The Use of Resources and Technology in the Interest of Mankind

USE OF RESOURCES AND TECHNOLOGY IN THE INTEREST OF MANKIND

Discoveries International Symposia

1. Tokyo, Japan
2. Rome, Italy
3. Paris, France
4. Stockholm, Sweden
5. Columbus, Ohio, USA
6. London, England
7. Melbourne, Australia

The Use of Resources and Technology in the Interest of Mankind

with special reference to the Western Pacific

7th Discoveries International Symposium
31st August-2nd September 1984

Edited by
J. T. Woodcock

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Foreword

The Australian Academy of Technological Sciences was greatly honoured to be invited to host the 1984 Honda Foundation Seventh Discoveries International Symposium in Melbourne from 31 August to 2 September 1984.

This volume places on record the notable contributions made to that symposium and worthily maintains the standards of the volumes reporting the six previous Honda Symposia held respectively in Tokyo, Rome, Paris, Stockholm, Columbus (Ohio, USA), and London.

Each of the symposia has addressed some facet of the important field of ecotechnology, a concept of achieving overall harmony in human activities as the populations of widely differing nations experience the impact of technological change, the momentum of which continues apace.

The theme of the Melbourne symposium was the "Use of resources and technology in the interest of mankind, with particular reference to the western Pacific". The languages of the Symposium were Japanese and English, and this involved some translation into English for this volume.

The volume generally follows the pattern of the symposium itself and takes us successively through

1. the lessons of history,
2. present problems in the use of resources for mankind,
3. the uses of high technology in the highly disparate countries of the western Pacific,
4. the importance of technology and its effect on culture and employment, and
5. post-industrial society with an insight into the effect of technological changes on human happiness and freedom.

I should like to place on record my own appreciation and that of the Academy to every contributor and also to thank most sincerely the Academy's Executive Officer, Miss B. E. Jacka, AM, MBE, and her staff, and the Honorary Editor, Mr J. T. Woodcock, for their sterling contributions which have made this valuable record possible.

Sir David Zeidler
President
Australian Academy of
Technological Sciences

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Mr Noboru Okamura
Vice President of Honda Motor Co., Ltd.

Mr Shigeru Shinomiya
Director of Honda Foundation;
Adviser to Honda Motor Co., Ltd.

Programme

The technical programme was held in the Regent Hotel, Melbourne, Australia.

Friday 31st August 1984

10.00 a.m.	Opening session Chairman: Sir David Zeidler, CBE
11.00 a.m.	Session 1: Keynote addresses Chairman: Sir Ian McLennan, KCMG, KBE
12.30 p.m.	Lunch
2.00 p.m.	Session 2: The roles of academia, industry, and government Chairman Dr L. W. Davies, AO, FAA
5.00 p.m.	Close
5.30 p.m.	Reception at Government House
7.00 p.m.	Dinner at Lakeside Reception Centre, Zoological Garden, Royal Park

Saturday 1st September 1984

9.30 a.m.	Session 3: The west Pacific technological competition, complementation, and cooperation Chairman: Sir Frank Espie, OBE
12.30 p.m.	Lunch
2.00 p.m.	Session 4: Technological and cultural needs and obligations of the less-developed countries Chairman: Mr J. E. Kolm, AO
5.00 p.m.	Close
7.00 p.m.	Cocktail reception hosted by Mr and Mrs S. Honda

Sunday 2nd September

9.30 a.m.	Session 5: Highly developed countries especially Europe, the Americas, and Japan Chairman: Dr Edgar M. Cortright
12.30 p.m.	Lunch
2.00 p.m.	Session 6: Panel discussion Chairman: Lord Caldecote
3.30 p.m.	Close
4.00 p.m.	Summing up, and closing addresses Chairman: Sir David Zeidler, CBE
5.00 p.m.	Refreshments
6.00 p.m.	Close

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President, Australian Academy of Technological Sciences

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Mr Soichiro Honda

Official opening

Sir David Zeidler, CBE

President
Australian Academy of Technological Sciences
Melbourne, Australia

By way of introduction I would like, on behalf of the Australian Academy of Technological Sciences and of the Honda Foundation, to welcome the Governor of Victoria, His Excellency Sir Brian Murray, who has accepted our invitation to open this symposium. It is an added pleasure that he is accompanied by Lady Murray.

I would also like to welcome all our distinguished guests to this the seventh in the series of the Discoveries International Symposia, and particularly His Excellency the Japanese Ambassador.

While I would like to mention individually each of our guests from overseas that would be scarcely practical because they number close to 50. However, I would like to welcome especially Mr and Mrs Honda. Mr Honda, as you are almost certainly aware, is Supreme Adviser to the Honda Motor Company Limited and the founder of the Honda Foundation. He is accompanied by Mr and Mrs. Shimoda. Mr Shimoda is President of the Honda Foundation.

I would also like to make special mention of those of our guests who represent the Academy's sister organisations overseas. A very warm welcome to Viscount Caldecote, President of the Fellowship of Engineering in Great Britain; to Professor Gunnar Hambraeus, Chairman of the Royal Swedish Academy of Engineering Sciences; and to Dr Edgar Cortwright representing the National Academy of Engineering in the United States of America.

I would also like to welcome and thank those of our guests who have agreed to act as session chairmen and those participants who have prepared papers for consideration at the symposium.

You will have noted from your programme that the first session today will be under the Chairmanship of Sir Ian McLennan, until recently the President of the Academy, and on whom, because of his great contributions to the development of the Academy, was conferred the title of 'The Foundation President'.

The organisation of this Symposium has been in the capable hands of Sir Frank Espie, a Vice-President of the Academy and chairman of its Symposium Organising Committee.

It is pleasing to note that a number of our overseas guests are accompanied by their wives. For many of them it will have been a long and tiring journey. We are glad to be able to welcome you and trust that your stay with us will be as rewarding as possible.

Finally, before asking His Excellency, Sir Brian Murray, to open the Symposium I should mention two matters.

First, we have received messages of goodwill and encouragement from the Academy's Royal Fellow, His Royal Highness the Prince Philip Duke of Edinburgh; His Excellency the Prime Minister of Japan; and from the Honorable R. J. L. Hawke, Prime Minister of Australia. These messages will be read after His Excellency's opening remarks.

The second matter relates to the fact that His Excellency has recently been indisposed and has, much to our pleasure, made a special effort to be with us this morning, somewhat I suspect against the advice of his medical advisers. We thank him most sincerely.

May I now ask Your Excellency to perform the opening ceremony for this the 7th Discoveries International Symposium.

Opening address

His Excellency Sir Brian Murray, KCMG, AO

Governor of Victoria

The honour of opening this symposium is one I happily accept on behalf of the Government and people of Victoria. May I say that I hope that you do not expect a contribution, or indeed a later intervention from me, of the standard given last year at the Discoveries International Symposium in London by H.R.H., the Duke of Edinburgh. While it is true that we share in common a naval career which of itself forces a close awareness of the relationship of humankind to technology, I hope that you do not expect me to match either his oratory or his well known preference for speaking bluntly and plainly and let the consequences follow as they may!

I thought it would be appropriate to greet you, as participants in a very distinguished seminar, with the thought that, in the 150 years of modern history in Victoria, there may be many parallels to those for the future of the Western Pacific which you will be discussing over the next three days.

As we in this State begin a series of both short term and longer term community activities to mark those 150 years, there are inescapable parallels for the future in the Western Pacific as disparate communities increasingly exchange goods and ideas to mutual benefit, and as technology frees human ingenuity from agricultural drudgery and poverty.

In everyday life, especially in the last 25 years, we have come to think of vast technological changes largely in terms of the dramatic shifts in communications and transport. We have, by contrast, tended to overlook what over the last century have been much more astonishing developments in agriculture, in mining, and other applications of engineering sciences in both public and private health, in extended life expectancy and the diminution of disease and pain.

In everyday life, and especially in the last 25 years, we have had our wider concept of resources distracted by the priority given to apparently limited energy and mineral resources. It is therefore most encouraging that, from their inception by Mr. Honda, these symposia have given particular attention to human resources—the most valuable and indispensable of all. On this, the driest continent, it is also particularly appropriate that water should receive attention; in world terms, the resource to which scientific and engineering urgency is least often directed—unless and until its supply is inadequate or interrupted.

The symposium is interdisciplinary and international. So too was the influx of people from more than 50 countries which began the rapid development of Victoria. Are there parallels for the Western Pacific which we can draw on? I believe there are.

The first, surely, is that a new technology is no more than a new combination of human resources and capital resources more productive than before.

The individual and corporate prosperity from gold discoveries in this State led to the foundation both of modern Australian agriculture and modern Australian history.

The second is that technology—people and money put together to innovate—literally creates resources. Whether it be water storage for irrigation, or the clearing of land for agriculture, or the digging of shafts and open cuts for mining, it is only this application of people and capital which makes a resource more than simply a concentration of physical properties at a higher than normal level.

The third is that the continued production from any new technology is highly unlikely unless there is a free and willing market for it. It is from this unavoidable imperative and its natural advantages that Australia in agricultural products became, even a century ago, one of the great exporting and trading nations, on a scale quite disproportionate to population.

At previous symposia, I understand there has been frequent discussion of the natural human tendencies to resist unwelcome change, and to regard technology with apprehension or even fear rather than as a tool which, like every other development given to us, has the capacity for good or evil use. My hope would be that Victoria's own history will tend this particular symposium towards optimism rather than to pessimism.

There is a good case for this, as I am sure Mr Jones will point out in his own paper. The technological advances which made Victoria a thriving community, and extended short term alluvial mining into a major longterm creation of other natural resources, led also to an outpouring of intellectual and technological energy which spread right across the world. There were not simply the adaptations to local conditions such as in agricultural engineering. There were also inventors and innovators whose ideas and risks came to transform a world rather than a local scene. Meat refrigeration, the Michell thrust bearing, flotation, and other metallurgical innovations; there is a long list indeed.

Let us be delighted not surprised, therefore, if education and economic development provide unexpected advances in developing nations. Humankind is often wiser and smarter than conventional opinion or computer trends.

It seems to many observers that in the next 50 years it is this quadrant of the globe, the area of the Western Pacific, which offers the best prospects for world economic growth. That represents an immense challenge to us and to our children in the richer countries of the region.

My hopes would be

1. that we look clearly at human weaknesses as well as human strengths, especially our own, as we share experience and knowledge,
2. that we do not overlook the need for ideas as well as products to pass easily and profitably across national and cultural boundaries,
3. that we come again to view technology and the future with wonder and acceptance of risk, rather than with uninformed pessimism, and
4. that we see problems as to be solved rather than administered.

Each of the Foundations has made solid contributions towards the realization of those hopes over the years. The Symposium is therefore a major event for this State, for this nation, and for the application of good sense and forward vision; and I have great pleasure in declaring it open.

Greetings

His Royal Highness, The Prince Philip, Duke of Edinburgh, KG, KT, OM, GBE, PC

The exchange of experience and the exchange of ideas has always been the stimulus for progress. I rather doubt whether anyone connected with the symposia of the International Discovery Series, initiated by the Honda Foundation, would claim that they had been directly responsible for some major development. However, it is more than likely that people who have taken part have had their ideas influenced or have been given new insights which in turn have given a new direction to their work.

I believe that these symposia have a further value. There are any number of conferences on strictly limited technical and scientific subjects but there are all too few which also are concerned with the general direction of scientific activity and with its moral and social consequences. Discovery for its own sake has always been an acceptable concept but it would be irresponsible to imagine that the consequences of all discoveries are inevitably good for human civilisation.

One thing is quite certain. Everyone attending the 7th symposium organised by the Australian Academy of Technological Sciences will find it an absorbing experience.

These greetings were read by Sir Ian McLennan, KCMG, KBE, The Foundation President, Australian Academy of Technological Sciences.

Greetings

Yasuhiro Nakasone

Prime Minister of Japan

It is a great pleasure to offer my heartfelt congratulation on the occasion of the "International Discoveries Symposium 1984" to be held here today.

Formerly, the cities of Tokyo, Rome, Paris, Stockholm, Columbus (Ohio), and London have been privileged to host this symposium, where sincere discussions toward "Creating a philosophy for a technological civilization" took place with a global perspective. It is my firm belief that from the results of these discussions will emerge a clear direction for developing a humane civilization toward the next century.

I myself aspire to development of a civilization in which science and humanity are coordinated well. It was on this basis that we sponsored the "Conference on life science and human beings" in Hakone last March attended by the intelligentsia from those countries participating in the summit meeting.

It is truly meaningful that the theme of the Melbourne symposium—"The use of resources and technology in the interest of mankind"—embraces a broad concept of resources from the land, energy, water, minerals, communications, and human beings, providing a forum for a candid exchange of views among world leaders in this field under the theme of "the social and cultural challenge of modern technology".

I sincerely hope that the "International Discoveries Symposium 1984" will achieve all the success it merits, and that "Discoveries" activities will be advanced even more in the future.

These greetings were read by Ambassador Kensuke Yanagiya, Japanese Ambassador to Australia.

Greetings

The Hon. R. J. L. Hawke, AC, MP

Prime Minister of Australia

I have much pleasure in associating myself with the Prime Minister of Japan in extending congratulations and best wishes to all associated with the 1984 Honda International Discoveries Symposium.

Australia, and the city of Melbourne in particular, are proud to be the host to this, the 7th Discoveries Symposium sponsored by the Honda Foundation of Japan and organised by the Australian Academy of Technological Sciences. We are delighted to welcome to this invitation conference distinguished scholars and representatives of industry, commerce, and the media from a number of countries of the world. We are particularly glad to welcome Mr Soichiro Honda and his countrymen from Japan.

It is most appropriate that this Discoveries Symposium should address the theme, "The use of resources and technology in the interest of mankind". My Government is vitally concerned with this issue and the participation in the symposium of my colleague, the Honourable Barry Jones, Minister for Science and Technology, is testimony to that interest.

Australia is blessed with many natural resources and in our relatively short history we have developed our agricultural and mining industries to the extent that we have become a major supplier of commodities such as wool, meat, wheat, minerals, and metals. However, the achievements of our manufacturing industries, whilst significant, are perhaps not as well known as those of industries in north America and Japan.

We have much to learn from each other and my Government warmly commends all endeavours to achieve not only more effective applications of technology to the production and processing of natural resources but more success in the application of our collective wisdom so that the human family as a whole may benefit from these advances.

I express my personal appreciation to Mr Honda and his Foundation for making this symposium possible and to the Academy of Technological Sciences for organising it so efficiently.

These greetings were read by Sir Frank Espie, OBE, Vice-President, Australian Academy of Technological Sciences.

Address

Mr Takeso Shimoda

President
Honda Foundation[1]
Tokyo, Japan

On behalf of all the participants of this symposium I would like, first of all, to express our sincere gratitude to His Excellency Rear Admiral Sir Brian Murray, Governor of Victoria, and His Excellency Mr Kensuke Yanagiya, Ambassador of Japan, for their distinguished presence at this opening ceremony. I wish also to express our gratitude to Sir Ian McLennan, Foundation President of the Australian Academy of Technological Sciences, to Sir David Zeidler, President of the Australian Academy of Technological Sciences and the host of the 1984 Discoveries International Symposium, to the members of the Australian Academy of Technological Sciences, and to Sir Frank Espie, Chairman of the Organising Committee of this symposium, as well as to all committee members for their valuable cooperation in the preparation of this international symposium.

It is our belief that the greatest desire of mankind at the present time is the creation of a civilization in which utmost respect is paid to human beings themselves. This goal can only be achieved through interdisciplinary cooperation by the many intellectuals belonging to various fields, and especially by those engaged in the field of science and technological engineering. Based on this concept, the Honda Foundation, founded by Mr Soichiro Honda, has sponsored Discoveries International symposia, of which the first was held in Tokyo in 1976. Subsequent symposia were held in Rome, Paris, Stockholm, Columbus (Ohio, USA), and last year in London in the distinguished presence of His Royal Highness, The Prince Philip, Duke of Edinburgh. This year's symposium, the 7th, is held for the first time in Australia.

At the previous symposia we have had discussions on the concept of catastrophe which is considered to be inherent in modern civilization. We were able to deepen our understanding of the status of major crises, a situation with which mankind is going to be confronted sooner or later. No doubt to help cope with such crises we conducted a comprehensive review

[1] 6-20, Yaesu-2 chome, Chuo-Ku, Tokyo 104, Japan.

on the concept of information and communication—the most fundamental aspect of human activity. In Columbus, we held discussions on the theme of the 'Social impact of advanced technology'; in London the theme was 'Social and cultural challenges of modern technology'. Now, at this symposium in Australia, which is a new continent full of hope with high human values and with rich natural resources, we look forward to lively discussions, beginning today, among the numerous participants and observers from various countries of the world.

The main theme is the 'Use of resources and technology in the interest of mankind with particular reference to the Western Pacific'. There are several sub-themes, with four sessions, which are

1. the roles of academia, industry, and government,
2. the Western Pacific technological competition, complementation, and cooperation,
3. technological and cultural needs and obligations of the less developed countries, and lastly
4. highly developed countries, especially Europe, the Americas, and Japan.

As a participant of this symposium, I am very pleased to meet again the leaders of past Discoveries Symposia including, among others, the Viscount Caldecote, Sir Henry Chilver, Mr Leonard, Mr Moeen Qureshi, Dr Chestnut, Professor Sheridan, Dr Fawcett, Dr Curran, Professor Simon, Professor Caianiello, Professor Hambraeus, Dr Schuster, Professor Marguilies, and Royal Professor Aziz.

On the basis of a number of opinions originating from active discussion amongst the participants here today, we hope to make a contribution to the creation of a civilization which has high respect for humanity, the basic concept of the Honda Foundation.

In closing, I would like to once again express our deep appreciation to the members of the Australian Academy of Technological Sciences for taking the lead in the organisation of this important international symposium.

Presentation of certificate of Honorary Fellowship of the Australian Academy of Technological Sciences to Mr Soichiro Honda

Address by Sir David Zeidler, CBE, in presenting the certificate

The Australian Academy of Technological Sciences was created nine years ago to promote the application of scientific knowledge to practical purposes.

Mr. Honda, his career, and his actions so admirably personify this objective that the Council of the Academy has determined that he should be admitted to our Fellowship; to a select category which we have been pleased to designate as Honorary Fellow.

You will perceive the measure of the recognition that is about to be conferred when I tell you that currently we have only three Honorary Fellows; in order of election they are

1. Sir Mark Oliphant, AC, KBE, distinguished scientist and former Governor of South Australia,
2. Dr. Alan Butement, CBE, a distinguished physicist, a pioneer in radar and who was, in a sense, father of this academy, and
3. The Right Honorable Sir Zelman Cowen, GCMG, GCVO, former Governor-General of the Commonwealth of Australia.

We have not lightly taken the step to add to this select group. In doing so we recognise not only the remarkably creative career of Mr Honda, but in a sense, too, the interaction which has developed in recent decades between Australia and Japan.

Australia has earned for itself considerable recognition in the world of commerce as a supplier of quality wool, wheat, meat, sugar, minerals, and metals. We have also achieved standing in the world of science and industry.

Japan's achievements have been somewhat different. By magnificent dedication, hard work, and national co-operation she has lifted herself to a high point among the world's manufacturing nations.

This presentation was made by His Excellency Rear Admiral Sir Brian Murray, KCMG, AO, Governor of Victoria, on 31st August 1984 at the Regent Hotel, Melbourne, Australia.

Mr Soichiro Honda, HonFTS

In Mr Soichiro Honda we have in one person the imagination, capacity for innovation and hard work, and commitment to lofty goals that has made Japan the envy of many of the older industrial countries. Our Fellowships are conferred only on achievers, and in admitting Mr Honda to our number we recognise one of Japan's outstanding achievers.

We proudly join the several other academies and seats of learning around the world, and notably Japan, the United States of America, Sweden, the United Kingdom, France, Italy, and Belgium, in honouring him and through him the nation which he represents.

Your Excellency and Lady Murray, ladies and gentlemen, I now have pleasure in asking Mr Honda to come forward so that His Excellency, the Governor of Victoria, may present to him the certificate which declares to all his election as Honorary Fellow in the Australian Academy of Technological Sciences, and in doing so to recognise his great contributions to technology, industry, and international co-operation.

Address by Mr Soichiro Honda after receiving the certificate

I, as a Japanese, am greatly honoured and gratified to have just been elected the first non-Australian Honorary Fellow of the Australian Academy of Technological Sciences. This honour is shared not only by my wife and myself, but also by the entire Honda Motor organisation.

Ever since I was young, I have endeavoured to bring benefits to many people through my work, and have given concrete shape to a number of inventions and innovations. But what has given me the utmost satisfaction is that I have been able to serve people in the technological field, which is my speciality.

Looking back on many sleepless nights of research to solve difficult problems, and looking back on my corporate management experience in which I learned the importance of thinking from the standpoint of other people, I am more convinced than ever that the very root of corporate management must lie in respect for man.

This, I believe, is true of any field of activity and in any age. Technology must always be a means of bringing happiness to mankind, and it must be based on the philosophy of respecting humanity.

Recognising that what I am today could not have been achieved without the cooperation of so many people, I established the Honda Foundation seven years ago with the basic aim of bringing about harmony between science and technology and the human society.

The Discoveries International Symposia have been held on the basis of the thought that it is incumbent on us to promote mutual understanding and cooperation through international human interchanges on a global scale for the good of mankind today and into the 21st Century.

I am extremely pleased that this year's international symposium is held here in Australia under the sponsorship of the Australian Academy of Technological Sciences.

I would like to express my deep appreciation to Sir David Zeidler and the Fellows of the Academy, and to thank all participants for coming to this gathering from many parts of the world. Thank you very much.

SESSION 1

Keynote addresses

Theme

The use of resources and technology in the interest of mankind, with particular reference to the western Pacific

Chairman

Sir Ian McLennan, KCMG, KBE
The Foundation President, Australian Academy of Technological Sciences

Speakers

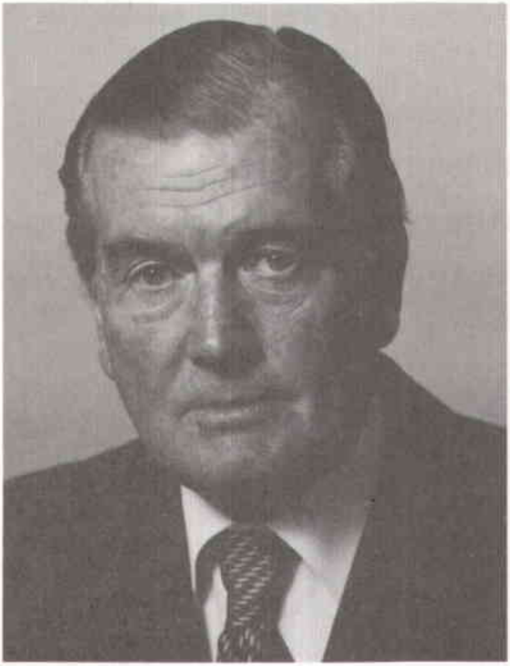
Sir David Zeidler, CBE: The use of resources and technology in the interest of mankind with particular reference to the western Pacific

Mr Moeen Qureshi: Challenges for technological development in Asia

KEYNOTE ADDRESS

The use of resources and technology in the interests of mankind with particular reference to the Western Pacific

Sir David Zeidler, CBE



Sir David Zeïdler, CBE, FTS

Sir David Zeidler, CBE, FTS, is President, Australian Academy of Technological Sciences and director of several companies. Sir David graduated in chemistry and engineering from the University of Melbourne and did chemical engineering research in the CSIRO from 1941 to 1951. He became Research Manager of ICI Australia Ltd in 1952 and rose to become Chairman and Managing Director in 1973. On retirement from ICI in 1980 he became Chairman of Metal Manufactures Ltd and is also on the Boards of The Broken Hill Proprietary Co. Ltd, Westpac Banking Corporation, Commercial Bank of Australia Ltd, Amatil Ltd, and Australian Foundation Investment Co Ltd. He has served on many government, university, and scientific society committees, having been Chairman of the Defence Industry Committee, Chairman of the Commonwealth Government Inquiry into Electricity Generation and Sharing between South Australia and Victoria, is National Vice President of The Queen Elizabeth II Silver Jubilee Trust, Vice President Walter and Eliza Hall Institute for Medical Research, and Member of the Victorian Division of Red Cross Commerce and Industry Committee. His CBE was awarded in 1971 and he was created Knight Bachelor in 1980.

KEYNOTE ADDRESS

The use of resources and technology in the interests of mankind with particular reference to the western Pacific

Sir David Zeidler, CBE

President
Australian Academy of Technological Sciences[1]
Melbourne, Australia

The decision some years ago by Dr Honda to establish the Honda Foundation, and through that to inaugurate an ongoing series of Discoveries International Symposia with the underlying and continuing theme 'The humane use of human ideas', is a fascinating concept with deep appeal for all thoughtful people.

From the recorded discussions at the six previous symposia in this important series, it is clear that if anything the concept is becoming more significant as the rate of change of scientific and technological developments continues its upward march.

In reviewing papers presented at previous symposia, and especially at more recent meetings, one cannot be other than impressed by the quality of the contributions. It is clear, too, that the discussions are developing along particular lines and that both needs and concerns are coming more into focus. In parallel there seems to be increasing recognition that the rate of change, the rate of technological development, is imposing substantial social stresses. This has resulted, I believe, in some frustration on the part of participants over these unusually intractable problems.

In these circumstances, even more importance attaches to Dr Honda's vision in making possible interdisciplinary studies by representatives of both the oriental and occidental worlds.

I believe I detected, too, a somewhat wistful note—what does one do usefully with the outcome of these symposia deliberations? Discussion between a group of distinguished scholars, scientists, engineers, industrialists, and others, is a fine concept, which has led to some profoundly useful

[1] Clunies Ross House, 191 Royal Parade, Parkville, Victoria, Australia 3052.

observations, but to what purpose? Should it be that the thinking at the Discoveries Symposia reach the media, the general public, the politicians, or is it destined to remain a high-level discussion group between east and west?

Over the series of the six Discoveries Symposia many facets of the relationship between technology and society have been explored and particularly in relation to developed economies. These discussions have been between wise men of considerable maturity – men who, because of the rapid changes resulting from the surge of technological development in their lifetime, are very conscious of its impact.

I noted a remark from the sixth symposium which, in effect, said the young people of today may not be so conscious of this aspect. Indeed, they are accustomed almost as a matter of course to a succession of inventions at which we older people marvel. This led me to wonder whether deliberations at these symposia might benefit from the presence of some younger participants, or alternatively that the underlying theme 'The humane use of human ideas' might be considered occasionally at a symposium especially for young people.

We are now about to set forth on the seventh of the series and it is an honour that Melbourne has been chosen as the venue. It is the first occasion that a city in the southern hemisphere has been host to a Discoveries International Symposium, and the Australian Academy of Technological Sciences was more than pleased to accept the invitation from the Honda Foundation to join in this challenging enterprise.

For those who have participated in previous symposia in the Discoveries International Series, you will know that based on your scholarship, your achievements, and your experience, discussions will range widely, but within the ambit of the underlying theme 'The humane use of human ideas', and more specifically on the occasion of the seventh symposium 'the use of resources and technology in the interests of mankind'.

In the present circumstances, and as Australia is for the time being our vantage point, it seemed appropriate that we should consider the underlying theme of the symposium in relation to a geographical region – to look toward the north to the nations of the western Pacific. It is a huge region of the world with large and diverse populations, enormous resources, enormous distances, and enormous potential for economic growth.

It is a particularly interesting part of the world where considerable need exists for the further development of resources and for the transfer of technology and of capital. These seemed to Dr John Farrands, who planned the programme, powerful reasons for embarking on such a course. We hoped, in issuing invitations to participate in the symposium, that we would have had a rather stronger response from individuals in the region in addition to the participants from Japan.

Australia sees itself increasingly as a part of the region rather than, as formerly, an outpost of western European traditions and commerce – Australia's largest trading partners are now in this region. The opportunities to develop and transfer resources and technology are great, and discussion on all these matters would seem to fit well with the overall concept of the Honda Foundation.

The presentation of a keynote address on such an occasion is in any event a daunting prospect, but doubly so when the theme involves such a large and important region of the world. When thinking about suitable material my mind turned to the introductory statement by Bronowski in his presentation *The Ascent of Man*. He said:

> "Man is a singular creature. He has a set of gifts which make him unique among animals: so that, unlike them, he is not a figure in the landscape—he is a shaper of the landscape.
>
> "In body and in mind he is the explorer of nature, the ubiquitous animal, who did not find but has made his home in every continent."

And, he went on:

> "His imagination, his reason, his emotional subtlety and toughness make it possible for him not to accept the environment but to change it. And that series of inventions, by which man from age to age has re-made his environment is a different kind of evolution—not biological but cultural evolution."

And, he concluded:

> "I call that brilliant sequence of cultural peaks '*The Ascent of man*'."

I am attracted to this concept so ably expressed by Bronowski. It seems appropriate to the launching of our forthcoming discussions. We are indeed concerned with the ascent of man.

However, while nobody, I feel sure, would gainsay such sentiments, they nevertheless seem to relate more realistically to the views which people from the developed regions of the world might have of themselves, of their environment and of the achievements of man.

There are in the western Pacific many who still eke out only a meagre existence and who, either through dire poverty or lack of education, would not feel in a position to appreciate such a wonderful expression of the upward thrust of man's spectacular achievements.

I am drawing attention to this difference for I feel it should be fundamental to our forthcoming discussions about matters which affect the well-being of the people of our region. It is important that realism should guide our discussions.

This will be the first occasion, I believe, that the symposium programme has been directed as specifically to a particular part of the world.

It has been stated by Eberhard Rhein of the Commission of the European Communities in an article entitled 'The significance of the Pacific region for Europe' that by the year 2000 about 6 per cent of the world's population will live in Europe, while 33 per cent will live in the Pacific Basin, and that by the year 2000 the combined gross national product of the most important Pacific states of Japan, South Korea, China, Taiwan, Hong Kong, the

ASEAN countries, New Zealand, Australia, the west coast states of United States, and of Canada, will be greater than that of western Europe.

We in Australia are vastly interested in the region around us. We are a small population, mainly of transplanted western European culture, occupying a large land mass with large natural resources within a region of nations most of which have large populations of entirely different cultures of considerable antiquity.

However that may be, at the risk of presenting information which may be well known to many, it seems desirable in setting the scene for our subsequent discussions to provide a little more detail about the countries comprising the region.

In many ways it is a region of extremes—climatically, economically, and demographically. Its member countries vary greatly in mineral, agricultural, and energy resources. It is, and will continue to be, a region of great trading activity.

With the exception of China, with an area of more than 9.5 million square kilometres, and Australia with more than 7.7 million square kilometres, the other nations of the western Pacific occupy relatively small land areas often divided among a number of islands.

To the north of the region is Japan with a population of some 118 million people, occupying a chain of four main islands with a total land area of about 370 000 square kilometres, approximately equal to two-thirds the area of France, but with roughly twice the population and with a gross national product per head greater than $10 000 (compared with France $11 500 and the Federal Republic of Germany $12 500).

To the south of the region is Australia, a distance of 8800 air kilometres, with a population of 15.4 million people and a gross national product per head greater than $11 000, and New Zealand with a population of 3.2 million and a gross national product per head of almost $8000.

The People's Republic of Korea (South Korea), numbering about 39 million, occupying a relatively tiny area of 98 thousand square kilometres, and Taiwan numbering 18 million, have, despite limited natural resources, pursued industrial policies which have lifted their gross national product into the range $2000-$2500 per head.

With the exception of Malaysia, their economic performance, though still low by developed country standards, is substantially better than all the remaining countries in the region.

Malaysia has a population of 14.5 million people, with gross national product per head of some $2000. It is well endowed with natural resources and should continue to develop these quite rapidly.

The Republic of the Philippines is one of the largest archipelagoes in the world with 11 main islands contributing 95 per cent of the total land area, a population of 51 million people and a gross national product of $820 per head.

Thailand is a country of some 48.5 million people with a gross national product of about $800 per head. It is the only South East Asian country that has not at some stage been colonised by a European power.

The Republic of Indonesia is the fifth most populous country in the world and extends as a chain of islands some 5000 kilometres between mainland Asia in the north to Australia in the south. The total land area is almost 2 million square kilometres (about four times the area of France) and the population is 153 million people, two-thirds of whom live on the island of Java. The gross domestic product is just under $600 per head.

The purpose of providing this broad statistical information is to emphasise the variation in living standards, the distances, and the concentrations of people in the region. It is not feasible to obtain readily corresponding figures for Vietnam and Kampuchea; however, Vietnam probably has a population of 57 million people.

China is a singular case with a population exceeding one billion people, a land area of 9.5 million square kilometres and a gross domestic product in the region of $300 per head.

Overall there is within the region some 1.3 billion people with a gross national product of substantially less than $1000 per head, some 70 million or so in the vicinity of $2000-$2500 per head and about 137 million exceeding $8000 per head.

So much for some broad statistics for the region to which we will be directing our attention in subsequent sessions of this Symposium.

As I said earlier, in approaching our discussions around the underlying theme of the 'Humane use of human ideas' we will need to bear well in mind the circumstances under which many people in the region exist. I may be emphasising this aspect unnecessarily, but over a number of years I have felt that the western hemisphere knows little of the eastern, and the northern little of the southern.

With this in mind, and primarily for our guests from overseas, I thought it could be helpful to talk a little about Australia—your host country. For a nation with a strong and developed economy it has a remarkably short history as far as western European style settlement is concerned.

Although from myths and legends a great southland was suspected to exist from time immemorial, it was not until the Portuguese, Spanish, and Dutch navigators came in the 17th century to the East Indies by way of the Cape of Good Hope that contact with a southern continent was recorded. Carstenz in 1623 said in his journal: "We have not seen one fruit-bearing tree, nor anything that man could make use of . . . It is the most arid and barren region that could be found anywhere on earth; the inhabitants, too, are the most wretched and poorest creatures that I have seen." Occasional reports in similar vein continued for 100 years or more.

The first white population of Australia consisted of 736 convicts, 17 children of convicts, 257 marines, wives, and children, and 20 officials who arrived as the First Fleet on 26 January 1788 to establish on behalf of Great Britain a penal settlement.

In the words of Geoffrey Dutton: "Settled by convicts, starved by nature of rain and rivers, offering no comforts of history or tradition, Australia was not a place to love. It is no wonder that even among those who tried to love the country, few could understand it and truly think of its uniqueness as home."

It was not an auspicious beginning for a new nation. Such, however, is the determination of men and women that despite hardship, loneliness, and privation the country was explored and the population grew and spread encouraged by mineral prospecting and by agriculture. Australia became, and continues to be, a major exporter of wool, wheat, and other agricultural products.

In more recent times it has become a major supplier to the western Pacific, and other regions, of minerals, especially iron ore and coal.

It is a matter worthy of note that although it has a relatively brief history Australia has raised its gross national product per head to a level close to that of the major economies of the northern hemisphere. It also has a record of successful innovation in the fields of agricultural production and of mineral processing.

From the start of settlement in 1788 Australia's story has been shaped by immigration. At first there were convicts and their keepers – the compulsory pioneers – followed by the small, but growing band of free settlers drawn by land and other opportunities.

Then came a flood of fortune seekers in the gold rushes of the 1850s – many to stay. Later arrivals fluctuated in numbers in response to economic conditions and world conflicts. For Europeans in those years it was a faraway country, a rather desperate throw.

By the turn of the 20th century the population had reached 3.8 million. Until the conclusion of World War II the population continued to be mainly of United Kingdom origin with a quite small proportion of other Europeans.

Since 1945 some 4 million people from more than 120 countries have settled in Australia helping to more than double the population from 7.4 million in 1945 to 15.4 million today.

Migration has been a major factor in Australia's post-war economic and cultural development, but the country's population is no longer essentially Anglo Saxon in background. Australia's trading partners have also changed significantly.

It is not surprising that this land which seemed so strange to early European settlers engendered in them a sense of challenge which has influenced many aspects of the country's rapid development.

There was the challenge to the adventurous young of exploration in countryside far more inhospitable than they could conceive. But, despite hardships, they succeeded.

There was the challenge to develop new farming methods in a land with upside down seasons. It was a new country requiring a robust and forward looking approach if you were to survive.

Out of these needs some surprisingly far-sighted developments occurred—research into new agricultural practices, for example, culminating in the 1920s with the formation of the government-funded Council for Scientific and Industrial Research, now the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Today the CSIRO's annual expenditure is about $377.5 million representing about 21.7 per cent of all R & D expenditure in Australia—a somewhat unusual national balance.

Again, in the early period of transplanting European ideas and procedures to this distant and harsh country, it is a matter of some surprise that education assumed an early position of importance.

Sydney University was founded in 1850 and the University of Melbourne in 1853, only 18 years after the first European settlers landed on the banks of the Yarra River at a site which is now the City of Melbourne.

Since time began education has been recognised as a key to social and economic progress. The success in recent decades of the Japanese economy is now legendary. Japan has a strong, well-developed education system with a high participation rate at tertiary level.

In a recent paper, Professor David Caro, Vice-Chancellor of the University of Melbourne, drew attention to a disturbing trend in Australia and he said:

> "The participation rate in education in Australia is markedly lower than that of many OECD countries where, on average, about two-thirds of all young people complete 12 years of schooling. That is double the Australian figure. In Japan, our leading trading partner, 90 per cent complete secondary school."

And, he said:

> "The low school participation rate is matched by a correspondingly low exposure to higher education and the fraction of the appropriate age cohort going on to universities or colleges of advanced education in Australia declined markedly between 1975 and 1982.
>
> "About 8.7 per cent of the relevant age group go to university or college in Australia. In Canada, the figure is 18 per cent, and in USA 27 per cent, and in Japan 29 per cent, more than three times the Australian figure."

This is indeed a disturbing trend. Perhaps in more recent and affluent times thoughts of survival are no longer an issue. Humanitarian and compassionate national policies are modifying the national will to achieve.

It is salutary to observe that over a 10-year period from 1971 to 1981 the number of people receiving government support, including pensioners, rose from 1.4 to 3.3 million and that the number per thousand workers has risen from 241 to 488. Such a change is clearly a significant reallocation of national resources.

I think we have cause to worry. A worry in which we are not alone. On the one hand there is the desire to expend increasing amounts on sustaining disadvantaged people in the developed economies and, on the other, the need to provide in those same economies the conditions which encourage learning and the search for, and the development of, new scientific understanding.

I believe it to be fair to say that the major steps forward in the worlds of science and engineering have occurred largely in those economies which, for the time being, have been able to accumulate wealth.

Undue community and political pre-occupation with 'doing good' can undermine almost surreptitiously the sources from which good in the longer term may stem. It is a difficult balance and one of considerable importance not only to developed countries.

When the Academy was invited to partner the Honda Foundation, the invitation was accepted with pleasure, but from the underlying theme some significant concerns arose in my mind. I asked myself two questions: first, was there any particular means which had been notably successful in developing human ideas for the welfare of mankind and, second, was there a particular scientific observation which, over a lifetime or so, had developed to bring the greatest benefit to people, and what lessons might we derive from that? I didn't find the second question easy, but perhaps it is worth thinking about.

Each of us no doubt will have particular achievements in mind; the development of antibiotics, the development of transistors and micro-circuitry, the green revolution, the DNA molecule, and even perhaps the managerial skills in organising men and machines to create ever-greater economic wealth to meet the needs of a rapidly growing world population.

For what it is worth, it seemed to me that the discovery that an electric current was generated when a metal conductor moved in a magnetic field might rank highly as an answer to my second question. It is, I believe, inconceivable to all of us to contemplate a world without the benefits of electricity, yet it is only about 150 years since Michael Faraday glimpsed something of the possible significance of his observation. The ability to perceive possibilites is at least as important as the discovery. More remarkable than the discovery, however, was the rate of engineering development of the new concept as the realisation grew that electricity could serve man in many ways—lighting, heat, and power—and over long distances.

Today, and at the risk of causing some amusement to my engineering colleagues, I must say that my mind is still filled with wonder and awe when standing at one end of a major electricity system I try to reconcile in my mind the huge mines, the immense boilers, and the great generators connected at the other to a great and distant metropolis with its industries, its transport systems, its buildings, and its suburbs by those long delicate transmission lines conveying all that power. To me it is almost unbelieveable—a series of marvellous achievements by successive generations of engineers. A good example, I believe, of a long chain of human ideas used for humane purposes.

It is also a fine example of the organising ability of which man is capable in bringing benefits to great numbers of people. The availability of electrical energy unlocks so much, even in the poorest countries.

Returning now to my first question about any particular means which had been notably successful in developing human ideas.

In reflecting about that I came to the conclusion that the concept of the joint stock company has proved an outstandingly successful means for marshalling financial resources and for stimulating the development of the discoveries of science. It is by no means the only way of achieving that, but it has some very effective ingredients not the least of which is the self-interest of the stock holders, the investors.

In drawing this keynote address to a close, and in thinking about the continuing flow, during my lifetime, of new insights into Nature and her forces, I do not find myself encouraged to feel other than that we are yet only on the fringe of what Nature can reveal to us. While we may see the pursuit of such possibilities as exciting and desirable, there are many today who are concerned and afraid and who would wish to curtail such activities.

I believe it would be greatly to the disadvantage of mankind if constraints are placed through educational or other means on those very few outstanding individuals who are endowed with the perception which underlies all the great strides forward in human understanding of Nature.

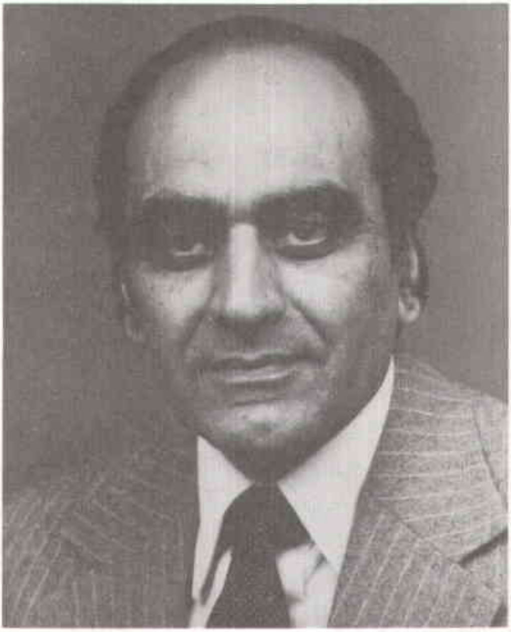
In this vein I would like to return to Bronowski's *Ascent of Man*; his concluding words were:

> "We are all afraid for our confidence, for the future, for the world. That is the nature of human imagination. Yet every man, every civilisation, has gone forward because of its engagement with what it has set itself to do. The personal commitment of a man to his skill—the intellectual commitment and the emotional commitment working together as one has made the Ascent of Man."

KEYNOTE ADDRESS

Challenges for technological development in Asia

Moeen Qureshi



Mr Moeen A. Qureshi

Mr Moeen A. Qureshi is Senior Vice President, Finance, The World Bank. A graduate of the University of Punjab in Pakistan, he took his doctorate in economics at Indiana University, USA. Mr Qureshi held various responsible positions in departments of the Government of Pakistan until he moved to the International Monetary Fund in Washington, serving in various capacities till 1970 when he joined the International Finance Corporation, moving up to be Executive Vice President in February 1977. In July 1979 he was concurrently appointed Vice President, Finance, of the World Bank and served in the joint capacity until the beginning of 1981. Mr Qureshi has written and lectured extensively on economic development, industrialization, and issues of private investment and finance.

KEYNOTE ADDRESS

Challenges for technological development in Asia

Moeen Qureshi

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Washington, USA

Thanks are due to Dr Soichiro Honda, the Honda Foundation, and the Australian Academy of Technological Sciences for making it possible for us to reflect together about how better to use resources and technology in the interest of mankind. Let me say how impressed I was by Sir David's address. It has got us off to an excellent start.

Let me begin with a question: Which two nations do you think achieved the highest rates of economic growth in the world last year? First, the Republic of Korea. Second, the People's Republic of China. India and Pakistan, with growth rates over 6 per cent, also came out in the top ten.

The world has changed. It has changed most in the developing world. We have traditionally looked upon labour, land, and capital as the three vital factors of production. I believe that we should identify a fourth—technology. The leap into the technological age explains more than anything else the dramatic change that has taken place in these countries.

A generation ago, the prospects for Korea were regarded as dismal. Mothers in England tried to get their children to eat their porridge by having them think about the starving children of India and China. And South Asia's mounting food deficits in the 1960s made many observers doubt whether India and Pakistan could ever again produce enough food for their growing populations.

Asia is one region of the world where technology has clearly contributed to the improved well-being of people. This afternoon I would like, first, to review the economic and technological achievements of the developing countries of Asia. And then I will focus on three major issues that are emerging as key factors in the further development and transfer of technology.

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Asia is a microcosm of the most and least advanced of countries; on the one hand Japan, with its highly advanced technological base, and on the other, countries ike Bangladesh and Nepal, where an indigenous technological base is only beginning to emerge. And even within some of the Asian countries, you have the old co-existing with the new; the development of nuclear power plants side by side with bullock and camel carts that have not changed over the centuries.

The global recession of the last few years has inflicted heavy costs on the Asian countries. But, in retrospect, this recession—the most severe recession in over 40 years—has also demonstrated, as never before, the exceptional economic resilience of this part of the world.

The economic downturn was more moderate in Japan than in any of the other major industrial nations. China, India, and Pakistan maintained relatively high growth rates throughout the recession. And the market-developing countries of East Asia—except perhaps for the Philippines—despite their exceptional dependence on international markets, are recovering from the recession remarkably well.

In 1983, the developing countries of Asia averaged economic growth of 6.5 per cent. That was in stunning contrast to the average growth rate of the Third World as a whole—less than 1 per cent. And it was nearly three times the average growth rate of the world's economically advanced nations.

Now, GNP growth is only one crude indicator of economic improvement. But indicators of basic human welfare also point to widespread progress in Asia. Average life expectancy in the developing countries of Asia is now about 59 years, 17 years more than it was even as late as 1960. In China and the middle-income countries of East Asia, nearly all children are now able to attend school. Even in the other low-income countries of Asia (other than China) literacy rates have dramatically improved.

When I was growing up in Pakistan, many people in the villages and rural areas had no shoes. Hook-worm and smallpox were problems. Since then, health and hygiene practices have progressed enormously. People have not only shoes but now frequently bicycles. The scourge of smallpox has now been eliminated.

Consider the dramatic changes in agriculture in Asia; the so-called "green revolution"—the technological transformation of peasant agriculture.

1. India had a severe drought in 1982, the kind of drought that would have provoked frightening headlines 20 years ago; but India's agriculture is now well enough developed so that the international press hardly noticed it.
2. Bangladesh is now routinely growing hybrid wheat on 10 million hectares where wheat was never grown before.
3. Some of the developing countries of East Asia have maintained, over the last 20 years, rates of agricultural growth that are among the highest in the world.

In industry, too, the market-developing countries of East Asia such as Korea and Taiwan have achieved spectacular results. They have oriented their industries towards international trade. Over the last decade, Korea has expanded its manufactured exports faster than any other country in the world, and the Philippines, Malaysia, and Thailand have expanded manufactured exports at rates of 20 to 30 per cent a year.

A major challenge in Asia now is, of course, China. After years of isolation, China's search for foreign technology is striking. No social system changes overnight, or even in a few years, but China's present leadership has been pressing hard for reform in almost every aspect of Chinese life. Technological modernization, openness to international commerce, and increased incentives for production are fundamental to China's present strategy. Technology transfer has been an important aspect of most of the projects the World Bank is now financing in China.

East Asia's achievement in advanced technology tends to make the headlines, and understandably so since it has given the region such a strong position in the international marketplace and underpins so much of its dynamic economic performance. The part technology played in East Asia's green revolution is also quite well known, although few people appreciate its impact from paddy to paddy and from one peasant family to another, and on Asian food deficits overall. Success with developing new, appropriate technology for low-cost earthwork and road construction, for water supply and sanitation, or for agricultural extension, urban shelter and the like has almost passed unnoticed.

All these technologies, glamorous and unglamorous, have played their part in the economic and social transformation of East Asia that I have just described.

The point is a simple one: the developing nations of Asia relying on improvements in technology have achieved higher standards of living for millions of their people.

Of course, great problems remain. Most people in the developing countries of Asia are still severely constrained by low incomes. Too many are still miserably poor. A few of the poorest countries have been left far behind the rest of the continent. But it is no small thing that the bulk of this region has been able to sustain economic growth and attain significant reductions in poverty.

There was a time, in the decade or two after World War II, when the major poles of potential growth in this part of the world were just Japan and Australia. The World Bank played its part in post-war development in both countries—our lending in the 1940s and 1950s to Australia and Japan totalled over $1.2 billion—and our financing facilitated the introduction of new technology in major sectors like power and transport. Examples that come to mind are the "Bullet" train in Japan and, here in Australia, the Snowy Mountains power scheme.

Now there are many poles of growth in this part of the world. This is what gives it its extraordinary dynamism. As I have pointed out, some of the most rapid growth rates in the region are being chalked up by developing countries. This presents Australia, Japan, and New Zealand—and indeed all developed countries—with the opportunity to reap great rewards by trading with the developing countries of Asia, by investing in them, by inventing for them, and by helping them strengthen their own capacity for invention.

But what Australia—or other industrialized countries—offer must match what the developing countries need and want to receive.

Indonesia, for example, has upgraded living conditions for millions of families in urban slums using very low-cost approaches which the Bank first advocated 12 years ago. Indeed, the World Bank has become a clearing house for information in certain key areas of potential technological improvement in the poor countries—e.g., in cost effective methods of food storage, cheap energy sources, and the development of rugged hand pumps that can provide a more dependable source of drinking water in many rural areas.

Such technology requires no less ingenuity than advanced electronics. Nor is it any less important for humanity; indeed, it answers to the challenge described by the Duke of Edinburgh at our London meeting of making 'the best use of modern technology in the long-term interest of human civilization'.

From my perspective at the World Bank, it seems to me there are three over-arching challenges for technological development in Asia right now.

1. We need to consider the implications of sustained high interest rates on technological development. It seems to me this is an issue which has not yet been adequately appreciated.
2. We need to focus on the proper role of government and of the private sector in the application of technology. How this balance is struck is crucial.
3. Finally, there is the urgent need to harness and adapt technology to address the pressing problem of rapid population growth.

First, high interest rates and the cost of capital.

We are living with the highest real interest rates—that is, nominal interest rates minus inflation—in modern history. For the last 50 years, real interest rates in the range of 2 to 3 per cent have been the norm. In the 1970s, inflation resulted in much lower, sometimes negative, real interest rates. But since about 1979, real interest rates have been extraordinarily high, of the order of 6 to 8 per cent. Nominal interest rates and inflation have both come down, so real interest rates still remain historically high.

You will recall how the explosion in energy prices sparked off much technological innovation to economize on the use of energy. Our first steps were rather crude. We turned down the thermostats. Then we installed double glazing. It took some time before we began to adopt new technologies, such as heat-pumps, to conserve energy.

For the same reasons, high interest rates suggest to me that technology has already begun taking a turn towards conserving capital even in the industrial world. Quite apart from several attempts at developing "appropriate technology" over the last two decades, most of the developing countries of Asia have responded to the increased scarcity and high cost of development capital by cutting back on their investment plans and by taking measurements to encourage the more efficient use of resources generally. Such reforms in national economic management are essential, but these cutbacks cannot be taken too far without seriously endangering prospects for future growth.

In addition—and I am not sure this is widely understood yet—higher interest rates have implications for the choice of technology. Obviously the payback period on an investment is quite different if the cost of capital is factored in at 6, 12, or 18 per cent. This is bound to affect technological choice as well, and to reinforce the attractiveness of less capital intensive appropriate technology.

I think I can speak for the economic effects of a high cost of capital on technological progress, but the substantive effects are more properly answered by those who are much closer to making technological choices. So I pose this issue as a question to the meeting. Specifically what kind of innovation will we see more of, and less of, if high interest rates persist? I would be most interested to know how scientists and engineers here today would answer this question.

The widening scope for the private sector in technological development is the second topic I would like to touch on. This is happening against the backdrop of a recession which has pushed many countries, both developed and developing, to be more receptive to foreign investment, which brings with it the benefits of access to new technologies.

At one time, most developing countries were quite wary of direct investment by multinationals, afraid that it might compromise their sovereignty. But it has become more and more obvious that heavy-handed restrictions on all foreign investment have resulted in tremendous waste and lost opportunities. India's former posture, with its heavy sheltering of domestic enterprise, has been very costly to the economy; in Latin America the protective policies of the Andean Pact countries are another major example. To my mind, experience has confirmed that direct foreign investment, properly managed, is often the simplest and cheapest way to acquire technology. In this area, the World Bank has frequently played a supportive role.

A trend towards more liberal treatment of foreign investors is apparent in many developing countries. This presents a challenge to private enterprise—to spot new opportunities as they open, and indeed make a larger contribution to the economic and technological development of these countries.

The nation whose technological development has most impressed me is Korea, and Korea is characterized by an especially happy relationship between the public and private sectors. The Korean government has supported technological development through research institutes, tax incentives for R & D, even though participation in a venture capital company to finance technology. Public investment in technology makes sense, because the social benefit of knowledge almost always exceeds the profit a firm can derive from developing it. But in Korea, the private sector is encouraged, not stifled, by the public sector.

I trust that international companies have also, like the developing countries, learned some lessons from experience. Perhaps the most important lesson is that the developing countries are determined to strengthen their own technological capacity. Developing countries want to learn at least enough about technology to be intelligent shoppers. In time, they want to be able to adapt technology to their own needs and, eventually, become creators and exporters of technology themselves.

International firms can help developing countries along this path—through their sales of equipment and software, and by making their subsidiaries active in technological creation. If international firms succeed in strengthening indigenous technological capacity, they will be welcome in the developing countries for a long time to come. Technology transfer has been an important aspect of most of the projects the World Bank is now financing in China.

Before I close, I want to highlight a third area where the needs of developing Asia challenge technology—population.

Rapid population growth in the developing countries tends to hamper progress towards higher standards of living. Throughout history, improvements in technology have enabled the increase in population to be absorbed. But now the rate of growth in many developing countries has reached unmanageable proportions. So now, for the first time in history, technology is being used to reduce population growth.

Nearly all the developing countries of Asia have recognized population growth as a problem, and many have been able to slow it down. Between 1965 and 1980, China reduced its crude birth rate 57 per cent, and the rest of East Asia reduced its crude birth rate 21 per cent. South Asia reduced its crude birth rate only 13 per cent, but that was still more than the reduction in Latin America or the Middle East. In Sub-Saharan Africa, there was virtually no fall in the crude birth rate.

General improvements in economic well-being tend to retard population growth, but there is clear evidence that programs of family planning also help. Yet there are an estimated 65 million couples in the developing countries, many of them poor people in remote areas, who don't want more children but don't have access to effective contraceptives.

And contraceptive technology is still very much inadequate. All the methods have disadvantages. Some methods aren't very reliable. Some methods have negative side-effects. Some methods are difficult to use under the conditions typical of rural areas in the developing countries. Sterilization is virtually irreversible, and abortion is morally controversial.

And do you have any idea what the world – the whole world – is spending on contraceptive research? Only $150 million a year.

Our *World Development Report* this year was devoted to population growth, and we are exploring opportunities for further research, including the possibility of direct Bank support for international efforts in contraceptive research.

The Bank is already participating in a coalition of development agencies to take advantage of new child health technologies that promise to dramatically reduce the number of early deaths in developing countries. Saving a child's life needs no further justification. But I mention the effort in this context of family planning because many couples in developing countries want many children to be sure that at least a few will survive to support them in old age. Thus, technologies to lower child mortality would also tend to reduce fertility.

The ultimate purpose of technology is to increase the sense and scope of life's possibilities. No one can visit Australia, or fly over this vast land without being struck by its immense possibilities which, I am confident, will in due course be realized through the efforts of its people and the application of capital and technology.

I believe that Asia is also a region of opportunity not least for Australia with its geographical advantage in this vast market. The impact of the green revolution shows what high returns technology can yield in the developing countries of Asia. Yet there remain so many under-funded and unexplored lines of technological development in Asia. Indeed, globally the problem of the developing countries – and especially of poor people in developing countries – have not received anywhere near the attention they deserve from scientists, engineers, and inventors.

The time has come to look anew at issues of appropriate technology and their linkage to economic and social progress. It is my hope that Australia and Japan, the two most technologically advanced countries of the region, will involve themselves in the up and coming developing nations all around them, and will work with them to realise for all the possibilities of a fuller life through the appropriate and effective use of technology.

SESSION 2

The roles of academia, industry, and government

Theme

To present and discuss from perspectives of members of the centres of higher learning, primary and secondary industry, and national and international government organisations, the lessons of history and present problems in use of resources for mankind. The concept of resources should embrace land, energy, water, minerals, communications and human components; the changing values of resources should be addressed, as should be the problems of community decision making.

Chairman

Dr L. W. Davies, AO, FAA
Vice President, Australian Academy of Technological Sciences

Speakers

Dr J. L. Farrands, CB: Decisions and values in the application of technology

Professor J. C. Simon: Some problems of human adaptation to a post-industrial age

Sir Henry Chilver: Academia—synergies with industry and government

Professor Kazuhiko Atsumi: Current status and trend for cooperation between industry, government, and academia

Decisions and values in the application of technology

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Decisions and values in the application of technology

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"... doing today those things that men of intelligence and goodwill would wish five or ten years hence had been done"—Edmund Burke (1729-97).

Twentieth century technology gives us great power to affect the future for good and bad. Because of that power, we must examine closely the values we adopt and the methods that we use in our politico-technological decisions.

Even the best intentions may lead to social damage—alleged or real, or not foreseen (or perhaps unforeseeable). The ensuing public concern is often a surprise to the initiators. Polarisation arises from the different perceptions of value in different sectors of the community or different nations.

On values

The field of values is complex; it has temporal, spatial, national and class aspects. Instantaneous unanimity on the "best" way to use technology is unlikely. In this symposium we shall be examining the issues from many viewpoints. It is important to direct attention to the existence of the value problem, and the difficulty of making rational decisions.

Examples of conflicts of values and perceptions in the application of technology to human affairs are in abundance.

An interesting current example is the controversy about the supply of infant breast-milk substitutes in underdeveloped countries. This application of technology would seem unexceptional—perhaps even philanthropic—in the light of the known effect of low nutrition of nursing mothers on infant health. Some social scientists see it as disruptive, as a diversion of scarce village resources, as affecting the immune response of the children and upsetting the natural population control mechanisms.

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Decisions on quantifiable issues are the easiest to make, but not all values are quantifiable, nor is quantification widely comprehensible. The quantification of one value-perceptor may not be acceptable to another.

Sir Eric Ashby has referred to the "utility value of the unquantifiable" (Ashby 1976), and used as an example the value of the songs of nightingales. Its parallel comes up often in the antitheses of technological development and environmental issues.

During the International Commission for the Conservation of Antarctic Marine Living Resources, it became apparent to me that although many aspects of the whaling problem were indeed quantifiable, the values assigned by members of the whaling nations, the fishing nations, the agricultural nations, and the conservationists were all different.

Conflict on the value of new technologies is pandemic. Almost every major industrial or mineral development, and indeed some agricultural ones, is assailed by some sector as a net negative value on some scale or other.

We should always be ready to submit our accepted values to re-examination. For example, the introduction of new technology is almost everywhere regarded as a "good thing" if it creates employment or if new jobs are created elsewhere.

When unemployment is widespread and where it almost universally equates to poverty this is understandable, even though the new technology may increase the total human wealth. (When faced with a paradox, re-examine your premises!)

It is conceivable, it may even be a reality, that if modern technology were to be applied intensively (given enough capital), all human essential needs and most comforts could be met without increasing the labour force. It would seem logical then to go ahead in an uninhibited way with the application of production technology. Work is, of itself, not an object to be sought, and for most of our fellows it is not even interesting. Throughout history, man has attempted to avoid work.

Unfortunately, the distribution problem seems to be beyond the scope of modern economics. Political realities and the hierarchy of perceived values do not, I believe, permit the intermediate situation, even though the final result might have been acceptable to all.

I do not want to pursue this important issue in this paper, but draw it to your attention as an example of a conflict between present and conditional future values. In such cases we are led into classical local sub-optima in the field of values.

It is unlikely that we shall establish here any new insights to the fundamental thinking of values, but discussions on the "best" use of technology will be abortive if we do not keep in mind that some of us may be working in a different conceptual frame of values from others.

Suppose that we were able to agree on the best objectives for the humane use of technology and then consider how to evaluate the courses of action which will achieve those objectives.

On objectives

It is easy enough to make a list of objectives. For example, full stomachs for everyone, health care for all, warmth for the cold and cool for the hot, working amenity, interesting work, adequate leisure, cultural facilities, convenient homes in an attractive environment, freedom from noise and smells, economic security, and access to nature are unexceptionable.

Technology can deliver all these, but history tells us that uncontrolled effort in some of these areas may be counter-productive in others. For example unrestrained industrialisation can lead to greater community wealth but greater individual poverty, and deterioration of the urban environment.

Even enhanced food production in undeveloped countries has on occasion led to greater misery for the greater number when the technology has disrupted the social structure.

Aids to decision

Techniques are needed to assist governments and board rooms to exploit technology for human good while avoiding adverse effects. We should, where possible, quantify effects or at least identify the unquantifiable aspects.

There are many cultures involved. Scientists, engineers, industrialists, financiers, and government share a lack of ability to communicate one with another; apart from semantic difficulties, the values and premises are different. Singly, they are ill-equipped to deal with the complex interplay of social and technical issues. Among them will be some who know the cost of everything and the value of nothing.

Dwight Eisenhower (1961) expressed the fear that "public policy could itself become the captive of a scientific technological elite". At about the same time, Hans Bethe was complaining " . . . one has the impression that the purpose of the Hearing is not to search the facts and then reach a solution, but that the solution has been determined and the Hearing will now put such facts on the record as will support the solution." (Wood, 1964).

Since that time almost every country has created some system of committees for advice from the technologists.

On advisers

The committees are composed of eminent scientists and engineers judged to be of sufficient breadth to interpret matters outside their own speciality. However, the range of technical questions at the strategic level transcends the expertise of any one man or small group. Only rarely do they address a matter in which they are the supreme experts. Consequently they need support systems. It is not enough for them to be interpreters of the messages to and from the technical community using some assumed lingua franca of science and engineering.

Analytical techniques

Often their task has to do with objective matters which could be put to analysis but is usually not. Miller (1977) has listed seventy-three forecasting techniques including technological forecasting, technology assessment, environmental impact studies, quality of life studies, and risk analysis and systems analysis. In addition there are the techniques of futures research, such as Delphic modelling.

Of all these perhaps the most respected is technology assessment. Library of Congress defines it as:

> " . . . the process of taking a powerful look at the consequences of technological change. It includes the primary cost benefit balance of short-term and localized market place economics, but particularly goes beyond these to identify affected parties and unanticipated impacts in as broad and long fashion as possible. It is neutral and objective, seeking to enrich the information for management decisions. Both 'good' and 'bad' side effects are investigated since a missed opportunity for benefit may be detrimental to society just as is an unexpected hazard."

Technology assessment is not a perfect tool. It is apparent that there are a lot of hidden subjective judgments involved. The words 'good', 'bad', and 'benefit' alert us to this. Additionally, it is not logical to assume that a wholly deductive system will reveal 'unanticipated impacts'.

All systems of future analysis have weaknesses. Hoos (1977) directs us to the data base, cost-benefit calculations, and methodology. Zadeh (1972) says that reductionist methods lead to a threshold beyond which precision and significance become mutually exclusive whilst holism leads to our knowing nothing about everything.

It is important to be on guard against false quantification or even worse the attempted quantification of the unquantifiable (*vide* "computer solutions").

In spite of these criticisms, there is a role for analytical techniques (quantitative where possible) which is largely ignored.

Data for decision makers

There are several kinds of data to be considered. Firstly there is the individual data base of the decision maker or adviser; secondly there are the data of the proponents and adversaries of the project; thirdly there are the data contained in the scientific and technical literature.

It might be assumed that, since the application will have derived from the technological literature, an adequate data base exists and merely needs to be sought out. Not so. In nearly every case where public discussion is involved, there will arise questions for which answers have not yet been found. Consider, for example, the green-house effect, the toxicology of chemical waste, even the sustainable yield of the sea.

Thus, in trying to apply technology, we find ourselves without the data support that we might reasonably have expected, and it is oftentimes not gatherable in any reasonable time scale.

Trans-science issues

The situation is in fact even more complex. There exists a set of questions which can reasonably be asked of, be phrased in the language of science, but which cannot be answered by science. For this class of question, Alvin Weinberg (1972) has proposed the term "trans-scientific".

A good example is the effect of very low levels of radiation on living organisms. The effect of large doses is fairly well known. The effect of zero radiation (if it could ever exist!) is presumed to be zero. Is there a linear relation, or is there a threshold? A typical figure for annually acceptable radiation dose is 150 millirem. If we ask the question "Will this dose increase the mutation rate by half a per cent, and please be confident at the 95 per cent level?" we will require, he says, 8 000 000 000 mice for our experiment!

The experiment is impossible yet the example is not irrelevant. A study here on atmospheric nuclear weapons testing took the 'worst case' of no threshold and produced a very significant political result. Another assumption might give another result.

There are many examples. For one, it is impossible to prove by a finite experiment that any level of chemical pollution is totally harmless.

Another is the calculation of extremely improbable events. Aircraft and nuclear reactor failures are examples. Suppose for example that a risk analysis gives 10^{-7} failure/reactor/year. How shall we test this? Shall we build 1000 reactors and operate them for 10 000 years? Even this would not be a statistically useful result. Worse, the result is incomprehensible to the lay and the timid.

Engineering has been defined as the transference of thought into action. "Big engineering" becomes trans-science since all the data are never in.

Science policy is itself trans-scientific. Priorities and emphases are established by scientific judgement and taste rather than scientific truth. Nevertheless, analyses of application are possible and should be done.

Conclusion

Mine is a cautionary tale. The application of technology to the good of mankind is more difficult than it seems. There are many values and we should be aware of conflicts among them. The Bangladeshi who lived just above subsistence on his farm, but who now lives in poverty in a city rather wishes we hadn't done so much to improve the agricultural techniques of his country. The introduction of new technologies may have good-for-some and bad-for-other effects. Political and engineering judgement will be the final arbiter; nevertheless we should use all the techniques we can to provide a solid underpinning to that judgement.

There is a responsibility on us to participate in the public debates on social problems and their possible technological solution; in doing so, however, we should make it explicit when

1. we speak as experts,
2. we speak because we understand some alleged lingua franca of science, and
3. we are in a trans-scientific area.

I hasten to add, and emphasise that this applies *a fortiori* to those with technological qualifications who have chosen the conservative road of "paradise regained".

Technology can, and will, solve many human problems and can create greater well being. It will not do so, however, if we proceed by leaping on hobby horses or responding to political expediencies without informed debate and analysis.

Envoi

In the end, decisions on the application of our work are judgemental and political or economic. Political decisions are not usually reached by the sort of analytical processes of the kind that are familiar to engineers or of the kind that I have brought to your attention. There is a need to either inject these processes into the political system, or to do it externally and publicly. It is important to be as scientific about science as we can, and to be aware when we are not being so.

Most great engineering achievements have an element of the trans-scientific in them in the form of engineering judgement. I do not believe that an enlightened public and government would inhibit this.

I began with a quote from an eighteenth century pundit; I close with one from the nineteenth. Oliver Wendell Holmes said:

> "Some of the sharpest men in argument are notoriously unsound in judgement. I should not trust the counsel of a smart debater, any more than that of a good chess-player. Either may of course advise wisely, but not necessarily because he wrangles or plays well."

References

Ashby, The Rt. Hon. Lord, 1976. *Proc. R. Soc. Med.*, 69: 721.

Eisenhower, D., 1961. Statement in *The New York Times*, 22 Jan. 1961.

Holmes, O. W. 1903. *The Autocrat of the Breakfast Table*, 313 pp. (Macmillan: London).

Hoos, I. R., 1977. Some fallacies in futures research, *J. Tech. Forecasting Soc. Change*, 10: 335-344.

Miller, D. C., 1977. Article in *Methodology of Social Impact Assessment* (Ed. Finsterbuch Dowden) (Hutchinson: Strandberg, Pa.).

Weinberg, A. M., 1972. Science and transcience, *Minerva*, 10: 209.

Wood, R. C., 1964. Chapter in *Scientists and National Policy Making* (Ed. R. G. Gilpin and C. Wright) (Colombia Press: New York).

Zadeh, I. A., 1972. Outline of a new approach to the analyses of complex systems and decision processes, 2 memo No. ERL-M342, Electronics Research Laboratory, Berkley, Califoria, USA.

Some problems of human adaptation to a post-industrial age

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Some problems of human adaptation to a post-industrial age

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Introduction

Before the Industrial Revolution, virtually all the labour force was employed in agriculture. Today only a few per cent are left, and there are vast surpluses of land products in western industrial countries.

Nobody would deny that these drastic changes are the consequence of technical progress. New tools and machines and new technologies and products have increased the efficiency of production, created new industries, and wiped out some others. All this has been discussed *ad nauseum*, and we do not wish to do it again, taking all these facts for granted. But socio-economic changes, because they are disquieting, are seldom discussed and emphasized. This is rather what we wish to do in the frame and with the spirit of the Discoveries International Symposium.

Two classes of consequences may be advanced for socio-economic changes. These are

1. open changes in social organization, such as unemployment and a new distribution of income, and
2. hidden changes in human mentality, such as the loss of cultural or religious values, belief in new ideas, and refusal of the new society.

Without proposing some magical solutions to our problems, I would like to emphasize the urgency of a general "prise de conscience", awareness of a very tense and dramatic situation due to great misunderstandings.

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Unemployment and distribution of income

Since the start of our industrial societies, it has been a golden rule that income should be linked to productive work, or at least to socially useful work.

As we emphasized, agriculture has lost most of its labour force, which worked directly in the fields. Now, industry, such as the steel or automobile industries, has to make a drastic reduction of its labour force under the impact of automation and robotics. Even the "information industries", i.e. offices and services, may witness the same trend; micro-PCs and word processors may replace the lower level workers.

If it was possible in former times to transfer workers from the fields to the mills, though with great hardships, it is less than clear that it will be possible to find any useful work for workers displaced from the mines, the steel mills, and the car production lines.

Of course, we may accept unemployment, the most dramatic and unjust consequence of these technical evolutions. But then economic pressures forbid it in our western competitive societies.

Politicians, elected under the promise that they would reduce unemployment, are simply unable to change the evolution, being threatened by complete bankruptcy. The French Government is a good example of a "socialist government", full of good will and comprehension of this human problem, which has allowed unemployment to soar from 2 million to 2.5 million and soon to 3 million. In fact this evolution was predicted by INSEE (Institut National de Statistique et d'Etude Economique) and not much could be done about it.

Two types of remedies are available to fight the tendency: retardation of job losses and the creation of new jobs. Neither seems very valuable.

Unions refuse job redundancies and modernization. They propose a marked reduction of working hours. It is clear that this approach may have a retardation effect, but it will not change the general picture.

Creating new jobs is the usual proposed remedy. But a clear distinction should be made between useful or productive jobs on the one hand, and social "ad hoc" jobs on the other. For the first type, the capital investment required becomes larger and larger. As the economy Nobel prize winner W. W. Leontieff says: "Given the rate of technological advance, the creation of one additional job that 20 years ago might have required an investment of US$50 000 now demands US$100 000 and in 20 years will demand US$500 000, even with inflation discounted." Recently A. Sauvy, the French economist and statistician, advising the French government, asked for job creations of the second type: use young people for works of general interest, such as cleaning the streets, repainting houses or public monuments, gardening and foresting, all these, of course, paid for by the State.

Again, the remedies against unemployment do not seem very effective. It should be emphasized also that the education of new specialists is very long, is very costly, and is not always bound to succeed. As a computer science professor, I know at first hand, how long, how expensive, and how inefficient the educative process is. Demand for high level specialists is high, but the present system is not able to fulfil it, even with an expenditure of 20 per cent of the total French budget.

In particular, efforts to transfer unemployed workers from heavy industries, such as non-specialized manual workers, to jobs requiring some general education seem bound to fail.

We should realize that labour-saving technologies will inevitably lead to unemployment, though at the same time there will be unfilled a high demand for skilled specialists.

In our modern western societies, income is traditionally related to "useful" and "rentable" work or services given to the community. Max Weber asserted that the "work ethic" made a success of the early industrial societies. In popular and political discourse on employment, emphasis is put on the necessary relation between work and income, rather than on the production of goods, which is becoming more and more independent of human labour.

The problem of income distribution is best stated as the paradox that we now have the means to produce richness and abundance, but we also face a critical probability of disruption in our socio-economic systems.

It should become clear to all that work is not an end in itself, but is only a way to produce goods and services which are still in very great demand at the world level. But today, human labour, especially unskilled human labour, is no longer the principal factor in this process.

As Leontieff states: "The history of technological progress over the past 200 years is essentially the story of the human species working its way slowly and steadily back to Paradise, where Adam and Eve enjoyed a high standard of living without working. What would happen, however, if we suddenly found ourselves in it? With all the goods and services provided without work, no one would be gainfully employed. Being unemployed means receiving no wages. As a result, until appropriate new income policies were formulated to fit the changed technological conditions, everyone would starve in Paradise."

It is our feeling that this problem of income redistribution in our modern post-industrial societies should be clearly stated in the light of the available and projected data, rather than to declare that we are in a temporary crisis due to oil shortages or prices (not true anymore) or that we may return to the past and to full employment. Man and society have proved highly adaptive to new situations but first the problems should be clearly stated.

However, this is not the only class of problem created by technological advances. What we have called the "hidden problems" of human understanding and appreciation of modern society may be quite serious and even more worrying.

Adaptation of man to a new culture and a new society

Innovative changes are at work not only for material objects, such as tools and techniques, but also for ideas, concepts, and knowledge, which, somewhat arbitrarily, we put under the term of culture. Most of it is termed scientific. De Sola Price asserted that: "The volume of scientific knowledge is said to have increased of a factor of 1 million between 1660 and 1970. Since 1970, the time for doubling of knowledge has been reduced to about 5 years. Today there are about 6000 to 7000 articles and reports published each working day. The present stock of scientific articles is 20 to 30 million. As far as books are concerned, if one were to list all the available books in one-line entries in very small type, it would take 10 000 volumes in quarto to mention the existence of these books."

Thus the amount of scientific knowledge can hardly be grasped anymore by a scientist even in his own field. The public feels helpless, or rather uninterested, at this flood of new concepts and new ideas, and so listens instead to the more easy talk of politicians, journalists, or even petty prophets.

Some new concepts introduced by information and biological sciences

A very large body of new scientific concepts has been discovered over the last 30 years, exploring and elucidating information transformation, transfer, memorization, and interpretation.

Information concepts are recognized as central in biology; the RNA and DNA codes condition the development and the life of living beings. The importance of programs is demonstrated in physiology, from the cell to the whole body. Even the social sciences, e.g. ethology, rely heavily on information concepts.

A new and very powerful universal machine, the computer, enables scientistics to build and demonstrate information models. Artificial intelligence (AI) and pattern recognition (PR) are the new scientific disciplines that may transform by experience and modelling our knowledge of the human brain.

Perception and natural language understanding are no longer only experimental fields in psychology and linguists. Computer models have been built that sometimes perform very well. As a specific example, let me cite an identification machine, built for the US Air Force by Texas Instrument Corporation that is able to identify a speaker with a success rate of 99.99 per cent. Logical thinking is much better understood through AI "expert-systems" modelling. Hundreds of expert-systems have been or are in the process of being built to record the knowledge of experts in a usable and intelligent data-base. Information machines have become competitive with humans in the highest information processing tasks.

There seems no doubt that all these results will radically modify our culture, particularly our opinion of our place in the universe. We could be at the eve of a second "Copernican revolution"; man is no longer the centre of the universe, around whom everything should revolve and contribute, nor is he, as God revealed, the ultimate goal of creation.

But the layman does not know of these discoveries. Moreover, such discoveries are quite unpleasant and disquieting to his ego. He resents being in competition with a machine in what he considers are his privileged fields of understanding, intelligence, and expertise.

Adaptation to new ideas and new social systems

Our culture comes from a deep past. Nearly everything that we know has been learned from our ancestors—how to speak, how to read, how to compute—and this is equally true of our social and ethical references; how to behave in social life, our notions of good or evil, just or unjust, fair or unfair, beautiful or ugly, lovable or hateful, . . .

In a sense there are no "new countries". Every human group or nation has a past, which for the Eurasian continent goes back to prehistoric times. Gaul before Caesar had 5 million inhabitants, and most of the present French villages were already settled. It is therefore not surprising to hear about the Basques, the Britons, and the Corsicans as cultural entities. Many traits and features of the French temperament may be traced to the inhabitants of Gaul, and a reading of de Tocqueville demonstrates the stability of US culture and institutions.

Whatever the new ideas or scientific discoveries are, they modify our frame of knowledge and judgement in a slow but constructive way. The time and effort required to adapt and grow a new culture based on new and better knowledge and better fitted to new social rules seems very long and very painful. One of the first and most notable effects of a new social order and of new scientific ideas is to devalue the common culture inherited from the past.

Let us come back to the ethic of work, which we in our western societies have inherited from our past. Unemployment has the effect of not only reducing the income and benefits that come with the act of working, but also transforms a worker into a social outcast. From his work, a worker may have the satisfaction of exercising his skills and judgement, of participating in group activities, and of being recognized as an active member.

He does not feel isolated. In our present mentality, a worker who does not work is in fact an unhappy man, whether or not this is a rational feeling.

One of the results of AI studies on understanding natural speech is a recognition of how much such speech is weighted with affective and sentimental meanings. Political speech is paramount in these respects. At the end of his nomination speech at the recent Republican National Convention in Dallas, Texas, President Reagan declared: "America has a great heart, her door is always a golden door, her future is full of light, her arms are open to welcome and strong to support. Her strength is the strength of her people. Her light is eternal."

Although, of course, the enthusiasm for such a "nice" speech was general, it would be difficult to find in it anything but an emotional appeal to subconscious human feelings. The selection of politicians is made by affective and mass media criteria, rather than by rational or efficiency ones. But this only shows that humans are more moved by feelings and by generous but sometimes hollow words that sound more like music than like reasonable plans.

We have to realize that we, as human beings, are conditioned by our past, that humanity will determine the future by referring to the past rather than to the present facts of social change or new knowledge. Thus, we are in a dangerous situation; great problems—material, moral, and ethical—have to be solved on a massive scale, but little is being done.

Political leaders are looking for votes, so they have to be as close as possible to public opinion. Religious leaders are looking to the past, and this may be the reason for their renewed popularity. Pope John Paul II, in his encyclical entitled "Redemptor Hominis", warns against the "evils of materialism" as opposed to "spiritualism": "Man cannot and must not become the slave of things, the slave of the economic system, the slave of technology."

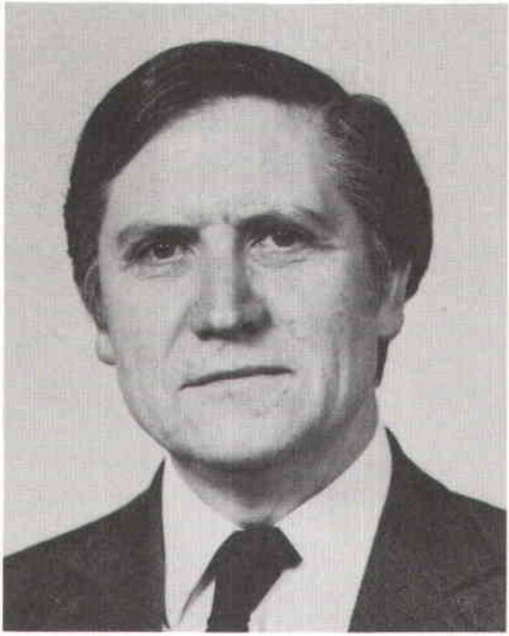
Rejection is not an answer to the new society that we see being created before our eyes. Nor can the answer be refusal, despair, drug addiction, religious sects, astrology, parapsychology, terrorism, war, or revolution; rather, it must include a general awareness and understanding of the world's future.

Conclusion

As a conclusion to this paper, which may seem too reasonable—and may be too superficial—let me indulge, as a human being, in an effective statement. Although this new society, brought by science and technology, may be sometimes frightening, I ask you to spread the good news that the problems can be solved by the good will and the efforts of all, for we have dramatic new possibilities of creating riches and of raising the creative level, mutual comprehension, and intelligence of mankind.

Academia – synergies with industry and government

Sir Henry Chilver



Sir Henry Chilver, FRS, FEng

Sir Henry Chilver, FRS, FEng, has occupied several important positions in academia, government, and industry. He was Professor of Civil Engineering at University College, London, and in 1970 was appointed Vice Chancellor at Cranfield. He is now Chairman of the UK Government's Advisory Council for Applied Research and Development (ACARD), is Chairman of the Electronics Economic Development Committee of NEDO, and Chairman of the Milton Keynes Development Corporation. He was knighted in 1978 and in addition to his Fellowships of the Royal Society and the Fellowship of Engineering he is an Honorary Fellow of Corpus Christi College, Cambridge, and holds honorary doctorates of Bristol, Leeds, and Selford Universities. In 1962 he was awarded the Telford Gold Medals of the Institution of Civil Engineers.

Academia – synergies with industry and government

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Introduction

Academic institutions have existed in society for centuries. Throughout their long history they have generally been concerned with the highest levels of knowledge and learning. They have their origins in religious and charitable bodies, secular organisations, industrial and commercial benefactors, and in the state itself. As a result, across the world scene academic institutions are very diverse. Nevertheless they all have the common pursuit of knowledge and learning.

Up to the 18th century, universities were dominated by scholarship in literature and the arts, although there were some limited activities in professional fields such as law and medicine. As early as the 16th century the Renaissance had generated new interest in the basic sciences, but it was not until the 19th century that science and technology began to figure more largely in university teaching and research.

Throughout the 19th and 20th centuries science and technology have expanded throughout the world at an exponential rate. Universities have played a major part in this, first by providing an increasing output of graduates of science and technology and second by themselves becoming important centres of ideas in science and technology. In this way academia has come to be associated with the highest levels of learning, coupled with the development of new ideas, particularly in the sciences.

Within academia, new ideas have also emerged in other fields of human endeavour, as for example in medicine and the applied sciences, in technology, and economics. But although we depend strongly on academia to provide much of the output of highly-educated graduates, academia is not the only source of new ideas. New concepts and ideas have come increasingly from special research centres and from other specialist groups.

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As research—particularly in the sciences and technology—has required increasing resources and sophistication, so the centres in which research is undertaken have become more specialist.

Throughout the history of universities there has always been a strong tradition of a degree of "detachment" of academia from the more immediate problems of society. The teaching of universities is based on principles of wide applicability; again research in universities is essentially long-term in nature, and such research may take decades to come to fruition. Both these factors bring about a degree of detachment of academia from local and more immediate problems. On the one hand, this has the advantage that universities can conduct their teaching and research relatively unaffected by other immediate pressures. On the other hand, it has the disadvantage that academia may fail to make significant contributions in areas where its knowledge and understanding could help overcome more local and immediate problems.

Industry and government are areas in which ideas must be developed on a range of time-scales, from the immediate and short-term to the long-term. Academia—with its background of long-term thinking and teaching—has much to contribute to this. This can be achieved through appropriate synergies between academia, industry, and government.

Academia and the developing world scene

Throughout the world, the general scene is one in which high-level education and research are becoming increasingly important and across an increasing number of fields. While teaching and research are making continuous progress in existing fields, at the same time they are extending continuously into new fields. Thus, over recent decades, we have seen remarkable strides made in research in the physical and chemical sciences, while at the same time important break-throughs have been made in new areas of the bio-sciences.

In the world scene, science and technology themselves have become major forces. They now enable man to meet his primary needs of food, shelter, and defence in increasingly sophisticated ways. They are increasingly the bais of man's many other needs, in areas such as health, travel, manufacture, leisure pursuits, and communication.

For these reasons, the economy of the world is based increasingly on the 'exploitation' of science and technology. Science and technology are the basis of key areas of industry and commerce, both in the public and private sectors of all economies. As a consequence, industry itself has become a major source of research and the development of new ideas. It is possible that more research is now conducted by industrial corporations throughout the world than by government organisations.

Most areas of government—particularly in the most advanced countries—are increasingly involved in science and technology. Thus, science and technology permeate the areas of food and agriculture, health, transport, defence, energy, environment, and indeed the whole spectrum of departments of modern governments.

Academia plays a leading role in all this through its teaching and research into the principles of science and technology. But the role of academia in research – and in the generation of new ideas – will always be limited by the ability of academic researchers to muster resources adequate for the research task. Centres of research will grow outside academia as such specialist centres are needed to concentrate resources for research.

We tend to describe research and development in terms largely of the efforts of various nations. Many areas of research can be conducted by small teams operating in an individual country. However, in some areas, a level of research and development is required which demands resources largely beyond single countries, let alone single institutions. Such areas are particle physics and nuclear fusion; in these areas the scale of resources required is so great that the risks of failure need to be spread across a number of countries. In this way, at the high level of resource requirements, progress in science and technology will become increasingly internationalised.

But there is already a high level of 'trading' internationally in ideas in knowledge, science and technology. Ideas generated in one country are developed and exploited rapidly in others. Although there is some 'protection' of ideas, the general trend over time is increasing diffusion of knowledge in the world scene generally. Science and technology form an international currency of ideas; the laws of science and technology are valid universally; they offer, therefore, one of the major forces for breaking down barriers to the international exchange of ideas.

The developing world scene is, therefore, one in which high-level skills and ideas are becoming increasingly important, both nationally and internationally. Academia has a very important role to play in this. Against the background of the pursuit of universal truths, academia can play not only more direct roles in industry and government but make a major contribution to wider international understanding.

The evolution of industrial technology

With the rapid evolution of science, industrial technology is itself undergoing a number of significant changes. Energy is still based essentially on the consumption of fossil fuels, but there is a growing use of other sources. The balance of supply and demand for oil is a delicate one, and is the cause of major problems of financing of some oil-producing developing countries. The range of materials is widening continuously, with less emphasis on volume production of metals. Manufacture and production have been revolutionised by automation and robotics. With the introduction of modern manufacturing methods, employment in manufacturing in western Europe had already reached peak levels in the mid 1960s, and before the oil crisis of the early 1970s. The problem of unemployment of production forces is a growing one, as more efficient manufacturing methods penetrate mature industries.

In the world industrial scene, while some areas of industrial technology are growing, others are stable or declining. Very broadly, the main growth areas in the medium term are likely to be linked to the wide field of communications and information technology. Other areas, such as biotechnology, may also produce important growth opportunities. At the same time there are 'niche' opportunities for exploiting new ideas in many of the 'mature' industries.

The 'exchange' of trade across the world evolves continuously although the actual barriers to free industrial trading are considerable. The European Economic Community (EEC) is committed to developing a large market in western Europe, with progressive reduction of trade barriers. But even with this commitment, the problems of national 'preference' are very strong. In this world scene, there is a growing body of industrial manufacturers who make products in many countries and distribute these worldwide.

At the highest levels of technology, major new developments are increasingly beyond the means of single industrial organisations. This means that governments become involved increasingly in expensive areas of research and development. When governments become involved, this tends to heighten the 'nationalistic' aspects of trading between nations.

The structure of industrial organisations—across the world scene—is never static. It is a scene in which some large companies continue to grow, while other large companies pass their peaks of maturity. It is also a scene in which a considerable number of small organisations grow rapidly, to become—in due course—large organisations. Many large organisations today began as small ones 20 to 30 years ago.

With the declining demand for large work forces in manufacturing industries, many countries are encouraging the formation of small, new industries. Academia has an important role to play in encouraging staff and graduates to create new small organisations in interesting fields of exploitation. A recent conference of British Commonwealth universities showed considerable interest—in both developing and developed countries—in the role of universities in generating new industrial opportunities.

In less developed countries, science and technology are being introduced progressively. In general, less developed countries tend to build indigenous industries, with varying degrees of inward investment by foreign countries. General industrial development of the country strengthens its economy and its ability to import more sophisticated technologies.

The result of all these factors is a 'patchwork' of many trading nations, all of them exploiting enhanced technology. Industries in those countries look to academia for highly-educated graduates, to lead those industries in domestic and world markets. Industries will exploit all possible sources of ideas in science and technology, whether these ideas are generated in their own or in other countries. The 'rules' of international trade are complex, and governments become increasingly involved in protecting their own indigenous industries. In such a situation, international companies—with bases in key locations—are strongly placed.

A vital area of 'industrial' production in the world scene is that of agriculture and food. In many countries, agriculture and food production have been strongly influenced by modern science and technology. In western countries, agriculture involves small production units, but large organisations for collection and distribution. This approach tends to dissociate production from the market place with the result, for example, of the food mountains in some commodities in western Europe.

The evolving roles of governments

Throughout the world, governments are increasingly concerned with knowledge, science, and technology, in almost all areas of government. The roles of science and technology in areas such as food and agriculture, medicine and defence are obvious. But knowledge, science, and technology extend into almost all areas of modern government, but of course in varying degrees. Thus departments of transport, public building, environment, law and order, all require appropriate inputs of knowledge, science, and technology.

In some countries, the importance of science and technology is recognised in a special department of government. But science and technology permeate all departments of government, and it is more realisitic that every area of government must recognise science and technology. There is a case for co-ordination of this work across departments of government. This is particularly important to ensure that overall objectives are achieved across the whole range of government policies in science and technology.

For countries with strong private-sector industries, the role of government is to establish a climate within which such industries can flourish successfully. In such countries, government itself will probably not play a leading role in establishing new products or services. When industries are led predominantly by government, then government itself becomes more deeply involved in market assessment, design, development, and even marketing. Between the extremes of private-led and government-led industries, there are many mixed systems, involving varying degrees of government involvement. The general trend, in the world scene, is for governments to become increasingly involved in the industries exploiting science and technology. There are a number of reasons for this: science and technology are seen by governments as offering solutions to some of the major problems facing their countries; as industries are faced with major structural changes—such as the diminishing use of labour for manufacturing—so governments attempt to facilitate such changes to avoid social and industrial disruption.

Again, numbers of new developments are beyond the means of single organisations, and governments may have to co-ordinate and fund projects. The exporting of minerals and manufactured goods may carry with it unreasonable risks for national companies; in such situations, governments may be prepared to take on increasingly the exporting risks of their indigenous companies.

Governments may also establish high national standards of production and services. National standards can become a key factor in determining the quality of output of that country. As governments become progressively more involved in industry, there is a general tendency to diffuse the use of research and development resources, to the point where the country has an increasing number of state-supported research centres.

The involvement of government with science and technology is particularly strong in developing countries. Major changes are needed in such countries, on a short time scale. In such countries, technology-based industries are not usually highly-developed. It is not surprising, therefore, that major innovations are led by central governments.

In the mixed economies of the western world, the role of government is essentially that of a facilitator of the successful exploitation of science and technology. In some areas, governments may go beyond the facilitator role and become involved directly in science and technology, and even in marketing. But, as industries become increasingly international in outlook and structure, and as science and technology permeate all areas of the world, we see an increasing number of international 'arrangements' for the exploitation of science and technology.

Academia in the world scene

Over the past 100 years or so, and in parallel with the growing exploitation of science and technology, higher education has grown very considerably in the world scene. In the most advanced countries, institutions of higher education have become increasingly diverse. They have led to a wide range of educational programmes and research activities.

Over the years, the movement has been strongly towards vocational studies, and there has been increasing emphasis on applied research. In less developed countries, the emphasis on vocational studies and applied research has been very strong. Thus, across the world there has been a growing movement towards vocational teaching and emphasis on research which can be applied in practice. As a result, the proportion of resources devoted to science and technology in higher education has progressively increased. In most countries, institutions of higher education are supported by public funds. This immediately brings governments into the funding of academia.

It means, too, that many initiatives in higher education have their origins in government, and not necessarily in higher education itself.

The increasing emphasis of governments on vocational teaching and applied research has put increasing pressures on the 'purer' activites of academia. To some extent, this begins to impinge on the freedom of universities to pursue their own policies on teaching and research. Academic freedom is one of the most important features of higher education, but it is important to consider in greater depth what is meant by this freedom. Where universities are funded from public resources, it is the responsibility of those universities to show that those resources have been used to enrich students and society more generally. The freedom of universities should in no way undermine this responsibility. Conflicts between academia and the society which funds it will always occur – to the detriment of both – when a healthy balance of academic freedom and social responsibility is disturbed.

The issue of academic freedom is associated closely with the importance of individualism in academia. Some of the most important contributions of scientists and scholars have been made by academics working as single researchers and thinkers. Any successful academic system must, therefore, have appropriate strengths of academic freedom and individualism. However, with this goes the consequent responsibility of academia for the highest levels of integrity of scholarship and learning.

The evolution of academia at the present time has a number of important characteristics. Academia is a major source of 'ideas' in society. This applies across the whole breadth of work of academic institutions, from science and technology to all areas of the arts. As we have seen, academia is not the only source of 'ideas', but it remains a major generator of new ideas and concepts. These new ideas and concepts are not limited only to science and technology. Much study and thinking in academia is devoted to other important fields of human endeavour. It is vital that society exploits, as effectively as possible, the plethora of ideas emerging from academia.

It can of course be argued that students themselves 'transmit' ideas from academia to the world of practice. This is certainly the case. But, at the same time, it is vital to bring the academic teachers, researchers and thinkers into closer contact with the world of real problems. Over the decades, academia in the world scene has become 'insulated' somewhat from the world of real problems. In almost all advanced countries, thought is being given to how academic 'detachment' can be translated into 'involvement'. This brings us naturally to the subject of synergies of academia with industry and government.

Synergies with industry and government

A primary role of academia in any society is providing that society with highly-educated graduates. In discussing the wider roles of academia, this primary role should not be forgotten. In providing a 'flow' of highly-educated graduates, the objective should be the highest levels of instruction in principles which are universally applicable.

The development of such educational ideals itself implies close synergy with industry. Academia must understand the nature of the problems confronting modern industrial societies. These problems are not only concerned with the materialism of science and technology. They are equally concerned with the problems of people and their aspirations. In this sense, academia trains much more than specialists in specific skills. It should provide its graduates with an insight into the wider issues facing man in his search for a constructive and prosperous future.

The teaching of academia should be conducted against the background of a deeper understanding of the wider problems facing industry and society. Industrial technology is now one of the greatest forces in the world economy, and academia must encourage a deeper understanding of this. In education, academia must consider its role not only of educating young graduates at the beginning of their careers, but of helping mature graduates during the development of their working lives.

The future of mankind depends critically on wider appreciation of the importance of modern ideas—including science and technology—in all areas of human endeavour. History shows that economic progress is possible when the potential of new knowledge is harnessed for the general good of society.

It is against this background that academia will make its high-level teaching of greater relevance. At the same time, it will direct its research increasingly towards fundamental problems of practical relevance. Research in academia will be increasingly stimulated by industrial problems. In the longer term, this will affect the funding of academia, which will look to industry for increasing support.

This movement towards industry will be encouraged by governments, which almost universally see the importance of greater synergy. Governments will be concerned to generate a healthy mix of high-level teaching and high-level research in academia. Basic research and basic teaching will be funded largely by governments. But, in the world scene, we shall see increasingly bridges built between academia and industry. In this way, there is an exciting future for academia as a source of knowledge and ideas which can be exploited successfully through industrial technology.

The objectives of academia in this are not to build centres of ideas remotely from industry. The aims are rather to build up a continuous flow of people with ideas for exploitation in industry. A healthy synergy between academia and industry will always attract the interests of government funding, because that synergy can have vital effects on the economy of the country.

Implications for the western Pacific

The western Pacific is a vast region, in which there are many different styles of academia, industry, and government. The potential interactions of these different styles present the most exciting opportunities for a vital area of the world economy.

Culturally, ethnically, and politically the region is a very varied one. But it has a long history of international trade, and trade will grow in the decades ahead. The region embraces, or touches on, around one-third of the world's population. A large proportion of that population has still to become industrialised. A small proportion of the population is already highly industrialised.

Because of the wide range of races and cultures, there will be much intermixing of people—particularly in academia. In the long-term, this will serve to reinforce the important international nature of academia. In the less-developed parts of the region, emphasis in academia will be on teaching. Research will tend to be concentrated, at least initially, in the most advanced countries of the region.

The future of the region will depend on the success of international trading in the western Pacific. In such a situation, governments would be wise if they encouraged strong interactions between academia in the various countries. Given the potential of the region, interesting new styles in academia—and particularly new international styles—could emerge in the decades ahead.

In summary, the implications for the western Pacific areas follows.

- Academia, through synergies with industries and governments, has much to contribute to the development of the economy and the quality of life in this vital region of the world.
- Synergies between academia and government are essential to ensure an effective system of higher education and research.
- Synergies between academia and industry are equally essential, to ensure that higher education is relevant and that academic knowledge is exploited effectively and constructively.
- The region has much to gain from interactions between academic institutions in the western Pacific, as well as from interactions between those institutions and academia in other parts of the world.
- The development of academia in the region will involve an increasing diversity of academic institutions.

- Against the background of the wide range of races and cultures in the region, new styles of academia will emerge in the decades ahead.

- Amongst these new styles, increasing synergies between academia, industry, and government will be a strong feature.

- Perhaps most importantly, within the region the interests of academia, industries, and governments will converge, particularly in areas of vital economic and social development.

Current status and trend for cooperation between industry, government, and academia

Kazuhiko Atsumi

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Current status and trend for cooperation between industry, government, and academia

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Introduction

Japan has a limited land mass, few natural resources, and a large population. For a country like this to sustain itself in this world, the only way seems to be the development of science and technology, and the utilization of it. Although it is often claimed that Japan has become a leading nation in the world in technology, the technology referred to is applied technology.

Japan in the past delegated original discoveries and inventions to foreign nations, and succeeded in imitating, improving, producing, and industrializing the original science and technology developed by foreigners. This success can be attributed to the policy of our government which places emphasis on increasing the potentials for practical application of technology.

Japanese industries have been no less enthusiastic in the development of applied technology, in recruiting talent, and investing in research and development. As far as the development of practical technology is concerned, we can say that the past progress has been made under the leadership of the private sector.

The share of private industry in the national research and development budget of Japan was 65.3 per cent in 1979. Compare this figure to 50.9 per cent in West Germany (1978), 45.0 per cent in the United States (1977), 41.1 per cent in France (1977), and 40.8 per cent in Great Britain, all of which were lower than the share in Japan.

Today, when Japan is at the top level in technology application, circumstances no longer permit her to simply pursue imitation and improvement of technology. Japan must now play a more creative role in the research and development of science and technology.

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In this context, the Japan Science and Technology Committe recommended the "Integrated Science and Technology Policy" in 1979, suggesting the long term planning of research and development.

In 1981, the Japan Science and Technology Agency selected the following projects to be promoted as the research and development activities of creative science and technology.

1. Ultra-micro practices
2. Special structured substances
3. Fine polymers
4. Complete crystal elements

As of 1981, MITI sponsors the following projects as the research and development for the next generation industry.

1. New materials
2. Biotechnology
3. New functional elements

Biotechnology is of particular interest, including such research as

a. bioreactor,
b. mass cell culture technology,
c. gene rearrangement technology, and
d. cell fusion technology.

In 1982, the Japan Economic Security Committee recommended that research of the unexplored fields of science and technology must be stimulated for the establishment of economic security.

Dr. Leona Ezaki, a Japanese Nobel Prize winner, has proposed the establishment of a Japan Society for Technology Academy for the promotion of creative science and technology in Japan.

In future, research and development activities in Japan must be equally shared by industry, academia, and government for the development of new technology. Private industry must advance research and development of applied technology, while universities concentrate on basic research in pursuit of original inventions and discoveries. The national research institutes should place emphasis on applied research that leads to technical innovations.

Universities and national institutions must be supported by the government for research of the following nature.

1. Original and basic research
2. Interdisciplinary and general research
3. Research that requires long and continued studies
4. Research that is specialized technically and requires very high expertise
5. Research that involves very large risks
6. Research that is not related to the interests of the industry but related to the national interest.

For some research and development projects of national interest, it is necessary to have universities assume basic research, have national institutions conduct applied research, and have industry share the technology development. A system must be devised to allow these three sectors to cooperate in such a manner that the characteristics of each sector are fully utilized. This could be an important theme for study, because a limited amount of research resources (talent, funds, facilities, and time) must be effectively mobilized for research activities.

Problems in research cooperation between industry and academia in Japan

There are several means of cooperative research activities between industry and academia in Japan. These are

1. commission of research (industry to academia),
2. cooperative research (reciprocal between industry and academia),
3. technical consultant (industry to academia), and
4. education and training of research experts (reciprocal between industry and academia).

Most co-operative research activities take the form of 1. and 2. In future, however, 3. and 4. will be increased as cooperation is performed in more sophisticated and diversified fields of research.

In the past, research cooperation between industry and academia was most frequent in engineering, and relatively frequent in medicine, medical science, and agriculture.

Recently, as the boundaries between the various fields of science and technology have become obscure, cooperation in the field of physics has been increasing.

Research cooperation between industry and academia generally proceeds by the following three steps.

1. Selection of the research partner.
2. Cooperative research activity.
3. Sharing the result of the cooperative research.

Selection of research partner

University

The following methods exist by which a university research staffer can find a partner for research cooperation with industry.

1. Indirectly, through introduction by a third person.
2. By direct approach from industry, which finds the university research staffer by exploring such information as theses, and proposes cooperative activity.

But in reality, there are few opportunities for development of research cooperation, for two reasons.

1. Young research staffers in universities seldom have any acquaintances within industry, and so they can negotiate only through an elder professor's acquaintance.

2. Research staffers have little opportunity to contact industry, and have little information about industry. Thus they cannot establish relations with industry other than personal ones.

Industry

Industry can find partners for co-operative research by the following methods.

1. Indirect approach through third persons or a public information center.
2. Direct approach after exploring academic information, such as theses.

The above methods, in reality, also face difficulties.

1. Universities generally do not like frequent visits by industry representatives.
2. Practically, it is difficult to find promising research staffers from theses and reports.

Thus industry often finds it difficult to contact the most suitable research partners.

Cooperative research activities

In a cooperative research activity, the university and the industry differ in their backgrounds, value judgements, customs, institutional restrictions, and objectives.

University

Thus a cooperative research activity often creates problems in the university. The following difficulties are encountered by the university.

1. There are few industries which venture innovative technological experiments.
2. Few industries understand the original ideas of the research staff, nor do they appreciate such ideas.
3. The target of the technological development the industry requests is not clearly defined.
4. The requirement of the industry is often to create only a certain "device".
5. The industry often rushes to the solution of a pending problem, giving short time for study.
6. There is the danger that the original ideas of the university research staffers may be cunningly stolen.
7. Neither the university nor the public in general have a very positive image of research cooperation between industry and academia.
8. The personnel management system of most universities is stagnant, so that it cannot respond flexibly to the fluid needs of society.

Industry

On the industry side, there are many dissatisfactions and problems as described below concerning cooperative research.

1. In selecting the subjects and contents of the cooperative research, there is a wide difference of value judgements between industry and university research staffers.
2. The needs of the university do not match the needs of the industry.
3. Industry does not like to fund basic research which it considers inefficient.
4. It is often difficult to reach a satisfactory agreement on the share and practice of research activities.
5. The progress of a study in a univers ity is slow, and a long time is taken to complete the task.
6. As the university is extremely sensitive to any restrictions imposed, formulating a research contract is often difficult.
7. The industry must bear a substantial burden and risk.
8. It is difficult to abandon a cooperative research project before it is completed.

Arrangement for outcome of cooperative research

Once cooperative research has been completed and a certain result reached, the university and the industry face the following problems.

University

The University can gain from the outcome of the cooperative research in the following manner.

1. Release the outcome as a thesis.
2. Apply for a patent.

However, the university faces the following problems.

1. The industry refuses to disclose the results of the research.
2. The evaluation of the outcome by the industry is usually based on a narrow point of view, and does not take into account the real scientific value.

Industry

Industry can gain from the cooperative research in the following manner.

1. Industry can establish personal relations with university research staffers.
2. It can obtain patents.

On the other hand, the industry may encounter the following problem.

1. A discrepancy of value judgement between university and industry concerning the methods of commercialization and profit taking of the outcome of the cooperative research.

Let us now examine the measures to be taken for problems in each step of cooperative research.

Measures for problems in cooperative research

Finding a partner for cooperative research

There are two possible measures to solve this problem.

1. Formulate basic rules by which both university and industry can find research partners smoothly.
2. Step up a data bank system that can be utilized by both sides.

Cooperative research activities

The following measures can be useful in realizing closer cooperation in research activities. These measures, however, must be implemented by government administrative actions.

1. Set up basic rules by which cooperative activities can be carried out smoothly.
2. Define the methods of cooperative research more clearly, from the point of view of the efficient use of national research resources.
3. Have universities adopt personnel management systems which enable more fluid exchanges of staff.
4. Introduce a contract system for cooperative research.
5. Define the allocation of research work more clearly and rationally.
6. Devise a simple accounting system for the funds and expenses of cooperative research. Have industry take care of accounting in the university if necessary.

Arrangement for outcome of research

The following measures can be taken to deal with the outcome of the cooperative research.

1. Have industry fund the research according to the value of the outcome.
2. Formulate a system for cooperative research.

Conclusion

In the cooperation between industry and academia, there are many problems to be solved. In order that cooperative research be addressed from a higher point of view, and to ensure that it is conducted smoothly, the following surveys and studies are needed. A study of examples abroad, analysis of the causes of failures, a distribution of information on successful examples of cooperation, formulation of cooperative systems, a method for the fluid exchange of research staffers, and so on.

In Japan's interest, serious studies should be performed on the feasibility of the following improvements.

1. Formulation of institutional arrangements for research cooperation between industry and academia.
2. Establishment of a third party coordinating institution.

In conclusion, I would like to propose the establishment of an international research institute for the Asian Pacific area.

Asian Pacific Institute of System Analysis (APISA)

There is an institute called the "International Institute of Applied System Analysis (IIASA) in Luxenbourg, on the outskirt of Vienna, in Austria. This is an international institute dedicated to finding solutions, by application of system analysis, to problems which are important world issues but difficult to solve because of the complexity of the system involved. The themes the institution is working on include problems concerning population, food supply, energy, water, health, and medical care.

It is necessary that a common consensus be developed in the Asian Pacific area on these problems. And APISA can play an important role in this respect.

SESSION 3

The west Pacific technological competition, complementation, and cooperation

Theme

To examine the uses to which high technology is put among the highly disparate countries of the western Pacific area. The solutions of the physical resource poor-human resource rich nations, and their impact on the other nations. Resources diplomacy, its rights and wrongs. The special communications problems of the area. Changes in national cultures generated by technology transfer in the region.

Chairman

Sir Frank Espie, OBE
Chairman, Honda Symposium Organising Committee, and Vice President, Australian Academy of Technological Sciences

Speakers

Professor Mineo Nakajima: The Australian-Japanese relationship and mutual interdependence in the new Pacific era

Professor T. B. Sheridan and P. R. Sheridan: Technological advances and issues of justice in allocation of ocean resources

Sir Roderick Carnegie: A look back from 2004

Professor Yip Yat Hoong: Technology transfer in the west Pacific Basin: prospects and problems for Japan and Asean

The Australian-Japanese relationship and mutual interdependence in the new Pacific era

Mineo Nakajima

Professor Mineo Nakajima

Professor Mineo Nakajima is Professor of International Relations and Contemporary China Studies in Tokyo University of Foreign Studies. A graduate in Chinese Studies and International Relations of the University of Tokyo, Professor Nakajima occupied several positions in the Tokyo University of Foreign Studies, becoming full Professor in 1977. He is Managing Director of the Japan Association for Asian Political and Economic Studies, is Director of The Japan Association of International Relations, and is a Councillor of the Honda Foundation. He was awarded the Suntory Prize in 1981. He has published many books on Asian affairs; his latest volume being entitled *Politics and Civilization of Contemporary China*.

The Australian-Japanese relationship and mutual interdependence in the new Pacific era

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I am very honoured to have been given an opportunity to address the distinguished participants in this symposium. Personally, I feel a very nostalgic sentiment in Australia because I have returned here after six years abroad. I spent a year in Canberra at the Australian National University, and at that time I had a very good opportunity to observe Western Pacific international relations as seen from the Southern Hemisphere when Australia was just seeking a new identity as an Asian Pacific State.

I would like to talk about our joint concern for mutual interdependence in the new Pacific theatre, and to focus mainly on the implications of the Pacific international environment and Australian-Japanese relations.

With the passing of the uncertain 1970s, characterised by high oil prices, and the arrival of the 1980s, a new concept in international relations termed 'Pacific Basin co-operation', was suggested. This concept has aroused substantial interest in both Australia and Japan, and some other countries, among those who believe that a new idea for the Asian Pacific region has been created. Giving a name to a concept, however, is not a sufficient basis for substantial international co-operation, as a new concept supported only by a name often evaporates after discussion. The issue of Pacific Basin co-operation was a Pacific Basin concept. It is something which must be further developed with clear objectives and our policy target must be more clearly defined. In line with this trend another new phase appeared in 1984, that is the 'new Pacific theatre'. President Reagan, who envisions the future vitality of the United States, centred on the western sunbelts, including California, has stressed this concept. It was also introduced at the ASEAN Foreign Minister's meeting as a projection for the region.

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In this situation we must note the group of rapidly industrializing nations, including Hong Kong, Taiwan, South Korea, and Singapore, known as the 'Asian NICS' (newly industrializing countries), because they left the average third world countries far behind in the 1970s and have created a very lively economic zone in the proximity of both Australia and Japan.

In the case of Hong Kong, the result of the Sino-British diplomatic negotiations will be released this coming September, but there will still be some uncertainty in the future of Hong Kong. If life in Hong Kong became very difficult, socially and economically, many young people from Hong Kong might go to other Western Pacific regions. This may accelerate the increase in economic activity of the region, but for the present, Hong Kong still maintains a very dynamic economic activity of which the per capita GNP is already US$5 000.

In the case of Taiwan, some politically unstable situations may be expected, but perhaps Taiwan will become a much stronger economic entity. Over the last twelve years Taiwan has been excluded completely by the wide international community. If a political or social uncertainty or disturbance took place in Taiwan, not only Japan, but also many other Western Pacific countries would become very seriously embarrassed. But thanks to economic success, Taiwan is now playing a very important role in this region.

Others have already mentioned the cases of South Korea and Singapore, so there is no need for me to do so.

It is interesting to contemplate how those nations belonging to the Confucius culture zone—all the Asian NICS I have mentioned belong to the Confucius culture zone—would achieve complete modernization, and to study how they would relate to the development of the People's Republic of China, which has just started to liberalize part of her economic system.

As far as the recent development of the People's Republic of China is concerned, both of our keynote speakers, Sir David Zeidler and Mr Moeen Qureshi, mentioned yesterday the importance of China. So as a specialist on Chinese affairs, I would like to express briefly my basic view on China.

What will become of China tomorrow? After a quarter of century of turbulence and faced with various difficulties today, the country may look forward to eventually developing a unique socialist society, but that is not easy to achieve for many reasons. What is the goal of the present modernization plan in China? In a word it is to increase China's per capita gross national product from the present level of about US$250 or US$300 to US$1000 by the end of this century. It is a modest target when one realises that Japan's economy grew fortyfold in the last twenty years, but given China's massive economic goal it will be a difficult one to achieve. Even if full modernization is successfully achieved and the goal of US$1000 per capita GNP is attained, China will probably be further behind its neighbours than it is now. The surrounding countries such as Hong Kong, South Korea, and Singapore, and many other Asian countries, not to mention Japan, already have GNPs ten to twenty times larger than China's. That gap will probably more than double by the end of the century. For this very reason it is certain that China's economic stagnation will continue to pose a problem for mankind, perhaps the most serious of such issues for this century.

What are China's options, now that the experiment of achieving economic development with western assistance has clearly reached a limit? The country does not have many options left.

In the case of Japan, our relations with the People's Republic of China have become very strong. In Australia, recently, your relationship with China has become very close, and direct flights between Sydney and Peking and Melbourne and Shanghai have commenced. Even with such a close kind of relationship, western financial assistance to China has already reached a limit. In the case of Japan, we already aid China with about $US10billion in long term credit, but we cannot assist only China. In the case of the United States of America and other western countries there may be capacity to assist China, but even transfer of important western technology for management systems of highly industrialized societies must also reach a limit.

We Japanese concluded an agreement of long term economic assistance to China. Based on this agreement Japanese business recently constructed the famous Baoshan mill in the suburbs of Shanghai which had not produced iron and steel since 1978. Faced with this situation it seems likely that Chinese dealers will become aware of the importance of a relationship with the Soviet Union and other eastern nations whose systems are more in tune with its own. Needless to say, we shouldn't expect that the political and social conflict inherent in China today could become so great that the country is likely to go through another process of political turbulence. It seems impossible to divert the pragmatic trend against the system's politics, although some political conflict and resistance against the present Deng Xiao Ping's regime still exists there. In this situation, in my assessment, a Sino-Soviet reconciliation will be inevitable, although the society of China is very different in some basic respects from that of the Soviet Union. In the future, China's new leaders will restore the need of the two countries to unite together to cope with what they call the crisis of socialism exemplified by the recent case of Poland. This is my basic understanding on China's recent development and Sino-Soviet relations.

Now I will proceed to discuss Japan's goal in the new Pacific theatre. We have to admit the fact that the myth of Japan's industrialization being unique in Asia has now been completely destroyed, and Japan today is merely a model for the industrialization of other Asian countries. Even Malaysia, a semi-Islamic State, has set Japan as a model for industrialization. Under the circumstances a strong bond between Australia and Japan, especially as a complementary relationship of mutual dependence, is very important, not only for the sake of diplomacy between the two nations but as the axis for the development of our related vision of the new Pacific theatre. For this to be realisable, many problems between the two must be solved. For example, in regard to trade co-operation and expansion, Japan must overcome domestic political difficulties to create a freer trade environment for such commodities as farm products and it must also accelerate the transfer of technology abroad, without causing the so-called boomerang effects provided by newly industrializing countries. Although the argument still treats the matter in general terms, it may be a very important proposal in view of the conservative nature of our country, Japan, as a cultural policy.

Then in regard to the problem of resources exploitation, which demands close attention, a Pacific basin country should consider the problem of resources such as energy and food, in a co-operative manner, rather than be forced to deal with north-south issues within the region. There must be co-operation, not only at government level, but also between private sectors. The mutual dependence required is not limited to economics; what we need is closer relations in every sphere including technology, science, culture, and especially academic co-operation.

For Japan the relationship with Australia is one of special importance as it is one of the two fundamental friendships in the Pacific, the other being with the United States. On this basis, Japan's contribution to the Western Pacific region through economic and other non-military forms of co-operation, will become more promising. In this context, strengthened relations with Australia are all the more essential today when new governments have been elected in Australia and New Zealand, and traditional diplomatic policies with ANZUS nations are going to be reviewed. On this point I would like to learn from you.

Technological advances and issues of justice in allocation of ocean resources

Thomas B. Sheridan
and Paul R. Sheridan

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Technological advances and issues of justice in allocation of ocean resources

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The recent International Conference on Population in Mexico confronted the grim statistic that in the short 40 years from 1984 to 2025 the world population is likely to jump from 4.75 billion to 8.30 billion—almost double (World Bank). This great increase most certainly will not be within the technologically developed nations, but rather in third world countries. To make matters worse, agricultural capacity in many of these countries is getting worse as available croplands are over planted and the increased use of firewood for energy leads to deforestation and eventual destruction of potential croplands.

A potential great source of nutrient, as well as many other resources demanded by a world which is outstripping its terrestial supplies, is the ocean. This resource, which up to now has been seen primarily as a fickle and unfriendly provider of fish and a hazardous means of transportation, is being conquered by technology. In recent decades advances in submarine technology allowed exploration of all parts of the oceans. Then sonar developments allowed men to see underwater. Currently, further advances in sensors, and most of all the application of computers and robotics, are allowing people not only to see more clearly but more importantly to do, to manipulate with dexterity and perform useful work, almost anywhere in the undersea environment. New man-machine control technology is allowing people to mine resources and farm the oceans by remote control, i.e.,

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without exposing themselves to hazard. New developments in automation and artificial intelligence are allowing such operations to be conducted efficiently and in many cases automatically, or at least as electromechanical slaves under human supervision (Sheridan, 1984).

The new technology is permitting the developed nations to exploit the oceans as never before, and the pace of such new technological capability is accelerating, driven both by oil profits and by a recent surge in military spending on ocean technology.

But wait – who owns the oceans? Who is exploiting whose resource? Who has the right to exploit the oceans and who most needs the resources? One type of answer is evident: the technologically developed nations act as though they have both the right and the need. The rich are in a position to get much richer and leave the poor much poorer. This is why the issues of distributive justice undertaken at the recent United Nations Law of the Sea Convention are of profound importance.

Ocean resources: current trends in exploitation

The traditional ocean resource is protein in the form of fish, and the traditional technology fishing changed relatively little for thousands of years. Modern fishing methods, however, are changing rapidly. Schools of fish are now spotted from above by aircraft, and from below by acoustic echo sounders. Data are relayed electronically to the control rooms of large modern fishing boats where computers do real-time analysis and present maps, charts, and advice to ships' officers on computer display screens in living colour, telling them just where to take their ships. Powerful and high-speed hydraulic "roller rig" winders operate nets and haul in tons of fish in a few hours. Then the fish can be processed and frozen on board. The whole operation has become so efficient that certain species in certain areas have become overfished, including, for example, shrimp in the Gulf of Mexico and king crab in Alaska (Stutz, 1984). The need to moderate the extraction of these renewable but destructible resources is evident.

Certain now-plentiful species have not been in demand, but new processes for making fish flour or otherwise extracting and distributing protein from fish show great promise. In the farther future kelp and other salt-water plants are likely to be farmed and harvested on a much larger scale than now – using ocean farm machinery at least as automatic as that which now appears on terrestrial farms.

The ocean minerals most important at the moment are oil and gas. As reservoirs of oil and gas pumped from dry land gradually diminish there will be more and more development of offshore operations. However to find the oil and gas deposits and to do the required operations on subsea well-heads is very expensive.

Geological sensing by low frequency sonics combined with sophisticated geophysical computer modelling have allowed for more precision in locating oil and gas deposits. A variety of subsea oil and gas platforms have been developed at huge capital cost—due to the sheer size (taller than the Empire State building) and required force resistance (greater than the strongest hurricane) (Petroski, 1984).

A single working hour of a human diver skilled in well-head operations can cost from $1000 to $10 000, depending on depth and location. As subsea oil and gas operations go deeper than several hundred metres it simply becomes too hazardous for human divers. However a variety of remotely operated vehicles have appeared in recent years and are now hard at work in the North Sea and elsewhere—swimming around on the end of 1000 m tethers, with video and sonar eyes relaying information to human operators comfortably observing TV screens and computer displays on surface ships at the other end of those tethers.

Gradually these remotely-operated vehicles are being equipped with robotic mechanical arms and hands, developments which have evolved from space and industrial automation research. These are controlled by human operators on the surface who can see what their remote vehicles see and thereby can extend their body images and act as though the mechanical arms were just an extension of their own. "Teleoperation" (doing remotely whatever you can do with your own hands) and "telepresence" (television which is so good you feel like you are present at the remote site) are current criteria in the development of such systems. Touch sensors for these undersea slaves are currently being developed, as is sufficient computer intelligence so that the remote vehicle can be programmed to perform modest functions automatically, or to return to the surface by itself if the cable breaks, or to shed the cable it if becomes fouled (Sheridan, 1984).

New offshore oil and gas deposits continue to be discovered but only by going deeper and thus farther offshore. (Meanwhile depletion of current operation sites such as the North Sea deposits is foreseen after several decades.) Other ocean mineral resources are metallic ores, such as cobalt and manganese crusts and nodules, and polymetallic sulphide deposits characteristically found near hydrothermal vents. These ore deposits are deep, many of them at 500 m. Here remote control is a must (Roland, Goud, and McGregor).

By towing arrays of side-scan sonar transducers, sometimes mapping in swaths as wide as 60 km, the topography of the ocean floor can be determined to a few metres resolution and the probable locations of various mineral deposits can be determined (Roland, Goud, and McGregor). With such efficient discovery and removal operations major mineral deposits can be depleted in only a few months. Special machines resembling giant vacuum cleaners have been devised for sucking nodules and other relatively loose mineral deposits from the seabed, raising them to the surface, and performing some separation so that only a refined product needs to be hauled home.

Energy is not now being removed from the ocean commercially, but there are several possibilities being explored. One is to make use of the temperature difference which exists between deep and shallow water (Knight, Nyhart, and Stein, 1977), the other is to tap the recently discovered hydrothermal vents (from which hot water is tapped and put to work in the normal geothermal manner). Given sufficient energy in situ, of course, water can be desalinated and/or broken into component gasses.

Most current ocean technology is relatively crude and unsophisticated, and is much less developed than aerospace technology. However, a large change in ocean technology is now taking place due to the influx of aerospace technology. Further, the industry is fully aware that the riches are there to be taken, and so are the profits.

Who owns the oceans: contrasting viewpoints and the drive toward regulation

For many centuries national rulers have claimed to own the seas adjacent to their own shores. In 1609 a Dutch legal scholar, Hugo Grotius, argued that the oceans, beyond what a country could readily defend and control, belonged to everyone. "Is it not more just", he wrote, "that the benefits . . . from the enjoyment of common things should be given to the entire human race rather than one nation alone?" (Wertenbaker, 1983).

In the latter part of the 17th century the British philosopher John Locke offered a rather different viewpoint about the "universal common". In his two Treatises of Government he asserted that when we say something belongs to everyone we really mean it does not belong to anyone. " . . . what fish anyone catches in the ocean, that great and still remaining common of mankind . . . is made his property who takes that pains about it." (Wertenbaker, 1983). Are fish—and mineral nodules—still the property of the person or company or country who takes the pains—makes the (often huge) investment in money and takes the risk to bring them to the surface?

Thus there is a conceptual distinction between the "open frontier" (Locke) view, namely that the ocean's resources are there for anyone to exploit, and the "common heritage" (Grotius) view, namely that the oceans belong to everyone and that the benefits should be distributed to everyone. This distinction is without importance when (1) there are plenty of resources for everyone, and (2) there exists no practical way to make or enforce a claim by anyone over a portion of the open frontier. These conditions have characterized the oceans for most of the history of humankind.

Both Grotius and Locke seemed to agree that a person has a right to take from common property if the resource is plentiful enough to support all those who desire it. Neither Grotius nor Locke seemed to dispute that "might makes right" adjacent to one's national boundaries. Traditionally an empire that controlled the land surrounding a sea claimed that sea. In the

17th century the width of the territorial sea was defined by the distance of a cannon shot: right to the oceans was determined by the technology of control. Questions about what was just in the case of non-renewable resources in the deep ocean did not arise.

Technological development and the expansion of world population began to force the question of a just allocation of resources. As this occurred technology continued to provide the basis for rights allocation. 1958 saw the Geneva Convention on the Continental Shelf (the first of three United Nations Conferences on the Law of the Sea). Article 1 of this treaty included such a technology-driven provision—namely that countries own the resources of their continental shelves off their shores out to a depth of 200 metres "or beyond that limit to where the depth of the waters admits of the exploitation of the natural resources of the said areas" (Lesch, 1982). Allocation thus drawn became infinitely sensitive to changes in technology. Ocean mining companies meanwhile were already hard at work on exploratory drillings and excavations.

The second UN Law of the Sea Conference, held in 1960 to deal with each nation's territorial sea, failed by one vote to provide an agreement. Meanwhile there was increasing concern that in a shrinking world rights to the oceans might cease to be governed by technological capability.

In 1966 President Lyndon Johnson declared in a speech that "under no circumstances, we believe, must we ever allow the prospect of rich harvest and mineral wealth to create a new form of colonial competition among the maritime nations (Wertenbaker, 1983). We must be careful to avoid a race to grab and to hold the lands under the high seas. We must ensure that the deep seas and the ocean bottoms are, and remain, the legacy of all human beings." One year later Dr. Arvid Pardo, the UN Ambassador from Malta, delivered an impassioned speech in the General Assembly about the wealth of resources in the ocean and the growing ease with which developed nations could remove these resources as well as establish military bases and implant weapons. The less developed nations especially responded very sympathetically to Dr. Pardo.

In 1970 President Nixon proposed a draft treaty on the seabed to the United Nations, asserting "the international seabed area would be a common heritage of mankind, and no state could exercise sovereignty or sovereign rights over this area or its resources" (Wertenbaker, 1983). He proposed an International Seabed Authority which would collect royalties from profit-making operations in the International Seabed Area and distribute these among all nations. Nixon also proposed that marginal "trusteeship zones" between the deep International Area and 600 m depths adjacent to coastal zones be managed for oil and gas extraction by the adjacent nation on behalf of the International Seabed Authority. In that same year, 1970, the UN General Assembly, including the US, formally proclaimed the seabed "the common heritage of mankind".

The Nixon proposal was timed to lead off the third UN Law of the Sea Conference, which enlarged the scope of concern to include fishing rights, pollution, free passage (rights of ships, aircraft, and spacecraft to pass within, on or over international ocean areas), and other matters. The less developed nations were quick to agree on ideological principles which gave them rights they had not yet exercised as well as royalties on the profits made by the developed nations. The developed nations, on the other hand, were less eager to jump into any arrangements which would compromise their free exploitation of the oceans.

The sticking points came especially with regard to seabed mining (of gas, oil and other minerals) by the companies, both national and international, set up for this purpose. Unlike fishing, which can be done with relatively small investment and risk and without staking a claim (because the fish move around) mining involves huge investments and risks in fixed locations. (An MIT economic model estimated about a billion dollars to start a sufficient size seabed mining project, and one-fourth that sum per year to operate it) (Wertenbaker, 1983). The companies argue that they need assurances for exclusive and continued access, that once large investments are risked in developing specialized technoogy and finding deposits in a single location, others must not be free simply to join them by copying the same technology and extracting minerals at the same location. It should also be pointed out that in the richest nodule deposits (in the Pacific, south of Hawaii) it is estimated that there are only enough nodules for up to 30 full scale mining projects (Wertenbaker, 1983). The most precious seafloor mineral is cobalt (used for heat resistant alloys); one US Government study claims that the present world demand for cobalt can be satisfied by only nine seafloor mining operations. In other words, as far as seabed mining is concerned—first come, first served, and time is of the essence.

In December of 1982, after 9 years of painstaking and groundbreaking negotiations, unprecedented compromise by both rich and poor nations to accommodate the other, and even cooperation between the Soviet Union and the United States, the Law of the Sea treaty was ready for signature. It was called "the most complex and most inclusive redrafting of worldwide regulations ever undertaken" and "a constitution for the oceans" (Lesch, 1982). One hundred and twenty seven, all but three participating nations, were quick to sign it, and only the US has refused to sign it. If at least 60 nations ratify the treaty the unique International Seabed Authority will come into being and proceed to regulate the extraction of minerals from over half the earth's surface. Political observers are optimistic.

Dismay, hope, and the need for changed ideology brought about by new technology

Needless to say, the international community was dismayed when President Reagan announced in July 1982 that the US was rejecting the entire

United Nations Law of the Sea Convention "because the . . . deep seabed mining provisions are contrary to the interests and principles of industrialized nations and would not help attain the aspirations of developing countries". At the same time Reagan proclaimed the US would accept and act in accordance with the treaty's provisions on navigation and overflight rights and freedoms, and he proclaimed a 330 km coastal Exclusive Economic Zone in which "the US will exercise sovereign rights in living and nonliving resources" (Roland, Goud, and McGregor). In other words the US would claim for itself the treaty's benefits without acceding to its costs.

Responses from US mining industry were positive. James Lesch, Chairman of the US National Ocean Industries Association, was delighted with the US rejection of the treaty. In an interesting twist of concepts he characterized the treaty's limits on open exploitation of ocean resources by technologically advanced nations as theft. In an article entitled "Thank you, Mr. President" (Lesch, 1982) he used the terms of Gary Knight, a Louisiana State University professor of law, that the new treaty was "a polite way . . . of stealing from those who have and doling out on a gratuitous basis to those who have neither the energy nor the will to produce things of value to themselves". The President himself was reported to have said during his cabinet meeting "We're policed and patrolled on land and there is so much regulation that I kind of thought that when you go out on the high seas you can do as you want" (Wertenbaker, 1983). Others, however, asserted that US seabed mining interests had now put themselves at much greater risk for both acquiring and protecting capital, had ostracized themselves from cooperative ventures with Western European nations and Japan, and had alienated the rest of the world.

Clearly Mr. Reagan's administration currently takes what we called earlier the "open frontier" view rather than the "common heritage" view. The "open frontier" view continues to be shared by many around the world, not only in regard to oceans policy, but with regard to other physical "commons" like air and space as well as economic commons such as world markets. A combination of Locke, Adam Smith, and the traditional view of capitalism seems to be taken by them to be as appropriate and timely as ever.

It is the belief of the authors that the "open frontier" view of common resources such as the ocean is not appropriate for our world. It simply is not fair. Further, as increasing conflict is sure to result from such an approach, neither can it be workable in a pragmatic sense. Advances in technology make it impractical.

Naturally so long as one party's interests at any frontier do not interfere with another's, policy based on the "open frontier" ideology might work. If two or more parties are actively operating at some frontier that frontier ceases to be "open", and it rapidly closes (ceases to "work" politically and economically) as multiple parties' activities and interests are involved and conflict. We believe the "open frontier" becomes illegitimate even apart from the direct conflict which may result, namely when some of the parties are ignorant of their interests, or unable to work their legitimate claims. With some resources the commons might be gone forever before some parties ever have realistic access. This certainly would include the world's deep ocean resources.

The possibilities for unfairness and open conflict accelerate with technological development. Technology is in the process of making every person on earth potentially capable of sensing (seeing and learning about through video and other sensing and communication technology) and operating upon (through remote control and computation technology) anything anywhere. While this may seem like an exaggerated vision, right now such capability is being taken quite seriously by the military establishments of the developed nations. Yet no such capability is now or in the immediate future will be available to the poor, for obvious economic reasons. The point is, however, such powerful remote control technology exists now and can be demonstrated. Not only are the developed nations winning the races for limited resources, but potentially even now any person can do mischief (or good) in anyone else's back yard. Thus, we argue, the "open frontier" view is now de facto obsolescent and becoming obsolete.

As an aside we note that the "open frontier" in one sense is a peculiarly Western notion. Hindus and other great cultures of the world have long committed themselves to closely sharing the earth's resources with other species beyond humans. Those same cultures have not prospered technologically, however, at least in modern times, by comparison to the more aggressively exploitative cultures. Perhaps some hope lies in the possibility of uniting an ability to exploit resources and a vision of shared resources. Those who now have the power (the technology) claim a right to protect their technology from discovery by those without it. The motivation for that claim is understandable; yet some sharing, some technology transfer to the poorer nations, seems a legitimate way to help these others help themselves and prevent conflict.

The challenge before us is to evolve an approach to the technological exploitation of resources which is both collectively advantageous and fair. As technology advances the challenge grows more urgent. Great strides have been made by the international community through the process and results of the International Conference of the Law of the Sea. The success thus far for resource justice through international cooperation is cause for hope. There is also cause for concern: the "open frontier" mindset is still at large. Ultimately the outcome will depend on how widely and how deeply humankind appreciates how technology is changing profoundly our relationships to one another.

References

Knight, H. G., Nyhart, J. D., and Stein, R. E., 1977. *Ocean Energy Conversion* (Lexington Books: Lexington, Massachusetts).

Lesch, J. R., 1982. Thank you, Mr. President, *Sea Technology*, Aug., 1982, pp. 53-55.

Petroski, H., 1984. Offshore engineering: oil from troubled waters, *Technology Review*, July, 1984, pp. 52-61.

Roland, R. W., Goud, M. R., and McGregor, B. A., The U.S. exclusive economic zone—a summary of its geology, exploration, and resource potential, Circular 912 (U.S. Geological Survey: Washington).

Sheridan, T. B., 1984. Supervisory control of remote manipulators, vehicles and dynamic processes, in *Advances in Man-machine System Research Research* (Ed. W. Rouse), pp. 49-137 (JAI Press: New York).

Stutz, B. D., 1984. Catch as catch can, *Technology Review*, May-June, 1984, pp. 68-74.

Wertenbaker, W., 1983. A reporter at large: the law of the sea, Part I, *New Yorker*, 1 Aug. 1983, pp. 38-65; Part II, *New Yorker*, 8 Aug. 1983, pp. 56-77.

A look back from 2004

Sir Roderick Carnegie

Sir Roderick Carnegie

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A look back from 2004

Sir Roderick Carnegie

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Introduction

My colleagues in this section of the symposium each has particular expertise about some part of the subject which I do not, so I have had to think hard about how to make a contribution.

Each of us here has been greatly fortunate in life—our parents, our schools, our societies, all three of them combining to teach us the habit of hard work and hard thinking. We have also been individually fortunate in our luck as well as our opportunities.

Perhaps, I thought, the longer term perspective needed in the minerals industry might be the start for my contribution. So, as a forcing process to keep our minds working, may I propose that we are 20 years ahead. This year is in fact 2004. We are meeting once again at a Honda Symposium. Let us think how much the world has changed since 1984.

Since in a very real sense we help to create the future by thinking about it, let me click my fingers—here we are in 2004 in the Republic of Nauru. Once again, after a gap of 20 years, the Honda Foundation and the Australian Academy of Technological Sciences have combined. Why are we here, in what only 20 years ago was a very remote corner of the Pacific? It is to look in detail at the advances which have combined deep sea mining with the use of solar and nuclear electricity to generate the up-dwelling currents from the deep ocean which are transforming this whole sector of the Pacific into highly profitable farming, both of fish and seaweed. It is here, as we all know, that the world's first truly renewable food resources have been created by a new international industry.

In 1984 that seemed little more than science fiction fantasy. Let us think of a few other developments that we did not foresee just 20 years ago. New teaching. New communication. New health. New- and old-food. New- and old-exercise. New- and old-work patterns.

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The new teaching

Since this is an informal occasion, none of us have put on the ceremonial small beard to mark our roles as "Young Elders". The Young Elder is of course someone not yet due for retirement at 75, who in most countries now earns by advice at least some of the respect that the teacher – Sensei – had in Japan back in 1984.

It is not just our quadrant of the globe, but all western societies, which have rediscovered that natural affinity between the old and the very young that was, in 1984, a vastly underused resource.

As a teacher, of course, I am paid by students or their parents, and not by government. And paid by results!

It is now seven years since the Pacific Stock Exchange created the opportunity for that gallant band of 200 individuals from Monash and Tokyo Universities to float their private venture in international tertiary education.

They acted on a widespread trend in public awareness. Teachers 200 years ago were paid by result, had long term contractual roles with their students, and were forced to consider the cost of time as an economic reality. Twenty years ago, we had lost our way, with governments paying teachers irrespective of relevance or performance. Today, we have returned to more time-tested methods. Respect for results has risen sharply among students. They only needed teachers and academics to accept those same principles for themselves.

The trickle-down of that particular tidal wave is still not ended in some countries. But the demand for literacy and numeracy is so high that parents everywhere are willing to pay more than the standard tax-funded vouchers for teaching excellence – not just for their children, but for their own systematic reskilling in tomorrow's techniques.

The new communication

Teachers have respect, but they have not been replaced by television. Here in Nauru, 20 years on, we can see why this was a bad guess of the 1980s.

We now understand better the distinction that the Confucian cultures have always made between the mass of information available, the education which enables human beings to use the information, and the wisdom which human beings acquire with age and experience.

So, everywhere the screen remains largely a device for entertainment or instant information.

Then as now, most of the thousand-plus million people in our north-south quadrant of the globe are in villages. Satellite television was for big city audiences then. No longer!

Now, more than 70 per cent of people in rural areas are within 10 kilometers from at least one receiver, with constant choice between at least three channels on TV, and on average 12. Many isolated receivers are powered by a solar ceramic/silicon cell.

The replay of the Japanese win in the World Series Baseball, and what looks likely to turn out to be a clean sweep of every Gold Medal in the Pacific Athletics by teams from the People's Republic, are clearly today's major international viewing. Nevertheless, we are still being watched today by some hundreds of thousands of people, from Tsukubu City in Japan to Barry Jones City in the Antarctic. Interested in our topic, they are willing to pay to learn.

May I repeat for viewers what the Chairman said at the beginning, that I am deliberately speaking today using as far as possible only words and grammar which were in common use in 1984? As we have grown together, working English has changed dramatically, and those of you who begin to miss some of what I say should turn to Channel 6 for your particular simultaneous national language translation.

Most of us completely overlooked the unexpected other uses to which a satellite network could be put. To take just the common everyday example, where would any individual outside the tiniest village group be without his or her *purtsky*? The device itself did not exist 20 years ago, and the word remains to the language purists an unfortunate result of our international advertising. Yet the name has stuck. Once the second million users had the absolutely indispensable belt or pocket device which combined a 1984 "beeper" with a personal medical history, message-taker, and credit card—all internationally usable—the original technical names could not last.

Retired Prime Minister Hawke coined the word during the 1992 "Pacific Oscar" Awards. The new beeper, he said, was a cross between the purse and the Japanese netsuke. Purtsky became the slang, and then the official word, for what keeps us in contact with each other wherever we are.

New health

Some of the hopes invested at huge risk in biotechnology in the 1980s have been realised—but often not in the way the risktakers expected, and—ironically when we were forced to recognise by natural disaster that population growth was a benefit, not a problem.

Average life expectancy is significantly higher than in 1984. Japan's is still the highest.

Separation techniques only achievable in space—the third Japanese Space Shuttle—led to many other hoped-for discoveries.

Limiting of debilitating and general diseases, malaria effectively eradicated, most of the parasitic diseases gone except in Africa—those are vast steps forward.

Still, 20 years are nothing in the slow process by which people turn available information into self-education. Australians still have the highest skin cancer rate in the world. Too many people still smoke. As diet and culture changes, the Japanese stomach cancer rate declines—but no single cause has been identified. Hopefully, the oncogene vaccine will soon change both these and other rates drastically.

New (old) food

We are still very different in our particular preferences and traditions, but everywhere there is less meat, more fish, and more seaweed in diets. Our change in Australia has been particularly striking, with the new coldwater fishing industry in the deep oceans between Australia and the Antarctic supplementing the Pacific fish farms.

Gourmets argue about Nauru and Tasmanian *nori*, young people in sushi bars everywhere insist on krill omelettes, but people of my age in all our countries still prefer our historical dishes, whether open-air barbecues or *ochazuke*.

New (old) exercise

Fashion in exercise has changed as quickly as fashion in food. Jogging was a short-lived fad even before the orthopaedic consequences were clear. Walking for pleasure has increased exponentially and seems certain to last much longer.

Each part of the community has its particular tourist walk—the Shin Tokaido in Japan, the Gibson Desert trek on this continent. To see the hundreds of groups around their campfires on a winter's night in Central Australia is to understand mass tourism—even if few of our visitors believe that the Gibson Cocktail is in fact a North American not an Australian invention!

New (old) work patterns

In offices, as in food, we are much the same as 20 years ago, yet different. You in Japan have continued with open accommodation for a work group, with desks jammed together. We in the south have largely remained with individual small partitioned cubby holes—those of us who have offices, and most of us of course do not. Meeting together over food and drink is recognised as vital, even with remote communication always available.

In the irony of convergence, some of our business enterprises are into their fifth year of payment by twice yearly bonuses, just as many Japanese companies are abandoning them. More of us are willing to wear some kind of uniform common with others at the workplace, while more Japanese are using personalised clothing style to mark individuality.

It took until the end of the second Hawke Government for Australians generally to understand that they must work like everyone else when the work is there, with substitutions for those in our multi-national community for whom Friday or Saturday or Sunday are days of complete religious obligation. After the Two Discontinuities, we have many more such observing believers.

The two big discontinuities

In so many other ways we have changed, made progress, retained national identity while becoming more universal in outlook. Yet the two major discontinuities of the 20 years did much more than simply accelerate incremental change, and produce such terrible cost in human life and wealth. I need to outline each of them, even to over-simplify, because it was their major consequences which almost none of us guessed—or faced consciously—in 1984.

1. The Middle East debacle led to a sudden cohesion of continental European and North American markets; and gave the inescapable thrust to the creation of the Pacific trading bloc in which we now live. But even in 1984, Chase Econometrics had already forecast that "3-bloc-world" possibility.

From the need to barter in the recovery came the first impetus for the Pycu, the Pacific yen currency unit.

2. The earthquakes of 1989, while causing such terrible damage even in a well-prepared Japan and throughout the Pacific Rim of Fire, re-awakened the basic human truth half forgotten by rich Western economies (but always alive in Japan and China) that damage to food is more serious than that to property.

The Pacific volcanoes added more gas and dust to atmosphere than 300 years of world industrialisation. There has been the apparent green house effect, but no proof of permanent change to climate. Full recovery from the five years of temperate crop failure will be long coming, and of course it has changed every community by its tragic toll of human life.

Yet in disaster, always opportunity. It was a happy accident that in Australia, our history of wild variations in agricultural production caused by flood and drought meant we were able to help so much in world food revival.

But awareness of the stark consequences of loss of topsoil, especially in the Asian, Ukraine, and north American grain belts, has changed artificial barriers to transport and distribution efficiences, we would hope forever. All of us, not some of us, have now known hunger at close hand.

Much has changed but much remains the same. Australia is still "overgoverned and ungovernable"; State premiers are vocally restless in the west and north; and we are still a high noise society. Back then, we seemed to be approaching the north American dead end of legal interference with economic growth. It was not easy or quick to turn fashion and education away from law to science and engineering—indeed it took half a generation, and the grim need for hard competent skills in reconstruction.

Japan as in 1984, is still undergoverned because the Japanese very largely govern themselves. It is still a quieter society than ours, with a greater community sense of order and a greater respect for authority.

Let me close by looking forward. Today, we are close to agreement on the "Three Wisdoms" of 2004. They make a striking contrast to what were the "Three Wisdoms" of 1984. In those differences is the story of old wisdom painfully relearned.

The "three wisdoms" of 2004

In all our Pycu countries, the most striking change is the way in which natural disaster has reintroduced the idea of responsibility. Though I myself do not agree that what has happened in Australia is really a move towards a Confucian frame of mind, many more people have learned how to work together.

Yet today's "Three Wisdoms" all come from individual or family rather than group perceptions.

1. That permanent subsidies of any kind are economic time bombs, and we need no more of them.

All of our communities still diverge from economic reality for symbolic reasons. The Japanese Government still supports the silk worm industry, the Australian government still does the same for north Queensland sugar growers. But overall, they are exceptions to the rule.

2. That governments don't control national economies (and never did); because economists still don't know enough about a single small economy to plan it.

That, of course, is not yet a global wisdom. Those of us who have seen how competitive small business can raise living standards when markets are deregulated can look only with sadness at the continuing decline and stagnation of the Soviet countries and their African satellites. We must hope for change to come slowly and surely, as it has done in the People's Republic, in the way that communities select for themselves.

3. That government wisdom and economic guidance of the day is to be listened to, but by no means always followed. Governments often mean well, but do badly.

Our new museums and videos teach children directly the extent to which engineers can produce solutions once the public makes up its mind and governments get out of the way. Just 20 years ago most people still thought that to cut 25 per cent off the weight of the average consumer automobile in 10 years was about as far as manufacturing could go. We did not then understand fully the Honda contribution to the world economy through intelligent use of advanced technology. Nor did we understand how sensible the consumer was, when he or she was faced with real choices — or no choice at all.

The "three wisdoms" of 1984

When we met in Melbourne 20 years ago, most people in all our countries agreed, if asked, with three propositions. Today, they do not!

1. Politicians could deliver what they promised.

In 1984 Chase Econometrics could write: "The citizens of the world have looked to their governments for a solution to economic problems." By 1987, they were tired of looking to government. By 1989 they knew it was useless looking to government. Each of us, individually and in groups, had to learn to do it for ourselves. End of Proposition One.

2. The first use of a nuclear weapon would lead to Armageddon.

Armageddon was postponed indefinitely. Nuclear weapons were used twice in the South American 'Football War' of 1992. There was no proliferation. There are still military weapons, still defence forces. End of Proposition Two.

3. World "resources" were finite, unevenly and unjustly distributed, and the main source and cause of national wealth.

Recognition of the "resources illusion" has been the greatest change of all. It is work by people, and nothing else, which creates wealth and better jobs. The selling price of commodities in fact in 1984 had been flat over the whole century, when prices were adjusted in real terms; it was only the falsifying mirrors of paper money and deliberate inflation which hid that truth from most ordinary citizens 20 years ago. Remember how politicians used to talk glibly back then about "sunrise industry" and "resources diplomacy"?

Resources now, as then, aren't what they used to be. We are, after all, on Nauru! Plastics and ceramics have made metals less essential in traditional uses, less necessary. There has been a quantum shift in perception of "strategic resources" because of ability to source ceramics worldwide, almost anywhere. End of Proposition Three, the resources illusion.

Conclusion

To end, I leave with you the thought that, in contrasting the "Three Wisdoms" of 1984 and 2004, I will certainly be at least partly wrong. Of course! Yet surely we must try — now — to think hard about what the Three Wisdoms of 2024 will be.

We still do not fully grasp the slow trend of powerful ideas. Since 1964, the world has moved in my own lifetime from "Big is Better" to "Small is Beautiful" to "Think Big/Work Small".

To our own children in another 20 years looking back from 2024, it will seem perfectly clear where we in our turn were wrong in this year's meeting on Nauru.

In my own lifetime, since 1932, a damaged world has twice repaired itself, with false gloom bred from over-comfortable luxury in the years between. Trend, we have had twice to prove for ourselves uncomfortably, is not destiny.

Human beings are still alive, still smart when they have to be, and—all in all—getting smarter as they go. Unsolvable problems? That is why I want to be here in another 20 years, to see the answers that we have overlooked this time round!

As I stated at the beginning of this article, it cannot be denied that the advent of the oil crisis triggered changes in our values, especially in terms of human resources. Highly trained intellects will be increasingly in demand, while the need for the traditional types of manual labour will decrease massively. This implies the need for us to give careful consideration to the content of education in the post-industrial society.

For those who have been sufficiently and appropriately trained to handle the high technology employed in the post-industrial society, the degree of human freedom is bound to be more extensive than that in the old industrial society. In the post-industrial era, however, there will also be an increasing need to create a new social order, which could not have been predicted in the old industrial society. For example, together with the dissemination of information technologies, we shall be confronted with such issues as the need to protect the individual's right to privacy and to protect proprietary rights involved in software. While in the long term there is little doubt that mankind will be able to create the necessary social arrangement to cope with this situation as it has done on previous occasions throughout history, it is equally clear that we will encounter numerous problems and difficulties in the process of establishing the required system. When the new system is finally established, we will see for the first time the full potential of high-technology employed for the maximization of human freedom.

Technology transfer in the west Pacific Basin: prospects and problems for Japan and Asean

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Technology transfer in the west Pacific Basin: prospects and problems for Japan and Asean

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Introduction

The west Pacific Basin is a complex, heterogeneous region of pronounced diversity, made up of a great variety of countries which differ widely in economic structure and political philosophy, in the stage of economic growth, in the level of technological attainment, in ethnic composition, in culture, religion, and tradition, and in the endowment of both human and physical resources. Such a diversity, while presenting a serious constraint towards any attempt to create a west Pacific Basin regional community, provides at the same time great prospects for economic and technical cooperation based on complementarity of the countries within the region.

Within the west Pacific Basin may be found a number of broad groups of countries with certain common characteristics. First, there are the advanced industrial countries of Japan and the Soviet Union, although the latter is unlikely to play a significant role in regional technical cooperation. Secondly, there are the newly industrialised countries of South Korea, Taiwan, and Hong Kong which, in certain types of manufactures, are serious competitors for Japan. Thirdly, there are the emerging industrialised countries of Indonesia, Malaysia, Philippines, Singapore, and Thailand which make up Asean although Singapore might well be included among the newly industrialised countries. China, too, may be included within this group as a country aspiring to industrialise rapidly. Fourthly, there are the countries of Australia and New Zealand whose identification with Asia or inclusion within Asean would have great historical significance for the west Pacific Basin regional community.

This paper does not attempt to cover the whole of the west Pacific Basin but is confined to a discussion of the relationship between Japan and Asean.

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Japan and Asean: technological gap

A wide technological gap now exists between the advanced industrial countries on the one hand, and the newly industrialised countries on the other, and there are signs that this gap is widening. The same is true between Japan as an advanced industrial country within the west Pacific Basin and the emerging industrialised countries of Asean.

Advanced industrial countries, in recent years, have witnessed a rapid expansion of their technological frontiers, particularly in the field of electronics; an increasing amount of resources being directed at research and development (Table 1); and, with the exception of Japan, a growing importance of R & D work being undertaken by the government—more so if defence spending is taken into consideration (Table 2). At the same time, there is a growing recognition of the importance of modern technology in the promotion of industrial development and economic progress among the emerging and newly industrialised countries. This has led to greater em-

TABLE 1
R & D expenditure (in US$billion) by major countries

Country	1978	1979	1980	1981
USA	44.9	53.6	62.7	68.4
USSR	27.3	30.3	32.5	31.9
Japan	15.9	18.0	20.8	23.8
West Germany	14.0	19.2	21.8	17.9
France	8.9	10.1	12.1	11.3

Source: Embassy of Japan (1983).

TABLE 2
Government R & D spending as percentage of total by major countries

Country	Year	Govt. R & D spending as % of total (including defence spending)	Govt. R & D spending as % of total (excluding defence spending)
Japan	1982	23.6	23.1
USA	1982	46.7	30.3
UK	1978	48.1	31.6
West Germany	1981	43.1	40.9
France	1981	57.6	46.4

Source: Embassy of Japan (1983).

phasis being given to high-level technical manpower development as a prerequisite for technology transfer and adaptation. Both of these developments strongly suggest the prospects of increased transfer of technology in the future from the advanced industrial countries to the emerging and newly industrialised countries. At the same time, they also point to the need for a better understanding of the process of this technology transfer.

In the case of Japan and Asean, there are sufficient dissimilarities between the two to provide a strong basis for complementarity and cooperation. Japan, as an advanced industrial country, is poor in natural physical resources but rich in technology and technical know-how which she is willing to export to other countries while Asean is just emerging as an industrial region, rich in natural physical resources and hungry for modern technology and technical know-how. (For more about the complementarity between Japan and the Asean countries see Panglaykim (1983)). But such dissimilarities and economic and technological gaps have also created anti-Japanese feelings, based on the belief that a poor Asean is being exploited by a rich Japan (Shin'ichi Ichimura, 1980).

Development of technology

Historically, the economic growth of advanced industrial countries of the North has been closely associated with the development and use of technology. This technology has either been developed at home or imported from abroad. In many cases, the imported technology has been modified to make it more appropriate for the local environment.

Realising this, developing countries of the South have now begun to accept technology as an important "engine of growth" and, because they are late-comers, they are turning to the importation of technology as the quickest and most feasible means of acquiring this.technology.

Asean countries are no exception in this respect and technology has become a keyword in their national development efforts.

Local technology

In the Asean countries, locally-developed technology is by far the less important of the two. This is because of the small amount of money spent on R & D work, either by the government or by industry. In Malaysia, rubber technology is the only world-renowned technology, good enough to be exported overseas, which has been entirely developed locally. The Rubber Research Institute in Kuala Lumpur, which has been undertaking this type of R & D work for more than a half century, is funded by a cess collected through the export of rubber. The rubber industry itself conducts little R &

D work. Only the large multi-national rubber companies have research laboratories but the amount they spend on R & D work accounts for less than 2 per cent of their total expenditure (Yip Yat Hoong, 1978). The gap in R & D spending between Japan and the Asean countries becomes apparent when we refer to Tables 1 and 2.

So far, the development of technology locally has not amounted to much in the Asean countries. Except for the R & D work on primary commodities, such as rubber and tin, the installation of research and development laboratories has been almost non-existent except for small-scale facilities for product adaptation and quality control purposes.

Among the main reasons given for the lack of R & D facilities in the Asean countries are the following.

1. The lack of available capital, the shortage of experienced and skilled researchers, and the dearth of trained technical support personnel.
2. The lack of government support towards R & D work as evidenced by the absence of incentives; for example, deduction from corporate income tax expenditures incurred by a company on R & D work or tax measures like accelerated depreciation allowances for plant, machinery and equipment employed for R & D work.
3. Most local enterprises are too small to be able to launch into any meaningful R & D work which is both high-risk and high-cost.
4. The lack of competition in certain parts of the domestic markets which, sometimes through official favouritism and at other times as a result of monopolistic control, are shielded from competition.
5. The apparent shortage of government-financed research institutes dedicated to developing new products, inventing new production processes, or introducing technologies that would meet the growing and demanding requirements of industry and consumers; the Rubber Research Institute and the more recently established Palm Oil Research Institute of Malaysia are exceptions rather than the rule in Asean countries and these are essentially single-crop research institutes.

Imported technology

For the Asean countries, a more important way of broadening their technological base is through the importation and adaptation of foreign technology, often associated with the inflow of foreign direct investment. Foreign direct investment is almost always accompanied by the supply of foreign plant, equipment, and machinery, as well as technical personnel, and is therefore an important channel for the transfer of technology. Licensing agreements, management services contracts and other technical servicing agreements can also be significant channels of technology transfer.

In recent years, one important source of foreign direct investment has been Japan which, for Indonesia, Malaysia, and Thailand, has become even more significant than the United States (Table 3). The growth of Japan's direct investment overseas during the postwar period has been phenomenal. It began in the 1960s and grew rapidly during the 1970s and the early 1980s, particularly in the Asean countries. Japan's annual direct investment overseas jumped from US$2.8 billion in 1977 to US$4.6 billion in 1978 and three years later in 1981 this figure was doubled at US$8.9 billion (Table 4).

TABLE 3
Foreign direct investment accumulated in Asean countries up to 1977 (in US$million)

	Indonesia	Malaysia	Philippines	Singapore	Thailand
Total	$5,294	$416	$564	$1,699	$171
Japan	39.0%	23.4%	25.3%	15.3%	34.6%
US	19.2%	18.7%	33.1%	33.0%	15.6%

Source: Shin'ichi Ichimura (1980, p. 757).

TABLE 4
Japan's direct investment abroad by region (%)

Region	1977	1978	1979	1980	1981
North America	26.2	29.7	28.8	34.0	28.0
Latin America	16.3	13.4	24.4	12.5	13.3
Asia	30.8	29.1	19.5	25.3	37.5
ASEAN	18.5	18.3	10.1	23.2	32.4
Rest of Asia	12.3	10.8	9.4	3.1	5.1
Middle East	8.0	10.7	2.6	3.4	1.1
Europe	7.8	7.0	9.9	12.3	9.0
Africa	5.0	4.9	3.4	3.0	6.4
Oceania	0.7	0.8	0.3	0.3	0.9
Australia	5.2	4.4	11.3	9.2	3.9
Total	100.0	100.0	100.2*	100.0	100.1*
Total value in US$million†	2,806	4,598	4,995	4,693	8,906
% share of investment in industrialised countries††	39.2	41.1	50.0	55.5	40.9

Source: Panglaykim (1983).
* Statistical errors committed at source of reference.
† Based on approved investment.
†† Includes North America (USA and Canada), Europe, and Australia.

Although the advanced industrial countries in the north American continent obtained the largest share of this investment, the investment which flowed into the Asean countries was by no means insignificant, especially when compared with the rest of Asia.

How can this large outpouring of Japanese private investment into Asean countries be explained? There are several reasons for this. First, there was surplus capital in Japan beginning from the late 1960s and this surplus was growing rapidly during the 1970s. The period immediately after World War II was a period of industrial reconstruction in Japan. During this period, Japan had to rely on imports of raw materials as well as the inflow of capital and funds to purchase much needed technology. Because of this, Japan's annual balance of payments during the 1950s showed deficits. But the development of new industries, such as electronics, machinery, motor vehicles, and computer components during the 1960s and the improvement in production efficiency by taking advantage of economies of scale which a large domestic market provided, soon gave Japan a comparative advantage in the international market in the manufacture of standard technology-based products. Exports expanded rapidly and with the increasing availability of capital and access to international capital markets, Japanese industries began to invest overseas from the late 1960s.

Secondly, Japan, along with the other industrial countries, were experiencing long-term declines in relative rates of return on capital invested in these countries and were looking to the emerging and newly industrialised countries, like those in the Asean region, to export their surplus capital to. This move was also motivated by the deterioration of Japan's competitive advantage as an exporter of labour-intensive goods and standard technology-based consumer products as well as the need to develop natural resource supplies.The deterioration of Japan's competitive advantage was due to the appreciation of the yen in 1971 and 1973; rising costs of labour and raw materials; anti-pollution laws which raised domestic costs of production; and increasing competition from other advanced industrial countries, like the United States, which have relocated production to developing countries where costs are lower.

Thirdly, on the part of Asean countries longing to industrialise rapidly, there was not only a ready stock of capital waiting to come in but also a rich reservoir of manufacturing technologies developed by Japan both before and after the war which these countries could exploit and take advantage of. At the same time, there was a large pool of engineering, professional, and managerial personnel in Japan capable and willing to work overseas.

Absorption of the technologies transferred

Undoubtedly, the most dominant channel of transfer of Japanese technology to the Asean countries has been through subsidiaries of transnational corporations operating in these countries. But the mere supply of Japanese plant, equipment, and machinery and its associated inputs, like new production techniques and technical and managerial personnel, is no guarantee that the technology will be effectively absorbed and efficiently utilised. Much will have to depend on

1. how appropritae the technology, which is being transferred, is to the local conditions and requirements and the degree of its accessibility,
2. how successful is the transferred technology able to develop indigenous research and development capabilities and raise the efficiency of manpower resources needed to use the imported technologies, and
3. how receptive is the local social and cultural environment to the technology being transferred.

Appropriateness of transferred technology

One of the chief complaints of the types of technology transferred by transnational corporations to Asean countries has been the excessively capital-intensive nature of their production processes while the Asean economies, with the exception of Singapore, are largely labour-surplus developing economies. Also, major adaptation of plant or process designs to suit local Asean conditions or requirements by Japanese subsidiaries of transnational corporations is rarely undertaken. In a survey on the impact of Japanese direct investment in Malaysia undertaken in 1978, it was discovered that Japanese firms introduced their production technologies to Malaysia intact. Any adaptation made (which was very rare) was confined to production equipment and techniques rather than to product design (Chee Peng Lim and Lee Poh Peng, 1984).

Several reasons have been advanced for the use of relatively capital-intensive production processes at the subsidiaries of Japanese transnational corporations in the Asean countries. One is the concern with maintaining lower cost of production per unit of output and the established quality reputation for their products. This is especially so in the case of those subsidiaries producing mainly for the export markets. Another may be due to the trading houses (or *sogoshoshas*), which, acting as intermediaries in this process of technology transfer, are always interested in the sale of plants and equipment and possibly in continuing to supply industrial raw materials to be fed into such plants. The importance attributed to the trading houses of Japan is because most of them have assisted in identifying, organising, and financing investment projects in manufacturing and mining; in marketing their output overseas; and in supplying them with necessary inputs from abroad, particularly from Japan.

When it comes to the lack of major adaptation of production processes to the local conditions and requirements of Asean countries, the host countries, it is said, are also partly responsible. Host country governments in the Asean region are known to have discouraged and, at times, even prohibited the importation of second-hand equipment and machinery although these are simpler in design and operation, less capital-intensive, and less expensive to maintain. Asean governments, on the other hand, are justifiably afraid of their countries being turned into a dumping ground for obsolete Japanese equipment and machinery.

Japanese transnational corporations have also pointed out that labour legislations which exist in many of the Asean countries make it rather difficult and costly to dismiss redundant or inefficient employees, thus inducing their subsidiaries to resort to more labour-saving production processes. At the same time, the use of more capital-intensive production processes is also encouraged by investment incentives measures adopted by the governments of the Asean countries which serve to cheapen the cost of capital relative to labour. Such government measures include tariff concessions on the importation of new equipment, low-cost loans for the purchase of capital equipment, accelerated capital depreciation, and investment tax credits.

Development of indigenous R & D capabilities

From the Asean host countries' point of view, one of the greatest hopes attached to technology transfer is the development of indigenous research and development capabilities, including the development of scientific and technical manpower capable of making effective use of the technologies imported. Yet, few of the Japanese manufacturing subsidiaries in Asean have established R & D facilities in their host countries and those that do have set up only small-scale laboratories to provide testing facilities for minor product adaptation and quality control purposes. In the 1978 survey on the impact of Japanese direct investment in Malaysia, which was earlier referred to, it was reported that none of the Japanese firms surveyed carried out any R & D work in Malaysia and it was believed that the same was true with most of the other Japanese firms outside the survey sample (Chee Ping Lim and Lee Poh Peng, 1984, p. 376).

Two reasons have been advanced for this state of affairs. One is that there is a lack of understanding on the part of Japanese transnational corporations of the need of Asean countries for local R & D work. The second reason is that, as often quite rightly claimed by Japanese transnational corporations, there are too few competent researchers in the Asean host countries for much R & D work to be done. The first is attributed to the fact that most top executives at the subsidiaries of Japanese transnational corporations believe that the technologies developed in Japan and imported into the Asean countries are adequate for these countries and that changes either to plant, equipment, and machinery, or to product designs, quality, and so on, should be kept to a minimum or not undertaken at all, so as not to deviate from those of the parent firms.

The shortage of competent researchers in the Asean countries, on the other hand, has been the product of a number of factors: the absence of a long-term plan in the development of high-level, scientific and technical manpower; the over-emphasis given to the humanities in teaching at the universities; and last, but not least, brain-drains to advanced industrial countries where universities, independent research institutes, transnational corporations, and international agencies are able to offer more stimulating intellectual environments, better research facilities, higher salaries, and better fringe benefits.

However, there are encouraging signs in recent years that Asean countries, especially Singapore, are beginning to recognise the importance of promoting R & D work locally in order to reduce their dependence upon the importation of foreign technologies and to become more self-sufficient technologically. But they are still far from the wisdom and foresight shown by the government of the Republic of South Korea in setting up the Korean Institute of Science and Technology (KIST) which contributed, in no small way, towards the rapid expansion of that country's scientific and technological base which spearheaded that country's rapid industrialisation programme during the postwar era.

Social and cultural constraints

Whether a transplanted technology will take root and grow in a new environment depends, to a large extent, on the social and cultural infrastructure of the host country and how this differs from that within which that technology has been invented and/or developed.

In his paper entitled, "International environment for technological and cultural exchanges in Asia", Mineo Nakajima (1984) describes a debate between two Japanese academics—a political scientist and a social anthropologist—who were advising the Japanese government on its diplomatic policy towards the Southeast Asian countries. One view, held by the political scientist, was that Japan should begin to work out a diplomatic policy towards Southeast Asian countries based on technological and cultural transfer because, according to him, these countries have now achieved political stability and are moving rapidly towards national social and economic development. It was argued that by doing so, Japan would be responding to the Malaysian "Look-east policy" and Singapore's "Learn from Japanese experiences" campaign. The opposite view, held by the social anthropologist, was that it would be almost impossible to export Japanese technology and culture to Southeast Asian countries because these would not take root in countries not having a Japanese tradition.

Among Western academics writing about Japan's economic development and the prospects of transfer of her technology to the developing countries aspiring to follow her path of industrial development, this is a common point of debate. Mineo Nakajima reminds us, for instances, of the view held by Ezra F. Vogel which attaches the success of Japan to "things Japanese" and to "Japanese individuality", and the opposite view, held by Chalmers Johnson, that Japan's success is due to universal factors, such as high technology, a modern industrial system, better management and an excellent bureaucracy—all of which could be imitated and copied.

Wherein lies the truth of the matter? The answer, I suppose, lies somewhere between the two divergent views. For modern technology which has been developed entirely in an advanced industrial country to be successfully transferred and transplanted into a developing country or an emerging or newly industrialised country and take root there, the social and cultural infrastructure of the host country must be conducive to absorbing this technology. Ideally, for technology to be successfully transferred, not only should the donor and recipient country come from the same social and cultural stock but the recipient country should also have the human infrastructure needed to absorb the technology and make efficient use of it.

Let me illustrate with an example. Early postwar development economists thought that the most feasible way to narrow the income gaps between the rich and poor countries in the world was through massive economic aid from the rich to the poor countries. The economic diagnosis at the time was that, since the poor countries had abundant labour and land resources, what was needed was physical capital and modern technology. With sufficient physical capital employing the latest production techniques, take-off into sustained growth would be automatic. If war-torn Western Europe could recover so rapidly with an injection of physical capital and modern technology through the Marshall Plan, so could, it was thought, the poor countries.

But, as we know, what has succeeded in Western Europe was not repeated in the developing countries. Economic growth, it was painfully discovered, could not be explained simply by increasing in the stock of physical capital and the importation of technology. There was a "residual" factor involved. Western Europe succeeded because there was already in those countries the needed human infrastructure (in terms of the scientific and technological background, including high-level manpower), and a social and cultural background similar to that of north America and was therefore ready to absorb and take advantage of the physical capital and modern technology. By the way, Japan also recovered rapidly from the destruction of the war. But Japan, while not of the same social and cultural stock as north America, was already an industrial country before the war and was already accustomed to using imported Western technologies. It also had a rich human infrastructure capable of absorbing and, where necessary, modifying the modern technologies imported.

To what extent can the Asean countries adopt Japanese high technology, copy her industrial system and bureaucracy, and imitate her management style, and hope to follow her path of industrial development without having to understand, indeed, to absorb into their social and cultural system the Japanese way of life—Japanese history, philosophy, language, culture, and tradition? How far, for instance, can Malaysia "look East" without having first to understand the "mind" of the Japanese?

This provides both the fascination and the frustration for any attempt at understanding the relationship between Japan and the Asean countries.

References

Chee Peng Lim and Lee Poh Peng, 1984. The impact of Japanese investment in Malaysia: a summary of empirical work done, in *Technology, Culture, and Investment* (Ed. Ungku A. Aziz, Yip Yat Hoong, and Ling Chu Poh), pp. 362-396 (Institute of Advanced Studies, University of Malaya: Kuala Lumpur).

Embassy of Japan, Kuala Lumpur, 1983. Figures derived from *New Advances in Information-oriented Age*, white paper on science and technology, Japan, 1983.

Mineo Nakajima, 1984. International environment for technological and cultural exchanges in Asia, in *Technology, Culture, and Investment* (Ed. Ungku A. Aziz, Yip Yat Hoong, and Ling Chu Poh), pp. 307-317 (Institute of Advanced Studies, University of Malaya: Kuala Lumpur).

Panglaykim, J., 1983. *Japanese Direct Investment in Asean: The Indonesian Experience*, pp. 32-43 (Maruzen Asia).

Shin'ichi Ichimura, 1980. Japan and Southeast Asia, *Asian Survey*, 20 (7): 754-762.

Yip Yat Hoong, 1978. *Production Costs and Profit Margins of Rubber Estates among Members of the Rubber Producer's Council of Malaysia* (Rubber Producer's Council of Malaysia).

SESSION 4

Technological and cultural needs and obligations of the less developed countries

Theme

Special problems of food technologies and their impact on village and rural communities. The import of technology and its effect on culture and employment. Health care and drug availability. Development of alternative resources and their availability for other nations.

Chairman

Mr J. E. Kolm, AO
Councillor, Australian Academy of Technological Sciences

Speakers

Dr B. D. Nagchaudhuri: Beyond economic indices

Sir Russel Madigan: Minerals in the lesser developed countries of the Western Pacific

Royal Professor Ungku A. Aziz: Technological advance changes patterns of employment and culture

Dr John Bardach: Food from the hydrosphere—the role of eco-techniques

Beyond economic indices

B. D. Nagchaudhuri

Dr Basanti Dulal Nagchaudhuri

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Beyond economic indices

B. D. Nagchaudhuri[1]

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The concept of development is quite recent, and has been current for about two generations. The concept of backwardness goes back to the beginnings of the industrial age to denote non-industrial status. "Barbarians" and "civilized" are terms that have been in use for two or more millenia. The current jargon of development connoting industrialisation and machine-use for production, had led to misunderstandings and sometimes misconceptions. The vocabulary, however, is popular with economists, planners, governments and UN agencies and has produced a plethora of paper. While various recipes are offered, it is often overlooked that an understanding of basic human nature is needed to implement change in a society. It is the foundation on which the edifice of development, or for that matter any social engineering, can properly be built. Most of us have some vague notions about what human nature is. For my purposes, I would like to define human nature as an endowment built on the interaction of our environment with our anatomical, physiological, and intellectual structures. We often note the complex morphology of social behaviour due to environmental impacts. Much of our technological and economic behaviour, the institutional devices we invent, rests squarely on this anthropological base.

Most of us, apart from rare misogynists, like to think that although we are animals we are somehow unique. Biologically speaking, we are closer to the chimpanzee in the nucleotide sequences of DNA then the rat is to the vole, or the dog to the wolf. We are not, biologically speaking, unique. Even our social uniqueness is dubious. For almost every facet of human behaviour we can find animal equivalents. Forming pairs, rearing progeny, building shelters, protecting mate and progeny, sometimes with their life, are common to many birds and mammals. More complex organisations and social structures exist amongst many of the higher mammals. Monkeys and

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apes, dogs and wolves, deer and antelope act cooperatively to fight predators, to protect themselves, and to hunt for prey. When necessary one animal will sacrifice its own life to provide safety to the group. Love, group loyalty, self sacrifice, and intelligence are not unique to man. Animals communicate but man communicates most of all. Speech is unique in animal communication. It gives variety and precision to human communication and hence to human thoughts and their development. Speech is possible due to two sets of anatomical features. Firstly there are the speech organs such as the tongue, the larynx, the glottis, the lips, and the vocal chords. Secondly there is Broca's area in the brain which is located in the leftside in the frontal lobe and linked by a bundle of nerve fibres to Wernicke's area located in the temporal lobe. Broca's area is unique to man. It has probably evolved during the last million years or so. Signals from Wernicke's area (which is the storehouse of visual, auditory, and verbal memory) provide the appropriate words. These are structured syntactically into sentences by Broca's area and then transmitted to the vocal organs. No other animal, not even our cousins the chimpanzees nor our ancestors, the australopithecines, seem to have been endowed with Broca's area.

Apart from speech, another unique feature are our two opposable thumbs on our two hands. This makes the hand a very useful tool for a variety of uses. Hands are generalised. Feet, are more specialized. The fossil record has not yet revealed when and how the opposable thumb evolved. The evidence of the paleoliths indirectly proves that the thumb and fingers of the hand were fully functional more than a million years ago, and perhaps dates as early as the speciation of the australopithecines into homo erectus or his precursor (homo habilis). A synergistic relation probably developed between tool-using and the evolution of the hand and thumb. The evolution of homo sapiens from the homoerectus was paralleled by the increasing size of the brain and the flexibility of the hand.

Technological progress may be said to have started, at least evidentially, with the lithic cultures even before man (sapiens) appeared on the scene. The life of hunting and gathering was made more efficient by tools on one side and speech on the other. The efficiency of hunting was enhanced by cooperation. Sociability, a genetic trait amongst primates, became reinforced by speech, making and use of stone tools, and by sharing. Apart from enhancing sociability, speech made it possible to accumulate and transmit information and traditions over both space and time. This enhanced adaptation and assisted in migration into new areas to exploit new resource systems. The process of migration, adaptation, and sociability has led man to occupy almost every variety of the terrestrial ecosystem, except the extreme cold areas. The division of labours that began with hunting and gathering was sharpened with the growth of lithic technology, speech, and cooperation. Perhaps the last milestone in the ascent of man was the discovery of agriculture some of 10 000 years ago in northwestern Iraq and southeastern Anatolia from where it diffused very rapidly to other inhabited areas. Seeds could be harvested, stored, and shared. Land became precious.

Agriculture led to settled population. Human settlements could provide storage of grain, and the creation of surpluses freed man from daily hunting, and gave man a continuity for leisure and culture. The ancient trait of sharing developed into bartering. Barter developed into trade with surpluses to obtain things that were needed. Agriculture, villages, and barter was followed by ownership of land. Civilization had begun. Deliberate transmission of knowledge and skills, of trees and fruits, of tools and toolmaking, the sense of time, seasons and years, sowing and reaping, was the stuff of civilisation. It is not surprising, therefore, that the most ancient writing in dried clay tablets of ancient Sumer more than 6 000 years ago is not far from Jarmo the earliest of the agricultural settlements discovered. The clay tablets are accounts of trade and ownership of land. Sociability, speech, and technical ability had brought man from animalhood into civilization. Anthropology gave place to archaeology and history.

Developments during the last 6 000 years were extremely rapid because of the cumulative effects of the qualities of cooperation, speech, and technology. Writing became established 6 000 or 7 000 years ago. Copper, bronze, gold, and silver quickly followed each other. Terra cotta, that is burnt clay pottery, is first seen earlier than 6 000 years ago and in the next 2 000 years it developed into a well-established and many-sided technology which diffused throughout the inhabited world. These tremendous strides were possible because of the earlier evolution of human mental and manual capacities that had evolved in the course of a million years or perhaps longer. The same forces operate on us today perhaps with greater force than before, because those human traits which led to our success are founded in human biology. Social evolution has been continuous with biological evolution. Economic behaviour is not autonomous to modern human beings. It is a part of the process of social evolution. The processes of socio-economic change which make men more productive, more able to create surpluses, more able to exploit their environment and extend their resource base are "human" not "civilized" and are rooted in our biological past. Altruism and selfishness, heroism and self-sacrifice, secretiveness and sharing, are a part of our biological inheritance. Thus knowledge and skills were valuable and men liked to keep them to themselves; but it was also a part of his nature to pass on his skills and his knowledge as gifts to those he loved. Classical economists postulate one trait, greed, or rather selfishness to explain economic behaviour. The range of ecological niches, man's capacity to share, to adapt, to be sociable are, to my mind, important factors in determining economic behaviour.

Sharing and passing on information and skill is a behaviour pattern originally of transmission from father to son. It was extended to master and apprentice or disciple as a substitute to a filial relation and serve the purpose well for hundreds of years. Only in the last few hundred years did another institution develop, that of the guild which served a near equivalent purpose. The guild has been rapidly supplanted by organised institutional systems as storehouses of information. Vestigially, the guilds survive split into trade unions and professional societies (such as City and Guilds and Institute of Engineers). Their survival has been partly due to the need of memory devices to conserve skills and information together. The importance of information storage increases rapidly as information increases. Some information is lost in the process of conserving it. Information has become a valuable commodity and is now available for sale. It is needed to decide on technological and economic changes or modification, to assure oneself that a mistake is not repeated and to confirm that the assumptions regarding human nature have been sustantiated by subsequent economic behaviour.

My thesis is that the postulate of greed as the root of economic behaviour is severely restrictive. It is necessary to examine other aspects of human nature which can and probably do have an impact on human economic behaviour, such as sociability, altruism, and cooperation. Otherwise, we might be taking a narrow and distorted view of the underlying structure of socio-economic life. The narrowness and distortion of the economic view has been a major source of anxiety to economists. This is particularly evident when they ineptly try to be helpful and make predictions about the economics of development. Entrepreneurial activity is often a catalyst to development. Entrepreneurial ability has many components amongst which are technological insight, imagination, understanding human relations, and an information base. Economists have been very cautious about studies of these areas. Economic resources and management skills are also necessary ingredients for success. Japan's post-war development of optics and electronics are interesting examples in which management was able to utilize its knowledge of human nature and of Japanese social behaviour to structure the new industry. It paid off handsomely. It was manager sharing with labour, sympathising with it, utilising the strength and covering the weakness of labour that built a powerful but human structure to strengthen enterprises. It turned out that this was a more valuable asset than profit or money.

Phelps Brown, sometime president of the Royal Economic Society, once commented on "the smallness of the contribution that the most conspicuous developments of economics in the last quarter of a century has made to the solution of the most pressing problems of the times". Amongst the pressing problems he lists quality of life, population growth, quality of environment, and urban problems. The major direction of economics has been in the direction of quantification, so much so that economists have engaged in sophisticated calculations on whether full employment pays or it is more "economic" to run an economy at less than full employment to ensure a better stability of wages. This, it was argued would in addition provide greater mobility of the work force and incidentally give those who are unemployed the goods and services to sustain them not far below the level to which they are accustomed in the developed nations and ensure bare survivability in the case of most developing nations. In a socialist society, the same pressure to optimise production and exploit natural resources operates with the constraint that an effort is made towards full employment and a more equitable distribution of the wealth generated. Employment, at least conceptually, enters as a right of the individual and a concomitant obligation of a State rather than being ruled by market mechanisms and manipulated surpluses. There are thus two cases—one of freedom, market economy, and private ownership, and the other of totalitarianism, planned economy, and collective ownership. If we rule out the incompatibles we still have eight possible combinations (freedom, totalitarianism, market and planned economics, private and collective ownership) of which two are cited. One option is mentioned by Schumacher and called by him Buddhist economics. Schumacher argues that since Buddha preached a reverent and nonviolent attitude to all human beings and animals and extended it to trees, plants, and nature. An economist in this frame would prize renewable resources differently to nonrenewable resources. The essential difference from this view is that nonrenewable resources would be used only when they are indispensable and not used heedlessly or extravagantly. Renewable resources, on the other hand, could be used up to the limit of their renewability. The violation of these two rules is violence to nature. Buddha's nonviolence to nature has been taken up in several forms. Harrison Brown in his book *The Challenge of Man's Future* is more pessimistic. To quote: "When we examine all of the foreseeable difficulties which threaten the survival of industrial civilization, it is difficult to see how the achievement of stability and the maintenance of individual liberty can be made compatible."

The complexity of these issues is compounded by the nature of man. Man does not find it too satisfactory to accept a laissez-faire market economy with individual liberty, if it is freedom to starve, nor does he find a totalitarian and planned economy which assures the satisfaction of his basic needs of food, shelter, and work, worthwhile if this prevents him from doing many of the things he wants to, for pleasure or for knowledge or variety. The polarisation represented by the two choices lead one to explore the possibility of other choices. One example is that of Sweden which combines personal freedom and market economy with substantial collective ownership. Unfortunately the various options remain largely unexplored. My country, India, is a curious example where ownership is roughly half public and half private, the economy is partly market but substantially planned, and tries hard to be free and democratic. Consistent policies under the circumstances are difficult to formulate and even more troublesome to execute. On the other hand this structure has held strongly together, gaining support from a traditional framework and strength from its efforts to change and modernise. The weakness of such a structure is that it can only change slowly or not at all. It is not science that India lacks. Raman, Saha, and Bose are still big names in physics. They were educated in India, and did their researches in India. There were others who were born and educated in India but spent most of their research lives in the USA. Names like Chandrasekhar and Khurana come to mind. Technology has taken shallow roots. Steel and aluminium factories, automotive and electronic industries are well run. Some of them export competitively. We manufacture aircraft and computers, electric locomotives and petrochemicals. It is a strange thing to say, particularly to this audience, but perhaps many of these successes need analysis. I have a suspicion that many of these activities are successfully carried out because they have found sustenance in arcane traditional roots. We fail when such roots are not available when technology calls for innovation of organisation and enterprise.

A few years ago E. F. Schumacher visited Delhi and gave a number of lectures preaching a gospel he called intermediate technology as a panacea for India's ills. Very briefly what he was saying was don't carry excavated earth on headloads, carry them in wheelbarrows, you need not use dumpers. You will have more employment than if you use dumpers.

You can have small local industries making and repairing wheelbarrows as additional benefit of further employment. If he had suggested mopeds and scooters and bicycles instead of limousines and automobiles, I would have found more sympathy for his argument, although it would still be flawed.

A general feature of production systems is that for a particular technology and organisation the unit cost falls rapidly to a value between A and B on Fig. 1 which is appropriate to the production technology used and

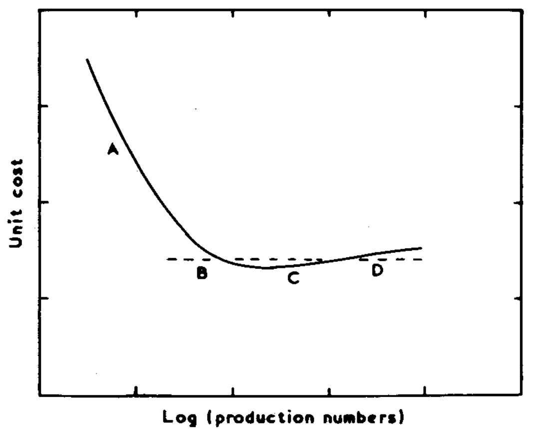

Fig. 1—General relationship between unit cost of a product and production numbers.

flattens out thereafter (BCD). In the flat portion there is a slight trend to increased costs as the economies of scale are counterbalanced by environmental, social, and organisational costs due to increasing size.

An optimal production for a particular production technology is a production unit close to the bend in the first part of the curve (B). If intermediate technology is conceived as something inferior, as something in between and make do, it is unlikely to find acceptability because we would be producing at costs somewhere near A. On the other hand if there are innovative elements in a product in terms of functional redesign, lower cost, higher production efficiency, and a not unnecessarily sophisticated product, the product can still find customers. The price of a 1903 Ford automobile was around $400 (Rs.4000/-) and the investment of Henry Ford was around $30 000. There were 125 workers. The first car came out in four months after the company started. In the subsequent 80 years the engine efficiency has increased only marginally, and the compression ratio has remained virtually constant. Major gains have been "aesthetic", "driving comfort", and "reliability". For these gains the time of production, tooling, and designing is now 3-4 years or longer, the price has increased by a factor of ten, and the amount of material used is three to four times as much.

The Ford T model car was at that time a major innovation. There has been no major rethinking on car design till the German Volkswagen was designed and production started in 1938 due to Hitler's desire for a people's car. It had a life of nearly forty years before production ceased. Interestingly, production ceased not due to lack of demand but due to the nature of human behaviour, sheer boredom of the producer, desire for change in the production system, and the drive to do something different. The Rabbit which replaced the Volkswagen has no major conceptual or technical innovation. Automobile design and production has gradually shifted into a style of conspicuous consumption, acceptable in the developed nations but unsatisfactory for developing nations. In the developing world, bicycles, mopeds, and scooters, both two-wheel and three-wheel, are fast becoming the people's transport. It is in a sense intermediate technology. However, having examined and ridden a moped, I discovered that in many ways designing a moped is quite sophisticated and as difficult conceptually as that of an automobile. The margin of weight and space being severely restricted the challenge to the designers is substantial. For example, the basic tubular frame in a bicycle is replaced in a moped by a hollow seamed rectangular structure which is both the gasoline tank and the frame of the chassis for mounting the wheels. Several such innovations give this light pedal motocycle an excellent power to weight ratio.

Electronics is a prime example of an area where a smaller scale of operation or a dispersed system of small scale manufacture can hold its own, if the design, standardisation, component choice, and material base are carefully chosen, and suitable quality control systems operate. Japan, and in some ways, Singapore and Hong Kong, are good examples of such manufacturng. The scale of operation is capital intensive only in the matter of large scale integrated (LSI) chips, and even then it is small compared to steel or automobile manufacture. Other components and materials such as the piezoelectrics, ferrites, circuit boards, speakers, small motors, rotary switches, tuning condensers, TV coils, and many others are, or can be, basically manufactured in the small or medium scale with efficiency and low investment. Singapore is now trying to scale down in certain types of integrated circuit manufacture so as to retain the flexibility for rapid change as innovation leads to design changes, yet still be able to manufacture at low cost. In a way, since the big Japanese and US companies operating from Singapore compete, but rarely cooperate, the Government of Singapore utilises the situation by monitoring these companies carefully to encourage local enterprise not to compete or cooperate with any of them but to keep options open. However the local companies are not averse to playing one foreign company against another. All this has been possible because labour is disciplined, entrepreneurs well informed, and engineers hard working. In electronics, technological changes have been rapid and big companies who have locked themselves into large highly automated specialised plants are now finding difficulties in switching to new plants and methods and in retraining workers rapidly. Singapore, Hong Kong, Taiwan, and to a lesser extent Japan, Switzerland, and South Korea, cultivated their flexibility even to the extent of building modular plants which could be rebuilt in modules, adding or discarding some in the process and rapidly re-engineering their production line to suit changing products. Such manufactures, however carefully chosen, require organisation, energy, machinery, materials, and components. The components of industrial success that are required are each characteristically different and cannot normally be substituted by another.

All goods can be classified minimally as primary (divided into non-renewable and renewable) and secondary (such as manufactures or services). Some conversion of a primary product is possible using primary energy, e.g. primary energy such as fuel (kerosene) can be used to cook, or as a solvent, or to operate a truck engine. In each case, there is an important factor, the efficiency of use, that is the output/input energy ratio. Another important factor is its renewability. Kerosene is a petroleum product, hence it is non-renewable; wood or alcohol on the other hand are renewable fuels. Ordinarily, economists do not differentiate these forms of goods, since a money value is attached which makes one commodity distinguishable from another only by price which would equate say 15 kg of wood to 2 kg of kerosene if the ratio of price per kg is 2:15. The ratio of the energy per kilogram of kerosene to wood tends to be 10 times. Other factors are also important such as portability, efficiency, and aesthetics. The pricing often ignores these directly.

While the ancient system of barter had the advantage of being needs based on both the sides, and additionally brought about sociability and mutuality, current market mechanisms tend to be distant, lacking perception, and are often inhuman. From an anthropological point of view the problem often is how to organise industry, or for that matter other economic activities, to combine a maximum sense of freedom, happiness, and human dignity without foregoing profit, efficiency, or flexibility.

In a large nation, such as India, there are differences between various States (there are eighteen in India) in income and well-being. One of the curious features that our economists came across is that one State, Kerala, in the south-western tip of the subcontinent is somewhere in the middle, i.e. eighth in order of per capita income among the States of India. Yet it turned out that Kerala has 80 per cent of the adult women educated, 87 per cent of adult men educated, a population growth rate of marginally less than 1 per cent, and a high level of health and freedom from malnutrition. Curiously, there are very few very poor and even fewer rich people in Kerala. While the disparities of income are singularly low, the density of population is high but there are no large urban complexes. Trivandrum, Cochin, and Calicut are modest towns linked by a continuity of human settlements over a 450 km length.

Many sociologists and economists have studied Kerala and its people. Dr. K. N. Raj a distinguished economist and himself a Keralite holds the view that the education of women and the status of women in Kerala is largely responsible for the health, nutritional status, and low population growth rate of that State. Professor Roger Revelle makes an anthropological comment to the effect that Kerala society was, and even today tends to be, matriarchal. The economic power of women has helped to change social attitudes. Mr. Stafford Beer mentions Kerala as an example of an eudemonic society, a society that strives to achieve happiness through maximum harmony rather than competition. Whatever explanation or reasons are sought to be given, Kerala, admittedly still an imperfect society, is an interesting example that the well-being of a society is not entirely or even largely a matter of per capita income. A healthy, highly socialising, cooperative society can be a pleasant, worthwhile, and innovative society. Competition and ambition exists but there seem to be some social restraints in keeping them within bounds. There are a score of political parties, half a dozen of them call themselves communists (of various shades, viz., CPI, CPM, RCPI, CPI(ML). There are various socialist and social democratic labels. Political discussions are intense. I suppose it is a way for people to have fun. Unfortunately, in recent years, Kerala governments have tended to be coalition ones with reduced life expectancies.

A well-meaning and interesting experiment by a Scottish self-made millionaire, Ernest Bader, mentioned by Schumacher bears retelling. Bader set out to organise a society which would combine a maximum sense of human freedom, happiness, and dignity without loss of profit. He stumbled when he sought to do this by ways and means that would be generally acceptable to individual owners of industry. Another, somewhat novel, experiment was the reorganisation of the Swedish Volvo plant several years ago. A large part of the ownership was vested in the workers. Norms were set up by mutual discussion and agreed to. Workers now work on their own chosen times, place, and pace of work to meet the set norms of production. Once in two or three years norms can be changed through discussion and analysis of achievements and difficulties. Human freedom and dignity is certainly achieved, and quite often efficiency as well.

Economists have tried to introduce new concepts and explanations to meet the demand of new situations. I have mentioned one of these, the quality of the environment and I will come back to it. A second concept of some consequence is the quality of life. An index called QLI (quality of life index) is often used to try to explain situations such as the one we find in Kerala, where a society is less prone to conflict because it is less competitive. The QLI is a composite index generated from the following.

1. Infant mortality defined as the ratio of surviving infants at the age of one year to the total number of live births per thousand of population: *Mi*
2. The life expectancy at the age of one year: *Le*
3. The percentage of adult literates as percentage of the adult population: *La*

$$QLI = f(Mi, Le, La).$$

It is apparent that such an index will run into difficulties since the index leaves out important factors such as environmental quality, overcrowding, and nutritional status. Some have argued that the advantage of QLI is its quantifiability, although it does ignore certain factors. Some further argue that environmental quality and nutritional status are reflected in the life expectancy and infant mortality. The attractiveness of QLI is that it becomes possible to conceive high QLI societies whose per capita income is comparatively small. Kerala has possibly the highest quality of life amongst the States of India with a per capita income lower than many of the States of the Union.

Let us examine the other side of the coin—the high per capita income societies, particularly those like Japan where the resource base is poor and population density high or the Federal Republic of Germany (FRG) where the resource base is better, but the population density is equally high. The high unit productivity of these two nations calls for a few comments. In both these countries, as in other nations of western Europe, initial investments after World War II came from the USA via the Marshal Plan. In 1949, FRG ranked fourteenth below that of Sweden, Australia, South Africa, Argentine, Brazil, and India. By 1960 FRG ranked next to the USA in the democratic world (excluding USSR) in production and trade, Japan overtook the FRG by 1970, and ranked next to the USA in production as well as foreign trade. It is hard to explain the economic resurgence of the FRG and Japan in terms of investments alone. There have been other nations with comparable investments but lower output to investment ratios. Even in the case of Japan where technological choices played a role, the high output to investment ratio was not entirely due to technological choices. The organisation and the use of traditional social ethos for production organisations was a key factor.

The role of the State as enunciated by Keynes and others was applied mainly during World War II and the immediate post-war years. His ideas were only partially effective in Britain. In western Europe, Japan, and the USA, Keynes' ideas were not as influential. Two types of ideas began to take hold. One set of ideas depended on the fact that high productivity is often not as much related to the quantum of investment as the harnessing of the citizenry's technical competence to a society's organisational skills. West Germany and Japan became prime examples, particularly Japan as Okita pointed out, where technical skills, technological choices, and organisational ability worked together to produce high unit production, high growth rates, and rapid increases in per capita income. The post-World War II industrial growth of Germany and Japan has been phenomenal for a variety of reasons. Since 1970 Japan has overtaken Germany, ranking only next to the USA with Germany following behind – the three industrial giants of this decade. There has been considerable interest in the phenomenon and some envy about the "miracle". Even in mechanical engineering products the FRG had 24 per cent of world trade compared to 6.3 per cent of Japan and 25.8 per cent of the USA. By 1982 Japan had a 12.4 per cent share of world trade in mechanical engineering products compared to the FRG's 20.2 per cent and the USA, 26.3 per cent. Yet mechanical engineering in Japan was given less priority than the key areas. As far as the key areas of current technological advances of Japan, the integrated circuit chips, microcircuitry, computers, robotics, and biotechnology, Japan is ahead of the FRG and USSR in R&D and organisational effort, but it is still overshadowed by the US effort. The present industrial growth rate of Japan is 2.2 per cent compared to USA 1.2 per cent, and FRG 0.4 per cent. It is remarkable to note that Japan's natural resource endowments are much less than that of the FRG and far below that of the USA. Even the quantum of Marshal aid was substantially smaller than that received by the FRG. The social and cooperative skills demonstrated by the Japanese people are however remarkable. The social history of Japan exemplifies these abilities; the hierarchies, the concepts of "giri" and "on" which have evolved over the last 1500 years, have had an important role in downplaying competition and emphasizing cooperation. The post-World War II resurgence of Japan has taken advantage of these older social coherences in its economic structures.

Technical skills both in the FRG and Japan have had an imporant role in school education since Bismarck's time in Germany and from the Meiji restoration (1868) in Japan. These have been linked to their social ethos of being a special people. Even in Hong Kong the importance of the Chinese concept of the family unit is woven into the electronic industry of Hong Kong.

In the last 15 years certain novel features have been recognised. These are related to an increased awareness of our environment, the matrix of geobiological features in which our life and well-being is imbedded. This has resulted in the efforts to define an environmental quality in which a society lives and works. Any society, primitive or sophisticated, draws upon its environment as the resource base. Environmental quality is, largely, the maintenance of the environment as a resource base without depletion or degradation so that the interest of future generations is maintained and not lost by a greedy society. The degradation of the resource base is aggravated by a high density of population. The environmental quality has been often looked upon as a social cost by economists. This is only a partial view. There are both social and economic gains which are difficult to quantify and are thus ignored. The example of Kerala in our country demonstrates the attraction a society may have for eudemonic rather than economic well-being provided minimal well-being can be assured. It is certain that the access to world's resources of energy and minerals that, for example, the USA has, cannot be a formula for developmental success. The power, the financial strength, and the penetration of the USA is not reproducible in any developing nation today, to any significant extent. New types of solutions consistent with the nature of man and narrowing resource base have to be thought of. These must take into account the quality of life, the quality of the environment, the encouragement of a nonconsumerist social ethos, together with economic advancement adapted advantageously to social tradition. A social tradition survives usually because in some ways it finds sustenance from human sociability in its ability to communicate within the group easily and outside the group less easily. A group of human beings will use and develop dexterity of the hand and fingers not because they always need it but because it is built into their genes. A human being will try to express these genes in a variety of ways depending on how he interacts with his group and his environment. Development is in some ways the expression of a people to utilise and control their environment more efficiently and more fully. To do so one needs skills derived from the interaction and reinforcement of the fingers with the brain and one needs to accumulate skills by communication and cooperation.

The importance of the traditional ethos and how its positive features can be utilized in the developmental objectives is one of the important tasks that we and many other developing nations face. Developmental objectives which have economic goals which are consistent with eudemonic goals have to be fostered. This calls for the use of science and technology at the most sophisticated level which will not unduly stress the environment and yet increasingly fulfil the aspirations of a people for a better life. It means not a retreat from industry, but development of industries that are energy-efficient and have little or no wastes. Or rather, if they have wastes these are planned to provide raw materials for other industries. It means agriculture that is not energy-intensive or seriously nutrient-depleting. It means considerable scientific effort not only for primary production but equally to get maximum advantage from wastes and from the various plant chemicals. It means the encouragement of extensive communication, education, and entertainment that has become possible at low cost due to electronics, computers, and telecommunication techniques. These are low energy-consuming, low cost, and enormously powerful industries at affordable effort and cost.

There are several ways of packaging such a system to suit the social advantages and constraints of different peoples. The packages need not necessarily postulate a totalitarian society or a fully free market system. If the goals are clear, suitable systems can be engineered. The most difficult and neglected issue is the nature of the human being. He is rational only part of the time. For the rest, neither science nor technology nor the general well being of people are adequate guidelines to steer us through the pitfalls of human nature and the biogeological crevasses in our environment.

The problems of food, water, health, and shelter are increasingly amenable to solutions by the application of science and technology. Food is lost or wasted at various stages and up to 15-20 per cent is lost in India. We are short of energy, and refrigerative preservation is not always feasible. We must investigate chemical, biochemical, and fermentation processes of preservation consistent with our behavioural predilections. Burma and Indonesia have done better than us, they have nappi and tempe as traditional foods. Water storage, irrigation, and aquaculture can be combined in the tanks and ponds of the development programmes at lower costs and comparable benefits as large dams. Soil nitrogen can be increased by application of nitgrogen-fixing algae, bacteria, and fungi to substitute expensive and energy-intensive inorganic nitrogen fertilisers. Wastes can give energy and fertilisers by anaerobic fermentation. The options that science and technology opens up are extensive. To choose and apply successfully, goals have to be clearly defined, the human behavioural factors have to be taken into account, and various biogeological pitfalls carefully avoided. All this calls for more sophisticated science, not less. In many instances the science that is needed is neither fashionable nor easily available in the developed world.

Minerals in the lesser developed countries of the Western Pacific

Sir Russel Madigan, OBE

Sir Russel Madigan, OBE, FTS

Sir Russel Madigan, OBE, FTS, is Deputy Chairman of CRA Ltd and Director of The Rio Tinto-Zinc Corporation PLC, UK. He is also Councillor and Honorary Treasurer, Australian Academy of Technological Sciences, and Chairman of the Academy Study on Aerospace Technology for the Australian Government. Sir Russel graduated in both mining engineering and law from the University of Adelaide and has had a distinguished career in the minerals industry, being, *inter alia*, Managing Director and Chairman of Hamersley Holdings Ltd. He is President of the Australian Institute of International Affairs and Past President of The Australasian Institute of Mining and Metallurgy, a Councillor of the Royal Flying Doctor Service of Australia, and Vice-Chairman of the Australian Mineral Foundation. His other directorships include National Commercial Union Ltd, APV Holdings PLC, and he is Chairman of APV Bell Briant Ltd. His OBE was awarded in 1970 and he was created Knight Bachelor in the 1981 New Year Honours.

Minerals in the lesser developed countries of the Western Pacific

Sir Russel Madigan, OBE

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Introduction

Because I am a mining engineer and have spent all my working life in the pursuit of developing the mineral industry, you may regard with suspicion my contention that the development of our present civilization from the Stone Age was based, stage by stage, on the progressive discovery of Earth's minerals and their metal derivatives. But without metals, and the recognition and useful application of their various special properties, we would be by definition still Palaeolithic men, nomads roaming the Earth in search of food and shelter. There would be no industry and not even any agriculture.

So as I talk about the topic of this session—"The technological and cultural needs and obligations of the less developed countries"—I will do so on the assumption that minerals are the basis of the standards of living of the industrialised countries, and that these countries have got where they are by developing their natural resources (or somebody else's)—not only for their own use but to exchange for something they haven't got, or got enough of. And I will use Australia as an historical example.

But first of all let me make a philosophical comment on the word "Needs" in the title of the topic. There seems to be a universal assumption that so-called less developed countries (LDCs) "need" all the things that people in industrialised countries think are necessary for a satisfactory way of life—as though people who are not like themselves are somehow underprivileged and deserve a better "standard of living". This seems to me to be a gross presumption, not at all consistent with the historical facts. Some of the newly industrialised countries (NICs) of today are the youngest countries in the world—the US, Canada, and Australia are a mere few hundred years old—whereas many of the LDCs (our term) are thousands of years old, with

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plenty of time to develop in any way they wanted, and not without the wherewithall to do it. Why didn't they, centuries ago, develop like the new, English-speaking countries? The better presumption is that they didn't want to and probably still don't. Perhaps it is only bodies like the UN with its UNCTADs and UNESCOs, aid programmes, market developers, IMFs, and the rest who want to make the Third World into instant NICs.

Perhaps the LDCs themselves think it is all a bit bewildering, because they certainly don't pursue the conventional route which they must know would enable them to get there on their own initiative—that is, the route successfully followed by the latest industrialised countries. I will be discussing the obligations of the LDCs to those who want to help them acquire industrialised status, but I recognise that obligations should not be forced on people who only want to be left alone.

My essay into philosophy notwithstanding, the conventional wisdom is that everyone in the world ought to be like the industrialised people, and wants to be, so I will go along with that assumption for the purpose of discussing what he or she ought to be doing to help himself or herself to get there. And although I will be doing it from the viewpoint of the paramountcy of the mineral industry, the argument could no doubt be developed by practitioners of other disciplines.

Let me begin by describing the impact of mining on the development of Australia. It is a good example because Australia has developed literally from the Stone Age in 200 years. I do not say this disparagingly of the people who occupied this country when the Europeans arrived, because maybe they were a civilization which had been better left undisturbed, but they were in fact people who had failed to develop the use of metals. There are lessons to be learnt from this story for those LDCs who genuinely want to have more of what we like to think are the good things of life.

Mining in Australia

Throughout history the discovery and development of mineral resources provided enormous impetus to the economic and social developments of many nations, and Australia is the latest example. Early development of mineral resources was slow because mineral prospecting was not encouraged, perhaps not even considered.

The discovery of payable alluvial gold near Bathurst, New South Wales, in 1851 was the start of Australia's mineral development. At about the same time, the potential of the Ballarat and Bendigo goldfields here in Victoria was recognised and the rush was on. As further important discoveries were made, more new settlers were attracted, new communities were established, and significant infrastructure developed.

Prospecting for gold led to the discovery of other mineral resources such as tin, and eastern Australia was the world's leading producer of this commodity in the 1870s and 1880s. Much the same happened with copper in South Australia.

The discovery of alluvial gold at Coolgardie in 1893 and the subsequent recognition by Irishman, Paddy Hannan, of the famous gold lodes of Kalgoorlie, Western Australia, shortly thereafter, opened up the western part of the continent.

In 1883 Charles Rasp, a boundary rider, discovered the famous silver-lead-zinc lodes of Broken Hill, New South Wales. As is so often the case, the significance of the manganiferous ironstone outcrops was not initially recognised. Some investors were prepared to take the risk and the first shafts encountered rich and extensive ore, and the field rapidly developed with the introduction of smelting in 1885. The first dividends were paid in 1886 and production from this great orebody has continued for a century. Last year, in fact, we celebrated the centenary of production from this remarkable mineral field. These dividends permitted The Broken Hill Proprietary Company Ltd (BHP), one of the companies with leases over the orebody, to open steelworks at Newcastle in 1915, treating iron ore from South Australian deposits that had originally supplied flux to the silver-lead smelters at Port Pirie. BHP grew to be Australia's only integrated steelmaker and largest company. BHP entered allied fields such as coal mining, coastal shipping, shipbuilding, cement manufacture, and speciality steel manufacture. A commitment to long term exploration led to participation, in joint venture with Esso Exploration and Production Inc., in petroleum exploration in the Gippsland Basin, Victoria, in the mid-1960s, which led to a number of significant discoveries. These discoveries have eliminated 70 per cent of Australia's dependence on overseas supplies for petroleum. It should never be forgotten that in the balance of payments, import substitution is the equivalent of exports.

Other prospecting and exploration successes were the forerunner to a number of major developments, often in remote and unpopulated areas of Australia. A few examples of these are the bauxite deposits of the Gulf of Carpentaria, Queensland; the iron ore deposits of Western Australia; the lead-zinc and copper deposits of Mount Isa, Queensland; the nickel-sulphide deposits of Western Australia; the coal deposits of the Bowen Basin, Queensland; the copper-lead-zinc deposits at Cobar, New South Wales; the uranium deposits of the Alligator Rivers area, Northern Territory; the base metal, tin, and tungsten mines in western Tasmania; and more recently the diamond deposits in the Kimberley region, Western Australia. In all cases, social and physical infrastructure has developed to support activities at these localities and with this a base for investment in new Australian industries.

To further highlight Australia's success in exploration, Table 1 outlines the effectiveness of exploration efforts for a wide range of commodities in recent years.

TABLE 1
Relative Australian resources

Commodity	1950	1984
Steaming coal	abundant	abundant
Brown coal	abundant	abundant
Lead	abundant	abundant
Zinc	abundant	abundant
Coking coal	modest	abundant
Iron ore	small	abundant
Bauxite	negligible	abundant
Uranium	negligible	abundant
Phosphate	negligible	large
Titanium	large	large
Copper	small	large
Nickel	negligible	moderate
Manganese	negligible	large
Natural gas	negligible	large
Crude oil	negligible	modest
Diamond	negligible	abundant
Gold	modest	small*
Tin	small	modest
Tungsten	modest	modest
Chromite	negligible	negligible†
Potash	negligible	negligible†
Platinum	negligible	negligible†

* Until recently there has been very little incentive to explore for gold.
† There is a continuing deficiency in these three strategic commodities.

Mineral discoveries provided Australia with a very significant boost to development that would otherwise have taken a much longer period to achieve.

A vigorous, healthy, and persistent exploration effort is the obvious precursor to a successful mining industry. Table 1 endorses clearly the success of Australian exploration efforts over the past three or four decades. Because of its importance, let us briefly examine exploration.

Exploration is a risky business—it is a complex mixture of science, economics, business acumen, experience, and calculated risk-taking. It is time consuming, it is expensive, it requires the skills of highly talented people and high technology, and it requires a dedicated effort over long periods. Even then it is not possible to predict with certainty the outcome of any programme as parameters such as location, depth, size, grade, and timing of discovery are unknown at the initiation of an exploration programme.

Exploration and development of a nation's mineral resources must continue if a country is to create new opportunities and sustain its standard of living. Exploration will proceed at an active level only when government policies encourage a viable mining industry. Those risking money in exploration must be confident that the development of exploration successes will not be unduly at risk through future instability, changes in government policies, the imposition of onerous contractual obligations, or unilateral action in re-negotiation of contractual terms, appropriation or compulsory dis-investment without adequate compensation.

Some of these aspects will be covered in my later analysis so let us return to the main theme. The contribution of the mineral industry to the structure of modern economies is often brushed aside or forgotten. Few people appreciate that every time you turn on the light, travel by private or public transport, eat fresh food or relax at home in front of the television, you do so because of the contribution made by the mineral industry—without it our modern lifestyle would be vastly different.

Different and distinctive characteristics

Mining is a relatively small employer of people in direct terms. Only just over one per cent of Australia's working population is involved in mining compared with 6.5 per cent in agricultural industries.

Despite being a major focus for the environmental lobby, mining has a minimal impact on the environment. Only a tiny fraction of 1 per cent of the surface area of Australia is affected by mining. Compare this with the 60 per cent affected by agricultural activity and I believe you can draw your own conclusion regarding which activity has most impact. Certainly open-cut mines, for example, may not be pleasing aesthetically while in production but rehabilitation after mining often results in a much better environment that existed before the initiation of production. In other cases the alleged "scars" of earlier activities are of major economic importance in terms of tourist income for the town concerned. The slag dumps at Broken Hill, New South Wales, and the treeless landscape around Queenstown, Tasmania, are good examples.

There are a number of other distinctive characteristics which make the mineral industry unique and highly sensitive to government policies.

1. Exploration is an extremely high risk and expensive activity. The chances of making commercial discoveries are low and, accordingly, there must be guaranteed tenure of title to protect such discoveries. Profits from their development must be sufficient to justify and compensate for the cost of exploration as well as providing an adequate rate of return on the development investment.
2. A mine is a wasting asset. As ore reserves are depleted, replacement of these can be achieved only through exploration for, and development of, new mines either nearby or elsewhere. Profits and cash flows must

be high enough during the limited life of the mine to fund further exploration so that the assets can be replaced with new discoveries.

3. The characteristics of each mine are unique. The mine and associated processing facilities must be designed to cater for the unique spatial, physical, and chemical parameters of each orebody. No two orebodies are identical.
4. The industry must compete in international markets. With few exceptions, domestic consumption of minerals falls well short of total production and the bulk of production must be exported. Reliance on international markets has exposed the industry to such things as large fluctuations in demand, and protection in the form of tariffs and quotas.
5. The industry can be exposed to currency fluctuations. These arise from export contracts typically priced in US dollars.
6. Volatile metal prices make new mines financially vulnerable. This is particularly the case in the early years when production might be below planned capacity and debt servicing costs are at their highest.
7. Mine locations are frequently in remote, inhospitable areas. Thus transport, communications, town, and port facilities often have to be provided.
8. Development costs are high. Costly investigation and proving up of each orebody is necessary to reduce risks associated with development.
9. Mining companies are often required to provide social and industrial infrastructure. In other industries such infrastructure would normally be provided by government.
10. Efficient transport is essential. More often than not the particular commodity is a low-value, high-volume product meaning that tranport costs are crucial in the economics of the operation.
11. High wages and good conditions are necessary. This is so because of the nature of the work and the often isolated location. Operating costs are consequently high.
12. Mining operations are capital intensive. This partly explains the industry's high productivity but carries with it the disadvantage of heavy interest and loan repayment commitments.
13. High cash flows are necessary in the early years to fund high loan repayments. Loan repayments are required in the early years because lenders perceive the higher risk in mining and lend on shorter term bases.
14. Replacement and incremental investment is high. After the early years, because of declining head grades and deeper mining levels, this expenditure must be incurred in order to maintain production levels.

15. Some countries require training programmes for nationals. These programmes invariably include the systematic transfer of responsibility for certain jobs from expatriates to locals.
16. Mine closure costs must be recovered. Examples of such costs are severance costs for labour, and rehabilitation and revegetation costs.

Despite the differences from other industries such as vehicle manufacturing, banking, and tourism, there is one common characteristic which the mineral industry shares with other businesses and that is the need to make a profit.

Investors will not be prepared to invest their savings in any activity which fails consistently to make an adequate return on investment, or which returns consistently less than alternative investments. This is one of the few key characteristics which the minerals business shares with other business.

Mining in the Western Pacific

The Western Pacific region is one of the most prospective regions in the world for mineral exploration and development. The region contains between one-quarter and one-half of the world's proven reserves of coal, tin, nickel, zinc, lead, iron ore, bauxite, and uranium and over half the world's reserves of a further range of minerals including copper, silver, and potash. There is good evidence to suggest that the region has the potential substantially to improve on this position. In the more developed and better explored countries many of the outcropping orebodies appear to have been discovered. As a result the difficulty and cost of making significant new discoveries is increasing due to the need to explore for concealed orebodies.

In lesser developed countries the discovery of significant mineral resources may be easier due to an historical lack of sustained exploration. But due to inaccessible terrain, lack of infrastructure, fiscal penalties, and the need to fund local partners or governments, the cost of success may be just as high or higher.

It is important that substantial exploration efforts continue in the region. Producing mines and petroleum fields are wasting assets—they contain finite resources which are being constantly depleted. For the maintenance and growth of the economic well-being of the industry it is necessary that the development of these mineral resources be enhanced by additional discoveries.

This will only occur when the local environment is conducive to a vigorous and effective exploration programme.

But most of the countries of the Western Pacific, including Australia, have a mining industry that is controlled by policies and legislation, no matter how well intentioned, that inhibit its growth.

Key issues

As mentioned earlier, exploration is a high-technology, high-cost, high-skill, high-risk business. Such expertise is usually captive to privately owned mineral companies with long experience in exploration. Provided a suitable environment exists, these companies are usually prepared to balance the increased risk of operating in a foreign country against the increased chance of success in a poorly- or under-explored country.

I believe governments in each country have a responsibility to their local populace to create such an environment. Naturally there will be conflicts when the aspirations of the government and the foreign mineral exploration company don't coincide but these must be reconciled if development is to proceed.

Following are some of the key issues that invariably arise in the negotiation of concessions for development of mineral resources.

Security of tenure and right to develop

Invariably a principal requirement by the investor is to be granted exclusive exploration and production rights to an area and to be guaranteed the right to develop a mine if a commercial discovery is made. The expenditure of high risk funds cannot be justified without such guarantees.

On the other hand governments are often reluctant to guarantee the right to proceed to development. In some cases there is even difficulty in obtaining exclusive exploration rights. Governments tend to have a desire to maintain control at all times with the power to prevent progress from one stage to the next by not issuing the necessary approvals.

Rules and regulations relating to exploration/mining

Before the investor decides to embark on exploration he needs to be able to identify all of the rules and regulations which will affect development and be sure that these will not change. A comprehensive agreement with the government is sought and the investor must be sure that this applies notwithstanding changes in the laws, etc., which conflict with the agreement. Parliamentary ratification is the usual means to achieve this.

Governments, however, frequently shy away from ratification of agreements and sometimes require that the investor complies with the laws which may be applicable from time to time, notwithstanding that these are inconsistent with or contrary to the terms of the negotiated concession agreement.

Increase in governmental controls and restrictions over the last two decades has been alarming. A comparison between the position since 1965 and 1983 in Australia demonstrates this. In 1965 a development decision could be made with reference to as few as four government departments and in a time frame of 18 months to 2 years. Now, approvals are required from

30 or more government departments and the time frame to obtain these is now measured in years and sometimes even a decade.

Local participation and funding

In order to maximise the return on investment and to ensure effective control over the operation, the foreign investor usually prefers to hold majority equity ownership in the venture. If local participation is to be introduced (including participation by government) the foreign investor requires the local parties to bear their pro rata share of the risk from the outset.

Government's position almost invariably differs from that of investors on this subject. More and more the requirement is being imposed for majority local ownership, and governments endeavour to have the foreign investor remove the risk before the local participation is introduced.

In the 1960s and 1970s there was a substantial increase in government ownership of mineral production. The copper industry provides a good example of this. In developing countries government ownership of this industry has increased from 2.5 per cent in 1960, to 43 per cent in 1970, and to 60 per cent in 1983.

In many countries, such as Chile, government ownership was achieved through nationalisation. Needless to say such action discourages further foreign investment.

Even if expropriation is not the method adopted, local ownership rules such as those imposed in Malaysia act as a disincentive.

It is unrealistic to expect foreign investors to fund 100 per cent of the risk if they do not receive a similar percentage of the reward in the rare cases when a commercial discovery is made.

Taxation

The foreign investor frequently takes the view that taxes must be considerably lower than in the home country to compensate for the added risk and cost involved in operating in a foreign country. Furthermore taxes should be on profits rather than on production or exports, and they should be proportional rather than progressive—otherwise the incentive will not be there to invest and the tax regimes imposed by some countries actually operate as a disincentive to exploration and development. The most publicised example in Australia in recent times is the Federal Government's proposed resource rent tax. Any tax which is imposed over and above corporate income tax on selected activities must serve as a disincentive to investment in those activities. This particularly applies to minerals and petroleum exploration where the risks are so high. The potential rewards from the sporadic success must be higher than in more traditional areas of investment; otherwise the risk will not be worth taking and exploration will cease.

In certain countries the policies pursued by governments for development of resources prevent the investor from taking advantage of taxation incentives. For example, in Indonesia government policy is that a company cannot hold more than one contract of work for the exploration or development of minerals. This means that a foreign explorer with a portfolio of exploration prospects must incorporate a separate company to operate each prospect. Moreover if expenditure under a contract of work proves to be unsuccessful, such expenditure is lost forever. It cannot be offset for tax purposes against the income from a sister company which is fortunate enough to make a commercial discovery. This means that there is no tax recognition for abortive exploration. Thus, the investor is considerably worse off than in those countries, such as Australia, which permit one company to undertake multiple exploration and development programmes.

I should not, however, praise Australia too highly as Australia will only permit exploration expenditure to be offset against mining income for tax purposes, and not against income from other sources. If the purpose of permitting deductions is to encourage exploration, surely this distinction should not exist. Deductions for petroleum exploration expenditure can be obtained against income from any source. There appears no obvious reason for the different treatment applied to mineral exploration.

Another unsatisfactory feature of Australia's treatment of exploration expenditure for tax purposes is that it does not permit consolidation of income and deductions within a group of companies. Thus, if for corporate or other reasons it is desirable for one company in a group to undertake an exploration programme, the costs incurred cannot be offset against mining income from another company in the same group.

Super or excess royalties

Governments in developing countries have tended to introduce concessional rates of corporate taxation in the early years to attract investment but the benefits from this are frequently eroded by progressive tax systems such as excess profits tax and super royalties.

Super or excess royalties imposed by governments usually do not take into account the cyclical nature of the industry. Unfortunately profit-based royalties generally result in higher royalties being paid in good years, but with no corresponding adjustment in the bad years.

For a profit-based royalty system to be properly applied

1. the rate must be set at a flat and reasonable rate of profits (i.e. it should not be a progressive rate),
2. profits must be calculated on a reasonable basis, e.g. appropriate allowances for depreciation and capital service, and
3. provision must be made for the indefinite carry back and carry forward of losses.

Foreign exchange requirements

Foreign investors usually require a guarantee that profits can be repatriated and that export earnings can be retained in foreign currency to meet foreign obligations such as dividends and debts servicing.

Governments, however, in order to boost their export earnings, prefer that all moneys be transmitted through the central bank and that the government has full control over the repatriation of funds from the country. This leaves the foreign investor with no guarantee of repatriation or protection against currency fluctuations or conversion costs.

Down stream processing

The foreign investor invariably requires the right to decide the scale of the operation to be undertaken and the extent to which the product is beneficiated and processed before it is sold. It is difficult enough these days to make any mining project economic, without the government dictating the type of project and the degree of processing to be undertaken. On the other hand governments generally seek to impose an obligation to process minerals at least to the refined stage.

It is an obligation of developing countries to resolve these differences in aspirations. Unfortunately, in many countries, despite genuine enthusiasm to encourage resource development, the bureaucracy is unwilling to depart from strict adherence to the government's stated aspirations. The result is that the exploration programmes are not started.

I believe it to be an obligation of the developing countries, wherever possible, to remove these and other impediments, thereby enhancing the prospects for a viable mining industry for their nation. My own company, CRA Limited, has been involved in exploration in foreign countries for more than two decades. The most notable success is the Bougainville copper-gold mine which was discovered in 1964 and owned by the company (53.6 per cent), the Government and other instrumentalities in Papua New Guinea (21.1 per cent), and public shareholders (25.3 per cent).

Our experience in other countries has not been so good. We have withdrawn from Malaysia and the Philippines, we have reduced our efforts in Canada and Chile, and are now in the seventh year of discussions in Thailand and Indonesia in an attempt to reach a suitable position.

The resources are there to be discovered and developed, just as they were in Australia. In Australia's case, the UK and the US were recruited to supply their capital, their technology, their expertise, their management, even their labour, to develop the mineral industry. But it all accrued to Australia's national benefit, on commercial terms acceptable to the expatriates. It could be argued that Australia is still an LDC but the extent to which it is an industrialised country is due to being prepared to accept outside help to help itself.

Everyone has the same opportunity, so if Australia can do it so can everybody else. If an LDC really does want to become an NIC then it has an obligation to do whatever is in its power to do so. If it is not prepared to help itself, including accepting help from outside, it should be a legitimate question whether it has any right to quality for gratuitous outside assistance.

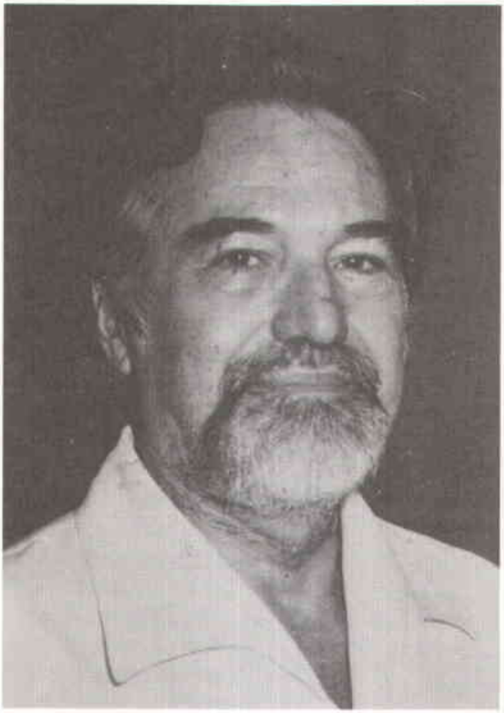
Conclusion

I hope I have provided some insight into the potential impact of the mineral industry on the economies of less developed countries, and in the process identified some of the problems which have to be tackled if the benefits are to be realised.

I have no argument with LDCs who want to be left alone but if they aspire to the status of NIC then they should take the steps necessary to encourage a climate conducive to a healthy, vigorous, and prosperous mineral industry.

Technological advance changes patterns of employment and culture

Royal Professor Ungku A. Aziz



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Technological advance changes patterns of employment and culture

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Introduction — a modicum of semantics

My topic explores a causal relationship between technological advance and patterns of employment as well as patterns of culture.

The nature of this relationship may appear to be so obvious that it would seem to be extravagant to discuss it. However, if we carefully examine certain third world countries today, we can see examples of situations where this causal relationship has either been deliberately ignored or it has been fatally misunderstood. Its inexorability has been overdiscounted.

Before explaining what I mean by the three concepts of technological advance, employment, and culture, I should remind the audience that the kind of change I am talking about is not only interactive (i.e. it is a two-way feedback process) but it is also cumulative.

Change is passive when it is other-directed. That is to say, the community, society, or nation in question does not have any effective control over the kind of technological advance or its pace of introduction. The changes are made either by some "other" party (e.g., colonial influence) or by outside forces on which the country is highly dependent for markets for its commodity exports or for its imports or manpower.

Change is active or positive when the decision-makers of the society or state in question seek to realize certain objectives by realizing plans that involve the mobilization of the resources at their disposal. While I agree that exhortation cannot be a substitute for works, I would like to suggest that leadership can play a crucial role in mobilizing or inspiring a community or society to levels of performance that result in the achievement of the desired goals.

I shall refer to "patterns" of change. In my concept, change is not linear. For example, if we introduce the bicycle, it does not have a domino-like

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series of changes. Or to change the example, it is not like a rolling billiard ball that cannons into other balls to drive some into pockets and/or cause others to strike other balls so that a favourable arrangement is created for the next shot. Change is perceived through variations in patterns.

Employment has a pattern just as a woven carpet has a pattern. Rarely is the pattern one of stripes or checks. It consists of a variety of sub-motifs that are constantly changing in shape and colour. For purposes of study, we can examine snapshots of the changing patterns. However, we should always realize that between the time the data are recorded and the time that new positive steps are taken to do something, the pattern will have changed. We should understand that patterns of change not only have three dimensions of shape, size, and colour but there is an important dimension of time which is relentless.

Employment

I anticipate no difficulty in defining the term "employment" to this audience. In the third world context, from whence I come, one major change can be from unpaid or irregularly-rewarded family work to a factory job with regular weekly wages. The significant element in the pattern of employment includes changes in gender (not sex please). Changes in age structure or an extension of education facilities reduce the labour supply of young workers. On the other hand, an increase in demand for young women workers reduces the supply of brides whose sole destiny was envisaged to be cooking and child-bearing. Marriage age is postponed as is the child-bearing age. Incidentally, in third world countries the state is a major employer.

In some third world countries the armed forces absorb significant proportions of the employable male population. In some instances, this may be just national service during the formative years; in other countries it may be for a substantial proportion of the working life of males. The number of third world countries experiencing military takeovers makes this a more significant aspect today than it was some thirty years ago. Unfortunately, economic textbook writers have yet to catch up with this phenomenon. They still regard it as being exotic. In some continents, it is the rule rather than the exception. Nevertheless, one should bear in mind that militarization can also be associated with certain forms of technological change.

In passing, it should be noticed that several radical changes in the patterns of employment and culture have occurred in our part of the world almost within living memory. In other words, technology transfer and changing patterns of culture and employment are not new topics.

Early in this century the creation of a great demand for natural rubber in the United States and Europe radically changed not only employment patterns but also altered trends in population growth. The indigenous small rubber farmers of Malaysia and Indonesia experienced rapid changes in material wealth during the boom times and unimaginable poverty during the great depression.

One significant difference between the effects of the expansion of rubber farms between the two world wars and the introduction of the assembly of electronic parts, especially integrated circuits, after the genesis of Japan as an economic super-power, is that the former involved male workers and their unpaid families who remained as producers in situ. On the other hand, young women have migrated to larger and smaller urban areas to work in the electronic assembly plants. Both innovations in the forms of production involved equally comprehensive changes in the patterns of employment and of culture even though the actual objects of change were different.

Before leaving the topic of employment, we should touch briefly on the issue of the organization of labour. The economic history of developed countries seems to indicate that after a period of fierce struggle, the organization of labour is accepted by industrial employers, the government, and the legal system. Later on, in the context of affluence, the pendulum swings the other way.

In the newly industrializing countries, while governments are committed to the eradication of poverty and the enhancement of the quality of life, they are also trying to attract foreign investment. One of the most attractive features a third world country can offer in this context, is the promise that there will not be any problems from trade unions. This puts employers in a strong position to cut corners regarding the welfare of workers and security of employment. For women workers who are taking up their first paid job, the adventure of the new life may mask the need for industrial representation at the beginning. It is likely that the pattern of industrial relationships will change quite rapidly as the whole system matures.

Culture

I shall now turn to culture. Since the UNESCO Dictionary of the Social Sciences offers a menu of 16 definitions of the term "culture", I do not experience an excessive loss of modesty by offering my own connotation for this term. Culture embraces the way of life and worldview of the people we are concerned with.

We are interested in changes in any patterns of culture which are associated with advances in technology.

To put it simply, as technology changes, we may expect a range of phenomena that can be grouped under the heading of "culture" to change. Clothing will change. The nature of factory work, be it chemical processing in a detergent factory or checking out in a supermarket, will determine the type of garment worn. Certain work processes many require the head to be completely covered. In some industries, face masks or gloves may be required. The journey to work or industrial safety may determine footware.

The receipt of regular cash wages will lead to the ownership of a handbag with a shoulder strap. This bag may contain cosmetics, and young ladies' knicknacks as well as keys. Sanitary towels are widely advertised and padded brassieres appear in Sunday markets.

One researcher at the Institute of Advanced Studies of the University of Malaya observed the spoken language of the new women factory workers who come from different parts of Malaysia. People with differing dialectical backgrounds tend to iron out phonological differences when they interact with one another. A whole new vocabulary has been created to describe the new phenomena in the lives of these workers. These new words range from calling work supervisors "Tarzan", the ladies' briefs as "comel" which means petite in the Malay language, to the use of "video" for day dreaming. Naughty children (in day care centres) are called "robos" after the English term robot.

Perhaps this is more than what Marshall McLuhan ever bargained for.

My concept of culture includes changes of language in the new women's magazines and weekly tabloids that have appeared in large quantities during the past few years because there now is a ready market for them. The market was created by

1. the rapid expansion of secondary school education for women, which began in the 1960s, and
2. the purchasing power of young women workers in industrial areas.

The same workers are vulnerable targets for direct selling campaigns organized by multinationals distributing cosmetics, detergents, and tupperware, or even pyrex.

The cultural changes in food range from the need to consume the fast foods to bottled cola drinks. Since much of this type of food is junk food, it is not a good foundation for a young girl who will have to cope with motherhood in a few years' time.

On a personal note, I regret the passing of Malaysia's itinerant hawkers who offer such a rich variety of well-cooked nourishing meals. They are systematically being eliminated by the challenge of fast food campaigns and by being relocated by City Administrators beset by health regulations and that bane of technological advance, the motor car, and the need to provide adequate parking space. Ultimately, affluence will bring back so-called "ethnic" cuisine but that will not be for daily consumption.

A big share of culture is pervaded by the media, especially radio and television. Programmes are mass produced for a global market. It is a moot point as to whether the working women of Malaysia or the nouveau riche middle classes really need to be entertained with soap operas about the weekly problems of white employers with black house servants in the USA.

Then there are the creatures (or should I say monsters) created by the media such as "superstars" like Michael Jackson or Boy George, who seem to be symptoms of societies that have been unable to adjust their humane relationships to the pace of technological advance.

I am quite clear that this is not the context to cavil at Western civilization. Nevertheless I cannot be so clinically objective that my worries about the impact of technological advance on employment and culture in my country do not share the worldviews of many intellectuals who have Malaysian, Arab, or oriental backgrounds.

Conclusion

I realize that, to a large extent, if we want technological advance then the package of progress is indivisible and inexorable. We can try to curb many of the execrable excesses of modern life. However, we have to be tolerant of substantial changes in patterns of employment and radical changes in patterns of culture.

The aspiration for progress has to be tempered by a disposition for toleration. While we may wish to re-establish the finest values of our religion and our own traditions, at the same time, we should try to avoid the excesses of xenophobia, chauvinism, and fundamentalist fanaticism.

Food from the hydrosphere – the role of eco-techniques

John E. Bardach

Dr John E. Bardach

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Food from the hydrosphere — the role of eco-techniques

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Introduction

The last ten years have made us aware that hunger and malnutrition have largely social and economic rather than technical roots. They have also made us aware that malnutrition is a complex phenomenon and that its physical solutions will have to deal with attaining proper balances in diet of carbohydrates, proteins, minerals, and other micro-nutrients (Berg, 1977). Animal proteins of aquatic origin—fish and shellfish—have been important protein-supplying components of the human diet from time immemorial. After World War II many pronouncements, even of reputable scientists, led us to pin great hopes on the hydrosphere as an all-important contributor to alleviating scarcities of high quality foods. It has now become evident that the procurement of proteins of aquatic origin—fisheries and aquaculture—have not kept the promise they seemed to have.

Here, as in several other pursuits, it has now dawned on us that until recently we had disregarded, or not known of, the existence of great complexities that characterize man's interfacing with the natural world. We have disregarded or underestimated the influence of man-induced externalities. Most importantly, we have established our increasing dominance over nature in a piece-meal rather than a systems fashion, an approach that has proved to be beset with difficulties, especially when it comes to dealing with the large fluid portion of the biosphere, the oceans. We have taken short- rather than long-term views, an attitude that now clearly threatens to haunt us, and we have, understandably but perhaps excessively, relied on economics as a guiding science. In doing so we have typically shown a rather simplistic reliance on "mechano-technical" rather than "eco-technical" approaches to certain aspects of exploitation and management of the water portion of the globe.

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Each of these mistakes, excusable as they may be in hindsight, could serve as the topic of a separate conference; here I wish to deal with certain approaches to the technology of aquatic food production. I shall stress aquaculture, prominently including mariculture, both because it provides good examples of different kinds of technologies and because it still seems to hold substantial promise to upgrade with affordable inputs even the diet of the less than affluent and because it is of great importance in the Western Pacific region.

Echo sounders and underwater television used to monitor and improve the power block-assisted operation of large fishnets are examples of highly mechanized primary production techniques, as are silo-based high-intensity schemes of shrimp production. In agriculture, giant tractor-drawn sets of planters, harvesters, and the like fall into this category.

Eco-technologies, in some contrast, use methods in the tending, rearing, attraction or capture of fish and shellfish that rely on manipulation of ecosystem components and processes, incidentally reducing direct or indirect energy inputs (e.g. chemical fertilizer or heavy nets and the like). This is not to say that eco-techniques use no instruments, but rather that they rely more prominently than the mechano-technical approach on the understanding of the natural systems in question and the integrated management of them. The two approaches to food-producing technology are not opposites, however, but rather form a continuum of complementary possibilities; there are far greater opportunities for mixing mechano- with eco-techniques than we have been wont to assume. Characteristically, eco-techniques may have roots in traditional techniques of management but these have been put through the filter of quantitative applied science. This filtering tends to raise their efficiency and enhances their potential of being transferred to situations other than those in which they arose. Some eco-techniques include few if any components which could readily be patented or trademarked, and would thus have to be promoted for their own sake rather than for the supplier's direct economic gain. As mentioned later, there are some eco-techniques that can include components suitable for patenting or trademarking, and that are therefore more likely to be developed on commercial grounds.

Background

Depending on the region, fish and shellfish supply from a few per cent to more than half of man's animal protein intake. They are, by and large, more important in Asia and the Pacific than in other parts of the world (Table 1). In China, Japan, and Korea, as well as on Pacific Islands, seaweeds supply minerals, vitamins, and fibre. Increasingly high technology is being used in the hunting and gathering of the grazers and predators of ocean pastures, but even so, fisheries yields have risen slowly during the last

TABLE 1
Nutritional significance of fish and seafoods in the diets of people in Asian countries

Country	Per capita GNP US$ (1976)	Daily per capita availability (1972-74) Calorie	Protein g	Protein of animal products g	Fish and seafoods g	In % of animal protein
East Asia						
China, People's Republic of	410	2,278	61.7	11.8	3.8	33.0
China, Taiwan	1,070	2,757	74.2	24.7	11.1	44.9
Korea, Republic of	670	2,749	72.0	13.1	9.0	68.7
Korea, DPR	470	2,636	76.4	12.1	8.0	66.1
Japan	4,910	2,832	85.5	40.1	22.1	55.1
Hong Kong	2,110	2,641	78.6	44.4	14.8	33.3
Mongolia	860	2,477	92.8	60.9	0.2	0.3
Southeast Asia						
Singapore	2,700	2,823	74.6	37.6	13.7	36.4
Malaysia, Peninsula	860	2,539	45.1	8.6	1.0	11.6
Malaysia, Sarawak	–	2,518	51.9	15.5	9.3	62.0
Malaysia, Sabah	–	2,776	59.7	22.1	11.3	51.1
Indonesia	240	2,031	42.0	5.3	3.6	67.9
Philippines	410	1,957	45.5	16.7	8.9	56.7
Thailand	380	2,302	49.5	13.2	6.8	51.5
Burma	120	2,125	55.2	8.8	4.0	45.5
Kampuchea	–	2,081	48.4	7.5	3.2	42.7
Laos	90	2,064	56.2	9.5	1.9	20.0
South Asia						
India	150	1,967	48.5	5.3	0.8	15.1
Bangladesh	110	1,949	43.2	6.7	3.5	52.2
Pakistan	170	2,128	57.2	12.7	0.3	2.3
Sri Lanka	200	2,075	40.9	6.6	2.6	39.4
Nepal	120	2,019	49.7	7.5	0.1	0.1
Afghanistan	160	2,001	61.5	6.9	–	–
Iran	1,930	2,319	60.8	11.8	0.1	0.1

Prepared by Y. H. Yang, RSI/EWC, from FAO (1977) and World Bank (n.d.).

several years while aquaculture has grown vigorously (Bardach, 1977; 1982) (Table 2 and Fig. 1).

Fisheries have relied very largely on conventional stocks in near-shore locations with pressures that were excessive in places, leading to serious declines in takes, but remaining sustainable in others, with operations being here and there bedevilled by pollution. Going further from shore, sometimes as far as the poles, as in the case of the Comecon and Japanese

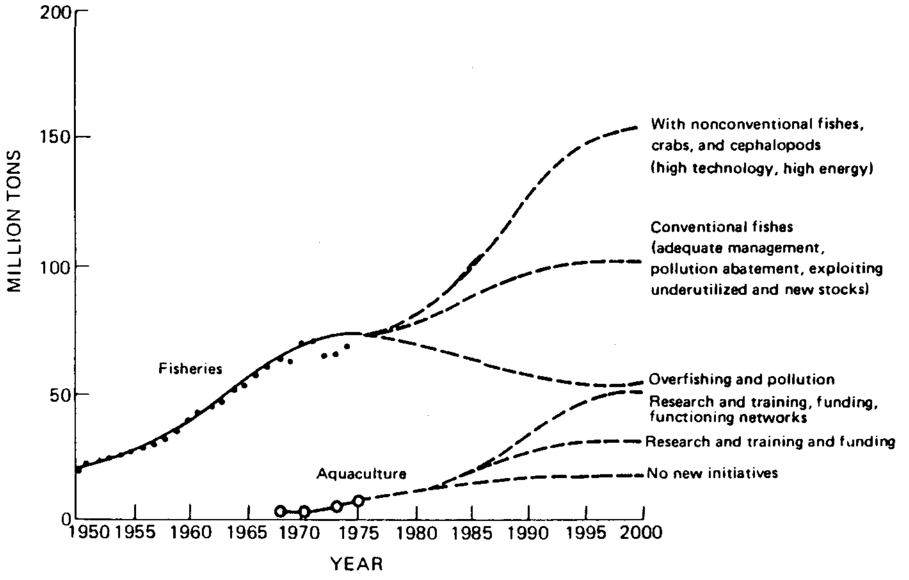

Fig. 1—Actual and projected world fish catch, 1950-2000 (after National Academy of Sciences, 1977).

TABLE 2

Five year comparison of production and growth of fisheries and aquaculture

	1976	1981	% Gain
Fisheries			
(edible products)	51.1	52.6	4.9
Aquaculture			
Fish, crustaceans, and mollusks for human consumption	5.05	6.51	28.9
Algae included	6.2	8.7	40.3

From FAO (1975-1982) and Pillay (in press).

pursuit of Antarctic krill, or thrusting into the mid-depths where large unused stocks exist, demands higher, and in some cases very high, technology and high energy inputs. It is well known that high-technology nations dominate world fisheries, for precisely these reasons; deep and distant ocean fishing may thus be of limited applicability to developing nations. At this time, developed nations have 54 per cent of the total catch and deal with two-thirds of the international trade in fish and fishery products. What is less well known, though, is that most fish in the world are caught in the north temperate rather than the tropical or southern oceans (Table 3), and

TABLE 3
1980 fishery landings of the major ocean areas

Area	Catch tonnes
Northern Atlantic	14 608 502
Central Atlantic	6 901 691
Southern Atlantic	3 864 881
Indian Ocean	3 750 887
Northern Pacific	20 730 370
Central Pacific	8 125 787
Southern Pacific	6 594 109
Total marine areas	64 576 200

Source: Adapted from FAO (1981).

that nearly 30 per cent of the catch is turned into fishmeal for animal feed. Of the fish intended for direct human consumption, it is estimated that as much as 10 per cent is wasted (Cuyvers, 1984).

With the 200 mile (322 km) exclusive economic zones (EEZs) established by the 1982 Law of the Sea Convention, all littoral nations have acquired much control over the aquatic extensions of their national territories. To make best use of the living resources there will take time, the acquisition of new knowledge, much technology and, it is estimated, more money than may be conveniently mustered (Karnicki, 1981). The protein gap in many developing nations is therefore not likely to be filled by more fish for quite some time, at least by means of conventional mechano-technical approaches to ocean fishing. It is urgently necessary, therefore, to examine alternative approaches. In particular, it may well be more effective to focus on fish keeping and new modes of fish protein utilization rather than on extending the oceanic fish-hunt horizontally and vertically. This might well include combining engineering and biological skills towards upgrading or fashioning anew of culture-compatible chemical and micro-biological low-energy-input methods to prevent or retard spoilage, as another variant of eco-techniques.

Culture fisheries have grown rapidly in the past decade, in part because knowledge of the physiology, biochemistry, behaviour and above all ecology of the cultivars has increased (Bardach and Magnuson, 1980; Muir and Roberts, 1982). Fish and shellfish husbandry requires control and hence, usually, containment in ponds, cages, or raceways and, among other exigencies, attention to feeding. Because of these requirements of control, aquaculture has flourished more in fresh and brackish water and in protected marine areas than in the sea proper, but with increasing competition for fresh water increasing also in the Western Pacific and with pollution, emphasis is to be noted on techniques that maximize biomass production from given volumes of water.

Eco-techniques in aquaculture

Extreme control, oxygenating with ozone rather than air, and expensive high quality feeds, can give many tons of shrimp or eels from a small area, albeit with very large inputs of all sorts. If one also attempts true recycling of water, costs usually become prohibitive. The two mentioned crops are high-priced and in demand in high-GNP nations which rely largely on receiving them as imports. Techniques here may be fully or semi-proprietary and, not that this is bad, they generally make the rich richer. At the other end of the intensity-mechanization continuum in aquaculture is the stocking of inundated rice fields, canals, ditches, artificial lakes, and the like. They are characterized by low inputs and low but possibly widespread yields, and they can augment the diets of the poor directly. In the middle lie various methods of more or less intensive polyculture, from the traditional way of growing several feeding types of carp in China to the growing together of several species of fish, of prawn and fish, and of aquatic with terrestrial or avian stock.

Doing so requires relatively sophisticated fine tuning of an ecosystem and its components as in manure-driven integrated farms existing in China (Pritchard, 1980), in Thailand, and in numerous other Asian countries (Pullin and Shehadeh, 1980; Edwards, 1980). These systems integrate livestock rearing, vegetable crops and fish polycultures on rotation cycles within the pond space. The fish culture systems are linked to adjacent agricultural systems not only by the utilization of agricultural wastes as feeds, but also by the irrigation and fertilization of crops with fish pond residues. Use of agricultural and animal wastes in fish farming replaces the need to add commercial feeds, often the highest annual expense in feedlot type aquaculture (Schroeder, 1974). Integrated systems not only produce high fish yields of 4 to 10 tons/ha/yr (ICLARM, 1984a, 1984b), but produce protein cheaply and efficiently due to the high outputs and low cost of inputs. Also, when the economics of monoculture and polyculture systems are analyzed, polyculture systems maximize profit; in Indian fish-pig-poultry demonstration farms, for instance, these were as high as 100-155 per cent of variable costs (Jhingran and Sharma, 1980). Clearly these integrated systems adapted from simpler traditional practices are important "new" methods of producing high protein foods cheaply and abundantly for the rapidly expanding populations of the developing nations in areas where such practices will find cultural acceptance. This certainly is the case in much of the Western Pacific but these systems may well be appealing in the West also, since they can make available cheaper fisheries products, and since diversification of agriculture is already being considered for adoption, also on environmental grounds.

Increasing competition for both land and freshwater has put a premium on the development of true mariculture. Here as in fresh and brackish water one can go the high-intensity, high-control, hence higher-technology route, as is done in sea trout or yellow tail culture in enclosures, or one can try to take lessons from nature and perhaps even try to go her one better. Practices in this category can be found predominently in Japan where the tradition of "gently leading nature" prevails perhaps more than in other places. They consist of various measures to enhance underwater habitats (fish shelters), the release of young, making use of traits in the animals' behaviour to enhance feeding as well as the control of time and place of fishing. It is this trend of habitat protection and upgrading that makes these practices resemble those of polyculture rather than those of the feedlot. As yet, however, they are usually directed to increase the yield of one or another rather than several species together, a task that would require fine tuning of "fuzzy" systems.

Red Sea bream (*Pagrus major*) for instance is a prized food fish in Japan. With adequate information on its life history, spawning times and places and the capability to govern its reproduction, one can add to the enhancement practices the strategic large scale placement of elaborate fish shelters, made from such waste materials as fly ash, with designs that are the result of years of trials. One can further retain the fish in a desired area by the conditioned reflex training of released juveniles that can be recalled by sound even after their release (Fujiya, Sakaguchi, and Fukuhara, 1980) (Fig. 2). These measures require the cooperation of fishermen over wider areas than is usually practised in intensive or semi-intensive aquaculture. In the Western Seas of Japan, bordering Kyushu, they rely on collaboration of research, management, and fishermen's organizations. Such use of ocean engineering coupled to management techniques that embody knowledge of animal behaviour (Table 4) as well as ocean ecology represents one of the environmentally sound, promising roads to obtain more from certain reaches of the sea than is possible by capture alone; in Japan they have also proved economical. In fact, the outstanding feature of interest here is that biologists and engineers have combined forces to produce tools that

1. are made of industry surplus (excess cement, fly-ash),
2. can be fabricated in large numbers,
3. are modular (research is in progress on how to assemble them on the spot and yet make them durable), and
4. have been fashioned so as to maximize the way in which they assemble fish—even to include consideration of interaction between construction material and enhancement of fish food organisms that grow on the material (Fig. 3).

The Japanese government instituted a national coastal fisheries program in response to the 1973 oil crisis, the growing impact of the 200-mile (322 km) extended jurisdiction statutes, and to development-related coastal

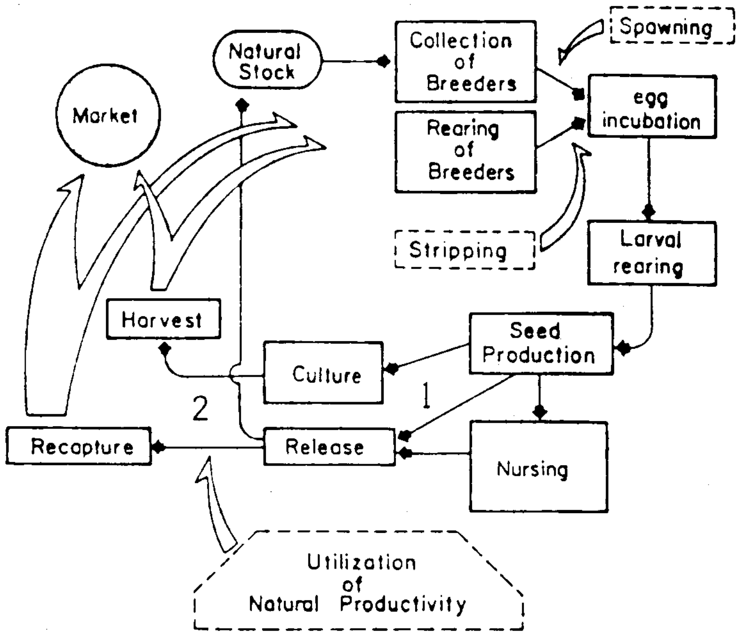

Fig. 2—Flow chart of steps in farming of Red Sea bream in Japan. 1. Conditioned feeding reflex training by sound; 2. Fish shelters.

environmental degradation. From 1976 to 1982 the budget for this program was $870 million of which $326 million was allocated to artificial (fishing) reefs (Mottet, 1982). This investment in artificial reef research and development is projected to develop 5 per cent of Japan's coastal waters into fishing zones with the placement of reefs at 2500 sites, the extent of which varies from few to many kilometres. These reefs are expected to yield 4.8 million tons of fishery products annually (Mottet, 1982), well over a third of Japan's present, the world's largest, fish production. This large undertaking by the government, universities, and private industry has resulted in dramatic new developments in reef module designs.

In the just-mentioned locations, the water is too deep for present direct, routine tending of the structure in the ocean, but on coral reefs, so prevalent around Pacific Islands and to some extent among mangroves equivalent modular practices, resembling true gardening are possible (Doty, 1982)

TABLE 4

Summary of barrier elements to contain fishes

Type of barrier	Previous use as repellent or barrier	Effectiveness	Mechanisms involved	Selectivity	Potential as a barrier element	Remarks
Light (white)	Yes	Good	Not understood	Fair	Fair	Usually used as attractant
Colour effects	Not intentionally	Fair	Not understood	Fair	Fair/Good	Distinct colour effects, so more repellent than others Contradictory results on which colours produce which effects and reasons for these effects
Electric barrier	Yes	Excellent	Understood	Good	Excellent	Best suited to barring large predators Fright reaction may be exploitable, with the use of very little electric power
Acoustic barriers (biological sound)	Yes	Excellent	Possibly understood	Good	Excellent	Boundaries likely to be indistinct
Bubble curtain	Yes	Very good	Possibly understood	Unknown	Very good	Effectiveness is limited in currents, turbid water, and at night
Chemical (olfactory)	Yes	Good	Possibly understood	Good/ excellent	Good/ excellent	Potential largely unknown May prove the most selective

Adapted from Bardach and Magnuson (1980).

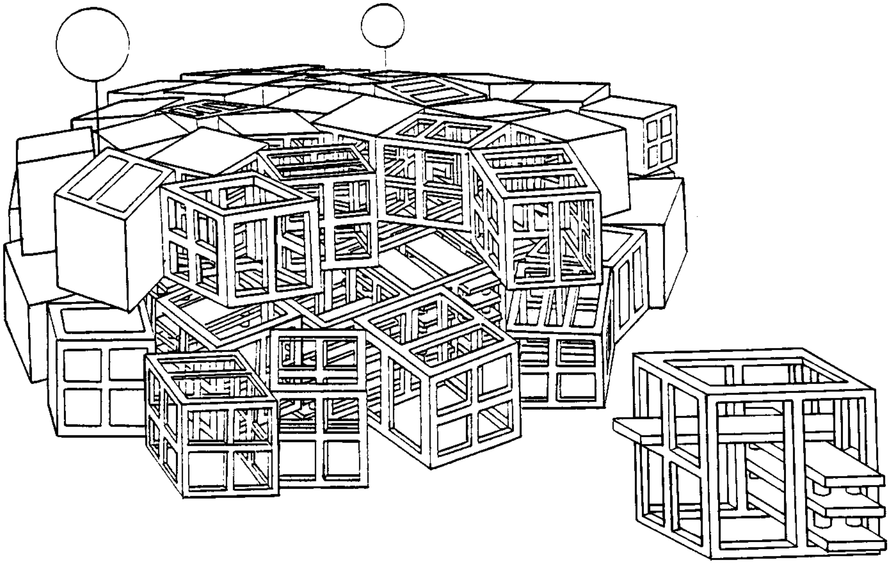

Fig. 3—Model of some of the proposed artificial reef modules being adapted to Hawaii by extending Japanese principles. They are shown with and without interior refuge habitat. Each cube measures 1.2 m on a side and weighs up to 900 kg. Included are two tautline moored midwater aggregation devices. At right is a single cube showing one configuration of the interior refuge habitat space (after Brock and Buckley, 1984).

(Table 5). Most measures here only eliminate competition and protect against predators, be they beast or man. Fertilization is not practised, but with mollusks and seaweeds, seeding is possible enabling the fashioning of eco-techniques. Among the mollusks, the giant clams (*Tridacnidae*) present an intriguing case; they grow slowly but to a large size and their mantle is edible, the flesh, preferably, to be dried to withstand spoilage. It can become something like a protein staple (Munro, 1983) while the shell-closing adductor muscle is among the most prized seafoods among wealthy Asian gourmets, so much so that the stock of giant clams could be threatened by poaching tuna fishermen over vast extents of their range in the tropical Pacific.

Giant clams are peculiar among edible animals in that they rely for their nutrition on symbiosis with a photosynthesizing unicellular alga that transfers its products directly to the clams. It is as if the giant clam were a plant in itself, extracting basic nutrients from its surroundings, without even the need for fertilization. The clams can now be propagated without need for elaborate facilities (Heslinga and Perron, 1983), made to settle on

TABLE 5

Thirty-five commonly marketable marine wild crops that appear to be favourable in the reef or mangal environment on a diversified reef farm (quite clearly no one site would be suitable for all in this list and many more organisms could be added)

Arthropods	Mollusks	Vertebrates
Mangrove crabs	*Anadara*	Aquarium species
Peneid shrimps	*Cardium*	Dragons/lizards
	Mussels	Fishes
Coelenterates	Other clams	Groupers
	Oysters	*Kyphosus*
Acroporoid corals	Pearl oysters	Sea horses
Alcyonarian corals	Tridacnids	Sea snakes
Precious corals		Siganids
Sea fans	**Seaweeds**	Turtles
Black corals		
	Caulerpa	
Echinoderms	*Digenia*	
	Eucheuma	
Sea urchins	*Gracilaria*	
Starfishes	*Halymenia*	
Trepang holothurians	*Hormophysa*	
	Monostroma	
	Sargassum	
	Turbinaria	

From Doty (1982).

rocks or slates, and then set out to their growing sites on the reef proper. They can be farmed alone or together with other reef species at intensities that will depend on how much management one wishes to, or can, apply to any one reef site. Some of these species can serve as raw materials for industry, by the way. The vast array of atolls in the Pacific and elsewhere makes this type of reef gardening (another polyculture venture in the sea, rather than in ponds on land) assume strong consideration as a possible contributor to the economic development of tropical island nations. It should be added that reef gardening is likely to have advantages over other modes of aquaculture on Pacific islands, the record of which has been poor to date (Uwate, 1984) but it must be acknowledge that the distribution of the products of such reef culture presents problems related to distances, size of operations that can be overseen, and the like.

Technology transfer in aquaculture

The highest-intensity growing schemes, such as the one for shrimp mentioned earlier, are transferred lock, stock, and barrel with engineers, managers, and instruments; only labor is local and its operations are so routine or controlled that few problems arise. They do not make for much local employment. Feeding machines for open sites, ponds, or net enclosures which have automatic sensors for water quality to adjust feeding levels and are computer-steered, are reasonably foolproof and, what is more, they are employed in locations where technically-trained personnel are available and, in extremis, the manufacturer can come to trouble shoot.

But when it comes to the implementation of eco-techniques the matter is different; I have recently learned from an Asian Development Bank officer in charge of aquaculture and fisheries loans that by and large extension is the most severe problem in the end use implementation of their area-wide several hundred million dollar projects. The problem is common to all agricultural technology change and revolves around the linkages among the various actors in the game—users, donors, and governments. Table 6, reproduced with permission from Matlock (1984), summarizes it well.

TABLE 6

Quality and strength of linkages among the components in agricultural technology change systems in less developed countries

Linkage	Quality and strength	Comments
Users to change agents	medium	Users have little confidence in the change agents, their past experience has not been good.
Users to scientists	low	Users have little or no contact with scientists.
Users to government	low	Fear and suspicion often dominate the relationship.
Users to donors	low	Users want help from the donors, but they have seen development projects come and go, often with minimal results.
Change agents to users	medium	The change agents want to do more than they are currently doing. Sometimes men as change agents are prohibited from contacting women farmers/herders.
Change agents to scientists	low	They may be aware of what scientists do, but have little understanding of how they can use results of research.
Change agents to government	medium	They depend on programme support (operating funds, transportation) from government; frequently little support is available after salaries are paid.
Change agents to donors	medium	They are cooperative, but donors may expect too much from change agents, given the constraints under which they operate.

TABLE 6 (*continued*)

Scientists to users	low	They have little contact with user problems.
Scientists to change agents	low	They may offer a package approach which is not always locally field-tested.
Scientists to government	high	They depend on government for support for research programmes, and are usually persuasive in getting it.
Scientists to donors	high	They seek support from donors for their research interests.
Government to users	low	The tax system may be the only perceived contact; they expect users to produce more.
Government to change agents	medium	They support the idea of 'extension', but do not understand exactly what is needed to make it work.
Government to scientists	high	Strong support is given with the hope of getting the "right" output; they form a mutually benefiting elite.
Government to donors	high	They depend on donor-support and cannot afford not to accept help.
Donors to users	low	Contact is usually superficial.
Donors to change agents	medium	Donors support philosophy of extension, outreach programmes.
Donors to scientists	high	Donors provide strong support; "look what science has done for us!"
Donors to government	high	Donors provide strong support; they have to work with and through the government of the host country.

Source: Matlock (1984).

Some corollary details here are as follows.

1. Since aquaculture is manipulation of nature, tradition- or culture-determined views or attitudes are important to be taken into account when one fashions regional or local extension procedures. Too little expertise exists anywhere in this area both in the various national as well as in expatriate quarters.

2. Local government services are essential, preferably as teams; their use has hardly begun.

3. Management skills are as important as, if not more important than, technical ones; they should be combined in the person of the operator/extension agent. Too little management is taught in all professional/technical schools and colleges; this is true in applied natural sciences as well as in the engineering fields. Scrutiny of and possible changes in the curricula of such institutions are indicated.

4. Little commercial incentive for transfer of eco-techniques exists for the initiator of such transfers. If the latter are mostly institutions, this may

not be overly important, but national interests may have to be considered in this domain nevertheless. One process in aquaculture where originators of techniques may gain, though, is breeding with the possibility of fashioning superior, certified strains, including, in the foreseeble future, the application of genetic engineering, probably mostly to sanitation and to enlarge the spectrum of tolerances to various environmental conditions (e.g. salinity). Conservative estimates suggest that traditional genetics may help to raise the yield of most species by at least 50 per cent over the levels attained at present (Gjedrem, 1985). Genetic engineering could well do more still, and may eventually open the door to new commercial possibilities through changes in patent laws, among other things.

It is unfortunate that technical aspects of transfer tend to be dealt with separately from its institutional-operational components if the latter receive emphasis at all. Applied team research into bridging that gap, involving all levels of acceptor governments, will have high pay-offs. It will help in the alleviation of socio-economic obstacles such as surety of entitlement to site, and credits, without which such technology transfers are rarely successful. It appears that in this domain especially, there can be the most serious bottlenecks, not only because vested and political interest may be involved but also because donors and change agents do not tend to account sufficiently for culture-specific patterns of some linkages.

Discussion

This short exposition deals with certain food production technologies. Whether they take place on land or in water they require fixed and variable inputs of energy, among other ingredients. Also, all food production has in common that its ultimate fabricating units are not machines but rather organisms, be they plants, cattle, poultry, fish, or eventually perhaps even single cells. The machines mainly help in applying mechanical power but they demand direct and indirect supplies of energy as do various instruments and other ingredients (many of them of a chemical nature). Finally, the importance of labor in the various food production processes varies with states of economic development. Usually more and better machines, and hence more energy and capital, will help in obtaining more wheat, meat, chicken, or tuna per unit time, space, or surface. As energy inputs rise in cost – which they are sure to do eventually despite recent short-term declines – they will assume an ever more important place in the calculus and substituting for it by labor has become an important consideration especially where the latter is plentiful and cheap.

In many developing and developed nations, planning priorities for various modes of food production stress energy considerations and therefore eco-technologies become strong contenders. In the field of fisheries, which nations will now develop to make full use of the resources in their 200 mile (322 km) EEZs – presumably by building new energy efficient, perhaps even sail-assisted, vessels that are cheaper per ton of displacement than the old ones—the fact still remains that fishing costs rise with increasing distance from the shore (Table 7).

Now contrast the eco-technical variant of aquaculture with fisheries and also with other high-input, high-output types of aquaculture and note that it can be appreciably cheaper to obtain meat by growing several kinds of animals together from a dollar and cents point of view but certainly also from a total energy input point of view. Comparisons here involve calories in all inputs versus calories or grams of meat gained, and should also account for economies of scale. Site advantages may, of course, be overarching determinants of choice of methods.

TABLE 7

Ship size, fuel consumption, weight and value of catch per kilolitre of fuel, and price of fish for 1975 in Japan (fisheries ordered from lowest to highest catch [kilogram] per kilolitre of fuel oil consumed)

			Catch Relative to Fuel Consumption		
Fishery	Ship size (tons)	Fuel oil consumption (kl/year)	Weight kg/kl	Value* (yen/kl)	Price of fish (yen/kg)
Tuna longline (far sea)	192 229 344	600† 960 1 050	270	118 000 208 000 175 000	740
Tuna longline (offshore)	69	390	430	233 000	540
Salmon drift net (mother boat type)	96	220	530	430 000	810
Squid angling (far sea)	300	660	820	172 000	209
Salmon drift net (catcher boat)	65	260	822	374 000	450
Skipjack pole and line (far sea)	284 374	1 500 1 200	860	130 000 178 000	206
Skipjack pole and line (offshore)	59	400	—	186 000	—
Demersal fish trawl (East China Sea)	114	1 200	960	190 000	197
Squid angling (offshore)	99	322	1 800	256 000	320
Pelagic fish purse seine (1 unit fleet)	111	3 100	3 600	218 000	60
Alaska pollack trawl (North Pacific)	349	2 800	4 800	146 000	30
Setnet large-scale 250 tons of catch per year	—	20	12 500	2 500 000	200

* In April 1975: 1 000 yen = US$41.
† Two voyages.
This table is reproduced by courtesy of the author, Masatsune Nomura (1980).

The eco-technique must enhance nutrient recycling as is achieved, for instance, by including in the classical scheme of Chinese pond polyculture the mud carp (*Cirrhinus molitorella*), which feeds on, among other things, the faeces of the fishes above it, or by using poultry, to fertilize the ponds.

The integrated mariculture/seabed management schema also has several energy saving components, the most prominent perhaps being the reliance on sensory stimuli and behavior to congregate the cultivars (Table 4). For national planning considerations one must add that integrated marine polyculture or fresh and brackish water polyculture can be small, medium, or large scale enterprises, with the latter having a wider range for economies of scale than the former.

To be fair, and since machines have been mentioned as prominent components in our schemes, energy saving can of course be achieved by improving their efficiencies through design—that is, essentially by mechano-, instead of eco-techniques.

One may also imagine that there will, one day, be much cheaper power, much cheaper raw materials, or artificial food produced without the intervention of living cells. The presently known rules that govern the game on earth and the sum total of human experience makes one doubt that these things will come to pass, at least in time to do much good to most of those who live on the planet at present. Thinking of food in this context, I would therefore urge us now to apply finesse, prominently in making use of our increasing knowledge of the smallest, the small, and also the larger building blocks of the biosphere and to combine that knowledge with sound engineering principles into the hybrid systems which I have termed eco-techniques.

Conclusions

If mankind is to realize the potentially great benefits of eco-technology, in aquaculture and elsewhere, it will be essential to deal with the following requirements for success.

1. Appropriate physical resource and environmental conditions, implying primarily the need for careful selection of sites and cultivars, and for regulation of both intentional and unintentional human influences on the ecosystems in question.
2. Basic knowledge about the systems and their components—much of which already exists for numerous present and potential eco-technologies. Extending such knowledge generally requires publicly supported basic research.
3. Application-oriented research, drawing on the skills of all relevant disciplines and ideally that of persons (e.g. fishermen) having practical knowledge of the cultivars and environments.

4. A favorable regulatory and political climate, through governmental actions and measures even with renewed appraisal of what modernization may really mean, together with public acceptance of specific eco-technology applications.
5. Economic and legal conditions that give potential developers a reasonable financial incentive to invest in experimental design and implementation of particular technologies.

It comes to mind that eco-techniques are easier to introduce or develop where culture and where certain constraints on land and water predispose towards them (e.g. China, Japan) and that computers will be eminently helpful in perfecting them, with the processes to be steered being complex and multifariously interacting.

The examples of Japanese fish-shelter development provides an excellent illustration of what can be done—an eco-technology which contributes to a nation's dietary requirements in a manner consistent with its socio-economic and cultural roots, improving the performance of the hydrosphere resource, employing a true systems view, offering long-term sustainability, and economic returns.

At present, the tendency is still strong in various technologies that deal with renewable resources for engineers and biological scientists to interact insufficiently, if at all. Their attitudes towards the natural world often differ, especially with regard to the kinds of limits and the means to deal with them. It would be salutary if both reconsidered their assumptions in this regard to lead to truly joint planning. While this may also lead to some adjustment in development attitudes it would certainly help to gear renewable resources technologies to the joint exigencies of sustainability and resilience.

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References

Bardach, J. E., 1982. Oil, fish, and the sun and the wind (Keynote Address), in *Appropriate Technology for Alternative Energy Sources in Fisheries, ICLARM Conference Proceedings 8* (Ed. R. C. May, I. R. Smith, and D. B. Thomson), 215 pp. (Asian Development Bank and International Center for Living Aquatic Resources Management: Manila).

Bardach, J. E., and Magnuson, J. J., 1980. Introduction and perspectives, in *Fish Behaviour and its Use in the Capture and Culture of Fishes, ICLARM Conference Proceedings 5* (Ed. J. E. Bardach, J. J. Magnuson, R. C. May, and J. M. Reinhart) (International Center for Living Aquatic Resources Management: Manila).

Bardach, J. E., *et al.*, 1977. Aquatic Food Sources: Report of Study Team 3, in *Supporting Papers: World Food and Nutritional Study*, pp. 251-318 (Commission on International Relations, USNAS/NRC: Washington).

Berg, A., 1977. Nutrition, in *Supporting Papers: World Food and Nutritional Study* (Commission on International Relations, USNAS/NRC: Washington).

Brock, R. E., and Buckley, R. M., 1984. A proposed fisheries enhancement program based on artificial reefs for nearshore Hawaiian waters, *Sea Grant Quarterly*, Vol. 6, No. 1 (University of Hawaii Sea Grant College Program: Honolulu).

Cuyvers, L., 1984. *Ocean Uses and their Regulation*, 180 pp. (John Wiley and Sons: New York).

Doty, M., 1982. The diversified farming of coral reefs, University of Hawaii H. L. Lyons Arboretum Lecture no. 11, 1981, 29 pp. (University of Hawaii Press: Honolulu).

Edwards, P., 1980. A review of recycling organic wastes into fish with emphasis on the tropics, *Aquaculture*, 21: 261-279.

FAO, 1975-1982. Yearbooks of Fishery Statistics, vols. for Catches and Landings and vols. for Fisheries Commodities for years 1975, 1976, 1980, 1981, 1982 (FAO: Rome).

FAO, 1977. Provisional Food Balance Sheets 1972-74 Average (FAO: Rome).

FAO, 1981. 1980 fishery landings of the major ocean areas (FAO: Rome).

Fujiya, M., Sakaguchi, S., and Fukahara, O., 1980. Training of fishes applied to ranching of Red Sea bream in Japan, in *Fish Behavior and its Use in the Capture and Culture of Fishes* (Ed. J. E. Bardach, J. J. Magnuson, R. C. May, and J. M. Reinhart), pp. 200-209 (International Center for Living Aquatic Resources Management: Manila).

Gjedrem, T., 1985. Improvement of productivity through breeding schemes, *GeoJournal*, Vol. 10, No. 3.

Heslinga, G., and Perron, F., 1983. Palau giant clam hatchery, *ICLARM Newsletter* 6(1): 5-6 (International Center for Living Aquatic Resources Management: Manila).

ICLARM, 1984a. Prospectus of the International Center for Living Aquatic Resources Management (International Centre for Living Aquatic Resources Management: Manila).

ICLARM, 1984b. Tilapia, the aquatic chicken, *ICLARM Newsletter* 7 (International Center for Living Aquatic Resources Management: Manila).

Jhingran, V. G., and Sharma, B. K., 1980. In *Integrated Agriculture-Aquaculture Farming Systems, ICLARM Conference Proceedings* 4 (Ed. S. V. Pullin and Z. H. Shehadeh), pp. 135-142 (International Center for Living Aquatic Resources Management: Manila).

Karnicki, Z. S., 1981. The effect on extended economic zones (EEZ) on world fishing production, in *Food from the Sea* (Nahrung ans den Meer) (Ed. H. Noelle), pp. 19-28 (Springer Verlag: Berlin and Heidelberg).

Masatsune Nomura, 1980. Influence of fish behaviour on use and design of setnets, in *Fish Behaviour and its Use in the Capture and Culture of Fishes* (Ed. J. E. Bardach, J. J. Magnuson, R. C. May, and J. M. Reinhart), pp. 446-471 (International Center for Living Aquatic Resources Management: Manila).

Matlock, W. G., 1984. Problems and solutions in agricultural technology change or transfer, *Internat. J. Develop. Technol.* 2(2): 93-106.

Mottet, M. G., 1982. Enhancement of the marine environment for fisheries and aquaculture in Japan, Department of Fisheries Tech. Rept. No. 69, State of Washington, 96 pp.

Munro, J. L., 1983. Giant clams—food for the future, *ICLARM Newsletter* 6(1): 3-4 (International Center for Living Aquatic Resources Management: Manila).

Muir, J. F., and Roberts, R. J. (eds.), 1982. *Recent Advances in Aquaculture*, 452 pp. (Westview Press: Boulder, Colorado).

National Academy of Sciences, 1977. Commission on International Relations, National Research Council, 1977, Supporting Papers: World Food and Nutrition Study, Vol. IV, National Academy of Sciences, Washington, D.C., 165 pp.

Pillay, T. R. V., In press. Opening address, Proceedings of World Aquaculture Conference, Venice 1981.

Pritchard, G. I., 1980. *Fisheries and aquaculture in the People's Republic of China*, 32 pp. (IDRC: Ottawa).

Pullin, S. V., and Shehadeh, Z. H. (eds.), 1980. *Integrated Agriculture-Aquaculture Farming Systems, ICLARM Conference Proceedings 4* (International Center for Living Aquatic Resources Management: Manila).

Schroeder, G., 1974. Use of fluid cowshed manure in fish ponds, *Bamidgeh*, 26: 84-96.

Uwate, K. R., 1984. Aquaculture assessment: final report. The Pacific Islands Development Program, East-West Center, Honolulu, Mimeo, 49 pp.

World Bank, n.d. *World Development Report 1978* (The World Bank: Washington).

SESSION 5

Highly developed countries, especially Europe, the Americas, and Japan

Theme

The post-industrial society. The changing roles of non-technical culture and technical culture in highly developed nations. The changing economic value of human and material resources. Technology and human freedom.

Chairman

Dr Edgar M. Cortright
National Academy of Engineering, USA

Speakers

The Hon. Barry O. Jones: The post-industrial society in Australia—a matter of values

Dr G. Schuster: The new technologies and the decision-making process in western Europe

Lord Caldecote: The role of engineers in society

Professor Takemochi Ishii: The post-industrial society and technology

The post-industrial society in Australia — a matter of values

The Hon. Barry O. Jones, MP

The Hon. Barry O. Jones, MP

The Hon Barry O. Jones, MP, is Minister for Science and Technology in the Australian Government. He is a graduate in both arts and law of the University of Melbourne, Mr Jones has been public servant, high school teacher, university lecturer, lawyer, and broadcaster before entering parliament, first as Member of the Victorian Legislative Assembly (1972-77), and since 1977 in the Federal House of Representatives. He was Shadow Minister for Science and Technology from 1980-83 and has been Minster since the Labor Government took office in 1983. He has played a leading role in the revival of the Australian film industry, being Foundation Chairman (1973-75) of the Australian Film and Television School and from 1974-80 was Chairman of the Australian Film Institute. He is the author of five books including the best selling *Sleepers, Wake—Technology and the Future of Work* which has been translated into Japanese, Swedish, and Braille.

The post-industrial society in Australia – a matter of values

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Introduction

I begin with an Australian perspective—for those of you who are unfamiliar with us—and I then go on to a broader human perspective.

Australian post-industrial society

Since the mid 1960s, Australia has been undergoing a fundamental transition from a traditional industrial economy based on the exploitation of physical resources, towards a "post-industrial" or "information" based economy, dependent on high and rising levels of skill.

In the first part of this century, the proportion of the Australian labour force employed in manufacturing rose from 16.8 per cent in 1901 to a plateau of 25 per cent in 1947. For the next 18 years manufacturing employment remained fairly constant, but since 1965 manufacturing employment has fallen (from 27.6 per cent) steadily to the point where only around one in six people (16.5 per cent) are employed in manufacturing. This trend will not be reversed.

The decline in manufacturing employment is taking place for exactly the same reason that agriculture, for more than a century, has contracted as an employer in Europe, North America, and Australia. Fewer people can produce more goods, because technology allows production processes to become less labour intensive.

The fall in manufacturing employment is a normal part of a development cycle in a sophisticated economy. In Australia it has been sharper and socially more destructive than in most technologically mature economies because of its rapidity and the failure of society to respond appropriately to the development of a global economy in which technology plays a vital part. *The World in Figures* (Economist, London) gives the 1979 figures for

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employment in manufacturing as West Germany 34 per cent, Switzerland 32 per cent, Austria 30 per cent, United Kingdom 28 per cent, Belgium, 25 per cent, Japan, France, Italy, Finland, and New Zealand all 24 per cent, the United States, the Netherlands, and Norway 22 per cent. Australia was then at 19 per cent.

Between 1965 and 1982 about 2 060 000 new jobs were created in Australia. However, there was no overall growth in jobs in manufacturing. In fact that sector lost 150 000 jobs (−7.3 per cent). The major growth in employment was in services, and this is the only employment sector with significant potential for growth.

Australia has traditionally exported large tonnages of low value, high bulk primary products—wheat, iron ore, and coal for example. As foreign exchange earners, primary products are increasingly unreliable and unprofitable, because the demand for raw materials in high technology societies is falling, transport costs are higher relative to the cost of moving high technology manufactured goods, and technology is continually giving rise to substitution resulting in unstable and unpredictable demand for many raw materials and primary products. Technology and population growth will combine to ensure that primary production continues to decline in proportional importance as an employment sector.

The world scene

In the period 1955-80 there was a striking change in the per capita order of Gross Domestic Product in the technologically advanced world. Resource-rich nations such as the United States, Canada, and Australia fell in ranking, while some nations with limited natural resources such as Switzerland, Sweden, Denmark, The Netherlands, Japan, and Singapore rose very rapidly. The major factor in the rise of resource-poor nations has been the proportion of export earnings directly attributable to intellectual input: invention, research and development, product innovation, design, patents, royalties, and copyright.

More than 60 per cent of the annual export earnings of Japan, France, Sweden, The Netherlands, and Italy depend on technology-based industries, while Australia's figure is less than 5 per cent. This proportion will be further reduced unless we have a fundamental change of economic direction, while our more technologically aware contemporaries will continue to increase their export earnings.

Australia has a population of 15 million, one of the richest natural resource bases of any nation, abundant cheap energy, and large agricultural output. In 1980 its GDP was US$140 billion or $9.59 billion per million of population.

The Netherlands, a small country with limited access to raw materials other than some North Sea oil and gas, has a population of 14 million (93 per cent of Australia's) and is strikingly successful as a trading nation by comparison. Its 1980 GDP was US$169 billion or $12.07 billion per million of population—26 per cent higher than Australia. This result has been achieved by the use of research and skills to produce very high value added goods and services—Philips Electronics for example. The dollar value of its farm exports—seeds, bulbs, flowers, fine fruits, cheese, sera, vaccines, and horticultural products—are second only to the U.S., and this from a country which is geographically a swamp, with no raw materials other than some North Sea oil and gas.

Sweden contrasts even more strongly with Australia. It has a population of 8.3 million (55 per cent of Australia's), rather limited raw materials, and a very short industrial working week of 30.2 hours. Nevertheless its 1980 GDP of $123 billion amounted to 88 per cent of ours—a figure representing $14.82 billion per million of population, 54.5 per cent higher than Australia's.

The success of Sweden and other nations in maintaining export income relies on their utilisation of skills and research, and at the same time coping with the problem of maintaining employment levels. The technologies currently being developed and applied in both manufacturing and service sectors are very sparing consumers of both raw materials and energy. There is thus very little basis for the commonly-held view that Australia can rely in the longer term on the exploitation of abundant energy and mineral resources. There is no alternative to undertaking a fundamental transformation of the economy to use technology as a wealth generator.

The speed of change is and has been profoundly disorienting, especially for those who do not understand it. We must learn to cope with it. Since 1950 Japan has had a technological revolution every 10 years, but Australia appears to have a turnaround time of 30-50 years. Australia has become an industrial museum and our factories are working models of the age of chisels, spanners, and hammers. Our industrial contemporaries are into lasers, CAD/CAM, and microelectronics.

In 1964 Donald Horne wrote *The Lucky Country*—and the title has passed into the language as a form of self-congratulation: its irony has been lost. His point was that in the past Australia has been saved from trauma by chance or lucky factors but that in an era of increasing technological demands we could not rely on our luck changing.

Technology and society

In reality the technological base of a nation is the economy itself. Technology has been defined by the US National Academy of Science as "a perishable resource comprising knowledge, skills, and the means of using and controlling factors of production for the purpose of producing, delivering to users, and maintaining goods and services for which there is an economic and/or social demand". A moment's thought will convince you that information is a major component of technology. Indeed, a whole sector of the economy is now concerned with the handling of information. I have been arguing for many years that the conventional three-sector analysis of the labour force is obsolete and should be replaced by a four-sector analysis including an information sector, or even five if we include domestic and quasi-domestic servicing and making. In the traditional three-sector analysis the "services" or tertiary sector is now too large and amorphous to give a clear idea of which areas are growing and which are contracting.

In a four-sector analysis, 26.9 per cent were employed in the information sector in 1981, more than in agriculture, mining, and manufacturing combined (the US figure is nearer 50 per cent). Australia is a large user of information already, but a passive one dependent largely on imported information and information-based hardware, including computers, electronic equipment, process technology, and ideas developed overseas. Australia must become an active information society in order to obtain more of the potential benefits of technology. In Japan, the attitude to skill acquisition and development is reflected in the fact that at the age of 17 years, 88.1 per cent of Japanese are still at school compared with only 31.7 per cent of Australians. In 1950 about 3.5 per cent of Australia's labour force entrants had degrees or diplomas, and by 1980 this figure had doubled to 7 per cent. Japan had less than 1 per cent in 1950, rising to 39 per cent in 1950, a 4 000 per cent increase. South Korea's rise is even sharper. We have increased to 8 per cent in 1984. Japan has tapered off to 35 per cent, but the discrepancy is more than 4:1.

In the US, there are *pro rata* three times as many young people studying science as there are in Australia and, of these, 28 per cent go on to take out PhDs compared with 5 per cent in Australia. We need to revolutionise the level of technological skills in the Australian workforce as a matter of urgency.

To be successful in supplementing traditional industries with high technology industries, Australia needs to adopt a fundamentally different attitude to the education of its workforce and to the development of skills. If we are to be an active information society we have too few graduates; if we remain passive we have too many. We do not need large numbers of graduates with technologically-oriented skills if we are to continue to import most of our high-technology goods, but to develop as a technologically productive and innovative nation we need to raise our overall education level.

Application of technology

With 0.3 per cent of the world's population, Australia produces 2.0 per cent of the world's scientific papers. In absolute figures we rank No. 10 in the world (No. 8 in OECD), behind Canada but well ahead of Switzerland, the Netherlands, and Sweden. Australia has the same number of Nobel Prize winners in the sciences (four) as Japan but only one-eighth of the population. We lodge 0.7 per cent of the world's patent applications but we finish up with 0.1 per cent of the world's high technology output. A great start but a dismal finish.

A major factor in Australia's lack of commercial success, despite our evident intellectual capacity, is the emphasis on "pure" research in our research and development effort. I have often said that we should refer to "big R" and "little D" when we speak of R&D in Australia. But, while I want to promote "development", I would not wish to do this at the expense of pure research. We need basic knowledge and ideas and we need the capacity to apply them commercially.

In recent years I have come to recognise that the greatest problem in transfer of technology to potential users in Australia is essentially domestic; the psychological distance from CSIRO or the ANU to Clayton or Fairfield seems far greater than the distance from Detroit to Dandenong. Australian managers and investors are often unaware of the technological and research capacity that surrounds them.

It is not entirely the fault of Australia's managers and investors that they believe themselves to be using technology more effectively than is really the case. Scientists are often not aware of the potential economic value or commercial application of their work. They want to be left alone to beaver away at their expertise. This compounds the difficulty of transferring pure research into products which can be made and marketed from Australia. The links between the research community and our industrial managers are rather tenuous.

The application of technology is not to be confined only to the generation of new products. While advanced technology such as microchips and biotechnology have the potential to be major wealth generators, they are not likely ever to promote major employment growth. To preserve the competitiveness of our existing industries, perhaps extend the range of their products and improve the quality of output, we need to apply modern technology to a whole range of existing industry. Our industrial base is an extremely important part of our economy, and must not be allowed to decline further.

The picture I am painting may sound fairly black. In some ways it is. However, in 1983-84 the Government began to address some of these issues. In the last 18 months we have taken initiatives which will encourage commercial development of research results and better use of Australian innovations.

It is hoped that private sector venture capital for the formation and development of Australian business utilizing innovative technology will be generated by the operation of the Management and Investment Companies Act which was passed late last year. Companies licensed under this Act are able to raise venture capital for investment in businesses which have the potential for rapid growth, are skill-intensive, export-oriented, internationally competitive, and are significant generators of employment in Australia.

In order to promote the commercial development of CSIRO research results, that organisation has set up a company known as Sirotech Ltd. This is a business-oriented company run by businessmen with entrepreneurial, commercial, and marketing expertise, and will gather together people with access to industry and to commercial and other skills. Sirotech will arrange for development of CSIRO research results to the stage where decisions on commercialisation can be made, will facilitate the transfer of CSIRO research results to industry, and will assist divisions in identifying and undertaking research work of more immediate relevance to particular firms.

Initiatives to improve linkages between industry and research in tertiary institutions include a pilot Teaching Company scheme which was announced in the recent Budget. This will provide a means of using academic resources to assist industrial restructuring by raising industrial performance. The first programs under the scheme are expected to commence early in 1985, and will be financed 50 per cent by industry. The scheme is expected to operate with a significant level of industry initiative.

I have talked about the need to increase participation rates and education in order to raise Australia's skill base. The Government has recently announced funding arrangements in the tertiary education sector which will enable the provision of an additional 3 000 places over the 1985-87 triennium. The Schools Computer Education Program has been given $18 million over three years to give secondary school students and understanding and awareness of the use of computers. The program is also significantly concerned with the professional development of teachers to enable them to become sufficiently skilled in computing to use it as a tool in their areas of interest.

Employment and time use

Because technology works to reduce labour requirements for the performance of industrial tasks, the relative amount of employment available to society will diminish. Only the service sector has the potential to generate new jobs in significant numbers. In the US research at Stanford University estimates that the five occupations to produce the most new jobs in the 1980s will all be in low-skilled areas: janitors, nurses-aides, sales clerks, cashiers, and waiters and waitresses. No high technology occupation is expected to even make the "top twenty" in terms of the total number of jobs added to the US economy. The US will generate nine unskilled jobs for every computer programmer. There is no reason to believe that the pattern in Australia will be very different.

It is frequently asserted that a long term decrease in the amount of employment available can be met either by increasing unemployment, or by distributing the available employment more equally. However, it is by no means certain that this will happen: labour force participation rates are almost at a historic high (62 per cent) and the standard working week (38 hours) has barely changed since 1947. The Swedish model suggests that a reduction in working life could lead to a much reduced role for paid work in our lives. Balancing this is the unprecedented rate of growth, and hence obsolescence, of knowledge and skills.

The reduced requirement to work will probably lead to earlier retirement, shorter working weeks or years, and increasing use of time for leisure and education throughout the working lifetime. There is a stronger need than ever for the individual to develop tastes, interests, and skills which will enrich non-work life.

We need to be aware of the danger of creating a polarised society in which those who cannot obtain employment are a growing underprivileged group. Equitable distribution of work should ensure that wealth is fairly distributed, but work with a significant intellectual content can only be performed by those equipped to handle it. Education seems to provide the key to individual flexibility and adaptability to new work situations. Sound basic education will contribute to the ability of the whole population to adapt to new situations resulting from technological change. More specifically, a highly educated population will be better equipped to handle changes in employment and undertake the retraining which will be necessary one or more times during the working life.

"Education for inner life", with emphasis on personal growth, creativity, the development of the capability for independent thought and evaluation, the ability to appreciate aesthetic qualities, and psychological rewards, is the personal aspect of education. To function effectively in post-industrial society, individuals will need technological literacy; a comprehension of the forces involved in technological and social innovation, and recognition of technological changes as the product of a series of human and institutional changes.

Technology and democracy

Technology needs to be designed and used to meet real human needs. It is essential that communities make rational decisions about technology, with democratic participation in those decisions. The democratic process will only work if there is a high level of community understanding of technological developments and their implications. Indiscriminate use or imposition of technology without regard to its impact and without regard to the democratic right of societies to choose is not desirable. I reject such "technological determinism" as inappropriate to a democratic society. We must assert the right to choose appropriate types of technology at our own pace, and to express a preference for those which will enhance and extend human capacity, dignity, diversity, and understanding.

The Government believes that public discussion of the long-term implications of technologically-based social change is vital to the adaptation of society to new technologies. Machinery to inform the public fully on specific matters is seen as a vital component of the discussion. To stimulate consideration and discussion of technology-based social change the Government has announced the establishment of a Commission for the Future similar to the body which operated with some success in New Zealand from 1977 to 1982 until it was abolished for an excess of zeal. The Commission will be given the task of promoting public debate on future options. It will publish popular discussion papers on a range of issues. It will use the media (newspapers, magazines, radio, and television) to promote discussion of these options. It will also work through local organisations, schools, unions, and community groups to raise people's awareness of these issues which are such an important part of their times.

We are now at a technological turning point where the traditional role of the centrality of work to life may be open to serious questioning.

Work to live? or live to work?

Traditionally, work was viewed as a means to attain certain goals (goods, services, and money). Now we are undergoing a fundamental transformation in which ends and means are being substituted/exchanged.

	(Economic)	(Economic)
Subject	*Means*	*Ends*
	(Economic/ (Non-Economic)	
Subject	*Means*	*Ends*

When economic ends can be achieved with far less work, work may then become an end in itself—work for work's sake, work as the primary social relationship, work as a certification of competence, work as a legitimation of personal worth (and its withdrawal as a certification of incapacity, economic illegitimacy).

Ever since the Agricultural Revolutions, there has been a declining relationship between the volume of labour's input and the value of total outputs in farming. Country A has 3.5 per cent of its labour force in agriculture, Country B has 72 per cent, and Country C has 93 per cent. Which country suffers most from malnutrition? The answer, of course, is Country C (Ruanda)—but it is amazing to note the number of people who think it must be Country A. 'Look how few farmers they have'. When you explain that Country A is the United States with the most abundant agriculture in world history, the connection is made. Country B is India.

The closer the agricultural labour force is towards 100 per cent of all workers, the closer that economy is to destitution. A figure above 90 per cent indicates a subsistence economy where people are struggling to grow enough to keep themselves alive, with nothing left over for export.

It is easy to see the psychological appeal of feudalism or life time employment: a very large proportion of people, perhaps a majority, seem to prefer externally-set goals to internally generated ones, and in no area is this more apparent than with time use. The fear of unemployment is not just a matter of loss of income, poverty, and physical hardship—it means losing a sense of personal *value*. We tend to measure value, in this highly materialistic age, in dollars: our value is what we are paid, in the overwhelming majority of cases paid by an employer. If an employer values us at $300 per week that is our value: if he withdraws the work we automatically lose our value. The prevalence of this view implies a fatalistic or passive attitude to self-organisation and time use—a feeling that the solution to employment problems depends on the creation of more employers—more masters will mean more servants. We tend to see our personal salvation as a result of somebody else's efforts, not of our own, although there is some evidence that the emergence of a counter-culture is encouraging people to move out of the urban economic/culture mode and find an alternative life style with lower living standards but a higher degree of self-sufficiency.

The technological revolution we are undergoing gives us—at least theoretically—an opportunity for some radical rethinking about labour/leisure/income trade-offs. Whether this will happen is another matter altogether; the old patterns are dying very hard, especially with the working class, the people most adversely affected by technological change.

We must stimulate public interest in and understanding of the value of time use outside work. Work is central to nearly everybody, both economically and psychologically, as one of life's main purposes. Compulsory withdrawal from work has crippling psychological effects, like amputation, blindness, or deafness. Ever since the Industrial Revolution, for 200 years, we have taught that life without work is meaningless and the lesson has been well learnt; if work is withdrawn we should not be surprised if people then self-destruct.

In the case of typical male working class experience, work accounts for one-seventh of a lifetime. Take as an example, a male who was born in 1920, leaves school at 15 and works a 50 year stretch, retires at 65, and dies at 75 years. If we assume that he worked a standard 229 day Australian working year for 8 hours per day for that 50 year period, this would account for 3778.5 days of a 27 375 day lifetime: 13.8 per cent. In practice, he would have worked a 44 hour week from 1935 to 1947 (assuming that he had a job) and the working year would have been longer for much of that period but that only takes the figure up to 14.4 per cent, without deducting long service leave and periods of unemployment.

For a Japanese male who attains 80 years (a good chance for the world's geriatric gold medallists), 'lifetime employment' would take up 12.4 per cent, assuming 40 years (of 275 days) at work.

The future

Developed nations are evolving towards a "post-service" society, in which new types of employment will be generated which are complementary to technology-based work. Such employment might be aimed at satisfying individual needs and deliberately intended to be labour and time-absorbing. Work will itself be part of the output of production, facilitating activities such as craftwork, gardening, research, sport, leisure, hobby, and do-it-yourself activities.

It is clear not only that technology is having a significant and continuing impact on all advanced economies, but also that there are substantial differences between nations in the ways in which they are responding to the introduction of high technology. The application of technology is not yet contributing substantially to Australia's national income. Steps need to be taken now to enhance the economic benefit to Australia of modern technology. The expansion of technology throughout the economy of Australia and other advanced nations has the potential to cause further profound changes in employment patterns and lifestyle. It is vital that we adapt our society and our values to cope with the changes to come.

I can summarise the responses needed to achieve the transition to a workable post-industrial society in Australia under five points.

1. We need to raise the level of Australia's intellectual skill base. Australia's future development depends on "knowledge-intensive" activities, but numbers completing secondary education and entering tertiary education are low compared to many OECD countries, and have fallen far behind Japan and Korea. We should aim to have 50 per cent of students completing secondary school and 20 per cent of school leavers entering tertiary education by 1995. Since skills and knowledge are now so rapidly becoming absolete we should aim to retain 1 per cent of the workforce each year.

2. Linkages between research and industry need to be improved through expenditure of a greater proportion of GDP on R&D (rising to 2 per cent by 1995), an increase in private sector funding and performance of R&D, greater emphasis on practical commercial application of research, and better overseas and local science and technology information gathering and dissemination.

3. The Australian economy must move away from high-bulk low value-added exports towards high value-added goods and services with high unit value and low volume. This will be achieved by application of key technologies such as biotechnology and microelectronics, and through application of research, invention, and design skills.

4. Stronger and more appropriate economic structures need to be created, capable of identifying market niches and producing goods which can be placed on a world market. This will require increased marketing sophistication, adequate means for raising capital and attracting talent, and the investigation of joint ventures with overseas outlets.

5. The problems of overspecialised regional economies need to be overcome by diversification and economic recovery in areas where the traditional employment bases are changing rapidly.

Government obviously has a significant role in the achievement of these objectives. Some of you are probably aware of the draft National Technology Strategy which has been considered widely by industry, unions, government, and community groups over the last few months. This strategy is now being revised in the light of the valuable comments we have received. I believe we can, as individuals, organisations, and as Government, take steps to ensure that Australia develops technologies which will revitalise our economy. I also strongly believe that we have choices about how we can use technologies to enrich our own lives and that we must make these choices wisely.

Conclusion

Recent research on the operation of the human brain suggests a profound dichotomy between the left and right hemispheres. The left hemisphere, it is argued, dictates behaviour that is analytical, reductionist, rule-following, verbal, aggressive, competitive, and linear, conforming to the masculine stereotype. The right hemisphere, more closely conforming to the feminine stereotype, is related to perceptions which are holistic, transcendental, impressionistic, visual, co-operative and lateral—with strong emphasis on seeing things in a broad context and linking them together.

Temperamentally, I am an optimist. Just as Francis Crick applied lateral thinking to solve the problem of the structure of DNA, which had defied orthodox analysis, and helped to create molecular biology and biotechnology (areas in which he had no formal training), so I believe that new approaches to social and economic problems can make the 1980s a creative era in which Mozartian man (and woman), as Dennis Gabor wrote, can evolve. If we remain imprisoned in the linear thinking so congenial to bureaucrats, capitalists, commissars and aspiring gauleiters, the 1980s will be a period of unemployment, alienation and unprecedented social crises.

The new technologies and the decision-making process in Western Europe

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The new technologies and the decision-making process in western Europe

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Introduction

In the Federal Republic of Germany in 1965 a rather well-known Professor of Physics at the University of Aix-la-Chapelle, Prof. Fuchs, had quite a success with his book *Formeln zur Macht* (*Formulae to Power*). This book has been widely discussed, taken up by the mass-media, and has been an example of the kind of perceptions of future developments in those years. It is based on one fundamental assumption, that the iron and steel production of a given country determines the industrial power of that nation. Take the population of a country and its probable growth rate, take its energy production and its steel production, and their probable future developments, and you will get, by superimposing the three curves, a single curve which is an indicator for the development of power for that country, both economically and militarily.

Now, one of his forecasts was the following: By the year 1970 China will surpass the Soviet Union in its industrial power and by 1990 China will have an industrial power equal to that of the USSR, the US, and their allies taken together.

Today, 19 years later, one cannot but laugh, or to be more polite, smile about this forecast. We do have a completely different world compared with that of 1965. The symbols of power of those years have gone. The industries and the societies of the industrialized countries are in a state of profound change. The technologies of the middle of our century, in particular the steel-, shipyard-, and coal-industries (the so-called smoke-stack industries) and also the textile-industry are in decline or in the process of transformation. The new technologies or high-technologies now are in full development and deployment.

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Under the heading "new technologies" I should like to include in particular

1. the use of nuclear energy for electricity production, be it through the taming of the thermal or the fast fission process or through the taming of the nuclear fusion process,
2. microprocessors and computers and their application in the control and in the doing of work (robots, automation, CAD, CAM), and
3. biotechnology, in particular biogenetics and bioengineering.

A new wave of technical innovations linked to microelectronics is at the basis of the "third industrial revolution" in the Western countries. Several families of new technological tools have meanwhile been developed and are at work. They are transforming the universe of machine systems and technical networks. A new generation of goods and services comes up through the multiple and rapid applications of the information and communication technologies. In short, The Western industrialized countries have entered a new stage in the age of technology which represents a qualitative change, a kind of "quantum-leap". Let me explain.

1. The use of nuclear energy for electricity production is different in nature from the energy sources used so far. It is an energy source with a very high potential risk which has a very low probability. It is an energy source with "ashes" which are radioactive for hundreds of years and of which care has to be taken by many future generations and it is an energy source with a weapons capability of an unprecedented destructive power. In order to avoid misunderstanding I must say I believe that mankind has to and is able to use nuclear energy but what I am trying to say is that the use of this new energy is not just adding another source to the already existing energy sources, it adds a new dimension to the spectrum of energies.

2. The use of robots and the computer-integrated factory of the future is different in nature from what we have had so far. Up to now mechanical tools and modern machinery gave the worker the possibility of multiplying his muscle-power and so improving the speed and the accuracy of his work; today the robots and new "intelligent machines" will replace the worker and this again adds a new dimension of considerable consequences to society in general (not enough work for everybody, new balance between work and leisure-time activities).

3. The future use of biogenetics and bioengineering will add a new dimension to the development of mankind. Man will be able to envisage the genetic modification of cells and micro-organisms, man can control the development of the embryo and the foetus and can detect, if not prevent, malformation.

This is what I mean with qualitative change in the technological development, a qualitative change with far-reaching consequences, chance and challenge, threat and trepidation. At the same time, the consequences of the unhampered use of coal, oil, and natural gas become noticeable. Our forests are in danger of dying, historical monuments are degrading. The consequences of "acid rain" are creating deep concern world-wide and this is one of the most prominent environmental problems of our time.

A general feeling of mistrust regarding the new technologies has been triggered by perceiving the potential risks and hazards and by realizing the damage to the environment. The young generation begins to feel very insecure and uncertain about the possible protections against and even the benefits of the new technologies. Well-known reactions are the movements of the ecologists and the peace movement.

Implications for the decision-making process

In the process of the taming, the introduction, and the use of the new technologies and the related societal and ethical issues parliaments and governments of the Western democratic countries are more and more involved in a decision-making process at national level which implies decisions with a high scientific and technical content and far-reaching longterm consequences and for which a high degree of scientific judgement and information is needed. Today, science and technology have become critical elements of the decision-making process. In the decision-making process many institutions have so far been involved. Obviously, the final responsibility lies with the parliament and the governments but the political parties, industry, and industrial associations as well as the trade unions have a role to play in it. In our time a new partner has intruded in this process, the general public, the lay community, sometimes represented through public and private interests groups, and citizens' initiatives. Their voices have been amplified by the press and by television, which have become very influential in shaping public awareness and public attitudes. So, decision-makers not only find themselves exposed to the influence of critics and lobbies, but are sometimes even under heavy public pressure. What are efficient decision-making procedures in this new situation? How do we recognize the potential, the implications, and consequences of new technological developments and how do we weigh their opportunities against risks and so substantiate the decisions on the utilization of new technologies? Over the past few years this issue has been the subject of investigations in the US and several Western countries. Only recently IIASA, the International Institute of Applied Systems Analysis in Vienna, Austria, organized an international forum on that subject.

I should like to deal in particular with four central problems of this issue: that is

1. the acceptance-consensus problem,
2. the uncertainty-element,
3. the implications of the new situation for the advisory system, and
4. the consequences of the different temporal and spatial dimensions.

The acceptance-consensus problem

New technologies may have great benefits, they may at the same time often bring about hazards, risks, and disadvantages for the society, the citizen, and the environment. This leads to one key question for the decision-making process—who should decide whether a certain risk is tolerable, is acceptable? This decision will have to be taken in the light of conflicting issues with irrational elements involved, issues that divide the main partners that are engaged in the decision-making process. This dilemma is aggravated by the fact that a certain hostility to the future development and massive introduction of new technologies is growing, as is the fear of possible invisible and unforeseen hazards. The public has become suspicious of both experts and policy makers. People are beginning to question the authority of experts and their calculations as a basis for decision-making on technical issues. The first doubts with regard to the ability of scientists and technicians became evident in some countries in the nuclear field and it was in this field that another phenomenon became apparent—the polarization of scientific expertise on many key issues. Experts find it difficult to agree, i.e. to reach consensus on the risks involved in certain technologies, as for example the consequences of the final storage of highly radioactive waste or the levels of dioxin emissions.

How could the public come to a positive attitude on these grounds? What are the consequences to be derived from that for the decision-making process? Every nation has its tradiational way of perceiving technology. Very strong rejection may be seen when certain forms of technology are introduced while no rejection may be observed for other types. Such situations arise from the culture of the nation on which the perception is based. Sometimes the receptivity of citizens is linked with a certain kind of emotional appeal; an example of which is "der deutsch Wald" (the German forest).

Technologies are more easily accepted by society when they meet with some strongly felt need of society. But sometimes people reaping the benefits from new technologies are not prepared to bear the disadvantages, e.g. an electrical plant, which causes local pollution, produces electricity for people living in a distant area. Occupational health hazards often reveal a conflict between the worker's safety and the general public benefits. How can we care for and safeguard the interest of future generations in the calculation of risks and benefits which have long term consequences and which have an impact on future generations, sometimes beyond the expected lifetime of those involved in the decision-making process?

Another new trend is the growing lack of acceptability with respect to governmental decisions. People nowadays are more frequently challenging the legitimacy of decisions implying potential risks that have a possibly significant impact on the environment and on human health. We seem to have an intensified sense of criticism with regard to governmental decision-making as a whole. People are demanding a greater public accountability of decision makers in the decision-making process. They are inclined to look upon them as operating in ways that neither are open nor responsive to the public interests or the public will. All these problems are serious enough indeed, they should be seen by decision-makers as alarm-signals and accepted as a challenge.

So we have a new situation with regard to the decision-making process. It will not be possible or advisable for the government to decide on the introduction and the use of a new technology against the will of the majority of the population. The consensus of a large majority is needed.

What does consensus mean? How do we bring it about? Consensus does not simply mean securing a majority vote for or against the use of a new technology in the existing institutional system. More and more the legitimacy of majority votes is being contested in those cases in which either a large majority of the public is against a certain technology or a strong polarization has taken place.

As the new technologies are interfering with and influencing society in general, new mechanisms will have to be developed by means of which such decisions can be taken on the basis of a sufficiently broad consensus. The sanctioning of a technology can only be achieved after a process has been gone through which satisfies this new requirement for the decision making process, i.e. that the decision be responsive to the will of the majority of the public.

By "the public" we mean, of course, many more people than those engaged in the actual decision-making process; the public in question must be larger than the professional elite.

In short, the decision-making process needs a new additional element in order to ensure the consensus-building process. It needs procedures for including the participation of the public in those parts of decisions on which conflicting issues require consensus.

This participatory element will not be a uniform procedure, it has to be conceived and to be developed according to national conditions. It should already accompany the preparatory stages of governmental decisions concerning the utilization of new technologies and ensure their legitimacy and their acceptance. Let me add two points: introducing and implementing such a participatory process does not mean to develop a system by which people just can "let off steam" or express themsleves in public without having any chance to influence the process because the governmental position has already been fixed. To follow such a way would be absolutely counterproductive. But—and this is also of importance—consensus here cannot include and realize everybody's position and view.

Some experiences concerning the development and implementation of a participatory process

1. Technical information generally cannot be substantiated by one's own experience. Therefore, it will not be a dominant factor in the formation or change of public attitudes with regard to conflicting technical issues. Technical safety studies undertaken with the idea of providing "hard facts" to influence public opinion are unlikely to achieve the desired effect. To avoid misunderstanding: accurate technical information is important, information is necessary but it is not sufficient.

2. In informing the public, hard facts and subjective judgement and values should be carefully distinguished. Everybody should be aware of the danger of simplification, which eventually may lead to falsification.

3. Numerical guidelines for "acceptable risks" based upon statistical data that are taken from the experience of already existing risks should not be expected to gain public acceptance.

Such guidelines are of interest for the experts in the decision-making process, they should be established and be used in the regulatory process to determine upper limits of risks that must not be exceeded, but they should not be used in the sense of "here it is, you must accept it".

4. One of the elements in a consensus-seeking process is the well-known cost-benefit analysis. It is an important and useful tool, but it should not be overestimated. One inherent difficulty is to express everything including potential negative side effects in terms of money.

What are then the elements which are to be used in the consensus building process? I see in particular four types of activities here.

The confrontation. On conflicting issues, proponents and opponents are being confronted in the presence of politicians and representatives of the public. This confrontation should allow factual uncertainties, disagreement, and value conflicts to be clearly separated.

Public hearings. Public hearings on conflicting issues can centre on specific points but they may also deal with general policies. Parliament or the government appoints the chairman, who is responsible for the organization.

Public local inquiries. Public local enquiries deal with site issues and planning matters. The inquiries are ordered by a minister who needs the information. He appoints an inspector who may be advised by assessors.

Let us take the case of a nuclear power plant or a reprocessing plant: the applicant begins with the proceedings, the objectors lodge their complaints, the applicant replies, and the inspector decides. The decision is published.

The organized dialogue between the conflicting parties. In this dialogue the opposite views are exchanged with the objective of identifying what the issues are on which consensus cannot be achieved. After that step the conflicting parties should try—by using the methodology of narrowing the arguments—to reduce points of disagreement. This is to be seen as an iterative process which may in the end give the possibility of agreeing jointly on a compromise through a better and deeper understanding of each others' view without giving up their differing position.

The government must be prepared to fund the opposition in those processes and to organize its access to information as far as possible. The process of consensus-building may require quite a period of time. This can create difficulties for the industry and the process of technological innovation and in cases of a very strong polarisation it may only be possible to introduce a new technology on a rather low-key approach. The best and most convincing argument in favour of a new technology is the safe and profitable operation of a first series of plants or new equipment or new techniques for a longer period of time.

No doubt, eventually the decision has to be taken through the democratic institutional channels. But the public can rely on everything possible being done to take a decision which will contain the elements of an acceptable consensus.

The situation in western Europe

To exemplify the acceptance-consensus problem I should like to sketch the situation in some western European countries in the nuclear field. Here you will find different national solutions and decisions which lie between the two extremes of going ahead full speed and of not using nuclear energy at all, both of which are based on a consensus of the majority of the population. I should like to start with France. France is in my view the most advanced country in the world in the use of nuclear energy for electricity production. France produced about 50 per cent of its electrical energy from nuclear power plants in 1983 and it succeeded in establishing the full fuel cycle for the light-water-reactor(LWR)-system. One liquid-metal-fast-breeder-reactor(LMFBR)-Prototype (Phénix, 300 MWe) has been in operation since 1984 and the first large size LMFBR prototype (Superphénix, 1200 MWe), to prove the industrial feasibility, will be commissioned in 1985. This extraordinary achievement in the introduction of a new energy technology has only been possible thanks to the existence of a consensus in France of a large majority of its population in favour of nuclear energy. What are the reasons for this phenomenon? How did it come about? France was lucky enough to have a positive attitude straight from the start towards the use of nuclear energy by the main partners involved in the decision-making process.

1. All governments—regardless of their composition—have always been in favour of making the best possible use of nuclear energy in order to get rid of too heavy oil imports and to secure the energy supply in the electricity sector.
2. All political parties—including the Communist Party—have been in favour of its use.
3. The trade unions took a favourable view, the main reason being job creation and job security.
4. The companies involved—i.e. producer companies and the EdF, the French utility—were firmly decided to do their best to promote the use of nuclear energy for electricity production.

Obviously, it was helpful too, that everything in France is very centralized.

The situation in the Federal Republic of Germany is quite different. A number of mutually escalating attitudes, perceptions and reactions (mostly with a non-technical background) has led to major political conflicts. In the 1970s the Lib-Lab coalition had difficulties in taking a firm stand in favour of nuclear energy because large parts of the Social-Democratic Party (SPD) were against the massive use of nuclear energy and—interestingly enough—the relatively small Communist Party (KPD) in the Federal Republic of Germany was strongly against the use of nuclear energy, using this issue as an instrument to fight the democratic system in the Federal Republic of Germany. The conflict about nuclear energy has been one of the reasons for the formation of citizens' initiatives (Bürgerinitiativen) and of the Green Party. The German government (under the chancellorship of H. Schmidt) made a big effort to get an acceptable consensus by distributing a maximum of information and by organizing—as a new consensus building mechanism—a dialogue procedure (Bürgerdialog) between representatives of Government, political parties, scientists, engineers, groups of citizens, and opponent groups.

Furthermore, the German Parliament established the so-called, "Enquete-Kommission" as an advisory body for Parliament. The "Enquete-Kommission" was composed of members of Parliament (50 per cent) and of high level experts (50 per cent) chosen by the political parties.

The dialogue procedure as well as the work of the "Enquete-Kommission" took years. The speed of the introduction of nuclear energy was considerably slowed down. Under this slowing-down process, there suffered in particular the so-called advanced reactor systems, the SNR (LMFBR-prototype) and the thorium-hochtemperatur-reaktor (THTR), but also the realization of the back-end of the fuel cycle (e.g. reprocessing, storage of high level waste). The continued operation of the existing LWR-power stations could only be secured through the French offer to store and to reprocess the irradiated fuel elements of the German nuclear power plants.

At the beginning of the 1980s the situation improved. This is on the one hand due to the more positive stand of the new Con-Lib Government and on the other hand due to the excellent performance of the existing nuclear power plants. But still quite a strong opposition exists within the Green Party and within the SPD. For the time being there is a certain majority in favour of using nuclear energy for electricity production, but the innovative process has been slowed down considerably.

Now I come to Austria. Austria is an example of a country which, in accordance with its constitution, uses the referendum in its decision-making process. For the time being, Austria has a small majority against the use of nuclear energy. I suppose most of you know the story of Zwentendorf, the LWR-power-plant near Vienna. Just after the completion of the construction of the plant but before commissioning it the public opposition forced the Government to organize a referendum on the question of putting the plant into operation or not. Chancellor Kreisky declared publicly that he was in favour of using the nuclear power plant and declared that he would retire if the referendum failed. The opposition in Austria, in large parts in favour of using nuclear energy, seized this chance to get rid of Kreisky.

The result of the referendum was by a small margin, against the use of the Zwentendorf-plant, the chancellor did not retire and Austria has got a new monument, the mothballed nuclear power plant at Zwentendorf. This is an example of the consequences if a consensus-building process has not been considered and organized early enough, i.e. before the decision to construct the power plant was taken.

Let me briefly comment on the situation in the US where the use of nuclear energy for electricity production seems to be in a rather difficult stage. The situation in the US developed from a rather large, if not to say overwhelming, majority in favour of nuclear energy in the 1960s to a majority against it in the late 1970s and 1980s.

I do not feel competent to analyse all the reasons for this change but there is a connection with my subject matter—I mean the decision-making process in the USA—which strikes the observer from overseas.

The US Government is relatively weak, non-hierarchical, and fragmented in a structure with several compelling centres of power conducted to a large extent in the open in a litigant style with great attention to procedure and with a complicated structure of checks and balances. People frequently challenge the legitimacy of decisions because the system gives ample opportunity for that. Such a system makes the process of consensus building a very long one, maybe too long for a new technology and the related industries to cope with the extended period of uncertainty and indecision.

The problem of consensus building has to be considered seriously in each country. Consensus building procedures and measures will differ from country to country. But I think that one should refrain from establishing new institutions for this specific purpose.

The uncertainty element

Another important point for the decision-making process involving controversial science and technology issues arises from the fact that in most cases a certain range of uncertainty with which the decision-maker must work has to be taken into account. Political decision-making involves the management of uncertainties. This is not unusual. The new point here is that a decision has to be made in which a given scientific or technical uncertainty gives rise to political, social, or economic uncertainties in the political process.

The first step in the decision-making process is to recognize that there exists a scientific or technical uncertainty and to agree upon its level. This becomes sometimes difficult, because scientists often disagree about the extent of the uncertainty. So all efforts have to be made so that the various institutions and groups in the decision-making process are prepared to accept and to agree on the level of the existing uncertainty.

This is not the question of finding one value in the middle of a band, it is the question of the uncertainty margin itself which exists for a given issue.

Often this margin will exist for years in spite of all research efforts and only gradually will it get narrowed. A good example is the enormous research efforts which are permanently made to reduce the existing uncertainties on the health effects of hundreds of commercial chemicals and wastes.

Sometimes the existing uncertainties may be alleviated by a simple cost-benefit calculation; the lower the cost of an error the less critical it is to take a decision. But in the end it is only compelling scientific evidence that will reduce or eliminate the margin of uncertainty and by it the political controversy and indecision.

Very often politicians find scientific evidence difficult to grasp or to accept. What are the consequences for the scientists and engineers involved with regard to their contribution to the decision-making process? They should not only be aware of the uncertainties that exist in their findings but it is their responsibility to express them very clearly and to draw the attention of the decision-maker to it.

It would be extremely helpful if they could establish—on a case by case basis—a set of criteria to justify or to reject the acceptability of the existing margin of uncertainty for the decision-making process.

The phenomenon of uncertainty gives dishonest people the opportunity to exploit or to manipulate the existing uncertainties either by supporting them or by ignoring or amplifying them. Thus, confusion and wrong perceptions may be created. As sometimes scientist and engineers are involved in this kind of dishonesty some people feel that a kind of moral codex for scientists should be established.

The implications for the advisory system

For a long time all the industrialized countries have established an advisory system for issues concerning science and technology by which the necessary input for the decision-making process is prepared and channelled into the institutions which need it. The system differs from nation to nation. In some countries the president or the prime minister has a special science adviser or chief scientist; other countries have a minister responsible for science and technology, sometimes in addition to other portfolios, be it industry or energy. He then represents science-and-technology issues to the chancellor or prime minister and the cabinet. All countries have scientists in the governmental machinery and all countries have a system of expert commissions, sometimes with a hierarchical structure, on which they can draw for advice and expertise. In case of conflicting issues it would be ideal if those giving advice would be independent, independent in the sense of not being involved in the prior conditioning of the prevailing view. This is practically not possible. Therefore, the advisory system has to have a fair mixture of members who come from different fields and different institutions in order to have a balance of experiences and interests. It should admit experts with diverging views and should not hesitate to include "concerned scientists" as well. It would be counter-productive for the expert commission to form a kind of establishment which is practically a closed shop for insiders, excluding non-conformistic and opposing views. The members of the commissions should be free to submit opposing views together with the majority vote.

I have already mentioned the implications concerning the uncertainty element and I should like to add one word on the technology analysis problem. The advisory system should be able to give advice on the potential of new technologies and their importance for the future development of the economy, on the risks and the hazards involved, on its societal and environmental consequences, on strategies how to use best the technology and what could be done and has to be done to counteract negative effects. This is too heavy a burden for experts, who work on an honorary basis.

To this end governments in several countries have created technology analysis or technology assessment groups, think tanks, or similar units and I think that an independent analytical capability is more or less a necessity under the new circumstances. The desirability also for Parliament to have its own analysis group to receive an independent judgement is being discussed in some countries.

The consequences of the different spatial and temporal dimensions

The decision-making process has to recognize and to correspond to the spatial and temporal scales of the problem in question.

The spatial dimension

There are different spatial scales involved in different problems, depending on whether they are local, subnational, national, regional (in the sense of a world region, e.g. Europe), or global in nature. For each of these spatial scales different political institutions, scientific communities, and channels of public participation or lay interference will be involved. Solid waste management is a local problem, toxic waste management mostly a national problem. The air pollution issue on the other hand is a transboundary problem which affects world regions. The acceleration in the rate of atmospheric accumulation of CO_2 may at some point in time lead to irreversible changes in the global climate. Here, indeed, we do have a global problem. For problems with a regional or global spatial dimension there generally does not exist a special decision-making institution. In the case of transboundary regional or global problems either international intergovernmental organisations can take initiatives and organize a kind of "decision-making platform" or the same is achieved by multilateral conferences initiated by one or more governments. As a result there will be in both cases an international convention or an international agreement. Experience has taught that this is not the most efficient way to solve problems. The legislative action is the privilege of the national governments which are in no way obliged really to undertake something which they have pledged themselves to in an international convention. More stringent, however, can be multilateral inter-governmental agreements.

I should like to give three examples for this situation, one from the field of air pollution, the two others from the nuclear field; and then I should like to make one more general point.

The problem of the air pollution, in particular through the production of energy, is a transboundary regional problem. It was at the end of the 1960s and the early 1970s that the air pollution and the acid-rain problem began to be considered seriously in Europe. Public pressure made itself felt, the mass media took the issue up and the subject was considered to be of great importance by most European Governments.

The 1972 UN Conference on Human Environment in Stockholm, Sweden, has been an important first step. In Stockholm it was agreed, that nations have a responsibility to control pollution that damages a neighbouring country's environment. After that this problem was taken up in Europe by the ECE (Economic Commission of Europe, UN Organisation). The ECE was accepted as the focal point for multilateral discussion of the pollution issue. After quite a dramatic round of discussions and negotiations with their ups and downs, the ECE succeeded in coming to an agreement on a convention (in particular thanks to a Breshnev initiative) in 1979. Signatory states pledged themselves "to endeavour to limit and as far as possible, gradually reduce and prevent air pollution". I think everybody who has ever been involved in international negotiations, will enjoy the wording of this agreement. No numerical goals, no time tables, abatement requirements, or enforcement provisions were to be found in the convention. This agreement has all the same to be considered as a real success given the lack of a more authoritative decision-making mechanism.

A more authoritative regional institution in this regard is the European Community (EC) to which I shall come back later. Let me now speak about the peaceful use of nuclear energy for electricity production, which is very often a regional problem. Any country that uses LWR-power plants for electricity production needs either a closed fuel cycle, in particular its back-end, or its dependent on such facilities in other countries.

So far only one country in the world has succeeded in establishing the closed nuclear fuel cycle, namely France, as I have said already. Not very many more countries in the world have the potential for the development of a closed fuel cycle. Those are the bigger industrial countries and some NICs (newly industrialized countries). Small industrialized countries, e.g. Denmark, Ireland, or the Netherlands, and most of the developing countries will not be able to establish a closed nuclear fuel cycle for a given reactor system in their respective countries.

Now my point. Concerning the use of nuclear energy for electricity production, smaller industrialized countries and developing countries have to depend on regional collaboration and a certain kind of regional decision-making procedure. By this the possibility of closing the fuel cycle on a regional basis is within their reach. By the establishment of a regional decision-making procedure regional nuclear fuel cycle pools or regional nuclear fuel cycle centres could be created. Obviously, the countries involved will have to accept commonly-agreed safeguards and will have to give the assurance to share full responsibility for the non-proliferation of nuclear materials.

There exists another solution: the country in question builds only nuclear power stations and all the services for the front-end and the back-end of the fuel cycle are taken care of by one of the industrialized countries which already has the fuel cycle elements established. In this case the country is dependent on its supplies, it is true, but it has few problems with safeguards.

My second example in the nuclear field deals with nuclear fusion. The research and development effort leading to the construction of nuclear fusion power plants for electricity production is a "billion dollar game". The requirements in manpower and money are enormous. So far three nations, the USA, the USSR, and Japan and one group of nations (the countries of the European Community) have developed strong activities in this area. My point here is the following. It may turn out that the future development in this field may even need collaboration at a global or at least an intercontinental scale. But how to come to a decision-making platform that is sure to work efficiently—that is the question.

The temporal structure

Problems have to be dealt with differently depending on whether their politically relevant consquences are felt immediately or only predicted for the distant future. The acid rain problem is one of greatest concern to us in our days; it has become a "burning issue". The consequences of the increase of the CO_2 in the atmosphere may not be felt until 20, 50, or 100 years from now. In the case of acid rain we have the pressure on the government and we have the governments which are preparing and taking action.

In the case of CO_2, there is a scientific community which gives warnings but there are no reactions at all on the political level. This is not surprising. For there is a large margin of uncertainty with regard to the results of the scientific fact finding and there is neither strong pressure nor any strongly felt justification for putting the problem on the political agenda. Who should then take care of it? Who should follow the research results, compile them, and give signals of alarm if more clarification is to be achieved?

How to come to appropriate decision preparing channels for long-term issues with relevant consequences at a regional or global level?

The European Community as an example for a regional institution with decision-making power

I mentioned the lack of institutional mechanisms for the decision-making process at a regional level regarding issues that transcend national boundaries and I mentioned problems which need joint or concerted action or harmonization at regional level. These issues are normally discussed, and if possible settled, by agreement through international intergovernmental organizations or through multilateral conferences.

But there is one regional institution which has a real power and that is the European Community. As this may be of interest to you, and because it is relevant for my subject, I should like to say a few words about it.

The European Community has ten Member States (Belgium, Denmark, France, the Federal Republic of Germany, Greece, Italy, Ireland, Luxembourg, the Netherlands, the United Kingdom); Spain and Portugal are candidates for entry.

Three treaties are the legal basis for the European Community: the Common-Market Treaty, the Coal- and Steel-Community Treaty, and the Euratom Treaty. They still exist independently of each other and therefore the proper name should be the European Communities. But normally one says the European Community, and this is to a certain extent justified by the fact that the institutions provided for by the three treaties have been merged.

The European Community has five institutions: the Parliament, the Council of Ministers, the Commission, the Court of Justice, and the Court of Auditors. This system is difficult to classify. The European Community is more than an intergovernmental organization. Its institutions have not only a definite legal status but also a real power of their own which has been delegated by the Member States according to the provisions of the treaties. Therefore, the European Community is a supranational organization.

The EC has the authority to establish directives, e.g. in the field of air pollution (CO_2-emissions), which are binding on Member States. But—to be clear—the European Community is not a federation, it does not have a federal government to which national parliaments and governments are subordinated in certain areas according to the treaties.

The Council of Ministers of the European Community consists of representatives of the Member States. Each Government sends one minister. The composition varies according to the subject under discussion. But the foreign minister is regarded as his country's main representative.

The Commission of the European Community (CEC) consists of 14 members (Commissioners) appointed by agreement between the member governments. Throughout their term of office the Commissioners must remain independent of the Government and the Council. The CEC has a staff of about 10 000 and its headquarters is in Brussels, Belgium.

The European Parliament has 434 members who are elected directly within the ten Member States. There are no national sections; the European Parliament is composed of political groupings with similar political attitudes. It holds its sessions in Strasbourg, Luxembourg, and Brussels.

The Council of Ministers is the most powerful institution in the EC. It is the Council which decides, but in order to make a decision, the Council needs a proposal from the Commission. So Council and Commission depend upon each other.

The Commission is the most active institution in the EC. It plays a key role in the preparation of proposals in the development of initiatives and in the implementation of Council decisions. So the decision-making procedure in the EC is roughly speaking the following.

The Commission issues proposals (after long internal discussions and deliberations with all partners involved in the ten Member States) and the Council then decides upon them. Very often the proposals are modified—which needs the consensus of the Commission—or they are rejected; in that case the Commission is asked to prepare a new proposal.

The Council decision has to be taken unanimously in all cases which are of vital interest for one Member State and this is practically the case in nearly 100 per cent of the decisions. This is one of the difficulties and weaknesses of the EC-system. The necessity of having unanimity is used in bargaining procedures and package-deals and sometimes is even used to block a proposal completely even if only one coutnry is strongly against it. So national interests play too strong a role in the EC decision-making process.

The Parliament has relatively limited power. It keeps a constant watch on what the Commission is doing. It has the last word in only a relatively small part of the EC expenditure. These are the so-called non-obligatory expenditures in the budget which are not automatically the result of a Community legislation. Among these non-obligatory expenditures are the Social Fund, the Regional Fund, the research and energy policy, and industrial restructuring activities.

Now I should like to say a few words about the experiences in the field of nuclear energy within the European Community. In 1958 when the Euratom Treaty was concluded the six founding countries of the EC (FRG, France, Italy, Benelux) felt very strongly that peaceful use of nuclear energy could only be achieved by joining forces in order to create "the conditions necessary for the speedy establishment and growth of nuclear industries".

In the early 1960s the so-called bigger countries of Euratom felt more and more that they were now able to continue on a national level the further development in the nuclear field. So the introduction of, and experimentation with, different thermal reactor types and different advanced reactor systems (in particular LMFBRs and HTRs) were made along the lines of different national policies. Euratom was not able to prevent this and so failed in introducing a common Community nuclear policy.

In the early 1980s it became clear that the introduction of the LMFBR-system in the market and the development and use of its fuel cycle is too heavy a task and a burden for one country. New links of intereuropean industrial and intergovernmental collaboration were established but not inside the Euratom Treaty. This is largely because only five of the ten Member States are really interested in developing the LMFBR-system (in spite of consensus problems in at least two of them).

But the Euratom history is not only a history of failures, there are also successes. And one of the most remarkable successes is the joint European nuclear fusion programme. In this field the Member States of Euratom had never gained the impression that they were able to go it alone. The manpower and money requirements were greatly in excess what one country could afford. In this case Euratom worked well as a regional decision-making centre and the joint construction and operation of the large Joint European Torus (JET), a magnetic confinement device, in Culham near London, is to be considered as a great success of the European Community.

Another field in which the regional decision-making platform of the EC works well is the environmental protection sector. I have already said that the EC has the authority to establish pollution control directives which are binding upon member states. Obviously, the decision has to be taken by the Council of Ministers which is in this case composed of the ten national ministers responsible for environment and you can imagine that a lot of negotiating and bargaining has to be done in order to reach unanimity.

The EC succeeded in deciding a CO_2- and Suspended Particles-Directive in 1979 and by this in setting a standard for CO_2-emissions and suspended particles. The directive is a complex document containing 18 articles and four annexes. It was an important achievement despite its rather modest limitation requirements. The existing regional decision-making procedure was a prerequisite for this success.

Conclusion

Now, in concluding, a few words about the consensus acceptance-problem and the uncertainty-element and the role the EC can play in these issues.

Reactions and perceptions of people differ from nation to nation. Therefore, it is not advisable nor possible to use the EC-platform and its decision-making power for intervening in conflicting issues as a kind of supreme judge. This will not work and will in the end be counterproductive. For the consensus-acceptance problem a regional approach is not the appropriate one.

Concerning the uncertainty margin and the question of acceptable uncertainty margins, the EC has a role to play. It is a useful platform to combine judgement and the experiences of all its members in defining the scientific or technical margin of a given uncertainty. The common result or votum has more weight compared with the national findings and it is a useful contribution to the decision-making process at national level and also at EC-level (e.g. directives).

The role of engineers in society

Lord Caldecote

Viscount Caldecote, DSC, FEng, FIEE, MRINA

Viscount Caldecote, DSC, FEng, FIEE, MRINA, is President of the Fellowship of Engineering, UK. He was educated at Eton College and King's College, Cambridge. His service in the Royal Naval Volunteer Reserve led to the award of the DSC: Lord Caldecote is a member of the Engineering Coucil, UK, and is currently Chairman, Investors in Industry Group PLC, Director, Lloyds Bank PLC, and a Member of British Railways Board. He was formerly Chairman, Delta Group PLC, the Design Council and Director of English Electric Co Ltd, British Aircraft Corporation Ltd, and the Legal and General Group Ltd. Lord Caldecote has received many honours which have included honorary doctorates from Cambridge, London, Aston, City, and Bristol Universities, and the Cranfield Institute of Technology.

The role of engineers in society

Lord Caldecote

President
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The subject of my address is "The role of engineers in society" which I believe is an important factor, closely related to this morning's theme.

In Britain, and I guess in Australia too, there is still confusion about what is meant by an engineer, and about the contribution which engineers make to society. I will return to the problem later on, but for the time being let us accept the simple definition of the engineer's function, which is inscribed in the entrance to the Institution of Civil Engineers in London—to "harness the great sources of power in nature for the use and convenience of man." I believe that indicates broadly but accurately what we do, for the fact is that we engineers are indeed very much involved in society, and in the absence of our skills life would be very different.

So we have a great responsibility to ensure that we do use our skills and experience to the best advantage in the service of the community. Quality of our contribution in the application of technology in society is at least as important as its scale. And the pursuit of excellence in engineering is of course one of the prime objectives of the Australian Academy of Technological Sciences and of the British Fellowship of Engineering, and the better understanding of the part which technology plays in everyday life is surely one of the main aims of these Discovery Symposia supported by the Honda Foundation.

There is nothing new about the interaction between the application of growing scientific knowledge to the cultural and social progress of mankind. From the earliest times man has worked to unravel the laws of nature and, as far as his understanding allowed, to make practical use of them. In addition to harnessing the great sources of power, probably the most significant developments directly affecting everyday life have been in the areas of public health and household equipment, in food production, and in transport and communications generally. But in spite of these and other obvious benefits to which the work of engineers has so greatly contributed,

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there are many today who fear the accelerating influence of technology on our lives, and do not appreciate the contribution we engineers have made and continue to make. So our voice in national affairs is muted and growth of prosperity is retarded.

The number of people still alive who can remember what living conditions were like at the beginning of this century is rapidly decreasing. For most younger people in industrialised countries it must be hard to imagine a carless society or a home without a refrigerator or electricity, and much of the drudgery of everyday living has been replaced by a wide variety of domestic appliances.

In industry, too, there have been vast changes. New methods of production have done away with millions of dull repetitive jobs and much of the hard and dangerous work in such industries as mining is now done by machines. So in industrialised nations we have been able to produce the wealth we need to increase our standard of living, with fewer people working shorter hours, as Mr Jones has indicated.

Through all this change the number of people in full time employment steadily increased through expanding demand for new products, and through the growth of service industries. Such has been the contribution which engineers have made in the industrialised nations. But of course over wide areas of the so-called Third World millions of people have been largely unaffected by advances in engineering and life goes on much as it has for hundreds of years, with much poverty, disease and illiteracy. And as the Brandt Report has pointed out, the gap between living conditions in the industrialised countries and others is still growing.

Recently, concern has been growing too within the industrialised countries themselves that the application of modern technology is creating more problems than it solves. New methods of production, dominated by the computer, seem to be creating permanent unemployment on a vast scale and to be increasing the gap between the quality of life for those in employment or able to benefit from the new technology in other ways, and those who are unemployed or unable to benefit perhaps through inadequate education. In his book, *Small is Beautiful*, Dr. Schumacher wrote "In the subtle system of nature, technology, and in particular the super-technology of the modern world, acts like a foreign body, and there are now numerous signs of rejection. Can we", he asked, "develop a technology which really helps us to solve our problems—a technology with a human face?" That is indeed a challenge to our profession and is surely one aspect of the engineers' role in society to which we must give more attention.

It is, I believe, much easier to agree on what must be avoided if life is to be enjoyable and satisfying, than to agree what should be added. Grinding poverty and lack of food and water, which require every available minute to be spent on a fight to keep body and soul together, to survive another day, cannot lead to a full life; neither can disease and malnutrition nor lack of elementary sanitation, or adequate shelter and clothing for protection from the elements. Child labour and back breaking drudgery in the home, especially for women, which destroy family life, are abhorrent, as are conditions of employment in factory or mine which degrade human dignity. Loneliness for the old, lack of care for them and for the sick, and of education for the young are all tragedies which detract from the achievement of a full and rewarding life. Thus it is not in doubt that nature in the raw with no leavening from the wealth created by engineering skills is at least as oppressive as the unrestrained advance of modern technology.

But the paradox remains that amongst us, the fortunate ones, criticism of technology and so scepticism about the engineer's role in applying it, is growing at the same time as we see much of the less fortunate Third World in a similar state as our society was before the great transformation brought about by the scientific and agricultural revolutions from the 17th Century onwards. It is only where engineers have provided people with new sources of power, that it has been possible to create real wealth out of nature's raw materials on a sufficient scale to enable society to rise above a survival existence and to provide spare time and energy which can be devoted to improving the quality of life.

Current problems and attitudes

One of the major challenges to engineers is the rapidly changing pattern of world trade. A hundred, even fifty, years ago a relatively few industrialised countries imported raw materials and food from all over the world. Engineering skills were mainly concentrated in them and made possible the production of a wide range of manufactured goods which they exported to pay for imported raw materials and food. Another important export from the industrialised countries was engineering skills themselves in the form of design and construction of ports, mines, and railway systems.

But since the last war, over the past 30 years, the so called newly industrialised countries (NICs) have rapidly developed their engineering skills, and with relatively low rates of pay have become formidable competitors to the older industrial societies. Producers of raw materials too, like Australia, have found excessive dependence on these industries unsatisfactory and have built up their manufacturing skills. On the other hand, the old industrialised societies have greatly expanded their output of food through the use of agricultural fertilizers and mechanical equipment.

To all these changes, not least in agriculture, engineers have made a major contribution. Nowhere have these developments made a greater impact than in Great Britain, and I believe what is happening in the UK may well be a foretaste of events elsewhere. As a result of memories of the hardship and suffering experienced by the unemployed in the recession of the 1930s post-war British Governments have, until recently, given the top priority to a policy of maintaining a high level of employment. But the achievement of this policy was at the expense of substantial reductions in productivity and so of competitiveness of British manufacturing industry. A related factor has been slowness in the introduction of new technology into the production process, combined with the high rates of pay.

However since 1979 there has been a major and effective drive to reduce manufacturing costs and so improve competitiveness through higher productivity, even if this resulted in increasing unemployment, as it has done. When this process started most people thought that the major unemployment was a temporary phenomenom which would disappear once the recession ended and demand increased. But now there is a growing realisation that through the application of new technology to the whole process of design, development, and production, productivity (in the sense of real wealth created or value added by each person employed), can be so dramatically increased that in future far fewer people will need to be employed in manufacturing industry to satisfy the demands of our home and export markets. In this sense it is asserted that engineers have created unemployment and the forward march of technology is therefore much feared by many people.

On the other hand in any industrialised country it is clear that if industry fails to take advantage of this new technology, such as computer aided design, flexible manufacturing systems, high productivity plant, and the extensive use of robots, together with computer control of the whole process from customer's order to completion, all leading to the minimum use of human labour, it will not be competitive either in quality, price or service, with the NICs with their lower rates of pay. This will result in a further loss of share in world trade, rising unemployment, and lower standards of living. So the phrase "innovate or liquidate" has been coined in Britain.

Yet other groups believe that advancing technology engenders a materialistic, selfish outlook in which the welfare of the individual is largely ignored and the interests of the financier and multi-national company dominate the scene. They feel an urge to reurn to the "good old days" of a simpler life, but often seem to forget that they were "good" for relatively few and fail to give credit to engineers for their great contributions in, for instance, power generation, public health, medical equipment and communications which have benefited so many. There is, I suggest, no evidence that a no-growth, stagnant economy is likely to lead to a more humane, more tolerant or more rewarding life and a more satisfied society. A former British Prime Minister, Edward Heath, put it rather well some 10 years ago—"The alternative to expansion is not, as some occasionally seem to suppose, an England of quiet market towns linked only by trains puffing slowly and peacefully through green meadows. The alternative is slums, dangerous roads, old factories, cramped schools, stunted lives." Similar descriptions I believe apply in other countries, for the fact is that it is impossible to put the clock back and dam the flow of increasing knowledge.

But we can channel it into ways which will benefit mankind and that is one of the challenges that we as engineers must accept as part of our contribution to society.

The engineering challenge

The most basic function of engineers is to contribute to the creation of real wealth. In many countries – in Europe, in wide areas of the British Commonwealth, and in the U.S.A. for instance – we have been doing this successfully for quite a long time, and thereby we have been enabled to raise our own standard of living, partly through the expansion of trade with other countries. To the extent that we were employing technology more advanced than was available elsewhere we prospered and it is only comparatively recently that this dominance has been challenged by newly industrialised countries becoming very effective competitors, by making use of advanced technology themselves and by accepting lower rates of pay and hard work while they grow.

To counter this competition manufacturing costs have had to be reduced, as I have indicated, by the use of more and more advanced technology leading to greater output per employee. As long as demand for the products of manufacturing industry grew, as it has in Japan through massive exports, employment did not suffer but over wide areas of the developed world demand has not kept pace with potential supply and large scale unemployment has resulted. And it is clear that employment in the form to which we have become accustomed in industrialised countries is unlikely ever to return even when the world economy expands again. A more fundamental structural change has occurred, stemming from our ability to produce what we need with far fewer people employed.

Must we then accept that the contribution which engineers make to society in enabling so much to be produced by so few will condemn large numbers of people in one part of the world to a boring life of inactivity, apparently unwanted by the community, and others elsewhere to a life of continuing poverty and malnutrition, with an ever widening gap between the richest and the poorest? If that were to be the outcome then I doubt whether engineers could retain the respect of society for we would have demonstrated that our skills were no longer being applied for the benefit of mankind.

There are those who do not accept that big increases in productivity are a major cause of unemployment. They quote as evidence the rise in employment in, for instance, the automotive and textile industries where the skill of engineers in reducing unit costs greatly increased the market; and to a similar expansion in demand for computers and consumer goods, such as domestic appliances and HiFi equipment. The gist of the argument is that advancing technology efficiently applied creates wider markets for new products and more jobs in their wake. This has certainly been true in the past but we cannot be confident that markets will expand at a greater rate than productivity in future.

Others claim that the growth in service and leisure industries will provide employment for those no longer required in manufacturing. To some extent this must be true, and these activities also generate demand for manufactured products, such as sports gear, and office and communication equipment, but they create no real wealth themselves and the ability to pay for the services they provide comes mainly from the wealth created in manufacturing industry, whose contribution to every country's prosperity will remain, whether their industry is producing manufactured products or raw materials. Again if the new wealth is simply diverted to expanding service and leisure activities for a fortunate few there will be minimal effect in helping to alleviate poverty and to care for the old and sick whether in the Third World or nearer home.

Yet others, including many in our Trade Union movements, maintain that the solution to these employment problems lies in work sharing in industry by, for instance, the reduction of working hours. But this solution poses many inconsistencies as Professor Simon has indicated, and, apart from these, is it really sensible to restrict wealth creation, when so many people are desperately in need of its benefits? No doubt shorter working hours will come and leave time for different constructive, perhaps more congenial, activities but they are certainly not a panacea for society's problems today.

All these ideas for matching demand and supply in circumstances created by the great increases in productivity which are now possible seem to me to accord too little significance to tasks unfulfilled in, for instance, housing, health, and education and to the needs of the poor and the growing proportion of old people in many societies. For as far ahead as we can see our primary objectives should surely be to make use of modern technology to create wealth and then to distribute it more effectively. To avoid any misunderstanding let me add that I am not advocating a policy of equality, for that invariably implies equality of misery. I am advocating the greater creation of wealth, which is now possible, and in which all should be able to share. This is a much more constructive policy than to seek ways of restricting wealth creation, and, engineers with their special practical skills have a real responsibility to contribute to it.

But the creation of unemployment is not the only evil blamed on modern technology, for engineers are also accused of encouraging pollution and damaging the environment. But the fact is that this happens only when engineers are denied the necessary resources. When these are provided we are well able to control pollution and protect the environment. It is not technology that causes pollution but society's failure to use it effectively and its reluctance to pay the price of applying it. Those are mainly political and economic problems, to which practitioners of these arts should pay much more attention. But engineers should also be more insistent in protecting society from those avoidable evils.

So to sum up I believe there are two great cultural and social challenges to engineers today.

The first is to promote understanding that technology is no different from any other powerful force; if wisely and firmly directed it can do much good, but if it is not well directed it could run riot and sweep all before it into a morass of selfish materialism. Technology is not unlike water power. Great dams have brought enormous benefit to countless millions of people, and there are many well known examples, such as the Churchill Falls project in Labrador, the dams at Aswan on the Nile, and at Mangla in Pakistan. Perhaps the closest analogy is the Snowy Mountains scheme here in Australia.

But when water power runs riot as in the floods which devastate the land and kill thousands of people from time to time, or when very occasionally some great dam bursts and a wall of water uncontrolled sweeps all before it, great suffering and damage result. The moral surely is clear; where the principles are understood and scientific knowledge is properly applied the forces can be usefully directed and the power harnessed for the benefit of mankind. But where through ignorance or inaction natural forces are allowed to take command or scientific knowledge is exploited without well-thought-out objectives, disaster follows.

So the second great challenge is to understand the principles which lie behind the harnessing of technology to good purpose, and a determination to apply it to that end. In that task we engineers have, I believe, an even greater responsibility than we have for successfully designing and making useful things. For we have had the good fortune to acquire the knowledge and experience on which alone full understanding can be based. But we have in the past been too introverted, and given scant attention or effort to explaining ourselves, our skills, and our responsibilities to those who have followed other callings.

There have been faults on the other side of the culture gap as well. Politicians have been too obsessed with how wealth is to be more evenly divided before enough has been created, and others too absorbed in financial juggling, rather than in directing financial resources into wealth creating channels.

And too often economic pressures wrongly applied have prevented engineers giving of their best and in extreme cases we have allowed them to damage our reputation. I refer to the powerful pressures applied to reduce the cost of engineering projects rather than to achieve value for money. Too often in my view engineers allow an inappropriate specification to determine a design without making sure that the limitations imposed are clearly defined and that the customer understands and accepts them.

So the challenge for us engineers is really one of communication, and the paradox is that technology itself is more and more providing the means to communicate quickly and effectively. Great benefits have stemmed from new communication technology in education over a wide field in, for instance, our 'Open University' project in Britain conducted mainly by radio and television, through documentary television programmes and up to date news of events brought to us via satellite. Now we are at the beginning of the information technology revolution.

Truly the means to communicate are there in abundance and all we need is the determination to apply them more constructively towards a better understanding particularly by decision makers of the significance of wealth creation, and to bridge the gap between those who understand technology, with all the great changes which it brings, and those who fear it through ignorance or bigotry.

Certainly we must not hope for more benefit to mankind from engineering than engineers can provide, for our contribution, albeit significant, is but one among many. But equally I am confident that fears about the future application of technology are likely to be misplaced rather than to be justified by events, but only if we engineers face up to explaining more effectively our skills and the contribution to society which we can and must make.

The post-industrial society and technology

Takemochi Ishii

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The post-industrial society and technology

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The advanced industrial societies saw the limits of the exploitable supply of natural resources, particularly that of petroleum, in the 1970s, and came to envisage an end to the old industrial society. In some of the advanced industrial countries, the technology to conserve energy and other natural resources became a stable and key part of the social and economic structure in the early part of the 1980s, so it can be argued that a major shift towards the post-industrial society has already begun. Information and related technologies are playing an especially important role as the motivating force for this structural change.

Innovation in information technology can be divided into two categories:

1. information processing, and
2. communication.

In the first category the development of semiconductor technology has played a vital role. Remarkable improvements in reliability and the astonishing decrease of production costs produced by the development of the integrated circuit (IC) have had the largest technological impact ever experienced by society. From the early 1970s, the introduction of large scale integration (LSI) has been considered the most important technological theme in Japan. Great efforts have been made to improve LSIs, and these are being continued aggressively. For example, in various electronic circuits there is a device called the dynamic random access memory (DRAM), which is widely used in various electronic devices as a memory. While the largest memory capacity of one chip was 64 k-bits, the 256 k-bit DRAM rapidly permeated the market this year, earlier than expected. Samples of a 1 M-bit DRAM have already been manufactured and the possibility of producing 4 M-bit DRAMs is now being examined. These technological developments suggest that society will be further influenced by electronics.

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In the second category, large capacity communication technology using laser beams and optical fibres, for instance, has yielded two-way video communications, as used in television-conferences. In addition, the combination of technological innovation in (1) and (2) makes it possible to configure an information network system in which many computers of various sizes communicate. This network system offers the possibility of building a global system using satellites as well as local area networks (LAN).

In the traditional industrial society, materials and energy played a crucial role; in the post-industrial society information technology has been combined as a key factor contributing to economic growth; and in fact, it will become the most important factor propelling the economy forward. In Japan, the initial steps towards the information technology age took the form of the dissemination of information technology throughout industry. In other words, factory automation (FA).

In the steel industry, the largest basic-materials industry, factory automation has achieved outstanding results. The continuous casting of steel is a typical technology where LAN is employed and was first realized using a fully computerized control system. As a result, energy consumption has decreased by two-thirds. The fact that more than 90 per cent of steel production in Japan now depends on continuous casting technology clearly suggests that FA is playing a very important role, even in mature industries such as the basic-materials industry. The results achieved have been broad-ranging; conservation of energy, higher quality, higher yield rates, shortening of processing time, smaller plant sites, and labour savings. An even more decisive effect of FA can be seen in the processing and assembling functions of the machinery industry. Typical examples here are industrial robots and NC (numerical control) machine tools. Innovations in this area go beyond improving quality and raising labour productivity. With the appearance of FMS (flexible manufacturing system), it is now possible to produce many different types of products in small quantities. These significant advances are bringing about large structural changes, to the extent that many observers are now talking about a "new industrial revolution". About 64 per cent of the machine tools produced in Japan in 1983 were NC machine tools and the expectation is that the shift to NC machine tools will increase. In addition, the performance of NC machine tools is at least three times that of non-NC machine tools. If large numbers of NC machine tools are applied properly, efficiency will increase by up to 100 times. Recently it has become quite popular for many factories to operate unmanned at night.

At this stage two important factors should be highlighted.

The first factor is the software problem associated with FA. Since NC machine tools need operating instructions in a machine-readable form (i.e. an electronic signal), computer aided design (CAD), by which design work is carried out using a light pen or pointer, and a CRT display is employed. That is to say, machining work based on soft copy is required rather than hard copy (design drawings on paper). In fact, CAD CRT-terminals have been taking the place of drawing desks in many engineering offices. As a result, flexibility in FMS can be achieved provided a variety of software is available. Therefore, software production has become an important problem today. This indicates that CAD and CAM (computer aided manufacturing) have become popular and that FA is essentially dependent on information technology.

The second factor is that the machine industry comprises a great many small to medium scale enterprises, most of them subcontractors. It had been thought that the quality of the final products of large scale enterprises in Japan suffered because of the low technical standard of these small to medium scaled enterprises. However, referring to recent FA, more than half of the NC machine tools produced today have been introduced (many of them are leased) to small to medium scale enterprises. These enterprises have also been very important in introducing industrial robots. The main cause of this change stems from the shortage of labour and from corporate growth. Thus, the dissemination of FA is occurring not only in large scale enterprises but also in small to medium scale business. I call the movement "grass roots technological innovation" and consider it a characteristic of the structural changes evident in Japanese industry.

As an example of this grass roots technological innovation, I will mention a small town called Sakaki with a population of 17 000 in Nagano Prefecture in the Chyubu area. In 1983 the industrial output of the town reached $560 million. There are 330 companies (small to medium scale enterprises) in this unpopular little town located in the narrow valley of the Chikuma river. The town is an extremely bad site for a factory because of an inconvenient transportation system, remote location, and so forth. However, due to the shortage of labour and space, NC machine tools have been widely applied, to the extent that the town has absorbed 1 per cent of all the NC machine tools in Japan. Sakaki also exports to more than 100 foreign countries. An electronic device company based in the town holds market shares of 70 per cent and 90 per cent respectively in world and domestic markets. Although this town is not well-known in Japan, five Chinese from the People's Daily (Renmin Ribao) and Radio Beijing came in July to collect data and expressed deep interest in various companies. It would be interesting to know what impression they obtained from grass roots technological innovation. From an engineering point of view, NC machine tools and industrial robots are hybrids of existing mechanical engineering and recent electronics technologies.

Since this new technology integrates electronics and mechanics, the new term mechatronics has been coined.

While traditional machinery was merely seen as a substitute for manual labour, mechatronics now makes it possible to have machines that are capable of performing functions related to man's nervous system. With this development, it can be said that a new era of machine-oriented civilization has begun. In this connection, when we consider the implications of information technology, we should not confine ourselves to thinking of electronics and telecommunications in isolation; we need to look at a broad range of application technologies including mechatronics if we are to make an accurate analysis. Put another way, the post-industrial society contains two phenomena: on the one hand information and information technology themselves comprise an industry, while on the other hand there is the application of information technology in various industries through mechatronics. There is a complex linkage between the two and they stimulate one another as they grow.

Quite apart from its impact on industry, the new information technology is bound to exert a significant influence on many aspects of social life such as in the academic world, the arts, and individual life-styles, as well as the social system itself. For instance, VTRs and pocket TVs, super computers, and computer graphics, as well as electronic music synthesizers, have already influenced science, art, and everyday life. We can anticipate that the impact will be similar in scope to that of the Industrial Revolution on the old society and culture. Naturally, since each region has a different culture inherited from the preceding era, the mechanism for accepting identical technological innovations will change, and the consequences of their introduction will also vary.

Up to this time, most of us have tended to think of technology as having a universal character common to all mankind with an identical pattern of development and dissemination. It was held that the technological gaps between the different regions of the world represented nothing more than differences in the state of their respective development. One manifestation of this way of thinking has been to place different countries within the framework of one linear pattern of development and to rank them as advanced countries, underdeveloped countries, and so forth. However, more recently there has been an increasing trend to think that differences in technology levels, to a large extent, reflect the differences in technology and cultures that prevail in different regions of the world. This approach, in turn, leads to a view that essentially there are diverse patterns, and parallel and multiple paths, in technological development. This argument has been winning increasing support in recent years.

With respect to the interrelationship between technical cultures and non-technical cultures, the dominant approach to date has been to emphasize their mutual negative and even destructive influences. However, here too, the possibilities of their having a complementary role has been given greater importance in more recent analyses. In fact, we frequently discover technologies from ancient history in the midst of the so-called non-technical cultures. Here is a recent example in Japan. A Japanese sentence consists of phonetic characters and ideograms. Due to the recent development of mechatronics, all Japanese sentences can now be handled by Japanese language word processors. Before mechatronics, for a non-technical culture such as language, there had been adopted the OA (office automation) system of not using ideograms (i.e. using phonetic characters only), with the tendency of destroying the tradition of the Japanese sentence. It is reasonable to assume that in the post-industrial society, the complementary relationships between the technical and non-technical cultures and their mutual dependence will increase even more.

In a society overflowing with high technology and its applications, there is a distinct danger that mankind will fall into a state of psychological instability as a result of excessive tension. It is possible that such things as natural scenery and sports will provide the means for coping with these pressures, and play a more important role than they do in today's society. Fortunately, the Western Pacific region has a diversity of cultures and this factor may play an unexpectedly important role in the post-industrial society.

Through the advances in FA (factory automation) described above, as well as OA (office automation) and the application of information technology in family life, economic activities throughout society are likely to increase even more and there will be a far more efficient utilization of natural resources and people's time. In such a post-industrial society, emphasis is likely to shift from a technological preference for heavy weight and large size to one for lightness and compact size. For example, the industrial zone complex by the sea symbolized a centralized industrial system pursuing economies of scale; however, locally-sited high-technology factories as in the case of Sakaki, will now form the main stream.

As I stated at the beginning of this article, it cannot be denied that the advent of the oil crisis triggered changes in our values, especially in terms of human resources. Highly trained intellects will be increasingly in demand, while the need for the traditional types of manual labour will decrease massively. This implies the need for us to give careful consideration to the content of education in the post-industrial society.

For those who have been sufficiently and appropriately trained to handle the high technology employed in the post-industrial society, the degree of human freedom is bound to be more extensive than that in the old industrial society. In the post-industrial era, however, there will also be an increasing need to create a new social order, which could not have been predicted in the old industrial society. For example, together with the dissemination of information technologies, we shall be confronted with such issues as the need to protect the individual's right to privacy and to protect proprietary rights involved in software. While in the long term there is little doubt that mankind will be able to create the necessary social arrangement to cope with this situation as it has done on previous occasions throughout history, it is equally clear that we will encounter numerous problems and difficulties in the process of establishing the required system. When the new system is finally established, we will see for the first time the full potential of high-technology employed for the maximization of human freedom.

SESSION 6

Addresses by Panel Members and general discussion

Chairman

Lord Caldecote
President, Fellowship of Engineering, UK

Panel Speakers

Professor Shuhei Aida: Human resources and the information society

Dr Harold Chestnut: Applications of systems engineering techniques to the use of resources and technology in the interest of mankind

Professor Gunnar Hambraeus: The use of resources and technology in the interest of mankind

Sir James McNeill: Technology and the well-being of mankind

PANEL DISCUSSION

Human resources and the information society

Shuhei Aida

Professor Shuhei Aida

Professor Shuhei Aida is Professor of Systems Engineering, University of Electrocommunications, Tokyo. He is a Director of Honda Foundation and of Society of Instrument and Control Engineers of Japan. He is a Member or Fellow of National Biomedical Research Foundation, USA, Laboratorio de Cibernetica, Italy, and Vice-Chairman on Social Effects of Automation, International Federation of Automation Control. His awards include Decoration of Cavalier Ufficial, Italy, 1981; The 23rd Mainichi Cultural and Publication Award, and 1976 Pattern Recognition Society Award. His publications include *Introduction to Cybernetics, Robot, Introduction to Ecology, Science of Prediction, Interdisciplinary Study,* and *Systems Engineering.*

PANEL DISCUSSION

Human resources and the information society

Shuhei Aida

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Learning from nature, from ecology for example, provides useful resources and information for ecological reconstitution of nature. Information is thus as much a natural resource for human beings, as are materials and energy. It is clear that environmental issues are of great concern to modern civilization. For human society, these issues have an impact on many different levels and forms of human activity, such as mental, cultural, economical, and ecological problems of human resources.

In this panel discussion I would like to comment on some of the fundamental points concerning human resources and information. That is, the most important resources in modern society, as these relate to post-industrial society to the year 1990.

It goes without saying that our awareness of the complexity in human society is stimulated by the rapid growth in technology.

It is often pointed out that if technological innovations continue to the extent that they have already, the year 2000 will be a time of technological complexity. It goes beyond our imagination what existence will be like under those conditions.

An understanding of technology and what it means to man and his environment is needed. We must understand how man plans to develop technology, and how he will apply it to realise the reconstruction of conventional technology.

Suppose we take the virtues of the computer-oriented information system as one of the driving forces in the rapid advances seen in technology. It is clear that we owe a great deal to its capacity to perform operations. The speed of the computer allows the establishment of new relationships that we have found in physics and chemistry, and especially in bio-technology.

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Computer advances provided the means for the conceptualization of new technology. Furthermore, new technologies seem to provide the impetus for change in the social system which moves toward greater harmony between nature and human activities such as technology.

Before this stage in man's development, society seemed to operate in a medium where culture and technology were in equilibrium. This equilibrium provided also a degree of diversity for human expression and existence. The further expansion of technology, however, threatens this balance with a destructive force.

Resulting from human activities, "advanced technology" has spread on a world-wide scale and its concepts have been adapted to resolve some of the problems of developed industrialised countries. Results achieved, whether in developing or developed countries, have amply shown the immense potential of technology in a great many fields; it has also become clear that a much wider dissemination of "technological know-how" is essential if the needs of all countries are to be met.

Among the developing countries there are some which already have a certain degree of technological background, and in these countries the low-cost, intermediate, and "soft" technologies already exist. Moreover, since this type of technological evolution is normally accompanied by a renovation of social and cultural values, it would seem most valuable to extend the scope of research and development, wherever possible, to include greater emphasis on advanced technology.

The foregoing will have shown that the exercise of human activities in the natural environment may be at many levels and may take many forms. Even when human activities are grouped into three classes (i.e. those concerned with materials energy, and information—which are all necessary resources for a society), human behaviour and capabilities are still dependent on technological conditions, technological expectations, and human aspirations. These latter three factors can play a most important role. The amounts of human resources involved and their potential for action (a quantitative measure of human resources) determine human ability to transform physical resources in the three groups into the many and various kinds of products that human society requires. Some products and information will then be further synthesised to promote further and better human activites. It is educational excellence that will be the key to improving human society.

The "growth" of a nation means, in general, the increase of its cultural and industrial products. Both of these are clearly dependent on the quantity of human activity (more activity gives more products and information). The "development" of a nation, however, is influenced not only by its material resources but also by the social, cultural, technological, and economic conditions of its society; the evaluation of "development" must therefore include a factor for quality.

In selecting advanced technology, it is very important for a nation to decide on the relative importance to be given to two distinct targets—quantitative growth and qualitative development. The possibilities in either direction are evidently limited by the relation between the nation's material resources and needs and human resources. This very important decision will, of course, affect the nation's material prosperity (in its most elementary—or material—sense) but it may have an even greater effect on whether or not the nation believes itself to be prosperous. This means that concepts of advanced technology, chosen for their practicability from social as well as material viewpoints, may well vary from one nation to another according to what each decides is its most important objective.

This in turn must of course affect the assessment of the advanced technology for transfer to a not-yet-fully-developed nation. In practice and at present, although such technology transfers are made in many fields and in many ways, the above criterion (quantity versus quality) is rarely considered. Nevertheless, there has for some time been a trend towards the transfer of information rather than materials—especially in advanced technical fields—and this trend seems generally advantageous, representing as it does the transfer of seed for local fertilisation rather than mature fruit with already-determined characteristics. The inescapable conclusion is that education and training, carefully chosen with regard to regional and technological conditions and requirements, are indispensable complements to (and may well be more important than) any material technology transfer.

The subject of advanced technology—intellectual methodologies, logic, mathematics, conceptual models, and artificial intelligence—has spread widely into domains far beyond technology in its normal sense, and is generally recognised as a matter of interculture communication.

It is obvious that interdisciplinary and information studies are necessary in the field of international political senses listed as follows.

1. First of all, the level and form of interactions among countries are remarkably diversified. This manifests itself in an inseparable interlocking of economic and political (in a narrow sense of the word) relationships. These interrelations cannot be understood in the context of traditional political relations. Nor can they be understood merely by rational economic thought.

2. The world today is culturally diversified. Whenever there is some sort of international relationship, the problem of cultural contact always arises. However, our notion of politico-economic 'common sense' is the product of our type of civilisation, rather than a universally-held concept. So, an anthropological approach is required.

3. Just like the first half of the 20th Century, the last half will be affected by technological innovation. Unless we understand it, we shall not be able to take a longer—i.e. more than medium range—view of international rela-

tions. Needless to say, since political intentions also intervene (as in resource issues), simple extrapolatory forecasts cannot bear much fruit.

4. In order to understand international relations, which are so diversified and have multiple "actors", massive amounts of data have to be processed. Of course, mere mathematical processing of such data is hardly sufficient to understand political phenomena. We need to know its basic requirements and limits, and then develop appropriate working methods.

From these points of view we should develop a four-part scenario in each region based on culture as follows.

1. What has modern technology done?
2. What does it lack?
3. What is needed to revitalise it?
4. What can we do?

Adapting information technology to man, culture, and society means that such technology produces life-enhancing products and services to be distributed on a just basis, provides creative and fulfilling employment of people, conforms to their physiological, social, and cultural norms, and is not exploitive of other persons or natural resources.

We are confident that information technology allows the individual man-machine interface new flexibility. Therefore, it is important that, along with a "system-measure of the man" a "man-measure of the system" be used to meet criteria which are fundamentally aesthetic and subjective in nature.

Optimisation or satisfaction under such constraints is a serious responsibility of all participants here in Melbourne. I am convinced that Discoveries movements could have better effects than we think.

PANEL DISCUSSION

Applications of systems engineering techniques to the use of resources and technology in the interest of mankind

Harold Chestnut

Dr Harold Chestnut

Dr Harold Chestnut is a member of the US National Academy of Engineering and a Fellow of IEEE, AAAS, and other technical organisations, Dr Chestnut is an electrical engineering graduate of MIT and has worked all his career with General Electric Company in the fields of automatic control and systems engineering. He has written books in these fields and has served as President of both IEEE and IFAC. Dr Chestnut was the recipient of the Honda Prize for Ecotechnology in 1981 and since his retirement in 1983, he has been active in the SWIIS Foundation Inc and has served as its President. He has also served as an Associate Professor of Electrical Engineering at the State University of New York at Binghamton.

PANEL DISCUSSION

Applications of systems engineering techniques to the use of resources and technology in the interest of mankind

Harold Chestnut

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Introduction

The processes of using resources and technology in the interest of mankind have been used with increasing frequency and influence throughout the world to bring about many changes in people's ways of living. Although these changes have generally been considered in the interest of mankind in some sense, there have also been occasions when certain aspects of the change have been contrary to other concerns of the people involved. Widespread unemployment and environmental degradation are two examples of such unfavourable results to mankind. It is highly essential that the more expanded use of resources and technology consider mankind's many different interests in a systematic fashion to limit the possible unfavourable effects caused by such technological changes.

In the case of changes caused by nature, especially those of an evolutionary nature such as an ice-age, these changes may be slow and almost imperceptible. In such cases, the human species may have time measured in generations to adapt to such changes.

In the case of some of the man-made changes caused by technology, such as by automation, computers, or agricultural mechanization, these changes may take place in decades, and whole regions or industries may be altered in the employment opportunities they afford. Fortunately, by this time, there has been widespread experience with the introduction of man-made changes through technology, and we are in a much better position to understand much of the processes of such changes and to reduce their possible harmful

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effects. It is important that advantage be taken of such experience of people with this process of technological change.

1984 highlights the 100th anniversary of IEEE

The 100th anniversary of the Institute of Electrical and Electronic Engineers in 1984 has highlighted the great progress in that field of technology over the past century. As chairman of the IEEE History Committee, I have had noted the advent and improvements in radio, television, world-wide communication, high-speed air transportation, electric power generation, and utilization, automation, computation, control, and nuclear power as examples of this greatly expanded use of technology. The work of other electrical engineering organizations, such as the older IEE, and other fields of engineering, such as mechanical, aeronautical, and mining engineering, have also contributed greatly to these accomplishments.

These last 100 years have witnessed a period of unprecedented growth and change in population, life-expectancy, general health and well-being, literacy and education, use of energy, use of new materials, and use of goods and services in general. Inventions and new technical discoveries have provided new breakthroughs into activities that had only been dreamed about heretofore. Also, there has been developed a systematic way of producing and introducing change. Thus, systems engineering has been identified as a way of considering the many aspects of largescale undertakings as they are introduced and brought into being.

Attention to and emphasis on the introduction of change, and the guidance and direction of change, have provided us with new and better ways of bringing about change. These activities have also helped change to be used effectively rather than to be disruptive to the environment and to people being changed.

Closed-loop systems principles have been identified and used

One of the important systems engineering techniques that have been involved in the process of introducing and managing change is the use of the closed-loop system. As shown in Fig. 1, a process being controlled has actuating signals inputs as well as system outputs. Control instrumentation and conditioning measure and interpret what is happening to the process and the control logic. The control logic is influenced by external signal inputs as well as internal signal inputs to determine the actuating signals. Various disturbances are also shown which indicate different ways in which uncertainties can be introduced into the system.

Many successful applications of closed-loop systems have been realized in industrial automation such as robotics, automatic control of industrial and utility systems, communication via satellites and more conventional means,

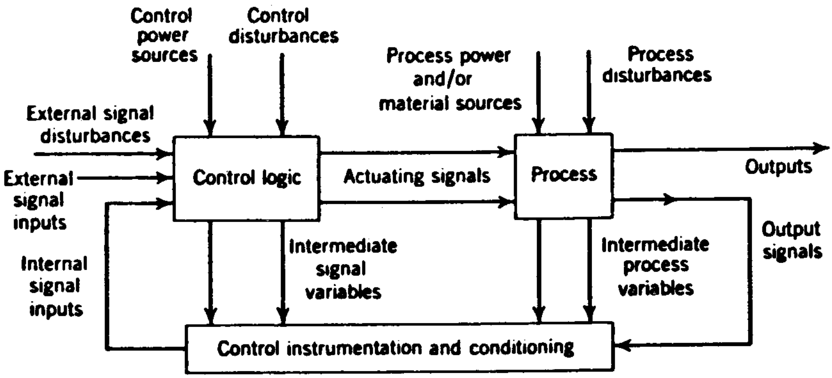

Fig. 1—Closed loop control system.

and in computing control applications. The process shown may include resources of energy, materials, information, and/or people. The references serve to establish and provide the goals, objectives, and signal inputs. Thus, depending on the choice of the results desired, the references serve to help establish what will be the output of the process being controlled.

The control logic performs the decision-making and management functions and may be manual or automatic. It is in this logic function that the perceptions or biases of the decision-makers are often incorporated and made evident. Depending on the choice of logic which is employed, the nature of the benefits to mankind may differ from application to application.

Control instrumentation provides an indication or measurement feedback of what is happening at the output and/or other places in the system. To the extent such measurements are valid and timely, the possibility for improved system and process performance is increased. Overall, the use of closed-loop systems has proved most effective in realizing in practice the sort of system achievement that was initially anticipated.

Interests of mankind are varied and broad

In using resources and technology, it is important to note that mankind's interests include the values and perceptions of people. These values and perceptions are influenced by education and training and are themselves subject to change with time. The benefits of an automated plant may be perceived differently by the management of the plant in contrast to the employees of the same plant, some of whose employment may be terminated.

Also of significance in considering the benefit of a system to mankind, is the various levels at which mankind's interest is evaluated. Table 1 lists

TABLE 1
Level of mankind's interest and basis of evaluation

Level of mankind's interest	*Nature of mankind's benefit or evaluation basis*
Person or individual	Education, health, economic well-being, family influence
Group or community	City or State, infrastructures, education, training, economic or environmental impact
Industry	Company or productive enterprise, food, clothing, housing, transportation, energy, communication
Nation	Geographic boundaries, economic influence, social impact, ethnic considerations, political influence
World or international perspectives	World-wide and international concerns for security, environment, and survival of mankind as a whole

several levels of mankind's interest, many of which must be considered in a project's design and operation.

Depending on what criteria and weight are given to mankind's interests, the ways that resources and technologies are used may differ considerably.

Application of systems engineering methods

In the use of resources and technologies, there are benefits to be realized by using well-established systems engineering methods such as the following.

1. Understanding the processes, both human and technical, involved.
2. Identifying the objectives, goals, and references.
3. Specifying and getting agreement on the weighing and the relative priority of the goals and objectives.
4. Use of simulation, models, and scenarios to understand the influence of the areas of relative certainty and uncertainty.
5. Design, management, and program control of the project.

These systems methods are becoming increasingly better known and more extensively used as transportation, communication, and technology transfer are being used more extensively and effectively. The suggestion of Professor Atsumi of an Asian Pacific Institute of Systems Analysis could be of considerable help in this process of applying systems engineering method's application.

Need for improving international stability

Increasing numbers of people around the world are getting concerned that the benefits of technology to mankind, that have already been demonstrated as being possible, may be lost completely as a result of worldwide destruction caused by nuclear military weapons. In contrast to win-win situations provided by wide use of technology and resources, all-out nuclear war promises to be a lose-lose situation in which there will be no winners—all parties will lose.

The principles of closed-loop systems and the application of systems engineering have been employed extensively for military systems. Considerably greater effort is required by physical and social scientists, and by skilled people in other disciplines as well, to find ways in which non-military, supplemental ways for improving international stability can be employed to reduce the likelihood of nuclear war.

As one thinks of the use of resources and technology in the interest of mankind, increased attention must be paid to the survival of mankind. Means for improving international stability can be developed and implemented as part of the educational and training process which must accompany the use of resources and technology in the interest of mankind.

Conclusion

The 7th Honda Discoveries Symposium has helped to identify many of the needs and opportunities for the use of resources and technology in the interest of mankind—with particular reference to the Western Pacific.

Techniques and examples of similar efforts in other times and other places give us faith and hope that much can be gained by the application of resources and technology to the Western Pacific, including Australia and Japan, the co-hosts of this Symposium.

PANEL DISCUSSION

The use of resources and technology in the interest of mankind

Professor G. Hambraeus

Professor Gunnar Hambraeus, FTS

Professor Gunnar Hambraeus, FTS, is Professor and Chairman, Royal Swedish Academy of Engineering Sciences, Member, Royal Swedish Academy of Sciences, Royal Swedish Academy of Military Sciences, Finnish Academy of Technology, The National Academy of Engineering of Mexico, Fellow, Australian Academy of Technological Sciences, and of the Academy Nacional de Ingenieria, Argentina. Professor Hambraeus has occupied many important posts in science and technology in Sweden and has been consultant at the International Atomic Energy Agency (1968-69), Managing Director of the Swedish Technical Press (1969-70), following a decade and a half as Editor in Chief and Publisher of "Teknisk Tidskrift". He was Chairman of the Honda *Discoveries Symposium* in Stockholm and his many awards have included the Dr Tech h.c., Gothenburg 1975, the Seraphim Medal, and The Order of the Northern Star, The Legion of Honour, and The Grand Cross of the Order of Merit. He has been a member of numerous government bodies and was the author of *Progress in Swedish Research and Technology* and other publications.

PANEL DISCUSSION

The use of resources and technology in the interest of mankind

Professor G. Hambraeus

Chairman
The Royal Swedish Academy of Engineering Sciences[1]
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The subject which we have been discussing over the last three days is, in fact, what all governments have been fumbling with from the very start of organised society.

The elders of the Neolithic village had to think ahead. How could they bring the collective thoughts and the combined work of the tribe to bear on the use of their meagre resources. Their existence depended on this to ensure at least the survival and hopefully some wealth for their community.

In an immensely more complicated world this is essentially the aims of our governments. Their task is difficult to say the least. They carry the responsibility, they usually have to account for their decisions, their information is woefully incomplete, and the consequences of their actions may be catastrophic. As a one-time politician and now a government adviser I have deep sympathy for their situation.

How easy now, seems the life of a cabinet minister of yesterday. The pace of events was slow, the finances of even a great nation were manageable. Cabinet ministers wielded great authority; their constituents were ignorant, uninformed, and docile.

In contrast let us look on some characteristic features of our modern society. Dr. Schuster this morning dwelt on the fears and foibles of the great public in face of new technology, of nuclear power, of chemical pollution, computer rule, and genetic manipulation. I would like to add to that the resistance to change of every kind that permeates our wealthy societies. We can perceive a hardening of the arteries of the social body. No one is willing to give up any part of his or her benefits; you know and like what you have.

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A promise of a better life somewhere else tomorrow, in this world or another, is no more than a promise.

This inertia is a burden of traditional industrial countries. It is much discussed as a characteristic of the working class, where new conditions, new technology, demands for retraining, relocations, and other changes demanded by management are fiercely resisted. The same phenomenon can, however, be observed on all levels among the directors and managers of industry as well as in the ministries and agencies of State bureaucracies.

As physicists we recall the basic rule that every force applied to a system immediately brings forth a counter force. This applies to our society as well as for the material world. Economists speak of the conservatism of capital. The more you have invested in a system the more expensive and difficult it is to achieve changes. And our systems are growing ever larger and harder to influence. Obvious examples are steelworks, petrochemical complexes, databanks, communication systems, electric power production and transmission, pipelines for oil and gas, air defence and other types of military installations, and vehicles.

You could also envisage our entire industrial world as one interlocked miraculous system. The interdependencies are unaccountable and largely unobserved. Only when a vital link is broken are we reminded how utterly vulnerable is the modern industrial society.

The inertia of these systems, be they social, industrial, or commercial, can be expressed as characteristic time constants. They are like the half time figure used to express the life of a radioactive product. The systems can be changed but it takes ten years to open a mine or to build a nuclear power station. You can move or close a production facility but it takes decades to restore the prosperity of the surrounding community. It was easy to abandon gold as a monetary base or to leave the fixed currency relations of the 1950s, but the stability of our international money relations seems to be gone forever.

I would now like to contrast this high viscosity society with the easy movement of our intellectual and emotional facilities. Our industrial world is subjected to wave after wave of ideas and notions; the green wave, the youth revolt, the new mysticism.

The markets for industrial products, and specifically the sophisticated leisure goods, are rapidly changing. The Japanese, to take one example, have been masters in discovering and exploiting entirely new needs and demands. The light Honda motor bike is an outstanding example. I could also mention the transistor radio, the Sony walkman concept, as well as the computer games and electronic musical instruments.

Now I see a similar increase in the rate of change in another area. This is the new dimension in science created by computers and improved telecommunications. The collection of basic data can now be done automatically to a surprisingly large extent. The interpretation of basic information can be done in multi-dimensional space by computers. The programs are vastly superior to the best human intellect in finding the important interpretations. Large instruments can be controlled and read at great distances. The most obvious example is the interplanetary sond. The same principle applies to astronomical observatories and the huge accelerators of fundamental particles. Scientific communication is also turning instant. Our learned colleagues now correspond by computer nets, and their dependence on the traditional journals and other types of printed documentation is rapidly decreasing. The speed of scientific progress has made a quantum jump. The same holds for the application of the results for R & D in industry and public service systems.

I have tried to illustrate what I see as the dilemma of our decision-making procedures. This is obvious in government as well as in industrial management. The values, markets, and knowledge base is changing more rapidly than ever before. But our unions and capitalists and our social and industrial structures are becoming more and more rigid and immovable.

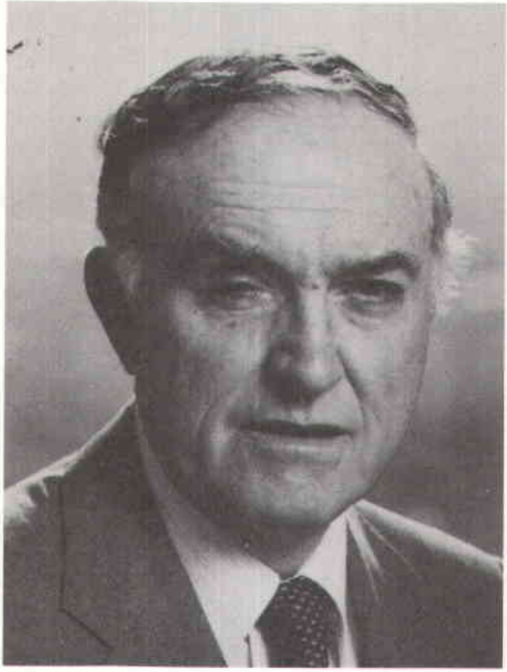
Like heavy vehicles moving at high speed, which take a long time to turn around, we have to use great foresight to guide our societies into an uncertain and rapidly changing future. There is a great need for better and more accurate methods to discern the future, to scan the horizon, and to distinguish the important signals against a noisy background. This is an area where I myself have been active and I would welcome it if the next Discoveries symposium were to take up this subject. We have, during the present conference, surveyed a great number of possibilities; we have described problems and listed symptoms.

There remains, however, the transformation of the distillation of this material into methods for decision-making on the political and managerial plane. The wise use of resources—intellectual, human, and material—depends on the interaction of the decision-makers with the fact-finders and information-producers. Here lies our great responsibility and our immense opportunities. We have accumulated a wealth of background information. We have the tools that Dr. Chestnut talked about. Let us now use this to try to re-direct the global politicial people to the proper use of resources for the benefit of mankind.

PANEL DISCUSSION

Technology and the well-being of mankind

Sir James McNeill, CBE



Sir James McNeill, CBE

Sir James McNeill, CBE, was Chairman and Director of Administration, The Broken Hill Proprietary Company Limited and major subsidiaries from 1977 to July 1984. Sir James joined BHP in 1933 and has occupied many important commercial positions in Australia's largest company, rising to become Executive General Manager Finance (1967-71), a Director (1970), Managing Director (1971-77), and finally Chairman (1977). His present positions include Chairman, Tubemakers of Australia Limited; Director, ANZ Banking Group Limited; Member International Council, Morgan Guaranty Trust Company of N.Y.; Member Asia Pacific Advisory Council, AT&T International; International Councillor, the Conference Board; Councillor, Monash University and Chairman Monash University Finance Committee; Councillor, Institute of Public Affairs, Victoria; member, Finance Committee, Walter & Eliza Hall Institute; Member, Institute of Directors in Australia. His CBE was awarded in 1972 and he was created a Knight Bachelor in 1978.

PANEL DISCUSSION

Technology and the well-being of mankind

Sir James McNeill,[1] CBE

Formerly Chairman
The Broken Hill Proprietary Company Limited
Melbourne, Australia

I speak to you as a mere industrialist, as one who has not had training in a technological science, but who has enjoyed working with technologists, in resource development, and in the Asian Pacific Region, and who looks to technology to provide the major advances in the well-being of mankind.

Having made this declaration, let me say that in placing such great hopes on technology, I am not without some apprehension. Technology has not yet been able to deliver in many areas of everyday concern where mankind needs its help—the common cold; Circadian disrythmia; faster baggage recovery; better seismic forecasts; better long range weather forecasts—I could go on. In this space age, is any of that asking too much? We certainly can't be satisfied with "progress" which has led to some parts of the world paying for agricultural products not to be produced when a large part of the world is starving. This also was touched on in this morning's discussion.

There are other grounds for apprehension. Not all new technology is going to succeed and it will rarely be easy in the early stages to distinguish that which is destined to be successful from that which will fail to live up to its early promise. The cost to industry of a wrong judgment can be catastrophic; yet if we wait for evidence beyond reasonable doubt, we may miss the boat.

New technology does not, as a rule, come cheaply. I have great admiration for scientists, but observe that they find the discipline of budgets irksome. I have little doubt that with modern technology, engineers can build almost anything given enough dollars. That is another cause for concern.

Even large companies cannot operate on unlimited budgets. Even if cost estimates are adhered to, there are risks enough in major projects. We need

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to know what technology can deliver, what it will cost, when it can be available, and (within reasonable limits) what it will cost to operate.

Am I asking too much? Sir Russel Madigan went some way to making the point that companies depend on profitability for survival. Profit is a signal of efficiency; that the product is needed and is competitive. Profits protect jobs and encourage investment, growth, and research. I suggest that companies which make the greatest contribution to mankind will be those which make the greatest profits.

Whilst this perspective from the corporation position may leave scope for differing views, this is not to be compared with the difficulty of determining what in fact is in the best interests of mankind. Mankind itself seems quite incapable of reaching agreement on this. Dr Schuster covered this very well indeed. One only has to consider some of the current debates, for example, the nuclear fuel cycle—would mankind have been better had the atom not been split?—which I suppose is akin to the age-old question of whether the invention of gunpowder has been beneficial. There is the important and topical question of embryo transplants (IVF); here there is sharp division in the community on the legal and ethical issues.

Should we aspire to economic growth if that requires the development of freeways, airports, and dams, and the sacrifice of wildlife or of atmospheric purity?—or if it encourages the emergence of super star pop groups such as worry Professor Aziz? These are but a few of the areas where some people believe science and technology are being misused in terms of benefits for mankind.

Clearly mankind, with the rapid expansion of technology, with the explosion of knowledge and the adaptation of that knowledge to alter lifestyles, has become increasingly concerned with "quality of life", and I for one would not want to discourage this. The concept of improving the quality of life indeed compels our unqualified support until we realise that definitions and objectives differ. One common manifestation of concern with quality of life, in its more extreme form, means leaving nature totally undisturbed to wreak its own changes on the environment; to avoid heavy industry and its requirement for shift work, which even at a time of high unemployment is considered by some to be anti-social. To the extent any solution of these contradictions is possible, it will be provided by technology.

This task certainly requires the energies and skills of technologists but also of all other disciplines. One of the problems is the rate at which knowledge is being acquired and partly in consequence the rate at which change is occurring. Some time ago engineering graduates were considered to have a half life of less than a decade, that is to say, less than ten years from graduation half of what the engineer knows will be obsolete and not needed for his work, half of what he will need will not have been provided by his initial university education. I do not know how these things are measured but it is said that the amount of knowledge is at least doubling each decade. If that is even approximately correct, what great responsibilities it places on our educational processes. It was with this in mind that I found particular interest in proceedings of the previous symposium where one of the goals identified was "the improvement of understanding and intellectual exchange between scientists and technologists on the one hand and politicans and decision makers on the other". That previous symposium, however, concluded with an observation that it had not really come to grips with the question of the fundamental relationship between technology and mankind. The question was posed whether society should adapt to technology or whether technology should look ahead and organise itself to meet the needs of man. Two distinguished members of this panel were participants in the equivalent final session at the previous symposium (Dr Chestnut and Professor Hambraeus). Perhaps they would agree we have not yet really answered that question.

I now want to come back to the question of resources and resources diplomacy which was particularly dealt with in Session 3.

We in Australia find this an area of special interest, having as we do a generous endowment of land, minerals, and energy resources but limited resources of water and people. This at least is the current view but we would be wise to remember that nothing is static. Notwithstanding Sir Roderick's brave excursion to 2004, attempts at forecasting the future have, to say the least, an unimpressive record and at the worst have been downright misleading. But it would be too pessimistic to assume that all of the presently unforeseeable errors are likely to be for the worse. After all, technology has continually released more land for arable use; available water resources have been considerably amplified by technology; dry farming is a field in which Australia continues to develop special techniques, although we still have a great deal to learn in water conservation from countries like Israel. Nothing is static. Less than twenty years ago the world was hooked on oil, and coal was a cheap but relatively unattractive energy source in many cases. Not so today! Fifty years ago uranium resources were meaningless in a commercial sense, as also were the vast but then untapped hydrocarbon resources for which finding and production technology was not available. Ten years ago the Club of Rome was creating alarm and despondency (except, of course, among the Greenies who relished it) because of its prediction that the world was running out of resources but the reality now is that the world has become a steadily less intensive user of materials and fuels. It is an interesting paradox which has attracted curiously little attention.

A conventional but over-simplified explanation for the reduced usage of materials and fuels is that these changes are caused by shifts in relative prices. Obviously there is some truth in this but the price of metals has fallen in real terms over the last decade, in which time metals usage has also declined. I think the only exception is gold. In fairness, one has to acknowledge that the fall in real prices of other metals has largely been due to surplus capacity arising from earlier and misleadingly over-optimistic forecasts of consumption; at the same time it should be acknowledged that new technology has enabled the mining industry to contain its costs in a quite remarkable manner.

If we Australians with our abundance of mineral wealth feel especially fortunate, our sense of well-being should be tempered by the relatively more impressive performance of other countries in the Asian Pacific area which do not enjoy much in the way of indigenous mineral resources but have vast resources of industrious people. It is salutary to be reminded, as we have been, that high growth rates in the Asian Pacific area have been achieved by countries which have this imbalance of people rather than mineral resources. The economic textbooks suggest that low wage countries should use more labour-intensive technologies than high wage countries. If this had been generally accepted we may have had fewer problems with lesser developed countries over-committing themselves in terms of indebtedness but in the more labour-intensive industries, modern technology is busily reducing labour intensity and countries which decide they must have (e.g.) their own steel industry can scarcely be expected to seek plant which will minimise productivity. Certainly that has not been the case, witness the People's Republic of China, which is no less intent on adopting the best technology, notwithstanding its problem of finding useful employment for all its people. This point was made strongly in Session 3.

Resources diplomacy is specifically mentioned as an item to be addressed. This is a highly sensitive area, depending on whether you are a buyer or a seller and where the market strength lies. Domestic cartels are always seen as anti-social (unless, of course, they are government run) but international cartels may be accepted as having more virtue, provided, of course, that they do not hold us to ransom. The concept of cartels is as old as trade itself, but I agree with the comment that cartels are doomed to fail eventually because of the countervailing processes they set in motion. A good example in the Western Pacific is the tin cartel, which is continually being undermined by overproduction and smuggling by South East Asian producers, by producers outside the cartel such as Brazil taking advantage of the artificially high prices, and most of all by high prices encouraging substitution of other metals. Resources diplomacy really means the "haves" seeking to get the best possible deal from the "have nots" but it is market forces rather than diplomacy which finally determine the trading position.

Australia's interest in resources is not limited to water or minerals. There is great interest in people as a resource, in the question of whether we have too many or too few; whether they are in the right places; whether the composition of the population is a desirable mix, and so on. We, along with most other developed countries, are familiar with the cyclical patterns of "baby boom" after the war, followed by "birth dearth". Clearly technology has no small responsibility in this area, although the problems in Australia pale in comparison to, and I believe are the reverse of, those in the more populated parts of the Asian Pacific area.

Measures of population do not mean much unless related to land area and productivity but everywhere in the world land is regarded as having a very special resource value. A special form of resource diplomacy is that expressed as Aboriginal Land Rights. In Australia the community is struggling to reconcile the aspiration for ownership or control, with conflicting claims from the aboriginal and the white sections of the population. The issue divides the country in a way few other issues do. It is not unique to Australia by any means but I fear this symposium has not pointed to any technological solution of such dilemma.

But perhaps I am asking too much!

FINAL SESSION

Summing up and closing addresses

Chairman

Sir David Zeidler, CBE
President, Australian Academy of Technological Sciences

Summing up

Professor D. E. Tribe, OBE: Review of symposium

Closing addresses

Mr Hiromori Kawashima
Vice President, Honda Foundation

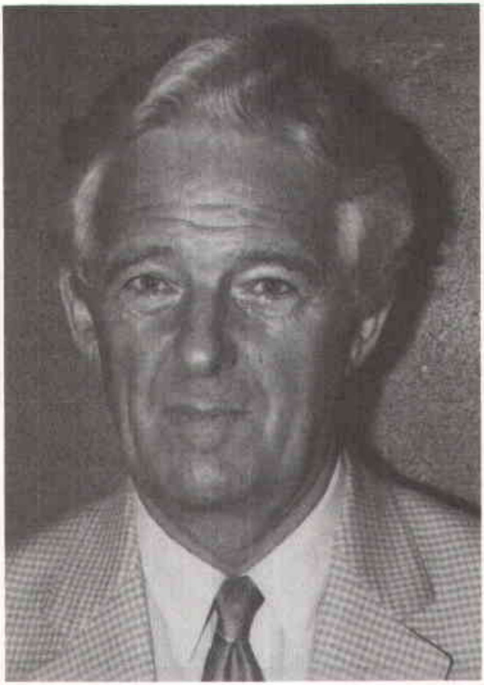
Sir David Zeidler, CBE

Summary of discussion

Dr L. J. Peel

Review of symposium

Emeritus Professor D. E. Tribe, OBE



Emeritus Professor Derek E. Tribe, OBE, FTS

Emeritus Professor Derek E. Tribe, OBE, FTS, has been Director of the Australian Universities' International Development Fund since 1980, and Member of Council, Australian Academy of Technological Sciences (1977-83). Professor Tribe was for many years Professor of Animal Nutrition and Dean of the Faculty of Agriculture at the University of Melbourne, of which he is now Emeritus Professor. For more than 20 years Professor Tribe has been active as an international consultant on issues concerning the development and higher education of agriculture. At various times he has acted as an adviser to the World Bank, the Australian Development Assistance Bureau, the International Development Research Centre (Canada), the Rockefeller Foundation, FAO, UNESCO, and the UN Development Program. He has had extensive experience in Africa, Asia, and the South Pacific. He has published extensively in his own field of animal nutrition and on topics related to agriculture in the developing world. He was awarded an OBE in 1977.

Review of symposium

Emeritus Professor D. E. Tribe, OBE

Executive Director
Australian Universities International Development Program[1]
Canberra, Australia

"The rich variety of viewpoints presented during this conference makes a full summing up quite impracticable. Instead, I intend to try to synthesize the discussion on the central theme of the meeting and to suggest some resulting topics for discussion here and elsewhere."

It was with these words that Sir Francis Tombs began his summing up at the Discoveries Symposium held in London last year. How well can I now understand the predicament he then faced and I can do no better than to endorse his conclusion and to follow his example.

The central theme of the present symposium has been a consideration of the new opportunities for mankind which are being created by technological innovations and, in particular, how these innovations can further the happiness and prosperity of the peoples of the Western Pacific.

That technological progress is a double-edged weapon, as capable of bringing death and destruction as improved standards of living, has been assumed by all speakers and participants.

Sir David Zeidler's opening remarks set the context for the symposium and his reference to Faraday reminded me of the story of Queen Victoria's visit to the Royal Institution of London. Having witnessed a demonstration of some recent experiements in physics, she asked, "But what, Dr. Faraday, is the use of this thing you call electricity?" "Madam," Faraday allegedly replied, "what is the use of a new-born babe?".

The modern technologies that we have been discussing during the last three days, are still very young, indeed some are still in the gestation stage. How will they develop and how useful, in terms of the welfare of mankind, will they prove to be? How can we, the parents of these technologies, so govern and guide their up-bringing as to ensure that they assist most effectively the "Ascent of Man", to use the words of Sir David, rather than bring about mankind's downfall and the destruction of his environment?

[1] G.P.O. Box 2006, Canberra, A.C.T. 2601, Australia.

Will nuclear energy be harnessed to satisfy our expanding needs for industrial and domestic power, or will it be used to fuel a final cataclysm?

Will automated technologies give men and women new opportunities for creative leisure or will they condemn more and more of us to the frustrations and indignities of permanent unemployment?

Will technology, and the industrial development that it makes possible, result in greater ecological stability and the more efficient renewal of resources, or will it aggravate further the present serious and world-wide pollution and environmental degradation?

Will continued technological progress benefit mankind equitably or accentuate further the gaps between the "haves" and the "have-nots"?

Will technological advances encourage the development of a more sensitive and generous society or will it disrupt traditional values and cultures and breed greed and materialism?

These are the questions which, although not always articulated in this fashion, have formed the basis of our discussions during the last three days.

That none of these issues is new, that none of these questions has in fact been answered, of course does not mean that they should not have been raised or that progress has not been made by discussing them. It would have been easy for us to leave this symposium feeling depressed, overwhelmed even, by the complexities, the uncertainties, and the urgencies of these seemingly intractable problems. My impression is that in fact we are in no such mood.

We are hardly going home feeling optimistic, relaxed, or complacent about the future—but, at least, I think that I can fairly describe our mood by the use of such adjectives as "soberly determined", "constructively stimulated", and "reasonably confident"—confident, that is, in the inherent adaptability, resilience, and enlightened self-interest of men and women and of the societies they constitute; and confident in the breadth of awareness, interest and concern of the technological community. We are conscious of the problems ahead and we are aware that mistakes will certainly be made. However, we are nevertheless optimistic that these mistakes will not prove to be terminal and we are confident that, on balance, the good that can and will result from technological innovation and development will far outweigh the bad.

A suprising aspect of this symposium has been the extent to which speakers have skirted around its stated theme. Indeed, the ways in which most speakers approached their topics proved to be a major point of interest in the symposium. Papers and discussions mainly avoided detailed consideration of the availability and development of conventional resources such as land, water, minerals, energy, plants, animals, labour, and capital.

Despite the occasional mention of circumstances or examples taken from Asia or Oceania, many speakers, as Professor Yip pointed out, did not refer particularly or systematically to the Western Pacific region.

Rather, there was a concentration on general principles and processes concerned with science policy, with structures of research and development, with institutional and sectoral co-operation, with decision making, resources diplomacy, international law, cultural impacts, and with moral implications.

One exciting feature of this symposium has been the acceptance by so many speakers of the inevitability of radical and speedy technological change—change that will alter dramatically the quality and organisation of our private and national lives. Crystal balls have been produced. Futuristic scenarios have come and gone! Complex issues of human behaviour, social psychology, political science, ethics, and philosphy have been debated—but seldom resolved!

In short, the symposium has raised many more questions than it has answered—and this comment is intended as a commendation rather than a criticism. When dealing with these sorts of complex issues it is at least half the battle to identify the priorities and to formulate the right questions. As Professor Aziz reminded us, "You have to ask the right questions before you can get the right answers."

The many detailed priorities that have been identified will be found in the papers and discussions published in the proceedings of this meeting. They are all important and I am sorry that time does not allow me to draw your attention to all of them. But I, for one, leave this symposium concerned (and stimulated) by three particular issues which have emerged from our discussions with renewed clarity and urgency.

The first relates to what one speaker described as "the unglamorous, forgotten child of technology", namely, the technological needs of rural development.

We have spent a great deal of time discussing the progress of high technology and the problems of the post-industrial society, yet most (something like 70 per cent) of those who live in the Western Pacific are rurally occupied, such as peasant farmers or fishermen, and to a considerable extent, therefore, are members of a *pre*-industrial society.

We have discussed the inadequacies of existing economic systems and it has been suggested that systems of rewards and exchange based on money are now becoming out-dated and irrelevant. Yet only recently, or comparatively recently, have most of the rural communities of the Western Pacific at last managed, for the first time, to enter the cash economy.

We have talked a good deal about the advent and potential of unmanned, electronic, computerised robots that are even now replacing the human workforce in industrialised countries. This trend, we have been told, is inevitable and not in itself undesirable. Rather, we should get used to the idea of non-productive and non-economic occupations for many, perhaps most, in the community. Yet, I am reminded that the Director General of the Food and Agricultural Organisation of the United Nations categorised the world's population into two classes; on the one hand, he said, there are those who long for the end of their working week, while, on the other hand, there are many more, particularly in less-developed countries, who long for the opportunity to begin a working week.

What, I wonder, would have been the reactions of the farmers and fishermen of the Western Pacific if they could have attended our discussions. Suppose some village representatives from the Islands of Tonga, Samoa, Kiribati, or Tuvalu had been invited to listen to the excellent papers of Professor Sheridan and Dr. Bardach. How they would have marvelled at the new and sophisticated technologies that are now available for the exploitation of the mineral and biological resources of the ocean and the ocean bed. Their interest would have been the greater because the only resources available to sustain their economic and social development are to be found in the sea.

Yet how dismayed they would have been to learn that the costs of purchasing and using these new and more efficient technologies are to be measured in millions of dollars—amounts far beyond the means or even imaginations of the fishermen—or of their governments! High technology in their minds conjures up a vision of small, better-designed fishing boats, made of fibreglass, with more reliable in-board engines, and equipped with nylon lines and nets. They may, perhaps, even include hopes of a solar fish drier or a refrigerator. Their livelihoods are already under threat from the high capital, high technology, fishing industries of Japan and the USA and what they would have heard at this meeting would have sounded to them ominous and threatening.

The potential for modern or appropriate technologies in rural development is a topic that needs further consideration and, I suggest, a much higher priority. This problem is related to the second of the three issues that I want to mention. We have spent many hours considering the economic and social implications of high technology and of the post-industrial society. The case was strongly argued that, inevitably, high technology will result in a reduction of the workforce and that redeployment into alternative occupations will not be possible. If this proves to be the case, it will be necessary to restructure our existing systems of income determination and distribution, and to provide novel, creative, and satisfying (but non-productive and non-profitable) means of occupying the permanently unemployed during their waking hours.

Moreover, not only will individuals become redundant, unnecessary, and unemployed, whole communities, even nations, will similarly become non-competitive and irrelevant if the resources upon which they depend are to be used and developed more efficiently by the high technologies of foreign, post-industrialised societies. How, for example, can the small Pacific island states survive if the oceanic resources on which they have always depended are to be utilised by other countries, or supra-national agencies, which can afford to use modern technologies far beyond the means of the island states themselves? Who is to pay individuals, communities, even nations to "sit in the sun"—and will they be content to do so?

This is the second and most controversial theme which has emerged from our discussions and which deserves much more detailed, critical, and systematic analysis than has been possible at this meeting.

This second theme is in turn related to my final point. The piece of technology that represents the greatest potential for the future good of mankind, and which has been referred to most consistently throughout our discussions, is in fact the oldest bit of technology of all. It is that mobile, self-reproducing, tested and proven, computerised machine we call a human being. This computerised hardware has been freely available on a worldwide basis for a very long time, it shows no signs of becoming obsolete and, unlike the Honda motor car and despite the advances being made in genetic engineering, the current model has remained virtually unchanged for some millions of years and it is unlikely to change drastically in the foreseeable future.

What have changed, and what need to be continually revised and updated, are the software packages that are used to program this traditional form of hardware.

That we are not using these sophisticated and highly competent human computers to anything like their full potential is obvious and the reason is equally clear. The packages of information, the software programs, that are presently made available to the peasant farmers and fishermen of the Western Pacific are antiquated, inadequate and, in many localities, even non-existent.

But we do not have to go to the extreme example of peasant farmers and fishermen. Would any of us argue that the software packages represented by the primary, secondary, and tertiary educational systems of Australia, Europe, Japan, or the USA serve adequately to equip contemporary men and women to develop and cope with the challenges and opportunities of modern technology?

Much has been said during the last three days about education:

1. the information and training that is essential in both the plug and the socket if the processes of technology transfer are to be effective;
2. the training of operators, technicians, managers, planners, technologists, and scientists that is essential at all levels, and as a continuous and balanced continuum, if developments are to be initiated, adopted, adapted, controlled and ultimately replaced by something better.

In terms of most countries in the Western Pacific it needs to be recognised that frequently the priority is not for more and better training at the doctoral and post-doctoral levels (important though these are) but, rather, for more and better training at the operator, technician, and managerial levels.

Then, there is the education of the politicians, the decision makers, the public servants, and the community at large. Their current ignorance of the issues that we have been discussing at this symposium is even greater than our own! Indeed, it is so great that, in worlds of all numbers, it often leads to misguided attitudes of uncertainty, suspicion, and antagonism.

We have discussed in detail the desirability and attendant difficulties of co-operation between industry, government, and academe, but I think that we have dealt insufficiently with the desirability and attendant difficulties of co-operation between trainers, educators, and developers in the different countries of the Western Pacific region.

How warmly I agree with Professor Aida when he says in his paper that "educational excellence is the key to improve human society". With enthusiasm I endorse his "inescapable conclusion that education and training, carefully chosen with regard to regional and technological conditions and requirements, are indispensable complements to (and may well be more important than) any material technology transfer".

Mr Chairman, many of us leave this meeting converted to, or confirmed in, the view that the highest priority for future discussion and action deserves to be given to modernising present policies and programs of education and training, and to making appropriate packages generally available to all men and women in the region.

But I must not trespass further on your patience. I hope that I have said enough to reflect the vigour and breadth that have characterised the discussions at this meeting. Its undoubted success has of course been due to the policy of the Honda Foundation in bringing together, on a continuing basis, a limited number of senior and influential participants from different countries, disciplines, institutions, and backgrounds.

It has been a stimulating and enjoyable experience. I believe that you will all agree that this International Symposium has warmly reflected the imagination, the enthusiasm, the humanity, and the good humour that all of us have now come to associate with that remarkable man whose Foundation made it possible.

Closing address

Hiromori Kawashima

Vice President
Honda Foundation[1]
Tokyo, Japan

The success of the "Discoveries International Symposium Melbourne 1984", held under the theme "The use of resources and technology in the interest of mankind" has greatly exceeded original expectations.

The conference was distinguished by the presence of His Excellency Rear Admiral Sir Brian Murray and Lady Murray at the opening ceremony. It was also honoured with opening addresses by HRH The Prince Philip Duke of Edinburgh and by the Prime Minister of Australia, The Right Hon. R. J. L. Hawke.

Sir Ian McLennan, founder of the Australian Academy of Technological Sciences, provided outstanding chairmanship of the opening ceremony. His review of the motives behind the academy's establishment, its activities during the past seven years, and its future course of action reaffirmed the authority and the powerful influence of the academy, our future partner. The keynote address by the president of the academy, Sir David Zeidler was, in a word, superb.

This symposium was significant in that it took up proposals concerning the future of the Western Pacific region and the role that the Discoveries Symposia can play. The penetrating analysis and feasibility of the proposals was most impressive.

Today we are fortunate to reap the benefits of the advanced technological age. This age was made possible by scientific progress, which grew out of modern Western thought and culture.

The transmission of the seeds of Western civilization to a multitude of different cultural spheres has brought about the blossoming of many diverse societies.

It goes without saying that the true successor to the legacy of modern Western technology in the Southern Hemisphere is none other than Australia.

[1] 6-20 Yaesu-2-chome, Chuo-ku, Tokyo 104, Japan.

As noted by many of the speakers at the symposium, the Western Pacific region incorporates many different cultural spheres, including the Christian, Confucian, Buddhist, and Muslim cultural spheres. The region also boasts a variety of natural environments, histories, ethnic groups, and languages. Thus, this area's differences are not restricted to scientific development, but encompass historical, social, and ethnic differences as well.

The area's leading trait may well be its diversity, but it is this very diversity that holds the key to the region's future dynamism.

History has shown us, however, that diversity can often lead to friction and confrontation. But as Shoichiro Honda emphasized at the reception last evening, personal links and mutual understanding go a long way toward overcoming such problems and building cooperative ties.

Please allow me to digress for a moment. I have always liked the Australian term "mate". This is no doubt because I can identify it with the magnanimity associated with *girininjo*, a phrase meaning "compassion versus duty" that strikes deep in the hearts of Japanese.

I am confident that this "mate" spirit will be instrumental in future cooperation and development in this region. We all look forward to Australia's contributions in this regard.

To return to my address, I feel that it is worthwhile to recall some of the points taken up in other Discovery Symposiums. We must not overlook the negative aspects of science, which stem from the disparity between the spirit of humanity and a fully mechanized society. We must not be carried away by the power of modern scientific technology. In the light of the rapid advances and developments in science, we must seriously consider ways to put a brake on its dangerous application, so that scientists need not fear the consequences of their creations.

In his keynote address, President Zeidler expressed concern over the present educational system in Australia. This problem is not limited to Australia alone. Today, Japanese educators and the general public are having a heated debate on the decline of the Japanese educational system. This decline is attributed to an overemphasis on acquiring technical skills at the expense of other knowledge.

The basis of education is the development of human beings. The most valuable asset of any society is nothing less than human dignity.

We must not part with the fruits of modern scientific society now in hand. The question is what we must do to retain our present blessings. According to an old saying, "To bear good luck and riches requires more virtue than to endure misfortune and poverty."

The Honda Foundation, which was established on the basis of Shoichiro Honda's philosophy of life, aims for a symbiosis of technology and ecology, and strives to build a new technological society.

Our use of the word "ecology" is not restricted merely to the "natural environment". It encompasses the human environment—in other words spiritual culture as well.

To meet this end, we have held symposiums in Tokyo, Rome, Paris, Stockholm, Ohio, London, and this Melbourne 1984 symposium, our seventh to date.

The enthusiastic academic debates during this symposium were gratifying. We are confident that the realistic proposals for the development of the Western Pacific area, surely the regional centre of scientific and technological developments in the 21st Century, will be a source of inspiration to the 1.3 billion residents of the area.

At this point, I would like to express my deepest gratitude to those leading authorities from nations around the world who have shared their astute and penetrating views with this symposium.

I am confident that the nations participating in this symposium are ready to take any necessary measures to deepen mutual understanding in the future. Certainly, this trust and deepened mutual understanding is by far the greatest contribution of this symposium in Australia.

In closing, I would like to thank all of the members of the Secretariat, whose untiring efforts made this symposium such a success; Miss B. E. Jacka, AM, MBE, Mrs. M. McIlwaine, Miss S. Williams, Miss L. Barry, Mr. J. T. Woodcock, Mr. J. M. Dew, Mr. D. C. Hensher, and the rest of the staff.

Final address

Sir David Zeidler, CBE

President
Australian Academy of Technological Sciences
Melbourne, Australia

I approach the formal conclusion of this, the 7th Discoveries International Symposium with mixed feelings. On the one hand, pleasure—pleasure that the various contributions and discussions have, I believe, matched or bettered our highest expectations. On the other hand, a feeling of sadness that we are all about to go our separate ways again—we will all, however, be a little different from when we arrived. We will, I am sure, all have gained in perspective of the changes and problems which are affecting mankind.

It is not my intention to do more than thank Professor Tribe for his splendid contribution in drawing together all the threads of our discussions so that you all may have an overview of what has been traversed in the closed discussion sessions. It has been a very worthwhile programme.

We have concentrated to a greater extent than I had expected on matters of concern to the less developed countries and I was pleased about that—as I am sure Dr Farrands who planned the programme was.

If I may make an observation we are, not surprisingly, better at perceiving and talking about the problems of poorer social groups than we are at suggesting means to diminish the gap. I made some reference to this aspect in my opening remarks on Friday morning. I do not have any ready suggestions to make, other than that the Honda Foundation may see it as feasible to study this aspect to a depth not possible in a symposium lasting three days. It would be gratifying to all if it could be seen more clearly that the valuable outcome of this Discoveries Series of International Symposia was proving of growing benefit to mankind.

I cannot let this opportunity go by without commenting on the deep and underlying concern felt by many of the growing world problem; of work as a means to allocate a living standard to individuals as technological change diminishes the need for many tasks which hitherto have involved people. This concern was a frequently recurring matter in our discussions. I have no doubt the significance of the problem will not diminish.

It may, however, in itself, be a part solution to the more effective transfer of technology to less developed countries. We could presumably train more of our young people to see technology transfer as an important social mission.

In concluding this, the final session of the 7th Discoveries International Symposium, I would like to thank again all those who participated so willingly and so effectively and on your behalf to express to the Honda Foundation and to Mr Shimoda and to Mr Honda our most sincere thanks for making this splendid occasion possible for all of us.

Thank you, and as I said at the outset, it is with both pleasure at what has been achieved and with regret that we will soon be parting—that I now close formally—the final session of the 7th Discoveries International Symposium.

Summary of discussion

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Session 2. The roles of academia, industry and government

Two main topics, arising from Professor Simon's and Professor Atsumi's papers, were considered.

The first was Professor Simon's proposition that technological advance was leading to increased and continuing unemployment of unskilled people, while a shortage of skilled people able to work with the new technologies persisted. Dr Cortright began the discussion by asking Professor Simon to comment further on the fallacy of the shorter working week as a solution to the increasing unemployment of the unskilled, and on what role he saw for international public works in providing work for the unskilled.

Professor Simon noted that a shorter working week was a short-sighted remedy which did not work for reasons of efficiency. He quoted the experience of agriculture where it would not have been efficient to retain the numbers of people and to share out the work; instead numbers had been reduced. The economic machine must be made to run efficiently and following the reduction of working hours from 60 per week to 40 per week in the 1940s about 40 hours had remained the efficient level. More particularly, though, reducing the working week was a solution that continued to adhere to the ethic of work—and the relevance of this ethic he now disputed.

In future the distribution of income will have to be achieved separately from the highly efficient production system. Money will be given to people even if they are not part of the production system but are doing something else. People need to be given work. They work not just to obtain income but in order to be occupied doing something they feel is useful and to be part of a social system. Not to be part of a group, to be isolated—like the unemployed or the old—is very painful. It is these considerations that sug-

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This summary was not presented orally at the symposium.

gest that public works could have a role in providing useful occupation and social contact, but this must be achieved without a 'dole' approach and without paternalism.

How can the mass of people admit such changed views? A small business man will say those not working are just lazy. Politicians cannot at present consider such ideas because public opinion is not yet prepared for them and politicians cannot go beyond what public opinion will permit. This is a problem which engineers and scientists should think about. We have to face the fact of increasing unemployment which the statisticians are predicting and start to consider a new form of society.

Dr. Bardach raised the question of the religious basis of the ethics of the income/work relationship and asked: How do you invent a religion to fit the future technologies? Professor Simon referred to the passage in his paper taken from Pope Jean-Paul II's encyclical entitled "Redemptor Hominis", and went on to point out that rather than scientific progress enslaving man, as the religious leader claimed, he believed that scientific progress liberated man—but within a new culture and a new way of thinking. At present man thinks of the past and cannot cope with this new freedom, instead he turns to astrology, ecology, or even terrorism. The general level of education should be raised to give people new goals of learning and discovery.

Professor Bennett wondered whether Professor Simon was not being a little too pessimistic about adjustments in time spent working and noted that an increasing demand for information had led to an increase in the employment of clerical workers which had offset the losses from computerisation. Craft work and the general field of 'care' were also providing increasing employment opportunities at the present time as society adjusted.

Dr Farrands reminded the meeting of the extent of holidays during the final period of the Roman Empire, but Professor Simon reiterated his concern about the numbers of unemployed, unskilled people being predicted by the statisticians, and particularly those without any intellectual interests. Royal Professor Aziz commented that in the long term religion would play an important part and possibly lead to quite large religious group-formations. He suggested looking at the question from a non-theistic point of view. Professor Simon, however, saw the immediate problem to be that of those accustomed to be in work and soon to have no work.

Professor Atsumi's proposal that an Asian Pacific Institute of Systems Analysis be established was then discussed. In response to Dr Chestnut's query about what facilities and information were already available, Professor Atsumi outlined a three-stage approach. Firstly, for members of the Pacific countries to meet together and consider the exchange of information; secondly, to define the problem having obtained this additional knowledge; and thirdly, to establish the best approach to solve the problem so defined. Mr Kolm inquired about a more limited exchange of data at a national level between industry and academia, and this question was taken up by Professor Yoshimura who pointed to the difficulties of disclosing confidential, industrial information.

Profesor Yip then led the discussion into a general consideration of the collaboration between universities and industry in the ASEAN region. He noted the very low level of R & D work being done in many of the ASEAN countries and that international companies tended to do their research in their parent country. Many of the best brains are in the universities and there has been pressure for the academics to do more of the applied research needed. In 1971 a regional institute was set up in Singapore to try to relate university work to development programmes. Sir Henry Chilver then reminded the meeting of the complexities of university-industry collaboration and that the models tried in the developed world had not all been successful. A further complication in the developing countries was that industry itself was still developing. Interdisciplinary studies will play a key role in the future as this tends to be the nature of applied studies. Professor Atsumi emphasized that many ASEAN countries had to improve their infrastructure before going into R & D. A model was needed to aid this process and this is what the proposed institute could provide.

Dr Farrands discussed the military origins of systems analysis, and agreed that a multidisciplinary institute to look at proposals in the Pacific area could be advantageous. Professor Simon then raised the difficult question of how to reward university staff for undertaking collaborative work with industry, as publication in international journals was more likely to advance their careers. In conclusion Dr. Kojima pointed to the work of journalistic companies in collecting data on research activities around the world and their value in collaboration with an institute such as that proposed.

Session 3. The West Pacific, technological competition, complementation, and co-operation

Professor Tribe raised the question of the likely future adaptability and resilience of human behaviour and human institutions. Sir Roderick Carnegie had considerable faith in the adaptability of human behaviour, especially in response to major shocks, but was less hopeful about the adaptability of institutions which, since the 19th Century, had become increasingly centralised and unresponsive.

Professor Bennett then enquired about the likely effects of the differing approaches to birth control in various countries. Professor Nakajima suggested that if the present policies in China fail and population growth rises beyond 1.5-2.0 per cent per annum the economic situation will become very serious and GDP will remain below $500 per person. Professor Yip then described the contrasting situation in Malaysia where government policy is to increase the birth rate and raise the total population from 14-15 million to a planned 17 million. This policy has given rise to considerable debate within Malaysia. Sir Roderick Carnegie then reminded the meeting that it was not just numbers of people that were important but also other aspects such as age distribution. A large number of 15-40 year-olds will require employment in the near future.

Lord Caldecote then asked what is the objective of technology? And suggested it should be to provide a more satisfying life to as many people as possible. How could this be achieved? This question was taken up by several speakers—there would be proponents for technology among the interested parties—should there be people to look specifically for the disadvantages? Cultural questions are also involved and should not be overlooked.

This led Professor Yip to state that developing countries were clear about their objective in seeking new technology, but wished to know how to obtain technology from another country and make it work in their own country. The problem was a lack of absorptive capacity for new technology. This involved a lack of adequate human infrastructure and frequently also involved problems of differing cultural background. These points were reiterated several times as the discussion proceeded.

Professor Dillon noted that much of the discussion had related to high technology developments but that the rural sector was especially important in the region and that location specificity and cultural factors were well recognised as critical in the transfer of rural technology.

In response to a question from Dr Davies, Professor Sheridan indicated that argument about the law of the sea was continuing in the U.S.

Dr Bardach then suggested that technology was being considered in too narrow a sense. Urbanisation, for instance, had barely begun in Asia and as cities grew there would be new demands on technology. Systems studies were needed to identify requirements, including those that would not yield a commercial reward. Professor Yip cited the overpumping of water in Bangkok as an example of unwanted side-effects of technology.

In response to Dr. Chestnut's query whether the dominant theme of the session was competition or co-operation, Professor Nakajima noted some possibilities for competition between the industrialised and newly industrialising countries in commodities.

Professor Yip argued for the sequence: complementality, co-operation, competition. But it was then pointed out that it was too easy to see nations as monolithic units; the question should be who benefits and who loses. The discussion was concluded by Sir Roderick Carnegie expressing faith in the power of the market place to overcome distortions and to make a nonsense of political arguments about resources diplomacy.

Session 4. Technological and cultural needs and obligations of the less developed countries

In response to a question from Dr Sheridan, Dr Bardach confirmed that the fish shelters he had described were for harvesting common property resources within large areas of water. The intention was to enhance natural productivity and it was not likely to become a production technique suited for industrial exploitation. Its characteristics were low energy input, the combination of imaginative thinking in biology and engineering, and sustainability.

Professor Bennett then asked Royal Professor Aziz if he believed a culture could protect itself from contact with Western technology. He believed so. Not so much in the sense of exclusion as seen in Tokugawa, Japan, but rather in terms of filtering out the less desirable elements. Unfortunate instances of culture intrusion have occurred when governments have tried to 'mine' tourism. The question of values was then raised, and it was pointed out that in Malaysia and Indonesia, for example, there was an ongoing debate in the media and in society generally about the values the country wished to maintain, and that the political leaders had to be sensitive to this debate when considering technological introductions.

Dr Allen then enquired how high technology could be kept going. Dr Bardach responded that the greatest bottleneck was technology transfer. Governments want projects but all too often the interactions between the acceptors, the transmitters, the originators, and the donors are not considered. This question was then discussed further and it was noted that there must be differentiation between technology as a product and as a process.

Dr Nagchaudhuri stated that the mystification of technology had done a lot of damage. The problems of obtaining trained manpower were again raised, and Sir Russel Madigan drew attention to the importance of time and the unrealistic pressures that arise for instant development without regard to the need for a realistic time scale.

The discussion then turned to Dr Nagchaudhuri's comments on Kerala. It was noted that the life style is unlikely to be undermined by increased communications, that reading and discussion are very important activities, particularly among the retired civil servants, and that the fact that the government is communist is not important—there are six communist parties in the State and many other parties.

Mr Jackson then commented on the problems China is having with patents procedures, and raised with Sir Russel Madigan the question of possible conflict between the nation's and a multi-national company's interests. Sir Russel considered this not a major problem with mining companies. The companies were well aware of the likely wishes and requirements of the countries in which they sought to operate, including the need to train locals to replace the expatriates.

Professor Marguilies emphasized that developing countries should become aware of their own requirements for technology and then seek to obtain what they need, rather than just accept what they are given. Several examples were discussed, including the need for Malaysia to develop its own tyre industry.

Mr. Leonard then concluded the discussion with the hopeful observation that in various countries there seemed to be developing a greater understanding between the haves and the have-nots. This he attributed to improved communications, and considered that communications will continue to be a key issue.

Session 5. Highly developed countries, especially Europe, the Americas, and Japan

Professor Marguilies opened the discussion by referring to the statement that the session was to deal with, in part, 'The changing economic value of human and material resources'. He hoped that it was not intended to evaluate human beings by economic parameters. He wished to discuss instead the use of human and material resources to enhance changing human values in particular human freedom.

To achieve this, the approach to man-machine relationships has to be changed. Man-machine systems need to be designed to make man the ruler of the system so that the machines are for use at his discretion, to perform his tasks and to carry out his ideas with the maximum of freedom. To develop such an approach is a challenge to all affected—scientists, government, employees; and the challenge should be accepted equally by all of them. Further, these parties should work together with social scientists to assess the adaptation of new technologies to human needs at an early stage before final decisions are taken.

Professor Margulies' second point concerned the economic system. He contrasted the lack of outlets for our production power, leading to the laying-off of people and closure of factories, with the inability of the production power to meet even the elementary needs of the world. This he attributed to the inability of purchasing power to keep pace with production and needs. If machinery, goods, and services could be supplied to those who urgently need them, full employment would be regained and would continue. There are many ways to solve this financial problem; suggestions have included institution of a North-South type of Marshall plan; detachment of supply from payment, rather than income from work as suggested on the first day; placement of a gradual freeze on the arms race from 1986 and reshuffling of this money to meet needs in other parts of the world.

His final point related to flexible automation, that is, the integration of various currently existing elements of automation. Examples can be seen, for instance, in automated transport or in office automation. The flexibility of such a system allows for quick and random change from one product to another, from mass production to individual production, and for the decentralisation of highly automated systems in small units distributed to meet local demands. This can then enable a revival of small enterprises by independent producers utilising high technology. At the same time competitive criteria are shifted from lower prices to higher quality, to better ideas, and to catering for individual needs. This requires a work force of highly but universally qualified workers equipped with the most modern automated systems catering for the customer from the original idea to the final product. Thus, each worker can bring to bear his ideas, creativity, and skill in a multitude of different tasks. At present a research project is being undertaken by the Austrian Academy of Science, with the support of the Austrian Government, to establish a number of pilot installations to check the economic, technical, and social viability of these ideas. The basic philosophy of this experiment is that technology is not deterministic but leads to a wide and ever-growing range of options as to its applications to individuals and to society.

Dr. Fawcett then questioned the priorities of the developed countries with their emphasis on electronics and communications. He noted that in the papers on the developed countries no one had mentioned the problems of the developing countries and how these might be related to those of the developed countries. He wondered whether we should be talking about the failure of technology, and then went on to point out that over the last 50 years there had been little improvement in the efficiency of conversion of heat energy to other useful forms; the efficiency of the modern automobile despite the potential for reducing fuel consumption to a third of present consumption; the speed and efficiency of surface vessels for ocean transport; the development of thermal heat pumps; and the delivery systems for food and drugs worldwide. Is there a sense of urgency to some of these problems? What is being done in terms of an action plan in your own country that would be aimed towards raising the average quality of life for all mankind?

In response, Mr. Jones elaborated on the need to provide assistance to developing countries in such a way that it enabled these countries to be more able to go on and assist themselves, for example in the provision of expertise that then enabled a country to solve its own problems. As a further comment on Dr Fawcett's statement, Lord Caldecote commented on the great problem of bringing together resources—human, financial, and physical—for the tasks that need to be done. There are many such tasks yet people are left unemployed and there are plenty of financial and physical resources. Perhaps this might be a possible subject for a future Discoveries Symposium: how we can get the tasks and the resources better matched. For example, it is a tragedy that Europe is producing food surpluses it cannot get rid of while elsewhere in the world people are hungry. Lord Caldecote also thought Dr Fawcett was taking a rather pessimistic view in his comments on energy conversion in the motor car, and on the speed of ocean transport.

Dr Farrands then supported Dr Fawcett's view about urgency but urged the emphasis be placed on the simple things before the more complex. Most of mankind did not live in the developed countries and much of what had been said about high technology was not relevant to the people in the developing countries because they did not have the resources to take advantage of it. Their greatest need was for simple things such as a basic sewage system. The high technology engineer should be involved but should be looking for the appropriate, rather than high technology, solution.

Professor Yip then reminded the meeting of the technological gap that exists and which is widening and that technological aid from the developed to the developing world has not made much impact. What is missing is the human infrastructure to accept this aid, and this has not been well understood. Lord Caldecote then endorsed the importance of human infrastructure and regretted the detrimental effect nationalism had had in some countries, such as Zimbabwe and Zambia, in leading to policies which were driving out the human infrastructure. He also agreed that too much emphasis was put on high technology instead of on appropriate technology. Mr James took up this last point and commented on the contrasts to be seen in Korea where human beings working as beasts of burden could be found outside a high technology factory. What, in other countries, had happened over hundreds of years was happening simultaneously. The contrasts were within the one country, not just between developed and developing countries.

Sir Henry Chilver, in directing a question to Mr Jones, remarked that the Netherlands, Sweden, and Japan had all exploited ideas generated in the world generally during their period of development, and wondered whether this had implications for countries the size of Australia. Should such countries have national policies to ensure that there is the most direct exploitation possible, by the skilled population, of inwardly imported ideas? How can you enhance communication between the people of such a country and the sources of the external ideas? And does this not also mean that the national policy must explore very carefully the markets in which the technically skilled people can be deployed? He had noted that Mr Jones had given a model of Australia as a highly technically skilled society. In reply, Mr Jones remarked that the skill basis in Australia was, in fact, very uneven. In this country the technological base is not as defined and cohesive as in the three countries referred to. Australia suffers to some extent from seeing itself as a small part, about 4 per cent, of the large English-language, world group. And Australians had grown up with the view that they were the providers of raw materials to someone else who gave finished goods in return. This had led to truncated development. For example, the motor industry had not been developed to be an exporter, it had looked only to the home market. The government is now looking to develop areas of industry where there are market opportunities in the world at large for high value-added products, for example in biotechnology. Mr Jones was optimistic about the future of employment in the service sector because of its characteristic utilisation of labour and time particularly, and that it is not intended to be highly productive. Instead, the development of human capacity, for instance in an artistic sense, is of increasing importance.

Profesor Ranger Curran then referred to the propensity to rush to solve a problem as soon as it was recognised that a problem existed. He cautioned against any tendency for the meeting to wish to do this, and emphasised the decision-making process of firstly defining the situation, secondly of generating and evaluating alternatives, and thirdly of choosing between the alternatives. Every country will have a different situation and a different solution. Mr Leonard continued this theme by raising the question of the process of decision-making and the need to consult, and in particular the time that is being taken by public enquiries into technological advances that affect society, such as the implementation of a nuclear power station programme. He was most concerned about the propensity of some groups to prolong the duration of these enquiries—is some form of guillotine procedure needed? The situation in France, he noted, was not as bad as in the UK and USA. In reply, Dr Schuster explained that France is a rather centralised country and the four main political forces are all in agreement that nuclear energy is good for France and therefore there is little pressure on the government to hold an enquiry. In Germany the opposite exists; the political parties are divided with large parts of the Socialist Party, the Green Party, and the Communist party opposing nuclear power. With regard to the period of time taken by enquiries there are two extremes; in one extreme much time is used and in the end there is no progress; in the other not enough time is given for the discussion and violence can occur. A path between has to be found.

Dr Kojima then raised with Mr Jones the question of how to survive in the age of high technology, and went on to propose five conditions for survival. These were foresightedness and the ability to have insights into the future; the ability to collect and analyse information and for people to adapt as a result of change; the ability to develop the D of R & D; provision for human resources development and the retention of human resources; and the fostering of an internationally orientated attitude. He then enquired about the attitude of the industrial world of Australia, and noted that Australia is so blessed with resources it does not have much stimulus. Perhaps an industrial policy or ministry is needed? Mr Jones replied that a national technological conference was held in Australia last year for the first time, and that a draft policy statement is now being prepared. He agreed that Australia had never been traumatised and made to face the aftermath as had countries such as Israel and Japan. Secondly, there has been a time when Japan has felt obliged to develop its own technological economy, for example after the oil crisis. Australia has never had to do this. Thirdly, the people in Australia have never had to live by their wits, instead they have been blessed with abundant raw materials. One result is that so far Australia does not have an inventory of brand name goods as does, for instance, Japan and Sweden.

Session 6. General discussions and conclusions

Professor Atsumi opened the discussion by referring to the Asian-Pacific Institute, he had earlier proposed, as a possible answer to the problem raised by Dr Fawcett. The theme of the symposium is 'The use of resources and technology in the interest of mankind'. This covers many problems—the energy, food, water, and medical resources problems. Where do we start? By using the systems analysis method, modelling will come first and then once a set of objectives has been developed data can be put in and solutions sought. Firstly a universal model would be developed and then each individual sub-system. As an example of a sub-system model, there is already a medical resources allocation model which has been developed. Using this in association with a population model for a particular country, the incidence of various diseases can be predicted together with the numbers of medical personnel required to treat the sufferers. The most important thing in systems analysis is first to identify where the problem lies and then what is the interaction between the various problems. It is because of the need to do this work that he proposed the Asian-Pacific Institute.

In reply, Dr Chestnut said he believed that Professor Atsumi's proposal warranted further effort but he noted that to be successful it was going to need considerable support. However, once given that support from government, industry, or academia, and agreement on the objectives, it could be very effective and possibly tie in with some of the activities of the International Institute for Applied Systems Analysis.

Professor Hambraeus then explained that IIASA had been set up as a vehicle for communication between East and West, as a political instrument below the political scene but influencing it. It has, however, met some financial difficulties and also some resistance from various political sectors, he hopes these difficulties will be overcome. Also of relevance is the Institute for Human Ecology and Energy in Stockholm. People there have successfully modelled the energy situation in some of the developing countries in Africa. The models work but no one is willing to pay for the answers provided, or to implement them. There is a gap generally between the fact-finders and those with influence in industry and government.

Professor Aida then remarked that if we are to continue to think about an Institute of International Studies then we should also consider the international political aspects. Could some thought be given to invisible institutions and the information networks. Sir James McNeill felt that he did not have sufficient information to agree or disagree with Professor Atsumi's proposal but nevertheless thought it should be tried. Professor Hambraeus then commented on a recent FAO report which showed that in Africa the food situation was getting worse. The main reasons for this were political difficulties and the inability of political leaders to deal with the situation even when the necessary knowledge was available. This he believes poses a threat, and scientists and technologists should bring their knowledge to bear on the political scene. Professor Atsumi then responded saying that in the ASEAN countries human infrastructure was a very serious problem and that the traditional forms of giving aid did not meet this problem. This was one reason for his proposal of an institute.

Professor Lazenby took up this theme and asked 'How can academia in our developed countries help the third-world countries of the Western Pacific?' He went on to describe the Australian Universities' International Development Program which had originated in the 1970s as the Australian Asian Universities Co-operation Scheme. Initially the emphasis had been on assisting with the development of university education in agriculture in Malaysia and Indonesia, although the scheme is now much broader. Under the scheme Australian university members give assistance to their counterparts in the developing countries in such areas as planning curricula, presenting courses, providing examiners, building up library resources, and developing research programmes. Scholarships are also awarded for study in Australia. In conclusion Professor Lazenby asked the panel 'Assuming that higher education institutions have an important role to play in contributing to the development of the countries in the Western Pacific, what do they think is the most effective form such help might take?' Professor Hambraeus replied that he was not familiar with the Australian scheme but had seen the Asian Institute of Technology outside Bangkok working on the same lines, and he thought that this was excellent. He is, however, frequently disturbed when, in other undeveloped countries he comes across the lone researcher, in a well-equipped laboratory, working on a topic quite unrelated to the needs of his country. Assistance which has led to this type of situation is misdirected. Dr Chestnut then added that India had faced this problem some time ago and now had five or six institutes of technology, each one of which was linked with a sister institute in another country.

Sir James McNeill then commented on the high proportion of Asian students to be found in some courses in the universities in Melbourne, but then went on to regret that many of them did not return to their own countries to use their skills after graduation; this was a difficult problem.

Dr Nagchaudhuri drew attention to the Swedish International Foundation for Science which he considered had done more with less money than many other funding organisations. This success he attributed to the very human level of operation involving personal understanding rather than an institution to institution approach. He believed there was no single model for development success but many possibilities which should be explored. Dr Bardach agreed with Dr Nagchaudhuri but added that such efforts had to be endowed with sufficient consistency and sufficient duration to have any effect at all. He also noted that it was difficult to obtain the services of the people who were most wanted for development work, probably there were not sufficient good people to go around.

Dr Bardach then raised with Professor Aida the point that he had referred to as interaction or interfacing between technological and natural systems; the ones are rather determinant and internally consistent, the others are indeterminant and messy, and this poses some rather difficult questions. Would Professor Aida like to comment? Professor Aida replied that we should learn from nature, from ecology for example. An holistic approach is required if we are to attain clarity.

Professor Bennett then returned to the question of aid to academic institutions. From his experience from involvement in a UNESCO study sometime ago he had concluded that money was best spent in building up the institutions in the countries concerned, possibly supplemented by an exchange of staff between the institutions in the developed and developing countries. Professor Hambraeus agreed with this and cited an institution in Siberia where the best students are selected by a competitive procedure and they are taught by the best teachers; they then work locally in Siberia on local problems. He does not know how successful the scheme is but the basic idea is attractive.

Professor Yip then brought the meeting's attention back to the West Pacific Basin. He believed that great diversity exists within this region which should be able to provide complementarities which could lead to co-operation. He proposed that the Institute suggested by Professor Atsumi should seek out these complementarities. Dr Kojima complimented Professor Atsumi on his proposal and went on to refer to the United Nations University in Tokyo and suggested that institutions such as that should be looked at as examples. He also wished to stress the importance of including studies of human relations in the programme of the proposed Institute.

Royal Professor Aziz concluded the discussion with a comment on the problem of rural poverty. In Malaysia over the years they had had many advisers and aid workers assisting with technical problems in the rural areas but these people had shied away from the human problems—land reform, formation of co-operatives, or rural leadership. This was partly because such problem areas were thought of as political. However, technology could not be made to work successfully without attention to the human problems. Technologists trained in developed country education patterns are not equipped to deal with problems at the village level because of this human dimension. Therefore some way has to be found of marrying the transfer of hard technology to an awareness for the need to change institutional relationships. The twinning idea between universities in developed and developing countries is one suggestion that would assist this.

Participants in Symposium

Participants in Symposium

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