HOF 01-026

本田財団レポート　No.26

「人々のニーズに効果的に応える技術」

GE研究開発センターコンサルタント

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1917 Born in Albany, New York, U.S.A.

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1957~1959 President, International Fedderation of Automatic Control (IFAC)

1962~1964 President, American Automatic Control Council

1973 President, Institute of Electrical and Electronics Engineers (IEEE)

Dr. Chestnut received Doctor of Engineering honoris causa from Case Western Reserve University and Villanova University.

● Publications

Book, "Servomechanisms and Regulating Systems Design", Vol. I, 1951, 1959 (with R. W. Mayer)
Book, "Servomechanisms and Regulating Systems Design", Vol. II, 1955 (with R. W. Mayer)
Book, "Systems Engineering Tools", 1965
Book, "Systems Engineering Methods", 1967
Journal publications on adaptive control, optimization methods, systems engineering, modeling and simulation, and application of systems engineering to socio-economic problems.

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●著書

「サーボメカニズムとレギュレートシステムデザイン」第1巻(1951, 1959)、第2巻(1955)、R.W.メイヤーと共著
「システムエンジニアリングツール」(1965)
「システムエンジニアリングメソッド」(1967)
適合制御、最適化法、システム工学、モデル化、及びシュミレーション及びシステム工学の社会経済問題への応用に関する各種寄稿。

このレポートは昭和56年11月17日、ホテル・オークラにおいて行なわれた第2回本田賞授与式の記念講演の要旨をまとめたものです。

APPLYING TECHNOLOGY MORE EFFECTIVELY TO MEET THE NEEDS OF PEOPLE

Lecture at the Conferring Ceremony on the 17th of November 1981, in Tokyo.

Doctor Harold CHESTNUT
The Winner of The Honda Prize 1981

It gives me great pleasure to receive the Second Honda Prize for Eco-Technology. I am delighted to be identified as having contributed to the successful use of technology to meet the needs of people. It was my good fortune to be associated with an industrial corporation which is dedicated to the slogan of "progress for people". My thanks to you and to the Honda Foundation for the recognition and gift.

I am glad to become identified through this Honda Prize with the positive objectives of Eco-Technology. I shall make every effort to capitalize on this identification to make the concept and value of Eco-Technology better understood in the engineering, scientific, and industrial communities to which I have access.

I am also honored to follow Dr. Gunnar Hambraeus who was the first recipient of the Honda Prize. As Managing Director of the Royal Swedish Academy of Engineering Sciences, Dr. Hambraeus has directed the Engineering Society efforts in Sweden. He has also been a world leader and poineer in strengthening the recognition of engineers and the formation of national engineering societies in other countries. I am happy to be a member of the National Academy of Engineering in the United States which has collaborated with Dr. Hambraeus in many joint activities.

Eco-Technology, as a word and as a concept, combines ecology and technology as they apply to meeting the needs of people. Eco-Technology emphasizes the multiple requirements of people for applying technology to achieve their individual needs, and for keeping in proper perspective their collective concern for ecology by maintaining a healthy and favorable environment for life itself.

Amplifying this important idea, technology, and especially Eco-Technology, should be influenced more effectively by the needs of people. In the book "Honda, the Man and His Machines", Sol Sanders attributes to Soichiro Honda the following statements: "Men desire something. Technology is something to achieve that goal. It's not that technology is there and that's why we make this; it is the other way around – there is a social need, hence the technology. The technology is simply a means. This is our fundamental philosophy"

Dr. Soichiro Honda, The Honda Foundation, and the Honda Motor Company, Inc. have demonstrated a serious concern in their activities for the principles of Eco-Technology.

The early Honda successes in providing inexpensive, reliable, low-cost transportation for people represents one facet of transportation of which technology can be proud. More recently, starting with the development of the CVCC engine, Mr. Honda and the Honda Motor Company have provided a motor car engine that has inherently lower emissions, as required by present day environmental standards, as well as higher gas mileage performance. These two examples serve to illustrate different concerns of technology and ecology

as they are merged to become Eco-Technology.

Although the term Eco-Technology is a relatively new one, the Honda Foundation is bringing the term and the concept into full view. For many years I, personally, have been strongly committed to the goals and objectives of what we now call Eco-Technology. My interests in recent years have been clearly identified in the area of systems concerned with both the basic needs of people as individuals, needs which are more and more being met with the aid of technology, and the collective needs of people as groups of individuals who are more and more concerned with ecology and the environment. As I read and learned more of the Honda Foundation, I became aware of Mr. Honda's statement noted above, which is directed to blending of technological progress with due regard to the needs of ecology and the long term needs of people. In view of the changing needs of the people of the world, it is fortunate that our vocabulary and word usage can change to adapt to the current situations and to incorporate new words, like Eco-Technology, to take on new meanings.

Applications of Technology

My experiences during the 1950's and 60's were heavily directed to the technology aspects of Eco-Technology. Automatic control and the rapidly advancing field of electronic computers, which had been developed extensively for military purposes, were then being applied to meet the newly emerging needs for electric power generation, industrial steel making, electronic numerical control of machine tools, and other industrial applications. Automatic control of start-up and shut-down of large steam turbine generators, as well as good control of speed with changing loads, were challenging requirements of the growing electrical utility business that I became closely associated with. The need for being able to instruct a computer to do the sequencing and make the decisions that had always been done by human beings was a problem that was finally solved after painstaking efforts.

A need in industry that had high financial incentives was for more effective automatic control of various aspects of the hot and the cold rolling of steel. Steel is used extensively for household appliances, automobiles, and other consumer goods. I remember rather vividly hearing from my associates in the steel mill control business of how they were able to apply control theory developed for one set of disciplines to quite different industrial applications.

It was during this period of time that I made one or two trips a year abroad on matters pertaining to the International Federation of Automatic Control which was just getting established. Not only did I learn something about the intrigues of international politics in a non-political organization, but I was also able to compare notes with my technical peers in other countries. From such discussions I learned that the same sort of technology and human limitations that were experienced in the United States were often ones which were to be found in other countries as well.

As the concerns with the environment in the United States and in Western Europe developed in the late 1960's, I was made increasingly aware that improvements in technology offered people more choices, but that technology by itself did not provide the human judgement or selection of criteria on which decision-making should be based. A more systematic approach involving reliability, effects on humans, and as well as other social considerations was needed.

In the early 1970's I became more concerned with the world's environment and resources. It was during the time of some of my prior visits to Japan, that I was first made aware of the close coupling between the increasing industrialization of Japan, and the effect of this industrialization on the local and national environment. In 1975 I attended an outstanding meeting at Kyoto entitled International Congress on the Human Environment (HESC). I learned from that meeting, as well as from visits to industrial sites, of some of the problems that were developing with regard to pollution of the air and water, including noise, chemical, electrical, and other forms of pollution.

Prior to that time, it had seemed to me that we in America had the most severe environmental problems. I soon became aware that these problems were not limited to the United States or Japan; they were to be found in varying degrees in all industrialized countries as well as in some developing countries. What impressed me was the willingness of some Japanese people to talk about the difficulties with the environment and to seek ways of lessening undersirable effects on the environment while the positive features of the useful results of technology were maintained. This ability to strike a responsible balance between the desirable features of technology and some of its undesirable side effects on the environment is an important quality for decision-makers to develop more fully.

The technical and mathematical means for ac-

complishing multi-objective optimization, as this process is called in systems science terminology, are two aspects of this sort of problem. Many ways of performing the mathematics have been suggested, and some are being employed. The more difficult aspects of the optimization problem are often the social, economic, political, and other facets in which differing concepts, principles, and values must be reconciled and brought to a mutually agreeable balance by individuals and groups that have differing interests and objectives. It is this ability to accomplish reconciliation or potential conflict resolution which offers great challenges for the future.

In order to provide an illustration of the idea of applying technology more effectively to meet people's needs, Figure 1 indicates the principal relationships involved. The results of the process and its technology are shown as the output of goods and services to meet the needs of people. Labor, materials and energy represent important inputs necessary to produce goods and services.

In addition, disturbances or undesirable inputs also may occur which cause unforeseen effects on the products, or perhaps the environment, and which affect the users of the goods and services or other people who may not have considered themselves a part of the process at all. Often studies in ecology are required to evaluate the future or distant effects on the environment of the processes involved.

So far in describing the figure, the effects of technology have been considered in a fashion without their feedback aspects receiving proper attention. Referring to the principal input on the far left, one sees that people's needs are represented as the desired value of the process of supplying goods and services to meet people's needs. In addition to people's needs, data and information from measurements about the process outputs are also supplied to technology in the form of decision-making. Thus, people needs are compared to the goods and services supplied to people and technology is used to make decisions on a current basis. These decisions supply additional inputs to the process itself to change it to make the actual goods and services more comparable with the desired needs of the people. In the jargon of automatic control and systems, the loop has been closed, and people's needs have been used by the decision making part of technology to make the goods and services produced by the process part of technology better relate to those needs.

ECO-TECHNOLOGY

In speaking about Eco-Technology this evening, there are some features of technology and ecology that I would like to touch upon because I think they may be able to show us how people's overall needs may be more effectively realized: in particular, how technology is proving to be more effective as it becomes more international in its character,

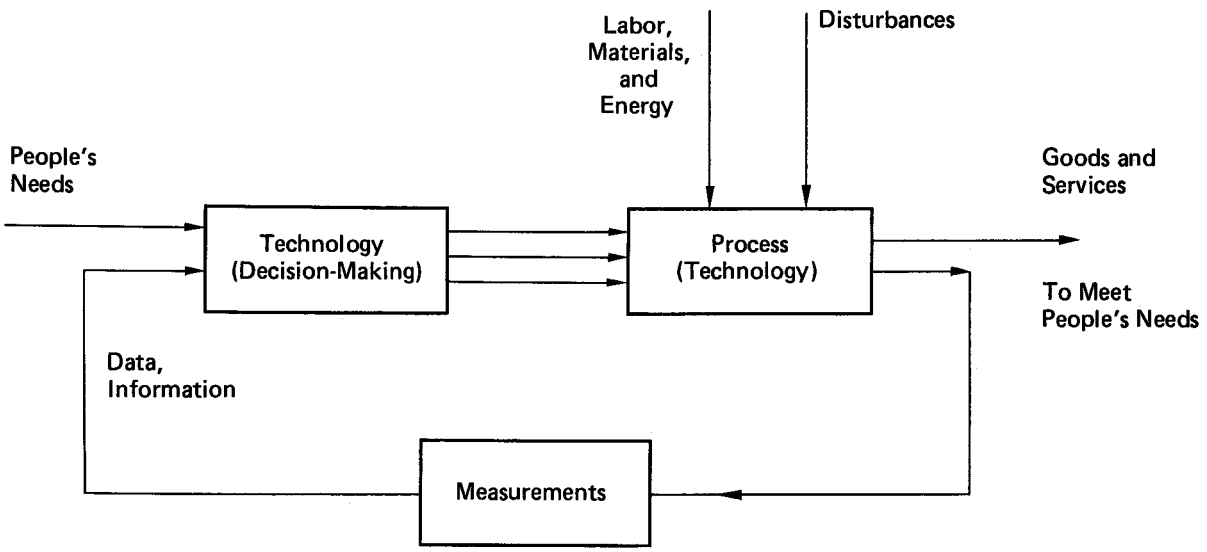

Figure 1. Applying technology more effectively to meet people's needs

and how the interdisciplinary aspects of technology are bringing together people with various skills to make industry more productive. Another facet of technology of considerable significance which I shall mention is the influence of society's physical, social, and cultural needs on technological change.

Whereas technological change tends to be rapid and visible, some of the changes to the environment tend to be slow and diffuse and not readily identified with their causes. It is for this reason the study of ecology is so important and necessary as an adjunct to the application of technology, hence the need for Eco-Technology.

At first thought, who can beagainst the use of technology for meeting the overall needs of people? Certainly the basic needs of people can be identified, and technology can help meet them. It is also necessary, however, to keep in mind that there are other groups of people who have an interest in supplying needs, and those groups must also be considered.

As a result of looking at the overall needs of people, one finds that many of the problems may be more involved than was originally though to be the case. In fact, given a better awareness of the overall needs of people, it becomes apparent that we may need to understand better a more advanced technology to meet these needs. It is at this point we may recognize that some of the principles and concepts that have been useful in the application of automatic control and systems can also be beneficial in applying technology more effectively to meet the overall needs of people.

One current problem for which I feel there is a particularly important need by people at this time is that for human safety. For a number of other of the human needs there are generally agreed upon ways for meeting those needs, even though they are not currently being implemented. In the case of human safety in the collective sense, it is not readily apparent that there exist commonly agreed upon principles among nations which can serve as the basis necessary to provide human safety. I will report briefly on some thoughts on this subject of human safety, which are presently in the formative stage.

We are in a very interesting and exciting period of world history. More people exist, have a longer life expectancy, are better educated, have greater expectations, can be transported more quickly, and can communicate more easily. At the same time, as a civilization, we have greater destructive capacity than ever before.

Technology has helped bring up to where we are. How can we help make technology to be more effective in meeting human needs in the future, keeping in mind the many potentially unfavorable side effects on the ecology that certain technologies might be capable of producing, with other requirements specified? Perhaps we may find still other technologies to employ which are capable of producing the desirable useful results being sought to meet mankind's needs with acceptable levels of the undesirable environmental aspects. So far this has been possible in many instances, and we must continue to seek technical solutions which are acceptable from the viewpoint of Eco-Technology.

TECHNOLOGY

Technology is "the application of science especially to industrial or commercial objectives." In accordance with Mesthene, of Harvard University, the term technology is taken to mean the organization of knowledge for the achievement of practical purposes. This permits us to consider technology as including techniques and tools in a general sense and is not limited to production processes. Technology is thus seen to have a pervasive influence throughout the whole of society. In the broader sense in which I would like to use the term, technology includes the overall process of making and distributing things to meet people's needs. It embraces science, engineering, and the knowledge of production, operation, and maintenance but it is more.

It involves the economics of making things at a price people can afford. It involves marketing and service so that enough items can be built with a unit cost made small enough to sustain an economic market size. It involves the acquisition of the financial capital to fund the enterprise. It involves dealing with social relationships so that people are able to work together cooperatively in the common undertaking.

As a means of providing a pictorial representation of the breadth of concerns which technology includes, Figure 2 shows the many and varied activities which comprise the industrial process of making a system as well as the operating system process itself. Although an important portion of this process is scientific research and development, there are obviously many other significant activities all of which must be present to enable the industrial operating system, say a steel mill, electric generating plant, or automobile factory, to per-

form satisfactorily. In addition to all the operations and equipment involved, i.e. hardware, there may be a considerable effort in instructions, training, procedures, and software paperwork required to describe, specify, operate, and maintain the overall technical activity. Thus technology employs these complex undertakings to carry out the "industrial or commercial objectives" that are necessary to provide people with the high standard of living enjoyed in many countries.

Technology is becoming more international

Whereas the industrial revolution started in Western Europe and was for a long time centered there, the greatly improved communications and transportation means in present times have enabled technology to become more international in character. One might make the case that the present high degree of technology has been made possible by virtue of the international exchange of information which is currently available. Noted below are several examples of specific technologies or industries in which the initial discoveries took place in one country, but subsequent developments by people in another country have enabled a second country and others to achieve a leadership position.

Electricity and Electronics – The pioneer electrical works of Michael Faraday and James Clark Maxwell in the United Kingdom in the 1800's helped explain the laws of electricity. Much later, the highly novel work in electronics of Bardeen, Brattain, and Shockley in the United States in the 1940's and 50's provided the foundation for transistors and microelectronics. Both works were complemented by the efforts of many other inventors, engineers, scientists, and entrepreneurs so that today electrical and electronics engineering is a worldwide activity affecting industry, commerce, and the home in many ways.

Airplanes – The Wright Brothers, Orville and and Wilbur, in the early 1900's demonstrated in the United States the flight of heavier-than-air airplanes. In the 1940's Frank Whittle of the United Kingdom developed the jet engine for aircraft use. Today's modern airplanes employ the principles of these inventors and many others to provide a highly advanced air international transportation system.

Food and Food Handling – The idea of an agricultural economy was said to have been established in the middle east and elsewhere long before the

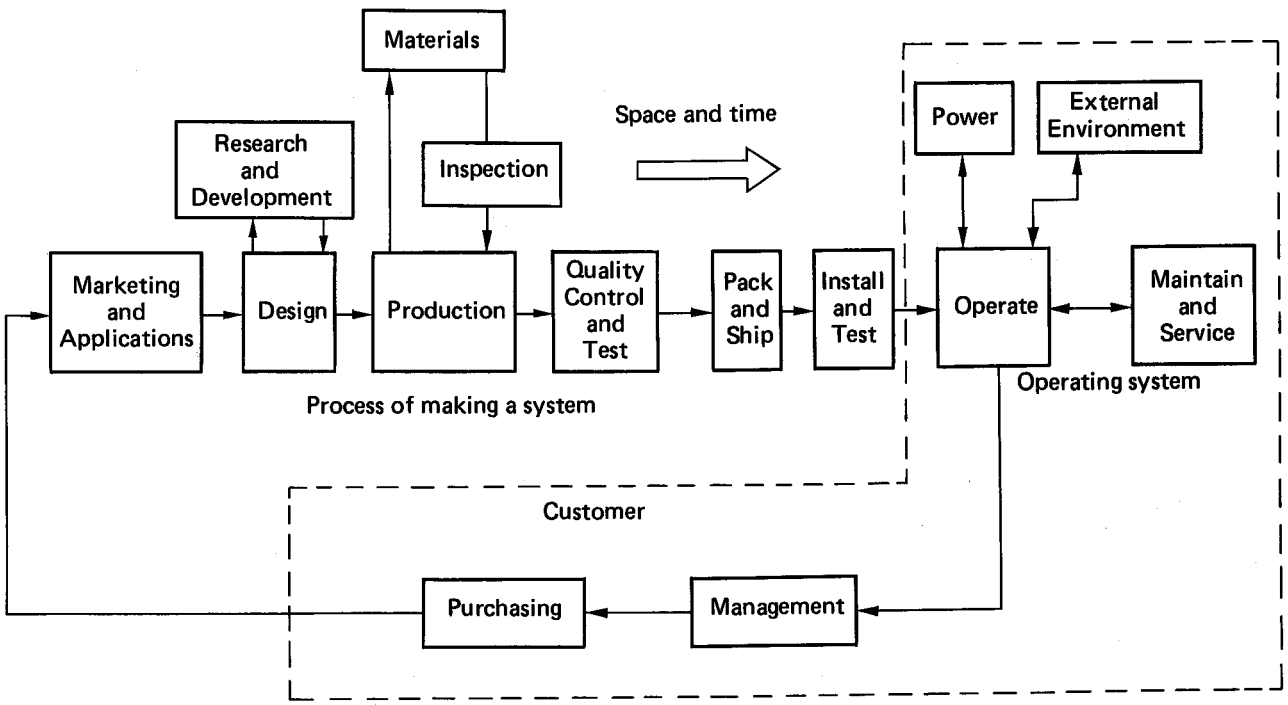

Figure 2. Interrelationship of process of making a system and the operating system itself

time of Christ. The works of McCormick in inventing the reaper, and those of others in developing food-processing machines and other means for handling food, have helped greatly in making possible a vastly improved food and agriculture technology.

In similar fashion, Table 1 shows several other technologies and major contributors to these technologies, and the countries they are associated with.

Figure 3 presents a generic business model showing a number of subsystem functions of an industrial system that is embraced by the term technology. In addition to the traditional research and engineering functional activities associated with development and design of the industrial enterprise, the other activities include presale award (or marketing/sales), personnel, management, planning and control, and financial functions. The responsibility of an employer for the health, safety, and pension for the employee represents contributions from some of these other disciplines.

Table 1

INTERNATIONAL ASPECTS OF TECHNOLOGY APPLICATIONS

TECHNOLOGY APPLICATION	INVENTOR OR DEVELOPER	COUNTRY OF ORIGIN
Communication		
Radio	G. Marconi	Italy
Satellites	J. Pierce	USA
Automobiles		
Mass Production	H. Ford	USA
Small Car	Volkswagen	Germany
CVCC	S. Honda	Japan
Medicine		
Ethics	Hippocrates	Greece
Pasteurization	L. Pasteur	France
X-Rays	W. Roentgen	Germany

Whereas initially many of the technologies or inventions noted above produced some undesirable outputs as well as the desirable effects sought, often it was necessary to apply other technologies than those initially used to establish a resultant production means and technology that met the overall ecological needs of the people of the world.

Technology is becoming more interdisciplinary

Although the preceding material has stressed the international and technical aspects of technology, another facet of technology is its interdisciplinary character. Not only are the customary scientific and engineering skills required, but skills such as personnel management, financial management, business administration, and others involving the social sciences are needed as well.

Traditionally, economic, social, political, as well as technical skills have been considered as making up the interdisciplinary mix that is beneficial to modern technology. It seems evident that as technological problems of increasing scope and complexity are approached, there may be benefits to be gained from having available people with still broader interdisciplinary skills.

Society's physical & cultural needs as the cause for technological change

Although the thought is often expressed that science and technology have been the driving forces for societal change, one may also view the

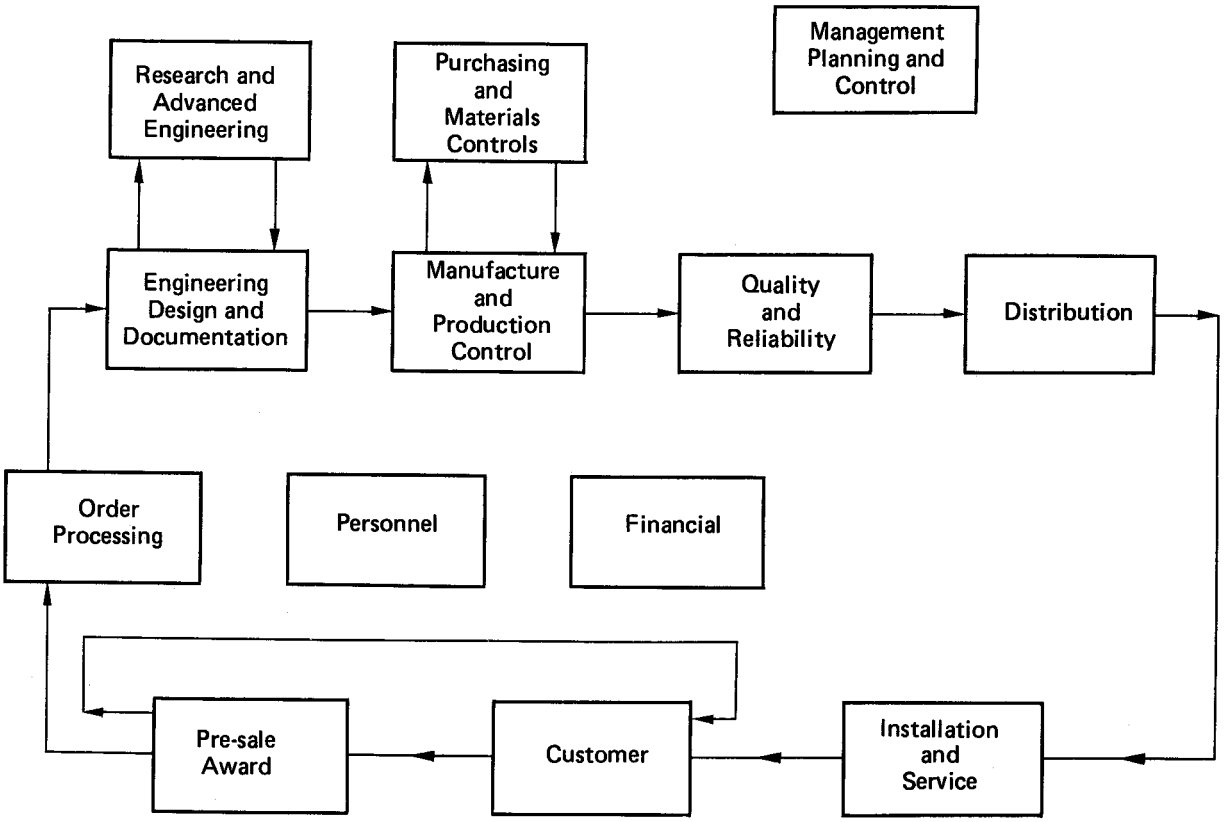

Figure 3. Generic business model showing function subsystems

phenomenon in a different perspective. Perhaps we are entering a period of history where, as Mr. Honda has said, it is in fact the physical and cultural needs of society which are causing changes in the applications of technology.

Figure 4 provides us with an interesting way of looking at society's needs, shown on the left, as being the basic cause for change. These physical and cultural needs for food, shelter, clothing, etc. provide the driving functions and serve to establish what goals should be appropriate for the nation. These needs are represented as economic demands, social expectations, as well as other generalized goals. These several goals chosen are used as a basis for comparison with what is actually being provided by the society in the way of industrial and economic applications, social conditions, and knowledge and capabilities. There, several comparisons enter into an overall decision process which allocates more or less financial capital and human resources to existing social concerns and economic applications, or allocates more or less financial capital and human resources to bring about technological as well as other changes.

The outputs from technological changes provide new capabilities for knowledge, new products for the economic applications, and new problems or new situations for the social conditions. Cradually, as time goes on, these needs on the part of society can be driving national and international systems to improve their knowledge capabilities, their economic applications, and their social conditions. There appears to be an insatiable desire on part of people to have more and different goods and services than heretofore; thus there is a drive to provide technological change.

This sort of positive feedback situation is indicated by the way that signals from all three major processes, i.e. knowledge and capabilities, economic applications, and social and environmental conditions, are used to provide an input to the society's physical and cultural needs. Thus most people's wants and needs tend to be influenced by what is possible.

We are fortunate to have lived during the past thirty years when the pace with which science and technology have been able to introduce change has

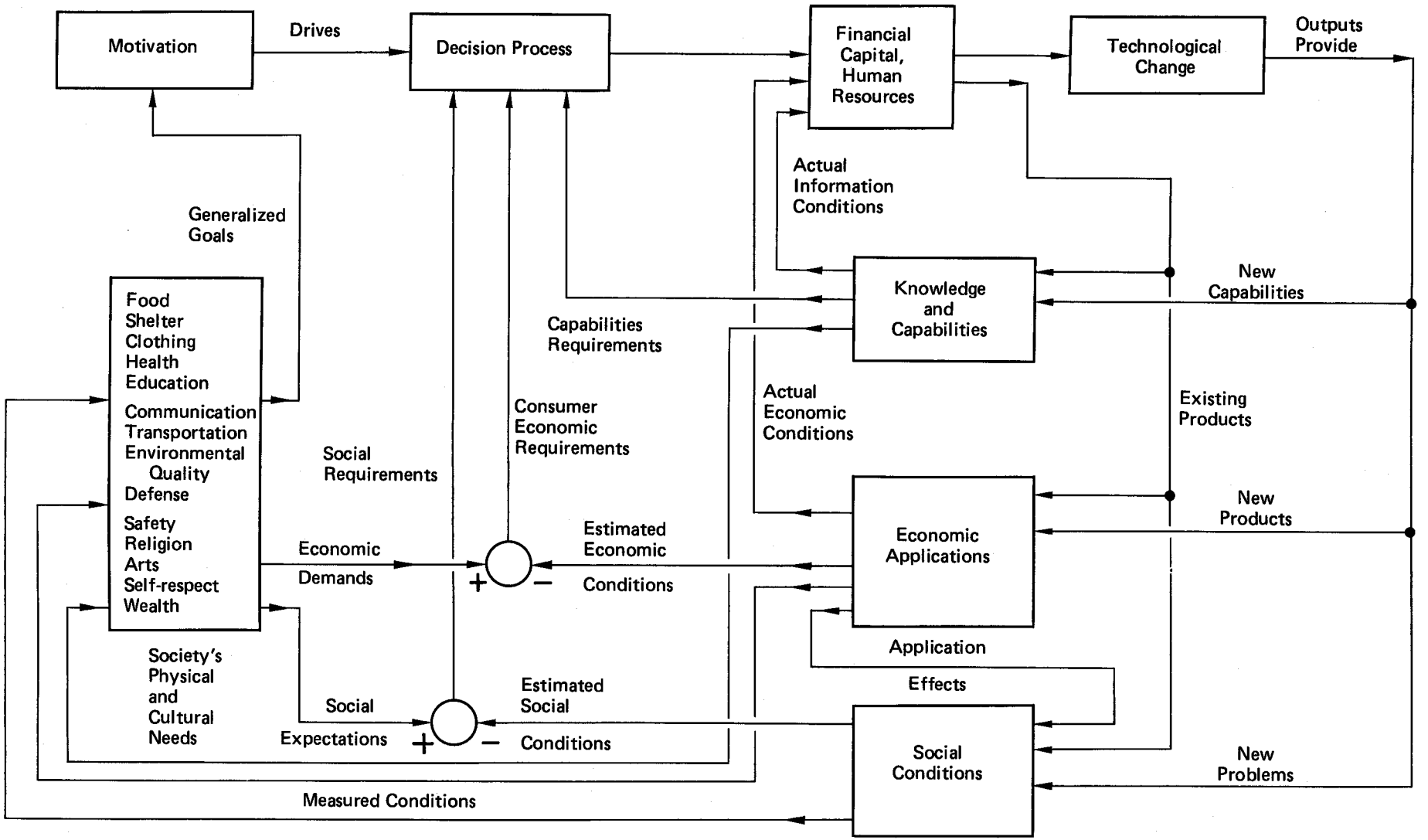

Figure 4. Society's physical and cultural needs as the cause for technological change

been at an extraordinary rate. The applications of technology have brought many new large scale systems into being such as those for energy, communication, transportation, food, manufacturing, and others. These large scale systems are characterized by their

- technical complexity, many parts, and their need for such functions as communication, control and computing;
- high cost as measured in terms of capital and/or materials resources; and
- capability to serve the needs of many people.

The number and size of these large scale systems are frequently influenced by the knowledge, wealth, and other resources of the people of the nation. It may well happen that the conditions associated with some countries are such that their needs for such systems are not sufficient to warrant their investing in them.

Some nations tend to emphasize social, cultural, and religious values. Other people place greater importance on physical comforts as well as material and economic benefits. With an awareness of the opportunities that maybe realized from people's choice, it may well be that a nation and a society can, in the future, become significally different from the way they were in the past. Such changes can be based on changes in their preceived needs, improved knowledge and capabilities, new economic applications, and changed social attitudes.

Some countries such as Japan have been able to perform "miraculous" changes in a matter of a few decades. By means of wise national leadership and strong dedication by its citizens, it may be possible for significant changes to take place in other parts of the world in comparable time periods.

ECOLOGY

Ecology is "biology dealing with the mutual relations between organisms and their environment". In particular, as it affects Eco-Technology, ecology may relate predominantly to people as the organisms and the environment as being the physical, economic, and social environment produced by technology associated with industry. The book "Science for Better Environment", the proceedings of the International Congress on the Human Environment (HESC)", Kyoto, 1975, presents a comprehensive description of the then current environmental problems in Japan. It emphasizes environmental problems such as those associated with water pollution, air pollution, noise pollution or atomic power generation, and indicates a number of different aspects in the solution of these problems.

Japan, because of its relatively small geographic size for its population of more than 115,000,000 people, and because of its high level of industrial activity, now said to be the second or third largest in the world in terms of Gross National Product, has reason to be acutely aware of the dangers and effects of industrial pollution on human beings. As a result of citizen pressures, as well as an awareness of its social responsibility, the industry of Japan now seems to be more responsive and sensitive to human needs as they relate to the environment. Thus Japan, which some time ago was identified with such adverse effects of technology as "environmental destruction, pollution, urban density, population explosion, food shortages, growing nationalizm plus a number of other deep-rooted complex issues", has more recently become identified as being among the leaders of the nations seeking constructive solutions to such environmental problems.

The introduction of ecological considerations into the evaluation of a technological system provides a basis for associating a series of cost elements into the system, which might otherwise not be present in the total cost calculations on which the ultimate management decisions for the system are made. Thus, for example, if the amount of chemical pollutant in a process effluent is identified and specified as to its upper allowable limit, any additional costs required to meet this technological specification must become part of the cost comparison with alternative designs for competitive technologies. The addition of ecological considerations can provide the basis for bringing new or other technologies to bear which may eliminate the undesirable effects of the original objectional technologies.

Implicit in the consideration of ecology are the very slow rates of change with time that may occur in the evolution of the natural environment. In contrast with these slow rates of change are the rapid changes which take place as a result of technological transitions that may take only decades to be effective. As people who have studied system stability are aware, the presence of numerous dynamic phenomena taking place at vastly different time rates gives rise to the possibility of instability with its many and varied difficulties.

Not only can the tendency for technology to promote rapid changes have a destructive effect on elements of the environment, but in some

cases the undesirable effects of technology may take place so slowly or over such a long time that they are barely apparent for many years. In the case of some drugs or toxic materials, time horizons of decades or generations are required to reveal objectionable results which may be irreversible. Thus ecological concerns often point up the need for viewing the effects of technology over longer time periods than might otherwise be considered necessary.

NEEDS OF PEOPLE

The subject of the needs of people is itself a very broad and widely changing phenomenon over the range of peoples' age, wealth, and intellectual capabilities. It is not my intent to try to quantify basic needs or to limit their definition, but it is rather to identify some different aspects of people's needs and to point out the necessity for reaching some realization that the differing needs of different people must also be considered. For the present purposes let us look at basic needs associated with survival as well as other needs related to wealth, power, or more socially oriented factors. Each of these different needs may affect different people in different ways.

Basic needs

Using the fundamental statement of Honda, that the needs of people are the driving force of technology, provides an interesting basis for future work in Eco-Technology. Basic needs can be expressed in such terms as food, clothing, shelter (housing), energy, water, and the other elements shown in Table 2. Although the magnitude and character of such basic needs will change in detail from country to country, as well as with time, nevertheless people in all nations share a common need for certain basic requirements of the sort mentioned.

At one time most people were on the farm, and the family provided the primary social and economic unit which enabled people to meet these basic needs. As technology has developed and transportation and communication have become more generally available, the state or nation and business or industry assumed a greater role in providing the rules, regulations, and framework within which these basic needs of people were met. The nature of technology is such that the needs for raw materials for industrial use and the need for markets for the resultant manufactured products have helped develop a situation of greater interdependence among nations. Thus, certain of the basic human needs are now not only dependent on governments and industry somewhat beyond the control or accessibility of the individual involved; in some cases, the basic needs are directly influenced by persons or governments outside the nation of the individuals concerned.

Table 2

REPRESENTATIVE BASIC NEEDS OF PEOPLE

Food	Communication
Clothing	Education
Shelter (Housing)	Employment (or a Pension)
Energy	Health
Water	Human Safety, (and Defense)
Transportation	Supportive Social Environment, etc.

From the extensive list of basic needs of people, the increasing number of people in the world with time, and their increasing expectations as they become more aware of what is possible, it is clear that there is a continuing challenge to technology to seek more effective ways to meet these human needs. Further, since many of these needs, such as food, shelter, water, and energy, are dependent on the weather for their supply and demand, there is a fair amount of uncertainty in the technological processes involved. Not only is technology challenged to help supply these needs of people, but there is the additional challenge to meet the needs in a fashion which does not do irreparable damage to the environment.

Needs of suppliers and beneficiaries – Motivation

In considering the basic needs of people, it is important to keep in mind that there is more than one group of people involved in helping to meet these needs. Thus there are, in addition to the users of the industrial product or service, groups such as the suppliers of capital, the designers and builders, the operators, and the third party persons who happen to be affected by the activity just because of their presence.

The nature of interests of the several groups involved in supplying the basic needs can be described as follows:

(a) Those people who use and benefit from the

particular systems; i.e., the users of the goods and services.

(b) The persons who supply the financial support for the systems; i.e., the owners, financiers, or government funding agencies which supply the capital funding necessary for production of goods and/or services.

(c) The persons designing, constructing, and installing the capital equipment or infrastructure by means of which the system operates; i.e., the architects, engineers, construction and installation firms, and equipment suppliers.

(d) The persons carrying out operational activities for the system and performing the work to enable the goods and services to be provided effectively, efficiently, and reliably; i.e., the workers and managers who make the system operate and are paid to perform their tasks so that the owners and the users both feel that the benefits to them exceed the costs (the value is good!).

(e) Those people who are involved in the system indirectly to the extent that the system affects the quality of the air, water, sound, and/or other significant characteristics of their living conditions. People who are thrown out of work by changes in technology are also affected by the system.

In planning and implementing ways for meeting present day human needs, it is essential that due consideration be given to the needs of all the parties involved. In this way the suppliers of capital, the designers, and the operators will be motivated to meet the particular needs of people by using the technologies judged to be most suitable in an Eco-Technology sense.

Criteria for judging the basic needs

The definition of what constitutes a basic need may itself be debated at great length, and it is not my intent to belabor this sort of a discussion. However, it is of interest to look at the quality of life description that was presented in the EPRI Journal for April 1980, in which was indicated a broad range of topics that might be included as a basis for judging a nation. Social, economic, health and education, environmental, and national vitality and security categories were present as shown in Table 3 as being the five major considerations in judging a nation.

The categories are weighted as noted by the number after each of the categories. These weights are percentages which add up to 100%. There are a number of subcategories under each major category. Although different people might see fit to use other numerical values for the weighting for the individual categories, it is of more than passing interest to note the relative importance (weighting) that was used by EPRI. For other organizations in other cultures, other weightings might well be recommended.

Under the social category is the satisfaction of basic human needs. This refers to the basic standard of living, the extent to which there is an informed citizenry with modern conveniences, and the extent to which welfare and independence status is considered.

The economic category includes; individual economic well-being; flow and stock measures; economics, structure, productivity, and other related topics. Health and education cover both individual and public health conditions as well as the educational attainments for the people of the country involved.

Environmental factors include natural environment and the way it is used. Man-made environmental problems are also included in this category.

National vitality and security relates to the national carrying capacity and also to international security and independence. Thus military measures are only a part of the judgement of the quality of life.

The categories and weighting of this EPRI Journal article for judging quality of life have been designed for use in judging a nation. It is also felt that many of these criteria have some meaning and applicability in terms of what are perceived to be the basic needs of the people who make up the nation. However, as demonstrated in the thinking of Hardin in the "tragedy of the commons", often what seems to be best results for the individual may, in the long run, not be the best for the group or nation. In the final analysis each group, nation, and society must be careful to develop meaningful criteria for identifying their basic and essential needs.

WHAT SHOULD BE DONE TO APPLY TECHNOLOGY

Using the Honda statement that needs provide the motivating force for the technology, let us consider what technology should do now to help meet

Table 3

QUALITY OF LIFE MODEL
WEIGHTED CATEGORIES OF VARIABLES

Social (24.0)
- Satisfaction of Basic Human Needs:
  - Standard of Living
  - Informed Citizenry with Modern Conveniences
  - Welfare and Independent Status

Economic (20.0)
- Individual Economic Well Being: Flow and Stock Measures
- Economics, Structure and Productivity

Health and Education (22.0)
- Individual Health Status
- Community Health Conditions
- Educational Attainments

Environmental (15.0)
- Natural Environment and Utilization
- Man-made Environmental Problems

National Vitality and Security (19.0)
- National Carrying Capacity
- International Security and independence

TOTAL 100.0

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more effectively the needs of all the people involved. First, it seems desirable to address the critical issues of basic needs on a functional and regional basis. Next, difficulties should be anticipated in terms of natural and man-made causes. The problem should be approached in a systematic fashion, and international and interdisciplinary assistance should be sought.

Address critical issues on a functional and on a regional basis

A number of critical issues of people's basic needs have been studied elsewhere on a functional basis. Food, water, and energy, for exapmle, have been the subject of worldwide conferences sponsored by the United Nations and other organizations. Many worthwhile recommendations have been made, and they point the directions for future actions. Ways should be sought to implement the better of these recommendations which in many cases could be reasonably accomplished.

Continuing efforts are required on a worldwide basis to re-evaluate the findings of such conferences and recommendations and to up-date their plans of action in the light of subsequent events which may be contrary to the initial assumptions. Due consideration should be given to the environmental aspects of the technologies involved as well as to their fundamental technical concerns.

No matter how valid a set of findings may be at the time they were made, events often cause certain changes to occur that were not orginally anticipated. Assumptions made at one time may no longer be valid at a later date. Emphasis should be placed on consideration of the world's current needs and development so that individual nations and entities within these nations may have a suitable overall frame of reference within which to work. Further it is necessary that there be implementation of the plans as agreed upon. Both implementation and planning are needed.

In a related fashion to the functional approach, a parallel effort of regional and/or multinational studies should be made to be sure that there is a consistent awareness of what is taking place and what is contemplated in neightboring or adjacent nations in the several functional fields. Present day national boundaries may not suitably reflect the natural phenomenon of drainage basins or of employment characteristics which actually exist. Ongoing studies of multinational groupings should be carried out on each continent, and for even smaller regions.

An interesting possibility for consideration in judging the different critical issues is suggested by the matrix shown on Table 4 where the geographical regions are represented in a column fashion,

and the functional areas are shown as rows. By comparing the functional areas in different regions, it may be possible to find ways of utilizing similar facilities or methodologies in different regions. Agricultural efforts in a number of different parts of the world have been used advantageously in some cases.

By comparing geographic regions with similar functional characteristics, it may be possible to affect technology transfers more readily and more economically. The experiences of some multinational corporations which have been successful in technology transfer may point to improved ways of accomplishing this worthwhile result. It may be found that there are benefits to be realized through technology transfers that can be beneficial in an Eco-Technology sense as well. The principles of matrix organization which are being recommended here are becoming readily recognized as having a number of advantages that can be useful for the solution of the critical issues here being considered.

Table 4

GEOGRAPHICAL REGIONS
Interrelationship of Functional and Regional Basic Needs

FUNCTIONAL AREAS	EUROPE	ASIA	AFRICA	LATIN AMERICA	NORTH AMERICA	AUSTRALIA EAST INDIES ETC.
Food						
Clothing						
Shelter (Housing)						
Energy						
Water						
Transportation						
Communication						
Education						
Employment						
Health						
Human Safety (and Defense)						
Supportive Social Environment						

Anticipate difficulties from natural and man-made causes

These studies on a functional and regional basis should consider what would take place under normal and under emergency conditions. Natural catastrophes such as floods, earthquakes, droughts, epidemics, and high winds should be analyzed on a scenario basis, and emergency plans should be formulated which are broader than for just one country. Man-made difficulties such as border disputes, wars, price changes, etc. should be discussed as to the possible emergency actions which may be required. The role of supplementary assistance in terms of stabilization or auxiliary forces available for natural or man-made disasters should be established and delineated. Suggestions for a World Stabilization Organization for such purposes have been made by F. Holub and others, which merit serious consideration. Organizations similar to those of the coast guard in some countries have been proven to be very helpful.

Study of abnormal conditions of operation has proved to be highly essential in complex technical systems such as electric power systems, flight systems, as well as for industrial complexes involving advanced technology.

Approach problem in a systematic fashion

The nature of the problems associated with better meeting people's needs are ones that require consideration of short, medium, and long time regimes, where a short time might be a year or less, medium time might be 1–10 years, and long time is 10–20 years or longer. To accomplish worthwhile results of the sort being sought, a sustained and continuing effort is needed that will require planning, funding, and staffing for carrying out many activities in various time relationships to one another. Thus some sort of organizational structure is needed to ensure that funds are available, manpower is trained, and a monitoring of ongoing activities is performed to see that the various items planned are accomplished satisfactorily and that appropriate changes in plans can be made on a timely basis.

This systems monitoring effort to ensure that functional and regional activities are carried out effectively should be incorporated in some suitable organization for which the successful results of these activities are meaningful and beneficial. Perhaps existing organizations can perform these roles, or newly instituted organizations may need to be formed.

Get adequate international and interdisciplinary assistance

As noted above, the concerns of technology on a worldwide basis are well served if they are performed on an international and interdisciplinary basis. In many cases there may exist suitable organizations which could provide the source for the skilled talent needed to provide the necessary assistance. Strong international technical societies exist already which could identify people in different countries who are qualified and interested in such efforts. In other disciplines no doubt, such assistance can be found if the need were made known.

NEED FOR HUMAN SAFETY

In the case of many of the basic human needs listed above, such as food, water, and communications, much is known about the processes involved and the ways of meeting these needs. Unfortunately because of the present limited resources of land, water, energy, financial capital, skilled labor, etc., or other constraints, it has not yet been possible up until now to accomplish the desired results of adequately meeting these essential human needs in many parts of the world. However, extensions of known methods or additional work with existing methods give promise of doing a much better job of satisfying people's basic needs than is currently the case. In the past fifty years, marked improvements in literacy, education, housing, and life expectancy in many nations have been realized. Time does not permit me to dwell on the significant technological efforts taking place in the world to help meet the presently existing and readily foreseen needs in the decades ahead.

In the case of at least one of the basic needs, that of human safety or defense, it is not readily apparent that there exist commonly agreed upon principles among nations which can serve as the basis for the satisfactory international stability necessary to provide human safety. In the process of extending technology and developing ways of obtaining increased energy for national defense, there have been developed weapons of tremendous destruction capability with very rapid (approximately one half hour) delivery means to any part of the world. The world has many tens of thousands of these weapons that could cause great human suffering to many people not directly involved in any military activities, as well as to those who are part of the military establishment.

There seems to be general agreement that a great danger to human safety exists. There does not seem to be agreement as to the practical means for reducing this threat to human safety. It is my perception that there is much agreement that such weapons should not be used. But there does not seem to be agreement on the means of foregoing the use of such weapons.

What appears to be needed now is some sort of cooperative security system that will enable the chances for survival for many millions of human beings to be markedly increased. The nature of the problem is such that international and interdisciplines involved.

There are doubtless many ways in which the problem or need forhuman safety may be stated, and it is worthwhile for various statements of the needs to be formulated. As a basis for providing a starting point for discussion of this subject of human safety, and how these needs can be met, I and number of my associates in the systems science and automatic control field in the United States and in several other countries have described these needs as those for "improving international stability". International stability refers to conditions in which nations in an interdependent fashion interact with one another in ways which permit gradual changes with time in a mutually acceptable fashion.

Supplemental Ways for Improving International Stability (SWIIS)

Our efforts are directed at seeking "Supplemental Ways for Improving International Stability" (SWIIS). "Supplemental way" refers to the use of positive non-military ways for nations to operate in addition to the negative peaceful ways of the present military efforts to obtain national security. Currently, efforts are beginning to take place at universities, institutes, and non-governmental organizations to define proposed solutions to meet this need for human safety and to establish useful networks of people and organizations to work on these solutions in an international and interdisciplinary fashion.

Table 5 lists seven tasks that are being considered for major attention under the heading of Supplemental Ways for Improving International Stability (SWIIS). Since items 3, 4, 5, and 7 have been mentioned in the section above under the subject of what should be done now to apply technology to help meet people's basic needs, I will describe briefly what is intended to take place with regard to the remaining three times.

Study peace process from an international and interdisciplinary view

A few groups of qualified and interested people should be established on an international and interdisciplinary basis using the skills of recognized scholars and practictioners as well as those of other qualified people with fresh approaches. These groups should be charged to study various processes leading to peace and to prepare a plan for activities to take place in various countries within the next 5 to 10 years, directed at improving international stability and improving the chances for peace. The groups should include people who are, or can have access to, people in government, industry, and universities in at least the 5–10 major countries of the world so that the plans

TABLE 5

SUPPLEMENTAL WAYS TO IMPROVE INTERNATIONAL STABILITY

1. Study peace process from international interdisciplinary viewpoint.
2. Educate people at all age levels in the nature of peace.
3. Develop international functional ties: food, water, energy, education, etc.
4. Develop world stabilization organizations on a regional basis.
5. Establish more effective international conflict resolution means.
6. Provide systematic international effort directed at establishing a cooperative world system.
7. Organize international technical, professional societies to work to improve international stability.

developed will have the support of the establishments in these major countries. As other countries of the world desire to participate they should be encouraged to do so. The emphasis should be on starting to move toward improved stability or peace in an evolutionary fashion by means of activities that can be observed and are agreed upon in advance by the countries concerned as being worthwhile and attainable.

The plans from the different groups should be compared, and a mutually agreed upon course of action should be undertaken by all the major

powers. This plan should be reviewed, and modified if necessary, on a continuing basis to take into account the actual events that will occur which may differ from the initial plan. Adequate funding must be provided to attract and hold the necessary talent with regard to quality and quantity of professional input. If the initial groups can not reach agreement, they should be replaced by others who may be more skillful in finding acceptable agreements.

After the first planning groups have completed their task, a new set of groups (with some hold over from the earlier ones) should be established, and the planning process continued as the operating changes take place. The process and plans must be evolutionary ones that change to meet the changing conditions in the world as they develop.

Educate people at all age levels in the nature of peace

The chances for there to be improved international stability are considerably enhanced by the presence of peace. There has been an increasing emphasis worldwide on the subject of peace research and peace education over the past twenty years, and basic definitions of such terms as negative peace, unstable peace, stable peace, and positive peace have served to clarify many important issues involved with the peace process. This sort of educational material, prepared for people at their several age and comprehension levels, is now more readily available for enabling them to appreciate better the interdependent world in which we live as a result of technological advances. Through national and international peace research associations, and other appropriate institutions, stepped up efforts made possible through increased funding should be instituted. Popular advertising means must be used to foster the ideas of peace. Entertainers, popular sports figures, and other business and intellectual leaders must become a part of this educational process.

Establish means for Conflict Resolution, Negotiation, and Factual Verification in International Disputes

With more than 4 billion people and 155 nations in the world, it is inevitable that differences between nations will exist. Means and needs for conflict resolution, negotiation, and factural verification are recognized *within* nations. Comparable means are needed at the international level. The advanced nations of the world recognized the need for such means for reaching agreement in their financial, industrial, and technical dealings. International stability would be greatly enhanced by the organization of international, interdisciplinary teams to draw up for national agreement comparable means in other important areas where such agreements are needed. Some of the ideas for conflict resolution developed for the Law of the Sea may be useful here.

The SWIIS effort just described above represents a promising approach to the process of improving international stability. It is hoped that the proposed method will become more accepted and successful in the next 3–5 years. If not, other, more effective methods should be sought and be developed during the interim period.

Certainly, there exists a major need for improvement in the international aspects of the human safety environment. Technological and other aids, including institutional ones, for bringing about this improvement are needed and should be sought.

CONCLUSIONS

Many important achievements to meet the basic needs of people have been realized in recent times through the use of technology. A continued and expanded use of technology on an international and interdisciplinary basis will be required to make available to an increasing number of persons the desirable benefits of modern civilization that are presently enjoyed by a limited number of people.

Through an increasing concern for the environment and with the aid of ecology, engineers and scientists are, with others, changing the ways of technology. Past equipment and methods must be and are being altered to meet the needs of people with proper regard for their collective concern for healthy conditions for life. As the perceived needs of people are changed with time, technology must also be successfully adapted to meet these changing objectives.

The emerging field of Eco-Technology, the blending of ecology and technology, has served to focus our attention on the need for improved human safety in the face of possible disaster caused by technological advances in weaponery in the past 40 years. The use of technology should now be challenged to seek ways to achieve significant improvements in international stability to enhance human safety. Some of the same systematic processes, methodology, and people that have created the present destructive situation may be able to provide alternative means to achieve the peace and safety that most people seek.

Those of us concerned with developing new technology should consider ourselves to have a major undertaiking to try to meet the expanding needs of the increasing number of people in the world with its finite resources and environments constraints.