
Brazil (82,300,000)	300 *			
Ecuador (5,080,000)	1 *			
Guatemala (4,438,000)	3 *			
Italy (51,515,000)	400 *			
New Zealand (2,640,000)	2 *			
Norway (3,723,000)	900 *			
West Germany (56,839,000)	3% *			

* Proceedings of the First International Conference of Women Engineers and Scientists, 1964.

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