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「技 術 と 文 化」

IVA事務総長　グナー・ハンベリュース

本田財団レポート

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Outline of Lecturer's career

Professor Gunnar HAMBRAEUS

1919	born in Orsa, Sweden
1944	Bachelor of Science, Uppsala University
1945	Master of Electric Engineering, Royal Swedish University of Technology
1975	Doctor of technology honoris causa, Gothenburg

1945～1950	Secretary of the Swedish Technical Research Council
1950～1951	Technical Advisor, Swedish Embassy, New York
1951～1953	Secretary of the Swedish Technical Research Council
1953～1968	Editor in Chief and Publisher Teknisk Tidskrift (Technical Journal)
1968～1969	Consultant International Atomic Energy Agency, Vienna
1969～1970	Managing Director of the Swedish Technical Press
1971～	Professor and Managing Director of the Royal Swedish Academy of Engineering Sciences

● **Publications**

Publications and lectures given on Progress in research and technology, Energy problems, R & D policy and in the fields of science and technology

講師略歴

グナー・ハンベリュース

1919	スウェーデン　オルサ生まれ
1944	ウプサラ大学理学士
1945	ストックホルム王立工科大学 電気工学修士
1975	ゴセンバーク大学名誉工学博士

1945～1950	スウェーデン技術研究審議会事務局
1950～1951	駐米スウェーデン大使館(ニューヨーク)技術顧問
1951～1953	スウェーデン技術研究審議会事務局
1953～1968	スウェーデン技術雑誌"Teknisk Tidskrift" 編集長兼発行人
1968～1969	国際原子力エネルギー機関顧問(ウィーン在住)
1969～1970	スウェーデンテクニカルプレス社長
1971～	スウェーデン王立理工学アカデミー事務総長

●**出版物**

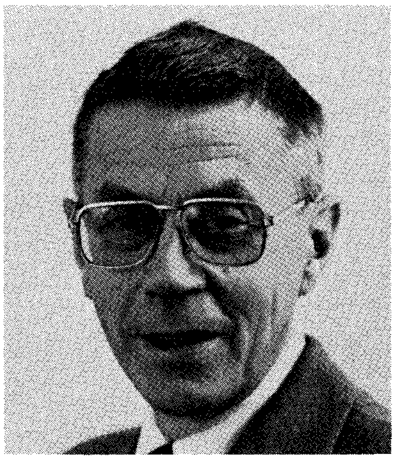
技術の進歩、エネルギー問題、R＆D政策及び科学技術に関する著書と講演

このレポートは昭和55年11月17日、ホテル・オークラにおいて行なわれた第1回本田賞授与式の記念講演の要旨をまとめたものです。

THE CULTURE OF TECHNOLOGY

Lecture at the Conferring Ceremony on the 17th of November 1980, in Tokyo.

Professor Gunnar HAMBRAEUS
The First Winner of The Honda Prize



The ultimate machine
is a thing of beauty
a multitude of symmetries,
an intricate pattern
of logical interrelations

Every part has a function,
everything needed is there
Each member is shaped
to carry its share of the load
for an alotted time

There is the force and the speed
for my use and pleasure
The machine aids my senses,
muliples my muscles,
increases the power of my brain

The ultimate machine
was a great joy to construct
it is yet one more proof
of Man's mastery of Nature
that Man is like to a God

Pray, that I will use it well!

To the day fourteen months ago, on August the 17th in Stockholm, his Excellency, Ambassador Shimoda made public the DISCOVERIES Declaration. This declaration was issued by the HONDA FOUNDATION of which Ambassador Shimoda is the chairman.

The leading paragraph of that declaration reads; "The ardent desire of mankind today is to create a civilisation in which utmost respect is paid for the human being as such. This will be possible only with mutual support and concerted action among the intellectuals of the world, especially among scientists and technologists."

I would like to quote also another part of this declaration. It says in the fourth paragraph: "The purpose of the DISCOVERIES activity is to identify the real problems facing the mechanical and technological civilisation of today, to discover the methodology which will enable us to cope with them and set a stage for the concentration of the wisdom of mankind upon this task."

I find it appropriate at this august celebration and in accordance with the purpose of the price which the HONDA FOUNDATION has bestowed upon me to discourse upon the theme of this DISCOVERIES Declaration. I have chosen as the topic for my lecture today "The culture of technology."

In the spring of humanity
at the early dawn of history
all knowledge was one.

There was at one time just one culture. The ancient philosophers saw no difference between pure science or mathematics and its application for defense, time reckoning and the measuring of land. The proconsul of Rome was equally interested in literature and music as in military operations, the planning of cities and the working of mines and metals.

When the Royal Society of Great Britain as well as the French Science Academy were founded, and I could also mention the Swedish Science Academy, they included in their statutes as one important function the application of scientific principle to the solving of practical problems as well as the furthering of agriculture, industry and commerce.

But lately, especially during this present century there has been a divorce of humanists, scientists and technologists. One reason is the great growth of all human activities. No single individual can any more encompass all the knowledge, not even within his own disciplin.

Each of these disciplins and cultures have developed their own language. We have seen the growth of a tower of Babel of our civilisation. Also there have been tendencies of snobbery where the scientists find pride in the fact that their intellectual excercises are totally devoid of any practical application. They see culture as something over and above things material. And the same holds for some proponents of philosohpy, of literature, fine art and music. On an imaginary ranking list of intellectual achievements some have been apt to place the material sciences as well as engineering for down.

Of course, as a technologist I would highly dispute this, not out of vanity but for philosophical reasons. If I look at the benefits to humanity which were brought by the Greeks and the Romans respectively, I can say that I admire the philosophical fertility of the Greeks, their superb intuition of natural philosophy and mathematics as well as their masterpieces of art and literature. But their peoples were torn by strife and wars. Very little of lasting material value came to the humble member of the Greek society.

Contrast that with the brute, from the Greek viewpoint barbaric Romans. They took over the Hellenic civilisation which they highly admired. But on another plane, they used that knowledge, these principles, to the solving of practical problems and to the creation of a better living for the citizens of Rome. They brought fresh water into the city, grain was distributed over the total empire. Society was given law and order and above they made an end to war. The Roman peace was kept in awe for many, many centuries after the Empire fell and the world again became poor and fragmented.

The boy cried: "Who is the King?"
His father answered:
"You will know when you see him."

Which are the criteria of a culture? It has to be created by humans. It is the sum of skills and knowledge, education and development, but added to that is an intellectual achievement, a shaping of a structure out of chaos. In scientific terms culture is the Maxwell demon, the gatekeeper against entrophy. Culture has an appealing order, elegant form, it is pleasing to the senses and it leaves an imprint on the whole of the human community.

You can apply these criteria to the traditional cultures, to literature, art, music, drama and even jazz and pop. But they hold also for traditions and customs, for styles of living in food and dress and architecture. Culture finds its expression in the ideals and ideas, values and ethics that permeate our environment.

The same criteria also identifies technology. It certainly is a human endeavour involving knowledge, understanding and ingenuity. It has order and elegance originating in its ever present functionality. The technology interrelates with most other human activities and it certainly has penetrated and shaped our society, from the Megapolis to the most remote hut in the wilderness.

There are a great number of definitions of technology. My own would sound like this: Technology is the application of knowledge to harness the forces of nature and to use the matter of the earth to ease the lot of mankind. Thus, it provides food and shelter, rest, comfort and security, movement and stimulation as well as information and entertainment.

The essence, the core of technology, are the tools. The tools set man apart from the rest of nature. We have been told, perhaps, of an ape putting two parts of a fishing rod together to reach an apple. The magpie uses twigs to pry open boxes where it can find food.

But anything more complicated than that is solely for man. The tools are for observation and measurement, for transformation of energy and materials, for shaping and handling, for travel and transport, for communication and entertainment.

With this definition I include among the tools the Honda motorbike and automobile as well as the Sony audio – visuals and a multitude of other things. My own country has been happy to contribute the Volvo car, the Atlas Copco drill, the Sandvik tool tip, the explosives of KemaNobel and the Hasselblad camera.

Technology has been with us for a long time. In the alluvial beds of Kenya in Africa there have been found crude tools of an age of about one million years. Ten thousand years ago man knew how to irrigate, to build great walls and to shape and burn clay for pots and pans.

In the wizard's garden
grow many proud plants,
the rich harvest of science

But the surge of technological achievement that has come during this present century surpasses anything that this world has ever seen. Modern technology has been with us a very short time. But already it provides ample and varied food for more people than at any earlier time. Energy is abundant and still cheap. We have learned to control our immediate surroundings and the problems of pure water supply and sanitation are solved.

The plastics and the synthetic fibres have come, electrification, rapid transport by automobile and aeroplane. Right now, telecommunications are again being revolutionized by optical glass fibres and satellites.

We now see the possibility to make foods, materials and new specific drugs by biochemical means, using our knowledge of the immensely intricate pattern of the long-chain proteins called DNA. And we are conquering space.

Technology also has immaterial effects. We are better informed, we are gathering new knowledge at a very rapid rate. The populations enjoy improved health and longer life. There are instant information systems that make it possible for everyone to learn what happened on the other side of the globe almost at the moment it occurs.

But all these benefits have been gained at a certain price. The world is tied together in a net of interdependencies. Our civilisation has a greater vulnerability now than formerly. We have lost basic skills that were former days' security. The speed of change has increased and this poses specific psychological and economical problems. We have a high complexity in technology and society. And the effects of technology are felt over the whole globe, lasting for we do not know how long.

In the warm summer night
strange birds make eerie sounds.
What do they wish to tell me?

And now I have to turn to reactions to this culture of engineering. During the last decade much abuse has been heaped on the collective heads of scientists and engineers. Urban suffocation, toxic pollution, the death toll of traffic, rape of nature as well as horrors of new weapons have been quoted as unavoidable consequences of technology. For the future are raised the spectres of computer invasion of privacy, nuclear disaster and genetic tampering with Man.

Much of this fear and reproof is directed towards the type of Society that permits the development and use of science and technology for dangerous and destructive purposes. Enough, however, has splashed over on the technical man to create bewilderment and distress. The public caricature of the engineers has no doubt discouraged many talented youths from entering our institutes of engineering and from devoting their career to industry and public works.

I will later come back to the reasons and motives behind these negative reactions towards technology. First, however, I will try to set down a few arguments on the side of scientists and engineers, arguments which will illustrate the attitudes of those most closely connected to technical development.

Knowledge is of good or evil. It is up to Man to make the right choice. Technology, being a small part of knowledge, takes in itself no side. What use will be made of ideas, theories, inventions and technical development is the responsibility of the user, be it the young driver of fast cars, the farmer of herbicides, the metal refinery manager of cyanide or a nation of an atom bomb.

In the main, the targets of technology are set by the forces of the market. A certain demand gives, with a certain delay, rise to a product or a service if the realization of the aims does not meet obstacles of an unreasonable magnitude.

There seems to exist a widespread fear of an inherent growth factor in technology, a Moloch, independent of human desire and control and unresistable in its blind progress. It has been said that everything that is technically possible will also be realized. As examples people refer to the development of ever more terrible weapons of war, to the cancerous growth of urbanism, and to any number of superfluous gadgets like electric tooth-brushes and food-colouring.

You asked to come with me to the summit
so why are you trembling?
Brave the precipices, see the white peaks!

To this we can answer that in all these cases there has been a demand, a market. Without politicians, willing to invest billions of dollars in nuclear weapons, no group of technologists, no matter how perverted, would have been able to force these weapons upon the world. On the contrary, we have in the broken developments of the supersonic transport and the hoovertrains examples of how technical dreams do capsize when markets are not found. We can also, with certainty, state that many products, which were technically possible, have not been produced because their realization would be of little use or would have made no sense.

We can widen the notion of markets to include not only demands of individuals but also vogues and fashions, values and opinions in Society. Of this we have many experiences from the latest decades. Words like rationalization, productivity, environment protection, ergonomy, work environment, job satisfaction, decentralization, appropriate technologies and alternative energy sources, all denote specific periods with a characteristic set of priorities. Very often such a societial demand rises rapidly within a few years. Although the scientist or the engineer may have been the first to raise the issue, he and his colleagues are often swamped by politicians and journalists, when a fashionable demand cannot be met fast enough.

This is in fact a serious dilemma. The unwieldy inertia of technology cannot keep up with the easy flights of popular values. Even in our small country of Sweden the introduction of environment protection has taken two decades and cost billions of crowns. The switch from oil as our main energy source to one or several alternative energy systems will take half a century. The new cities which we design today will last for a hundred years.

The need for technology to be timely is an ever present worry to the inventor and the designer of products and systems. This is obvious in the consumer market but no less true in the public area. The Swedish Royal Academy of Engineering Sciences published already in 1957 a report named Clean Water, advocating water pollution countermeasures. It went largely unheeded. Some years later, Atlas Copco, a Swedish company specializing in rockdrilling, issued a series of silenced compressors, again prompted by our Academy. It found few customers. To be before your time or to be idealistic and radical – at the wrong moment – proves just as humiliating, and thankless in engineering as it does in literature, art or music. Perhaps that is a characteristic feature of all cultures.

So we are caught in a tug between conflicting forces. Not only do we have the public reactions and the difficulties to suddenly switch from one societial need to the catering for another. We also see in the industrial and the commercial world the need for changing of direction when engineering fashions become obsolete and there is a call for a new technology to meet better the demands of a market.

There has to be created a greater flexibility, a preparedness, a base of wider knowledge and readymade plans to meet this type of situations. This has an even larger urgency now as the speed of change seems to be ever increasing and the political situation is so unstable that the whole world can suddenly be deprived of its energy base by to us uncontrollable events in a remote corner of the earth.

My little girl wept bitter tears.
To find the hidden treasure
she had broken her beautiful box.

There are many other dilemmas that face the engineer. It is so very hard to make the politicians, the decision makers and, above all, the great public see and understand the need to make choices, to weigh benefits aganist sacrifices and to calculate in a logical manner risks against gains.

You cannot break he ground to mine coal or precious metals without going through the soil and ruin the surface. If you want cheap energy you have to site the hydroelectric power station, the coal burning installations or the nuclear reactor somewhere. If you do really want rapid transport and good connections with the world around you, you have to provide space for airfields somewhere close to the centers of population. Many medical cures involve risks with the pharmaceuticals or the surgical incisions. And systems for social service need large scale computers and data banks which will contain sensitive information about individuals.

In engineering, big and small, there is always a need to count the good things against the sacrifices. This optimation of benefits is admittedly difficult. It becomes increasingly to when distant futures and remote areas are to be included. Certainly most of our basic decisions are suboptimal ones. The builder of a house considers only his initial investment not the total costs over the life of the building. Our politicians tend to vote with an eye to the next election. And how much does the average citizen wish to sacrifice to ease the lot of an antipodean or his great-great-grand-children?

A few years ago, it became fashionable to talk of technology assessment. The US Congress set up a special office for such studies and a Swedish Secretariat for Futures Studies was founded on similar thinking. The basic idea is sound. Before you decide on using new technology you should survey the consequences and explore the alternatives. The experience, however, is that the task is much more difficult than was thought.

Our knowledge is often insufficient. Time and money to acquire a better understanding is lacking. Values, opinions and prejudice obscure the issues. Finally, in many instances the various factors are incompatible – you cannot weigh a turnip against the song of a nightingale.

The use and misuse of science and technology thus become part of the wider problem of decision-making in our society. In a democracy everyone carries his part of that responsibility. The expert can claim no greater share of the vote than may the average citizen. But the more we know before we decide, the better. And it is in the task of fact-finding and problem-solving that the scientists and the engineers can serve and should be asked to serve.

The big wind came suddenly.
The wings of my mill whirl wildly.
Once more I turned the head in time.

I would like to widen these notions of risk and benefit analysis and technology assessment. It might be called the management of technological change. The first phase of this process is the early perception or discovery of new findings, innovations, break-throughs, tendencies or trends which have potentials to bring about changes in technology, industry, the services or in society as a whole.

The next step should be the formulation of plans based on these studies to take advantage of the possibilities and to avoid the threats – including the probing of alternatives. The plans would be for governments, state or local; for industries branches or individual companies and for organizations or schools of higher learning.

A third phase is the informing of and cooperation with decision makers, news media and the public to make them aware of coming change and to prepare the ground for actions that will maximize the benefits and avoid the difficulties.

The system on which a change will apply can be small: a new plant based on a new production method is built, an irrigation dam is erected, a closed cirquit television network is opened. They can be of medium size and work on a whole branch of industry. Examples are: the introduction of oxygen in steelmaking, the float glass production method or the use of hydraulics in place of pneumatic drilling of rock in mines or underground construction.

Mostly, however, we tend to think of the big changes, the mighty transformations which could be called industrial revolutions. Such are the emerging of steam power, the harnessing of electricity, the ongoing revolution in the information technology, and the advent of applied genetic engineering.

Ultimately these changes effect people. Jobs are created or destroyed, wealth is distributed differently, the environment is changed, people may have to move, relearning is necessary, new opportunities are opened to the young, the bright and healthy people. Life patterns may be changed as well as traditional rythms of the year, the week and the day. Social tensions may appear and there can well be political consequences, small or large.

At one time, this did not greatly disturb the engineers or scientists. Technical change appeared so obviously beneficial, relieving hard labour, making goods cheaper, improving communications and providing entertainment.

Also in the industrialized world almost everyone believed in the mechanism of the market economy. In this system the feed back mechanisms would make certain that any step input would automatically bring about reactions whereby the system would be brought to a new equilibrium, representing an optimum of good for the entire society.

Is my spectacles' glass tinted?
In the deep green of the summer
mingles the hues of autumn.

The last two decades have disproved our optimism. For this I see four main reasons.

The first concerns the real or physical change. The effects of human activities are now felt worldwide. The heat produced in the mega-metropolis is affecting the local climate. The immissions of SO_2, NO_x and dust are felt over whole continents, more than half of the acid rains over Scandinavia originates in continental Europe or in Great Britain.

As a boy I read the Oppenheimer novel "The man who stole the Gulf Stream". This is no longer science fiction. The Soviets are seriously contemplating turning the great rivers of northern Siberia south to water the dry republics of Kazakstan and Uzběkistan. The tropical rain forests are cut down at an alarming rate with immeasureable effects on the soil and the climate. The release of certain chemicals on a worldwide scale may have a dealyed but possibly ultimately lethal effect on our ecology.

Into the house of my father
I carried firewood and water.
Noone had to tell me
why earth was tilled, iron stuck.

On another level we see the sociological effects. A new affluence, unsurpassed in the history of Mankind, has created new social patterns. Work is no longer the main occupation or purpose of life. Education is, for whole groups of people, no longer an investment for a coming career but rather an occupation in itself or a pastime. The young see no direct connection between their own efforts and the benefits that they receive.

In the agricultural society of yesterday this connection was self-evident. A child took part in production from the age it could move out of its crib. Also the very nature of work has changed from dominantly physical to mental. Now even many mental efforts are becoming superfluous. This makes people more reluctant to accept changes in their present situation for the purpose of more distant – in time or in space – benefits. I am often reminded of the schoolboy who wrote in an excercise on the planetary system: "The Moon is fine because she gives light in the night, but the Sun shines in the day, when it is light anyhow".

This brings one to the third level of effects from technological change: the psychological one. The rate of change necessitates a constant adaption and relearning, an adjustment which is exciting but demanding. The flow of information is overwhelming there are conflicting evidence and opinions. How does one discern the real signals from the background noise?

Finally, there is the political level. Technological changes influence the relations between groups, parties, nations, and political blocks. The policies of energy and raw materials are obvious. The natural, national resources are being used not only for the furtering of national wealth but also to reach regional and political goals. The transnational organizations are a new factor of power that no nation can overlook.

The newly industrializing countries have demonstrated that technology can now be transferred much easier and in a shorter time than we ever thought possible. The developing world is fast learning that lesson. The failure of the north-south dialogue in various U.N. conferences means that many developing nations are taking unilateral action where and when they see an opening.

On the ball of my Leyden flask
a frail dragonfly settled.
Her wings' flutter released the bolt.

In brief the situation can be described as such: The tools of engineering are now more powerful than ever. The effects are being felt on a worldwide scale, not only on the physical level but also on the social, psychological and political levels. This fact must be realized by the scientists and the engineers. No longer can they avoid the responsibility for the use of their efforts. They have to take part in the management of technological change. Many of its tasks are familiar to us. But many things we have to learn. One of the most important is how to communicate with our clients and customers: the great public, the news media and the decision makers.

We see this most clearly in the nuclear debate. But this is no isolated case. From the Luddites onwards there have been similar reactions. There is now resistance to all types of large scale civil engineering. There is the fear of the effects of large scale computerization on the integrity of the individual. The Unions are uneasy in the face of large scale robotization and the automized office of the future.

In Europe there are now professional groups of young radicals who have mounted a travelling circus to join this type of popular and populist, anti-intellectual and anti-industrial movements. Issues they find in plenty! Water fluorization, new power plants, transmission lines and herbicide spraying are met by grassroot political manifestations.

This is the more disturbing as we are now facing more drastic changes than ever before. With a terrifying growth of world population, an alarming urbanization, food and energy deficits, changing climates, and increasing pollution there is no alternative to a wider and wiser use of science and technology. There is no doubt in my mind that good solutions can be found. But the greatest obstacle is not the lack of methods, production systems, products or even energy and materials. It is instead the lack of foresight, the absence of planning, the poor understanding and the many powerful conservatisms that exist in capital, labour, management and government.

Hear the pilot cry!
"There are shoals ahead!
Every man to his station!"

Thus the very first part of the management of technological change is the teaching and the informing of the public. In industry we know that a wise management builds into the organization an awareness that changes are inevitable, an urge for preparedness for these changes and a subsequent demand for R&D, for long range planning, encouragement of innovation, re-education and financial reserves. If this feeling and understanding can permeate all levels of an industrial company the management has a much more easy and efficient task to perform.

We should strive hard to create the same situation in society as a whole. For this is needed a forceful and penetrating R&D in universities and institutes, organisations to transform and translate information from indigenous and foreign sources and which can from this construct long range plans upon which industry and government can then act.

These same bodies should also see as their task to constantly inform and in fact press upon the public, the mass-media and the decision makers, the findings, the trends and tendencies and the conclusions as to the planning for the future. This task cannot be given to a government organisation, or an industrial federation alone, nor to a single university. It is imperative that the body should be strongly non-partial, objective and fearless. Such a body is an academy.

Old men walk in the garden.
Their eyes seek the horizon,
their thoughts roam the world.

It has been my pleasure and my privilege to serve out and in of an academy for the best part of my life. This is, as you know, the Royal Swedish Academy of Engineering Sciences, now in its sixty-first year. It is one of eight royal academies in Sweden. It is by far the youngest but also the one with the widest activities. It is a young and angry academy. If you would like to sum up its purpose in one sentence, it would be "the management of technological change".

Does modern Society really need academies? Are these undemocratic, élitist institutions not just as archaic as knights in saddles or courtiers in breeches? Are they not rusty relics of the past tottering on the brink of oblivion?

These are questions which are seldom put to me directly but which I now and then can read in the eyes of politicians, journalists and other laymen. I have found myself now and again in situations where I have had to justify the existence of our academy and the claims that this institution puts on government and industry for attention and resources.

In these discourses there is not much objection to societies where members meet together for mutual enlightenment, ceremonials and formal proceedings and for the recognition and rewards of talent and outstanding service. But such activities do not attract much outside attention either. And they do not form the hard core of a real academy.

As I noted earlier in this lecture, most academies were started with higher ambitions. They were intended as action groups for the support and promotion of some special area of progress – cultural, scientific, military, agricultural or industrial. Most of them track their origin to times when governments and state institutions only cared for a few basic functions in society and the rest was left to private initiative.

Our present century, however, has seen an unsurpassed growth of governments. In this process, the academies have been either enrolled as ministries or agencies and made part of the state machinery as in Eastern Europe, or they have been bereft of many functions and sometimes even reduced to ornaments of higher learning close to the popular caricature.

This process, however, is a loss to society as well as a waste of an important intellectual resource. Really talented people have much more to give than their ordinary working environment can absorb. They have a natural urge to set up spontaneous, informal groups for action on all sorts of issues that they feel important. Even if they themselves do not always rationalize their inclinations they feel a responsibility to put their talents to use to the benefit of their fellow men.

An academy is no ivory tower,
no keep for bones of dead science.
It is the house of the handymen.

This, I think, is the basic force behind the establishment of a growing number of engineering academies in the world. There is no set list of rules which can be applied to all of them. For the Royal Academy of Engineering Sciences in Sweden, however, we have formulated three functions which have given good guidance to our planning for a number of years.

The first of these is the scanning of the scientific technical horizon. The members of an academy, each in his own field, have unique opportunities to foresee important developments and new trends. Through its members an academy ought to be able to discern new possibilities and oncoming difficulties and threats. Based on this scanning and subsequent discussion and analysis, an academy ought to be able to suggest actions by government, state agencies, industrial organizations, individual firms and other institutions to reap the benefits and lessen the sacrifices. In some cases the academy can establish new organizations for such purposes.

The second function is the creation of a wide and closely knit network of personal liaisons and contacts. The multidisciplinary character of an academy is a natural environment for stimulating interface action between experts and specialists, between academic teachers and practical technologists, between industrialists and government officials within a country and abroad. This network, constantly growing and changing its shape, is an unsurpassed intelligence machine in a positive sense and also a mighty tool for initiating action fast and with a minimum of friction.

A third task for our academy is to promote a better understanding of science and technology, its potential possibilities, limitations and consequences among the decision makers and the public. In this you recognize the third phase in the technique of management of technological change.

Many other functions could be carried out by academies. One is the formulation of a national applied science policy. The academy's central position between government, industry and universities provides a good platform for the unified optimalization of the creation and application of new knowledge.

A more traditional role for an academy is to act as an adviser to the government and to state agencies. A related function could be a science and technology audit by which we mean a continuing review and criticism of the work of government agencies, research councils, branch institutes and industrial organisations. This is a task that at present is pursued by for instance the Science Council of Canada.

It is interesting to note that in many countries a need is felt for bodies of this type. This need has crystallized, as I have already said, into engineering academies in Australia, Mexico, Venezuela and other countries.

There is at present a discussion in the United States of the creation of a sister body to the Science Research Foundation called the National Engineering Foundation. This would cater for the support of applied research and industrial development. In Great Britain the engineering profession has for a long time felt neglected. They need a good voice with government and industry as well as a more prestigeous body to see to the proper education, training and utilization of technologists and engineers. You are certainly familiar with the Finneston report that is one result of the ongoing discussion in the U.K.

I also note with pleasure that there is a nucleus of international cooperation between these bodies. Three years ago in Washington D.C. the National Academy of Engineering of the United States called the first convocation of engineering academies in the world. A second convocation was held in Melbourne, Australia, this spring under the auspices of the Australian Academy of Technology. It is my hope that also Japan will some day join this cooperation.

Certainly you share the ideals and ideas of our engineering academies. This is well expressed in the leading paragraph of the DISCOVERIES Declaration of August 17 last year: "To create a civilisation in which utmost respect is paid for the human being as such." And I would like to add, where technology is brought to cater for the needs and desires of these humans. That task will be possible only with mutual support and concerted action among the intellectuals of the world. It is a call for all good scientists and technologists.

By this I have come to the end of my lecture. But before I step down, I would like to recite yet one more poem. In this I have tried to express my own crude engineer's philosophy:

I have been in Heaven
It was not at all
what I have been told

There were no angels,
no lovely houris,
no nectar, nor manna
and no strange, sweet music

I found endless struggle,
huge heaps of work,
unsolvable problems,
toil in black chaos

Great strength was I given
and thinking, deep and clear
I felt no fear, no tire
and sometimes I came through

I could bring a little order,
erect a humble hut,
bridge a boiling stream
or invent a useful thing

I was able to help a friend,
to relieve some pain,
ease someone's misery
And my joy was boundless