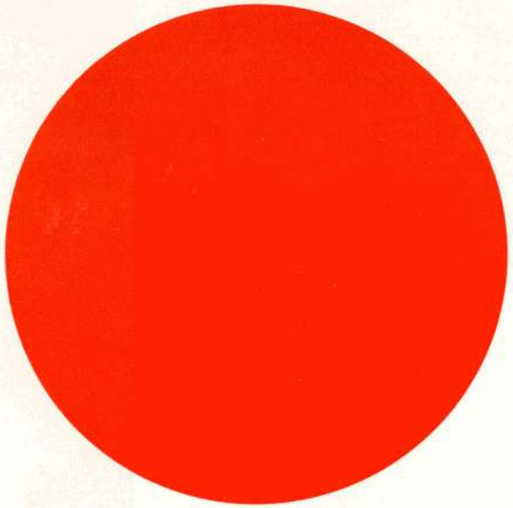
DISCOVERIES Proceedings of the DISCOVERIES Symposium International 1976



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HONDA-FUJISAWA MEMORIAL FOUNDATION

The "DISCOVERIES" Symposium International upholds the idea of being a forum in which scientists from all over the world discuss about various problems concerning human activities with candor, and on an equal footing, across the national boundaries.

In terms of traffic, a variety of nations exist, some have long histories behind them and others are looking forward to the future, and these nations vary in terms of their respective backgrounds and cultures. Scientists with different backgrounds will gather in one place, and try to understand each other. For this purpose perhaps the most important is for them to sit as a round table on an equal basis and when they discuss not only their success but also concrete theme, I think, avenues can be opened for mutual understanding and new discoveries.

I am very happy to be able to provide such a forum here on this occations.

Dr. Soichiro HONDA

DISCOVERIES Symposium International
Permanent Honorary Chairman

It is a pleasure to address this message to you in the name of the United Nations University.

We share with you a deep concern about the future of humanity and a serious interest in discovering and identifying major global problems.

We share with you the firm belief that humanity is able to solve its problems by mobilizing its intellectual potential, especially through an interdisciplinary effort of all the sciences, natural and social. We share with you the hope that an international exchange of ideas will help assure the survival of mankind in this age of increasing interdependence among nations.

Dr. James M. Hester

Rector
United Nations University

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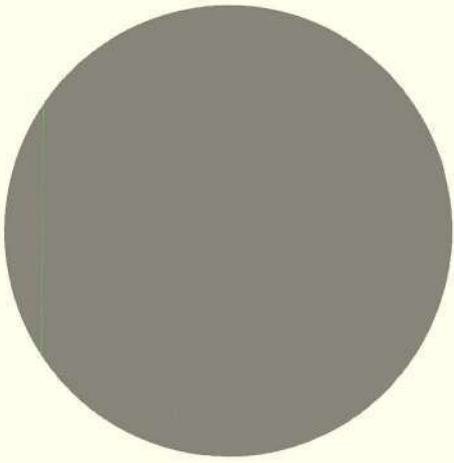

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Preface

This book is the record of the DISCOVERIES International Symposium held in Tokyo for three days from October 28 to 30, 1976. The symposium was designed to build foundation for interdisciplinary researches and a wide variety of discussion was made. The entire sessions of the symposium can be divided into five chapters from the points of research of modern civilization in terms of "spirit", quest for its future and creation of a new civilization based on human beings.

Subsequently, we edited this book in such a way that we could discuss three major subjects. They are:

(1) We discuss the developments of modern civilization, which has taken place chiefly in Europe, with an emphasis on spiritual and philosophical backgrounds. Our discussion will be made from the standpoint of the essence of human thoughts.

(2) We also discuss what impacts the developments of modern civilization gave on various levels of human lives. Or, what were the impacts human lives gave on mechanical civilization? This is to examine the cross-impacts between the society and technology. Technology assessment and social assessment are specific tools to do so. The results of

this will be used to build foundation for a new civilization.

(3) We clarify the interrelations between technological innovation of today and various rules and structures which human societies have. We thus create the basis, specific basis, for interdisciplinary researches. In other words, we discuss how to carry out practical interdisciplinary researches.

With those objectives in mind, the symposium aimed to discuss the importance of raising questions appropriately and play the role of lube oil to help quickly find potentially solvable problems and smoothly carry out activities on the part of human beings. At any rate, this book is the first step for the creation of a new science DISCOVERIES.

Just for reference, the content of the symposium is shown in the form of charts. We look forward to holding free and open symposiums of this sort on a global scale and we would like to have cooperation from every single person concerned.

We must ask the indulgence of the reader and everyone concerned for the fact that the contents of this book may not fully reflect the intent of each speaker, whose remarks had to be summarized, edited, and otherwise processed rather arbitrarily on the exclusive responsibility of the Editorial Committee due to time limitations and other compelling circumstances.

Shuhei Aida
for the Editors

Contents

Chapter 1

THE START OF THE "DISCOVERIES"

Beyond the Culture Shock

The DISCOVERIES International Symposium, planned and executed under the sponsorship of Dr. Soichiro Honda, was the beginning of a new science, "DISCOVERIES." The word, the plural form of an English word discover, also stands for a rather lengthy phrase, "Definition and Identification Studies on Conveyance of Values, Effects and Risks in Environmental Synthesis."

Needless to say, modern civilization was formed on the same foundation which gave birth to "philosophy," the source of human wisdom. Among others, "imagination," a human power for free conception, supplied the basis on which many types of civilization were eventually formed. As sciences progressed in Europe, for instance, many false beliefs, which were then considered "scientific," were destroyed one after another. This is called the "science shock" of Europe in the Middle Ages. Europe thus entered the Dark Age which brought about the "witch hunt."

In tremendous agony at the gap between their thoughts and the reality, human beings went through various stages and obtained the civilization they have today.

Once again, however, civilization is at stake today. In other words, human beings are experiencing another "civilization shock" amidst the on-going mechanical civilization.

Mechanical civilization was formed on two major undercurrents: "Roman engineering" and "Arabian engineering." Therefore, it is extremely important for us to know the difference between the two undercurrents as well as the patterns of their progress. Arabian engineering was, initially, the art of material refinery such as metallurgy. It developed into alchemy and then atomistic chemical theory. Thus, Arabian

engineering was always the pursuit of material. On the other hand, Roman engineering began as civil engineering based on the material science. It developed into the art of measuring time and space and the integration of technologies which is, in contemporary terms, "systematization."

The concept of "time' was something abstract in the agricultural civilization that preceded mechanical civilization. Time meant periodical cycle. People then did not measure time precisely; they felt, in such a cycle, the flow of time. As physical science made it possible to precisely measure time, the subsequent mechanical civilization began to give a variety of far-reaching effects on society.

That is, Europe in the Middle Ages experienced the shock that many commonly-held thoughts were contradicted by the scientific point of view. Europe went through a list of such science shocks before it saw the age of Newton. For instance, Galileo Galilei advocated the heliocentric theory. Also, the traditional understanding of power and speed in connection with the movement of objects — that power and acceleration was in proportion — was ruled out.

In physical science-generated modern civilization, where Newtonian determinism and probabilist thought and method coexist, its complexity has been intensified because of the amazing progress in computer technology. Take "time," for instance. It is now possible to measure physical phenomena that take place in a broad range of time ranging from an extremely long time span of hundreds of thousands of light years to such a short split of second as one-billionth. In the field of the molecule, we now have molecular biology which even treats material and life at the same level.

Every bit of information obtained through research and developments in many fields is fed into computers as "data" and, by the surprisingly high performance of computers, such information is processed and used to probe all kinds of physical phenomena.

The Reinstatement of Spiritual Culture

As physical science brought about many discoveries and mechanical civilization progressed, society found itself torn apart by an increasingly larger gap between spiritual culture and mechanical civilization. In this dilemma, people were caught in ever increasing emptiness. They just began to real-

ize the importance of questioning substantive humanity.

All this happened because mechanical civilization has made such a swift and sweeping progress. Countries aspiring for development introduced so-called "civilization" regardless of their natural and racial features. One example was the uniform "Americanization," so to speak, which posed various problems for the world's advanced industrial countries.

Perhaps, it was the Japanese who opened up and imported technologies in the most "generous" manner as they have done ever since the Meiji Restoration. For them, what it meant was modernization. Japanese intellectuals used to defend Japan saying she was progressive and full of vitality but, toward their own people, they were pondering on the uniform introduction of mechanical civilization.

The Meiji era

The Meiji era of Japan started with major political and social changes called the Meiji Restoration in 1868 and ended in 1912. During the period, the foundation of what later became highly advanced capitalistic industrial state was built. The 1868 changes transformed the traditional feudalistic political system into a centralized governmental system. Japan, under a new regime wiped out the vestiges of feudalism one after another and, simultaneously, carried out political and economic reforms. Japan eyed foreign systems and technologies to modernize herself and successfully transplanted them. In economic field, the state power vigorously intervened in industrialization and, as a result, the country in a few decades achieved the accumulation of industrial capital. By that time, however, advanced capitalist countries had entered the stage of imperialism. Japan's pursuit of imperialism thus resulted in the Japan-China war (1894−5) and the Japan-Russia war (1904−5). Japan further intensified her imperialistic and militaristic tendency which eventually led to her defeat in the World War II (1939−45).

During an Earth Science Association meeting in Dresden, in 1886, Ogai Mori* engaged in a hot debate with E. Naumann**. Mori felt a sort of contempt in Naumann's speech on Japan and attempted to counter in the form of a table speech over tea.

Among others, Mori focused on what Naumann said the pros and cons of Japan's motive for modernization and its future. Naumann's speech conveyed the then widely held

* **Ogai Mori.** *1862−1922 A doctor and writer, Mori was one of the outstanding intellectuals of Japan.*

** **E. Naumann.** *1850−1929 Naumann, during his stay in Japan from 1875 to 1885, helped modernize the country. He is also known as the founder of the archaelogical "Naumann Elephant."*

observation in Europe that Japan volunteered to open up to the Western civilization, it vigorously imported. In his criticism of Naumann, Mori argued that given foreign pressures, Japan had to do so. The indiscriminate import of the Western civilization, Mori said, casted a shadow over Japan's future. In front of a Western audience, he criticized Japan for simply copying not only science and technology but also political and social institutions which had nothing to do with her own unique natural and racial characteristics.

In short, although he defended Japan's Westernization to Naumann, Mori also told the Japanese about its "emptiness." He was entirely different from so many Japanese campaigners for "enlightenment" who, from that time to date, boarsted about Japan's "beautiful national characteristics" toward the West and the goodness of "Bunmei Kaika" (civilization) toward Japan. A self-avowed "foreign-educated conservative," Mori's attitude showed the concern of a man of letters about Japan which captured him for the rest of life. You might find this interesting especially if you look at the way Japan has since modernized herself. We will have to keep what Mori stated in mind as the basic point of thought for the DISCOVERIES we are trying to internationalize. If you think twice, you will see this basic thought is required to reinstate spiritual culture for human beings.

A New Viewpoint for Human Activities

After they achieved swift modernization, advanced industrial countries found themselves stuck with the immense accumulation of scientific achievements and, in return, the emergence of public mistrust of technology.

In such circumstances, environmental issues have been spotlighted and, subsequently, technologgy assessment has been introduced. You should realize, however, that the U.S. and other countries differ in cultural backgrounds and technology assessment cannot be applied in a uniform fashion. Important thing is that each country develops her own to meet unique environmental and cultural characteristics.

With the above concern, the DISCOVERIES Symposium was held. We are not going to confront problems which exist today and try to solve them. We are going to find out, from a whole new viewpoint of human activities, which problems we have to solve. Our purpose is to search, in such a chaotic

period as today, the philosophy for the prosperity of human beings. This might eventually lead to the "from-art-to-technology" transfer that Mr. Honda has been advocating.

We intend to assess, from both hardware and software points of view, the modern mechanism, put human spirit in it, and revitalize it into a well-balanced one. For that purpose, we will prepare a set of scenarios and strategies. Although people today feel some alianation from science and technology, they need a scientific probe to understand the interaction between people and cultural backgrounds, as well the interactions between people and environment.

For instance, genetics has clarified that even human thinking is determined by hereditary elements. That is, the genes determine not only the shape of brain but also phenomena which take place in there: thought. Well, we should not be scared off by scientific discoveries. We should overcome such "science shocks" to search for the basis of a new civilization. We will have to separate "honne" (real intention) from "tatemae" (principle) and convey good human wisdom to the future generations.

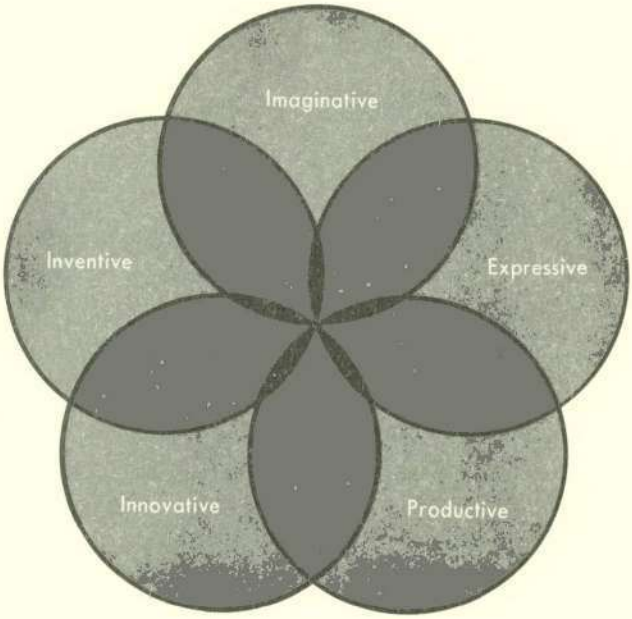
What this means is, in a way, the re-evaluation of the interaction between mechanical civilization and individual culture from an overall point of view. Or, specifically, we will examine the resistance against the uniform Americanization that has been taking place in advanced industrial countries.

To begin with, I have classified human activities into five categories as shown in the diagram. Mine is an attempt to grasp a wide spectrum of affairs from human thought to modern mechanism. Firstly, we will try to screen, with the classification filter, the end aspects of modern civilization and see what sort of picture comes up. In other words, the first objective is to reconstruct modern civilization with the "interdisciplinary" thought and find clues to create a new civilization.

MENTAL AND BEHAVIORAL ACTIVITIES OF HUMAN BEINGS IN FIVE AREAS

Our mental and behavioral activities may be divided into five areas: imaginative, innovative, inventive, productive and

expressive. These five areas are related with each other as shown in the figure.



Imaginative area:

This is the area where a so-called philosophical thinking of human beings develops. It is a subject of anthoropology which is true to the essence of human beings. Culture is a product made in this sphere. In other words, it is the area where our idea is fertilized and incubated. Most of the artistic concepts and products in human behaviors are instigated in this area.

Innovative area:

This is the area that is a basis of progressive creation in spirit and matter as seen at the time of Renaissance in the Middle Ages and in the technical renovation of today. It paves way for invention and discovery which lead to a new civilization. And it is able to express more concretely the concept of art that was incubated in immaginative area.

Inventive area:

In this area, governing laws of nature are discovered and an invention is made as consequence. Most of the techniques and their outcomes are created with rules following the natural law which human beings have found.

Invention and discovery made in this area can lead one civilization to its further development and can promote the intellectual productive activities. With such inventive power, a civilization starts rolling and continues to make progress.

Productive area:

This area means productive activities. In this area, technology, cultural products, economic activities under a social system are included. Many technologies have been developed on the basis of discoveries and inventions and, as a consequence, an industrial productivity has been progressed.

Expressive area:

What is focused on in this area is to develop a methodology or skill to express or universalize various phenomena in the natural world and society. Expression should be made through certain media such as literature, music, painting and so on.

From the above standpoint, we can perhaps sum up ten themes proposed at the Symposium into five:

(1) Background for Western European Science

Modern civilization has always been the pursuit of science, West European-style science. For the purpose of correcting chaotic modern civilization, therefore, it is necessary to know the basis of Western science and see what problems are built in. Thus, we will learn how those problems have arisen. In his reference to the Italian Renaissance, Prof. Eduardo Caianiello, director of the Laboratory of Cybernetics of the Italian National Research Council, spoke on **"Evolution and Revolution":**

"The most dramatic example of cultural change is perhaps the transition, effected in less than two centuries, from the world of the Middle Ages, impregnated with Aristotelianism and religious prejudice, to that of modern science, open to free enquiry and centered on the Galilean method. It strongly supports the cybernetical view that both evolution and revolution are essential paradigms in the development of a complex system as human society certainly is.

"Leonardo da Vinci and Galileo Galilei's lives and struggles clearly illustrate the extremes to which the innovation necessary for the change to a new pattern of life may force mankind.

"A new revolution of comparable magnitude faces us today: the study of the past, made with the outlook of new science, may enable us to come out of it as masters rather than slaves."

And then, Prof. Torgny Segerstedt, rector of Uppsala University, Sweden, took up an interdisciplinary subject "prediction" as the basic scientific approach. The sociologist showed a fine approach to the five domains of human activities which I have discussed.

"A Model of Interdisciplinary Research in Order to Make Prediction: *All prediction must be about the future situation of man in society. For that reason I believe we must start with a concept of society and its main characteristics. According to my theory we can discern in all societies three basic qualities or functions: (1) the reproductive function, (2) the socialization function and the (3) productive function. These functions must be realized in all social groups (society is a group in sociological meaning) if the group is going to survive. This is a general sociological statement and it is valid for a nation as well as for an association of stamp collectors.*

"In a society there may be different groups fulfilling different functions, as for example the family group around the reproductive function, schools and universities fulfilling the socialization function, and working groups in factories or offices carrying out the productive function. In some societies the functions are carried out in the same group that is the case in an agricultural society, which may be called a one-group society. In an industrial society there are three separate groups and the society can be called a three-group society.

"There is always an interaction between the basic function and the surrounding groups, that is, for example, between family and school, school and working group and working group and family. My main thesis is that every breakthrough in science must be of consequence for the functions of society. An interdisciplinary approach is to ask the question: what does, for example, a new discovery in bio-chemistry mean for family life. If we can predict such a consequence the next question will be: if we know that a discovery will influence the reproductive function what does it mean with regard to schools and work-groups? Or what does a technical innovation mean with regard to working groups, the educational group and finally for the family?

"The next step is to ask prominent scholars, as already has been practiced by the Delphi method, what new discoveries they expect in their fields of research during the three or four next decades, and to try to determine, what does that imply with regard to the basic function. In such a way we may discover alternative

futures and we will have a chance of making priorities with regard to our values.

"I call such an approach scientific strategy (or strategic scientific play). I am sure that will cover the five areas of mental and behavioral human activities."

(2) Search for Scientific Thought

Whenever we try to express scientific thought in a common language and use it as a real methodology or method, we will have to employ systems science.

Space development triggered the development of systems science. As a science to put free human conception in order, however, systems sciennce has been heavily leaning toward hardware, that is, the construction of engineering elements. On this, Prof. Harold Linstone, of Portland State University, has introduced a very clear approach which provides the reason behind it and a clue for solution.

"Breaking the Chains of Traditional Systems Science: *Systems science is historically the brainchild of science and technology. As such it has inherited the paradigms, the inquiring systems, the reductionist and analytic approaches so successful in the development of modern science. It is not surprising that our traditional education systems have a brainwashing effect as they compartmentalize knowledge. Even recent methodologies such as system dynamics, structural modeling, and technological forecasting reflect this strong bias.*

"I consider it the foremost task of systems practitioners to consciously work toward a better balance — between analysis and synthesis, between reductionism and holism. At least three of the five mental and hebavioral activities have a strong holistic flavor: imagination, innovation, and expression. The mention of anthropology, art, and culture in their description provides an important clue to this idea.

Holism: *the philosophic theory first formulated by Jan C. Smith that the determining factors in nature are wholes (as organisms) which are irreducible to the sum of their parts and that the evolution of the universe is the record of the activity and making of these wholes.*

"The talk will examine the needed balance in two specific contexts: health and mobility. Both have been the beneficiaries of powerful and sustained advances in technology. Medicine has conquered diseases and reduced the death rate, but we have paid scant attention to providing a reasonable quality of life and functional roles for the growing population of aged who represent the outcome of these medical triumphs. We have not provided a socio-cultural system to match the physical system.

"Technology has shrunk the earth by incredible advances in the movement of people and goods (transportation) as well as ideas (communication). This is leading to rapid homogenization of human cultures, to rootlessness of individuals,. to acceleration of discounting of both past and present, to a dramatic change in stimuli, and to creation of reality by media. We are barely beginning to recognize the impact of this technology on the human psyche.

"Focusing on specific situations, we recognize a striking and urgent challenge to systems science: true interdisciplinary — actually transdisciplinary — for innovation and invention."

Prof. Toshiro Terano, of Tokyo Institute of Technology, advocated "fuzzy" system, a methodology of holism. He discussed application of scientific thoughts in real world and much can be expected as he developes his theory in future.

"Individuals and Society: *The mental and behavioral activities of human beings are founded on the preservative instinct of individuals and society. Their wish to improve circumstances is the potential of imagination, innovation and invention. Unfortunately, the survival policies of individuals are sometimes contrary to those of society. The development of communication and transportation never filled the gap in the society but aggravated it. If this trend continues furthermore, society must be disrupted.*

"One way to prevent it is the introduction of technological methodology to social problems. We may find a compromise between the subjectives and the objectives by this way. However, we must point out that there are some defects in technological methodology. It avoids any vagueness in the objects. Human beings are so complex, fuzzy, flexible, subjective, multi-attributive and contradictive that it is more natural to consider such vagueness is an attribute of human beings.

"This author will talk about two kinds of methods which can be applied to such problems. One is a graphic model to probe the macroscopic structures of complex society, and the other is a "fuzzy" model which can deal with the mental activities of individuals."

(3) Two Phases in Civilization

When we think of the fabric of modern civilization, one way to do so is to examine hardware which has been rapidly

developing. In urbanization, for instance, we can see many examples of engineering system. The following is an account of new urban transportation system, focusing on the world's famous BART system in San Francisco. We will have to listen very carefully to Mr. Wilfred Owen, senior fellow at the Brookings Institute, who says BART system was a failure. As Prof. Linstone pointed out, systems science was not always a powerful probing instrument. Mr. Owen's thoughtful account of technology for technology's sake:

"San Francisco's BART System: *San Francisco has completed its 118 km Bay Area Rapid Transit System (BART) which connects the city with outlying communities to the north and south, and eastward across the Bay to Oakland, Berkeley, and other inland points. It is the first modern public transport system built in an American city.*

"The project was conceived in the 1950's as an essential means of overcoming the congestion and pollution of automobile traffic and of assuring the vitality of San Francisco. The city, it was believed, could maintain and strengthen its position as the focal point of the region if good access could be achieved by a modern public transit system of sufficient quality to compete with the automobile. As the project progressed it was promoted as a way to save energy, reduce highway requirements, create new growth centers, overcome suburban sprawl, and enhance the environment.

"BART has not lived up to expectations. It has had effects that were not anticipated. Travel on the new trains is half the volume expected; most riders were not lured from their cars but are former bus riders; bus systems that once gave good service are now financially embarrassed; the system has not added appreciably to the centralizing of functions in San Francisco, but has encouraged decentralization; costs are so high that fares cover less than half the operating costs; the environment has not been improved nor has energy been saved; the volume of automobile traffic on the Bay Bridge has not been reduced; and a recent study shows that people who are careless have not been aided by this long-distance commuter-type rail line. The rich ride, and the poor pay (through increased property taxes and sales taxes.)

"But there are many unknowns about BART: its unmeasured effects on people and the region; the various public policies that might have been adopted to help make BART succeed; and the need for understanding how BART is part of the

total transportation system, and how the transportation is part of the total urban system."

Modern civilization is also supported by the "soft" system which controls human activities. It ranges from the traffic control law which has much to do with urban dwellers to old laws which have already lost force. This is the newest — as described by the word "legal cybernetics" — and yet oldest mechanism to control human activities. From this viewpoint, Mr. Morio Miyahara, lawyer, discusses law.

"Flexible Structure of Law: *Defendant 'A,' driving a car, tried to turn right at the central part of an intersection. At that point, a motorcyclist 'B,' who was just behind 'A,' tried to pass 'A' from right. 'A' hit 'B,' who was injured. 'A' was prosecuted and put on trial on a charge of misdemeanor in driving. The rules of traffic are stipulated in the Road Traffic Act. Of course, 'A' was not driving a car with those rules in mind. Should his driving happen to be in accordance with the rules, 'A' was only reacting to changing traffic situations. 'A' was not consciously obeying the rules.*

"Firstly, law provides rationalization for whatever punishment a judge might give 'A' for misdemeanor. Law is a set of rules that judges and other public authorities employ for whatever happened.

"Secondly, since law is an 'expression,' it is doomed to have a 'fringe of vagueness' or it is doomed to be an 'open texture.' 'Expression' has both 'core of certainty' and 'penumbra of doubt.' As for the above case, the first and second trials found 'A' guilty. Contrary to lower rulings, however, the Supreme Court acquitted 'A' of a misdemeanor charge. This is the example of a creative judgement made by court.

Law's open structure entrusts courts with such an important power as 'judicial lawmaking.' Law is not just a straight jacket. Law has the kind of 'flexible' structure that anti-quake buildings have. Thus, law can contribute to the progress and reform of the society."

(4) Civilization Assessment

Human activities intensify their complexity. If We try to see the relations between human activities and society, we need to take into account the spiritual, economic, ecological

and environmental factors. In his attempt to apply technology assessment (an art developed in the U.S. to generally assess such aspects) to civilization, Prof. Saburo Ichii, of Seikei University, discusses environment with the concept of "absurd pain."

"The Environmental Problems and the Value Principle: *Modern civilization has brought about pollution on a scale and condition never before expected. A set of transportation and safety-related problems is part of larger pollution problem. Depending on the way transportation systems are developed, many difficult environmental conflicts will arise involving local inhabitants. As a philosopher, I think it necessary to work out a new principle of value as well as rules of application to deal with such conflicts.*

"As the civil society has developed, citizens have come up with various senses of right which have been deversified and conflicted each other. Progress in transportation only helped such conflicts emerge on the suurface and become more complex. In order to deal with this, it is necessary to work out the above principle of value and the rule of application — the 'theory of social equality.'

"For a decade, I have been calling for less 'absurd pain,' that is pain inflicted on individuals for no reason. In this symposium, I would like to elaborate on the application of this principle and give some specific examples in transportation."

Prof. Murray Turoff, of the New Jersey Institute of Technology, who once was on the staff of White House, discusses the future impact of computers and communications, featuring computer communications network, a new tool for the age of communication.

"Assessing the Future Impact of Computers and Communications: *The technology of these areas promises to continue its rapid rate of advancement with respect to significant increases of performance to price ratios. While there is little doubtt as to the magnitude of impact, these advances will have on society and such specific areas as energy and transportation, there is a great deal of uncertainty as to the manifestation of the impact and the exact nature of the resulting society.*

"This presentation will examine some of the potential futures that may result and the methodological difficulties in assessing which are the more likely directions that will be taken.

"An examination will be made of basic changes that may occur in such areas as:

Decentralization of Business Activities
The Paperless Office
Work at Home Concepts
Recreational Activities
Political Processes
Transportation Patterns
Employment Practices.

"The question will be addressed as to the impact the decision and planning process can have on the nature of the above areas and their ultimate impact on the individual and society."

(5) Internationalization and Civilization

As modern civilization has developed, the world has shrunk in terms of time which resulted in rapid internationalization. The progress of transportation and communications methods was largely responsible. Accordingly, on the front of culture, however superficial international exchanges have taken place. Given such a background, the presentation of a certain culture will have to be made in such a way that people with different environmental, social and cultural backgrounds understand it. Now, it is necessary to develop presentation techniques that helps appeal to different people.

It was for this purpose that the Georges Pompidou National Center for Art and Culture was built in Paris. Mr. Sébastian Loste, who, as the senior administrative officer, efforted from the planning to execution of the center, was going to explain the scheme. Unfortunately, however, he could not come to Japan and, instead, Mr. T. De Beaucé, the cultural counsellor of the French Embassy in Tokyo, made the report on behalf of him.

"Reflections upon the Reasons for the Creation of the Centre Georges Pompidou: *In the first place, a project of this kind should reflect the current interests of a wide section of the public, taking account of generally felt needs. Without a broad outlook, such a Centre may soon degenerate into a club for insiders.*

"Secondly, future needs must be kept in mind. Not passing fashions, but the deeper trends of the time should be brought to the forefront. Public tastes and desires need to be anticipated, and

an understanding of the present is impossible without at least some vision of the future, even a certain penetration into things to come.

"Finally, cultural matters stand in quite a different relationship to the past than does, for instance, progress in the sciences. The latter need feel little obligation to past effort; nor is a knowledge of the history of a science needed to guide or inspire present efforts. It is true that the cultural heritage of the past is constantly re-examined and re-interpreted by succeeding ages, but it is never simply reproduced. Even artists who seem the most innovative have need, appearances to the contrary notwithstanding, to find in the past points of reference which shape and control their present inspiration. Even the most modern cultural undertaking cannot be divorced from the past.

"The guiding principle of such an undertaking must, therefore, be an imaginative combination of the durable aspects of the present day, an anticipation of those of the future, and an acceptance of the legacy of the past in order to recreate the latter in terms more accessible to the present day.

"The project, conceived and inspired by President Georges Pompidou, and put in train in November 1969, embodies the principle mentioned above.

"All creations, whether living things or human endeavours, follow an inner logic of their own from conception to completion, shaped by an underlying necessity through the different stages of construction. Thus, there can be no truly fruitful outcome to either imaginative or inventive research unless a profound logical necessity guides the twists of imagination and the accidents of discovery.

"Each age interprets somewhat differently the nature of this logical structure which is, of necessity, complex. It is by no means certain that future generations will take a different view of the proportion of invention and logic needed by such an undertaking.

"But the fundamental notions are not likely to change: the joining together of State initiative with individual effort, the range of different disciplines, the making available to a wider public the value and benefits of the international heritage, illuminated by present notions and directed towards the expectations of the future."

Internationalization also poses many problems for international politics. Even cultural exchange cannot be carried

out without political considerations. Interdisciplinary study is required to smoothly carry out international politics. On this, Prof. Masataka Kosaka, of Kyoto University, makes a relevant point.

"Interdisciplinary Approach in the Field of International Political Science: *It is obvious that interdisciplinary studies are necessary in the field of international political science. I would like to list up four examples.*

"1. First of all, remarkably diversified are the level and form of interaction among countries. It manifests itself in an inseparable interlocking of economic and political (in a narrow sense of word) relationships. These interrelations cannot be understood in the context of traditional political relations. Nor is rational economic thought sufficient to do so.

"2. The world today is culturally diversified. Whenever there is some sort of international relations, the problem of cultural contact always arises. However, our notion of politico-economic "common sense" is the product of our type of civilization, rather than a universally held concept. So, an anthropological approach is required.

"3. Just like the first half of the century, the last half of the 20th Century will be affected by technological innovation. Unless we understand it, we won't be able to take a longer — more than medium range — view of international relations. Needless to say, since political intensions also intervene (as in resource issues), simple extrapolatory forecast won't bear much fruit.

"4. In order to understand international relations, which are so diversified and have multiplied 'actors,' massive data have to be processed. Of course, mere mathematical processing of massive data is hardly sufficient to understand political phenomena. We need to know its necessity and limits and work out appropriate methods to do so."

Having heard the above arguments made, we are now expected to find the way to materialize them to establish the DISCOVERIES as a science. When we conducted the general discussions, what we had in mind was to make a four-part scenario which was:

- What has modern civilization done?
- What does it lack?
- What to do in order to revitalize it?
- What can the DISCOVERIES do?

However, the Symposium failed to produce any specific proposal and we agreed to hold the "thought Olympics" again. Of course, it is not easy to make an appeal to the world opinion. A mere desk theory will not be regarded as any serious appeal. We reconfirmed that we can only do so through practice. For instance, one of our specific tasks will be to convey of the real engineering spirit to the people of the developing countries who are highly motivated for national construction. It is those people who can fully utilize what we have discussed: the enjoyment of and self-reflection on modern civilization. To help them feel the real engineering spirit is what Mr. Soichiro Honda called the "transfer of idea from art to technology."

I am convinced that the DISCOVERIES should be able to show that such a spirit will remain for long as the "gene" of human beings. **(Shuhei Aida)**

The computer, taken as a symbiotic part of the new society, may destroy the very foundation of its present hierarchical structure!

E. Caianiello

It is necessary to work out and develop a theoretical system by which we can formulate hypotheses about future consequences of scientific discoveries with regard to our physical and social reality. If we do not have such a general frame of reference, research may just be one instrument for creating social and environmental catastrophies.

T. Segerstedt

In 1543 A.D., Andreas Vesalius, professor of anatomy at the University of Padua in northern Italy, published his illustrious treaties "De humani corporis fabrica libri septum." In the same year, Nicolaus Copernicus expounded the heliocentric doctrine in his writing "De revolutionibus orbium coelestium."

Some 400 years later, in 1953, James D. Watson and Francis Crick discovered the double helix structure of deoxyribo-nucleic acid (DNA), after which event molecular biology began to develop at an accelerated pace. Meanwhile, it was also during the 1950's that the electronic computer came into practical use, the nuclear reactor was developed, and rockets were about to make their flights into space.

Currently, modecular biology is in the process of

unravelling the mechanism by which a DNA ribbon – endowed with a set of genetic messages – duplicates itself, and how such messages are read into proteins via the messenger ribonucleic acid (RNA). This science has advanced to such an extent that theoretically, all genetic codes are now considered decipherable. More recently, it is reported, that even the experimental synthesis of genes has been performed with success.

Under such a circumstance, the philosophical issues facing science now are just as serious as those that existed 400 years ago.

In those days, Vesalius negated the theory originally preached by the ancient Greek physician Galen and firmly accepted in medieval anatomy as well as physiology, which maintained that blood flowed from the right ventricle to the left ventricle of the heart through the central septum.

Until then, physicians adhered to reading ancient medical literature and performed no anatomical investigations on their own. Their break with that tradition, however, by bringing themselves to working with the scapel and describing the true picture of what they saw through their own eyes, owes much to the influence of the Renaissance artists such as Leonardo da Vinci toward the end of the 15th century, who conveyed their interdisciplinary attitudes also to the medical field.

In 1553, moreover, a co-worker of Vesalius called Michael Servetus advanced Vesalius' theory one step further to explain pulmonary circulation between the heart and the lungs, while he preached Unitarian theology in his treaties "Christianismi Restitutio". For this short, six-page thesis, Servetus was swiftly captured by the Calvinists and burned at stake.

However, the impact of what Servetus gave to the world was transmitted via Matteo Realdo Colombo (1559) to William Harvey's towering work "Exercitatio anatomica de motu cordis et sanguinis in animalibus." (1628)

The ideological consequence of what Vesalius had uncovered was nothing other than a first step in the direction of the mechanist philosophy. Moreover, discovery of circulatory motion which, until then, was thought to exist only for heavenly bodies, also in the movement of blood within the human body, implied that the same dynamic principle

ruling over the macrocosm applied likewise to the microcosmic human body. In addition, the Copernican theory on the rotation of heavenly bodies had broken down the notion existing since the Greek days, that the heavens (heavenly bodies) were holy and this world (the earth) was imperfect. Consequently, the idea saying that the earth, just like the other planets, was revolving round the sun in a circular orbit (a perfect circulation), was beginning to enjoy wider appreciation. Indeed this signified nothing less than the birth of a new unified mechanistic philosophy that the whole universe inclusive of the earth was penetrated by one and the same dynamic principle.

In his treaties "Exercitatio de generatione animalium," (1651) Harvey stated that although individual organisms were mortal, their species were assured eternal existence by a cyclic movement (reproduction) akin to that of a heavenly body. From the standpoint of modern molecular biology which regards a living organism as being a molecular mechanism of sorts, such a tendency for preservation of species is considered subject to a complete control by the physical and chemical laws. As the result, a central dogma is established which holds that genetic information is congenitally determined and encoded in the DNA ribbon, and passed down from parents to children unilaterally as a constant entity inalterable by an individual living organism on its own accord.

This central dogma compares the living organism to a tape recorder which, although it can play back as well as duplicate a given tape, is unable to record a new music. In other words, the living organism is in effect a tape player for timeworn popular hits which does no more than repeatedly play back (cyclic motion) "old" DNA tapes that were created through 3 billion years of evolutionary process.

Aside from the genetic phenomena, innumerable means of reproducing information have been developed through history, from the art of printing to modern photocopying systems. Nothing, however, can match the high speed and perfection with which electronic computers reproduce their programs. In particular, the digital mode of expressing electronic information has brought an immeasurable impact upon the present-day world, so much so that if a rapid popularization of digital watches completely drove out the

conventional timepieces — whose mechanism is homologous to the circular motion of heavenly bodies, man may very well experience a revolutionary change in his notion of time. In other words, chronological information entirely alien to spatial (circular) movement would be no different from an indication on a mere counter much like a taxi meter. Thus it would be only a matter of increasing the read-out digits in order to improve accuracy. It would follow that not only the accuracy of the computed value can be upgraded, but also the precision of control on time-dependent phenomena can be increased.

The fact that the dynamics of projectiles evolved out of the development of firearms in the 15th and 16th centuries, compares interestingly with the use of early electronic computers for making ballistic calculations. Moreover, just as the chronometer and the logarithmic table are indispensable for maritime navigation, the computer is essential for performing orbital calculations of a rocket flight. No less worthy of attention is the role of electronic engineering, a technology associated with one of the elementary constituents of matter called the electron, which lies at the bottom of the new mechanist philosophy of the present age.

Vesalius' anatomy belonged to a cosmos viewed through the naked eyes, but today's molecular biology literally exists at the molecular, or extremely microscopic level. Similarly, while reproduction of information realized through Gutenberg's art of printing belonged to the macroscopic world, what is accomplished by today's computer is electronic in scale. Thus it is evident that the temporal difference of 400 years translates to an enormous disparity in terms of the precision of the measures used. There is probably no unanimous agreement as to whether such a disparity is attributable to a simple quantitative difference or to a qualitative change. However, it is beyond dispute that the degree of the accuracy of measure available 400 years ago bears no comparison with what is available today, in terms of its impact on society. As evidenced by the latest technology of large-scale integrated circuits, man is acquiring an increasingly larger capability to freely design and construct ultra-microscopic structures, and to have them operate (function) at ultra-high speeds.

Moreover, while the anatomy of Vesalius went no further than to explain the human body, molecular biology as

well as genetic engineering show much potential in the field of artificial synthesis, through active planning. It is therefore extremely likely that a revolutionary change will take place in man's understanding of himself, some time in the latter part of the 20th century and on.

The philosophical facet of such a revolution, it seems, would be a shift from atomism to holism, since the logic underlying "parts versus the whole" is expected to be too inadequate to cope with the changes foreseen.

It is needless to say, however, that holism will never be able to expand and add to itself toward perfection, if the world remains content with an easy and premature proliferation of the "interdisciplinary," with no substance to accompany it.

Therefore, it will be for us to create a better and fruitful future through developing ways of thinking that are "interdisciplinary" in their true sense, which will depend on our profound understanding of the essence permeating the history of modern civilization.

From such a standpoint, the opinions expressed by Professors Eduardo Caianiello and Torgny Segerstedt are fraught with tremendous significance. **(T. Ishii)**

Evolution and Revolution

Eduardo R. Caianiello

Wheeler, John Archibald (1911 –)
American physicist. When Otto Hahn of Germany et al. discovered nuclear fission in 1938, Wheeler proposed the theorectical method to explain this phenomenon together with Danish physicist Niels Bohr (1885 – 1962). Also, in connection with the problem of describing matter in the general theory of relativity, succeeded in giving an interpretation to mass and electric charge in 1957, by expanding German physicist Albert Einstein's (1879 – 1955) way of thinking into the unified theory of field and using harmonic integration.

Galileo Galilei (1564 – 1642)
Italian mathematician and scientist of the late Renaissance period. One of the pioneers of modern physics. Discovered the "isochronism of the pendulum" in 1582 at the age of 18, and performed an experiment on free falling bodies at the leaning tower of Pisa in 1589, thereby proving the fallacy of the Aristotelian doctrine, then cosidered to be the absolute truth.
In 1609 invented the telescope, utilizing it for astronomical observation. In the following year discovered Jupiter's satellites as well as maculae on the sun and the moon, in addition to making numerous other astronomical findings that served to prove the correctness of Copernicus' heliocentric theory.

The problem of the age of the Universe is crucial in today's natural philosophy; present evidence points to a pulsating Universe, that explodes from point-size into an expanding whirl of matter and radiation, to recontract, to again re-explode. Physics goes here beyond imagination, the highest authority on the subject, J.A. Wheeler, compares this impasse with the failure of classical physics that gave way to the Quantum Theory (Vedic philosophers would, though, happily agree to this picture: even their estimate of the duration of a cycle coincides to within a factor 10 with that of modern astrophysics). Let me just say, that nobody would dare claim today to any degree of certainty on this subject.

The situation was very different not so long ago. Two years after the printing of the 'Dialogue Concerning the Two Principal Systems of the World' by Galileo, in 1634, the 'Prince of chronology', Jacques Auzolles de la Peyre, was in a position to state that the age of the world was exactly 5954 years. The Bible permitted precise mathematical computations: creation had taken place on the autumn equinox, a Wednesday.

How has such a change in knowledge and perspective occurred? How has Man changed his familiar cozy small world into an infinite expanse, his certainties into anxieties, to find himself again delved into another, perhaps bigger cultural revolution, entered with easy optimism and soon found likely to portend unspeakable disaster? To speak of cultural change, I think no better situation could be proposed for illustration and thought.

Two cautions must be kept in mind before venturing any

analysis of the impact of innovation on culture. The first concerns the use of language. Though this need hardly be stressed in the country of Zen, *words are traps,* they easily become the masters rather than the tools of thought. The greatest obstacle against the acceptance of Relativity has been that 'time' and 'space' mean something entirely different in physics and in common parlance, and yet it is the latter that sets up mental patterns: wasn't it 'absurd' that different observers might not agree on events being simultaneous? The examples are innumerable: the 'De revolutionibus Orbium Coelestium' by Copernicus expounded in 1543 A.D. the very same heliocentric doctrine advanced by Aristarkhos of Samos in 280 B.C.; but the cultural pattern imposed by words had drastically changed by then, 'heavy' and 'light' did not necessarily go with 'earth' and 'fire', and, though the sun was still 'fire', it was no longer 'obvious' and 'natural' that the earth should be as far down as possible, here, and the sun float lightly up and around, as with the Ptolemaic system: the main, hidden objection had ceased to exist. Such is the power of words, and of the associations that are formed of them, beyond our awareness, in any culture, including of course the one that has us. All conditionings imbedded into words are the first we have to unlearn if we are to think of the 'next' culture.

Copernicus, Nicolaus (1473 – 1543)
Polish astronomer. Proponent of the heliocentric doctrine which he expounded in "De revolutionibus orbium coelestium" (1543), to overthrow the geocentric doctrine advocated since the time of Greek astronomer Ptolemy (Ptolemaios Klaudios, second century A.D.). In so doing, opened the way to modern astronomy.

Aristarkhos (ca. 301 – 230 B.C.)
Greek astronomer. Known as the originator of mathematical geography and geodesy. Said to be the earliest to believe that the earth undergoes revolution around its axis and round the sun simultaneously. Aristarkhos gave a strong hint to Copernicus in his formulation of the helliocentric doctrine later in history.

The other caution has to do with our predictive powers: they are very, very limited, for at least two reasons. Statistics gives an 'average value', but we live always in a 'fluctuation' around that average, and I can hardly be interested in the prediction of a value of which the same statistics proves that it has vanishing probability of being true here and now (I am quoting Norbert Wiener, who estimated the duration of a fluctuation in social predictions to be no less than a human lifetime). An even more forceful reason is that culture, science and technology form an adaptive system, which changes its structure as a consequence of its evolution (of this I shall have to say more), but mostly because of unforeseeable discoveries (of America, of atomic power, of computers...): what sane man would venture predictions about a system for a time when its structure will have changed in a way and by an amount certainly unknown? Yet we are far from powerless: if we cannot predict a distant future, we do determine it in every way with our actions.

Wiener, Nobert (1894 – 1964)
American mathematician. Founder of the science of cybernetics. His formulation of cybernetics was motivated by his experience in the design of computers as well as his joint research with neurophysiologists. Based on the recognition that a functional similarity exists between the construction of computers and the structure of the nervous system in living organisms, cybernetics attempts to explain such a similarity through a unified mathematical theory. Not only does it serve as the starting point for today's theory of man as a machine, but also constitutes one of the theoretical bases for automation technology. Author of "Cybernetics: or, Control and Communication in the Animal and the Machine," 1948.

Euclid (330? – 275? B.C.)
Founder of geometry. Through his writing "Stoicheia," Euclid perfected geometry for the first time in history as a superb axiomatic system of deductive reasoning. Euclid's geometry set the norm as the only geometric system, untill N.I. Lobachevskii's (1793 – 1856) non-Euclidean system made its appearance.

A measure of the magnitude of the change that took place when the Middle Ages gave way to modern science is given by the cited problem of the age of the Universe; but there is much more than that. To size up really the issue one must make the almost impossible attempt to forget what is obvious and natural *now*, and to readjust to what was obvious and natural *before* the revolution took place. We must get into a world that, besides being less than 6000 years old, was also very small: it amounted to no more than the Earth, rooted at the center of everything and meant only for Man, with a pageantry of lights revolving around it, in geometric circular perfections, possibly pushed by angels. The very concept of 'space' was far from ours: Euclid treats 'objects', only with Descartes these became 'portions of space' (the concept of 'infinite' was surreptitiously introduced by the Jesuits of Coimbra with the notion that, finite as the world might be, it still had to be contained in God, who possessed the metaphysical attribute of infinity; slowly the divinity disappeared and the attribute remained). Science – its quintessence geometry – was abstract speculation, worthy of intellectual respect because 'pure' and not to be polluted by contact with the 'mechanical arts', which obliged to use instruments and had practical, therefore less meritorious purposes (the major exceptions were Archimedes among men, astronomy among sciences: but this served the practical aims of navigation and horoscope casting, so Ptolemy could properly describe in his Almagest the astrolabe and other instruments). Of Plato and Aristotle (and Pythagoras, Philolaos...) I need not speak here: like with Yin and Yang for Chinese things, it has always been a favorite game for Westerners to trace their thoughts back to them. The true age of logic was that of Scholasticism, St. Thomas Aquinas brought Aristotelianism to diamond perfection: as with the Coran for Muslims, what was in it was true, what was not, false.

Ptolemy (Ptolemaios Klaudios; second century A.D.)
Greek astronomer and geographer. His principal astronomical writing "Megale syntax" ("Almagest" in Arabic) was the comprehensive compilation of astronomy practised in Greece and Alexandria.

Plato (427 – 347 B.C.)
Greek philosopher and follower of Socrates. In his theory of human soul versus the body, Plato asserted the immortality of the soul and taught that Idea, the timeless essence or universal which is the archetype of an individual existent as sensed by the soul, is the truly immutable real existence.

Aristotle (384 – 322 B.C.)
Greek philosopher. Studied at the Academy taught by Plato. While Plato considered Idea as being transcendental, Aristotle on the contrary believed form (Eidos) as being the essense inherent to matter (Hyle), and explained all formative processes as processes by which matter actualizes form.

The crucial point, in my opinion, is that this whole body of doctrines, that lasted over two thousand years (in places is not dead yet), clumsy and absurd as it may seem to us *now*, was in fact a perfectly coherent, majestic and faultless system of thought. It was in excellent agreement with all known

Philolaus (420? B.C.)
Greek philosopher of the Pythagorean school. His theory on celestial bodies said that the earth, endowed with a spherical shape, was suspended in space and furthermore, that it revolved around the fire (Hestia) at the center of the universe, as did other planets, fixed stars as well as the sun, in accordance with a definite mathematical law.

facts; furthermore, it responded beautifully to the claims of common sense: the sun does move around the earth, heavy bodies fall because what is heavy tends to go down, force is proportional to velocity as everybody who tries to push a cart knows; astronomy – the geometry of luminous, therefore pure entities – has nothing to do with physics, the science of what grows and decays, rises and falls, is impure. And what use can a system of thought be, if it does not explain everything at the same time, animals and plants and the cosmos? Why stoop at so trivial a question, how does a falling stone fall, inch by inch?

Newton, Isaac (1643 – 1727)
British mathematician, physicist and astronomer famous for his three great discoveries: resolution of light, the law of gravitation, and differential and integral calculus. His great accomplishments are contained in "Principia mathematica philosophiae naturalis" (1686 – 1687), which encompasses his entire achievements in the field of mechanics. This mathematical and physical treatise became the foundation for the study of mechanics for the next 200 years.

Newton's 'Philosophiae Naturalis Principis Mathematica' appeared in 1687; one might say – comparing with the 1543 of Copernicus's treatise – that in about 150 years the full revolution had been accomplished, events more important for mankind than all wars had taken place. One innovation caused all this: the inductive or experimental method, that we call Galilean, replaced recourse to authority with plain, persevering observation and measurement; attention was fixed on simple and reproducible phenomena (such as the falling of stones) rather than on complex wholes; people stopped asking 'why' and started searching 'how'; the 'explanation' of facts, not sought any more in names and final causes, was replaced with their 'description', for which a new language was found necessary. Hear Galileo ('The Assayer'): 'Philosophy is written in this most large of books that stays continually open to our eyes (I say the Universe), but it cannot be comprehended if the language of it is not learned before and the characters in which it is written are not known. It is written in mathematical language, its characters are triangles, circles and other geometrical figures; without such means it is humanly impossible to understand a single word of it, without them there is only inane wandering through a dark labyrinth'.

Leonardo da Vinci (1450 – 1519)
Artist, scientist as well as engineer, and a great master of Italian Renaissance art. At the same time a pioneer of modern scientific thought in a tradition starting with Galileo Galilei. The scientific philosophy found in da Vinci's voluminous manuscripts emphasize the inseparable bond existing between theory and experiment as well as the application of mathematical techniques to the study of natural science, and thus contains a novel methodological discovery that breaks down the medieval and Aristotelian view of Nature.

The path of innovation, I propose to state, involves both evolution and revolution. Let me first illustrate this concept with a mention of Leonardo and Galileo. We have no room

here to describe, or even name, the causes of Italian Renaissance. To set the stage, think of wars storming for ever the country; of the rediscovery of ancient art and philosophy; of the fall of Constantinopole to the Turks in 1453, that flooded the Italian courts with learned and haughty refugées; of the ennoblement of skilled labor (no longer a debasing activity: Florentine artisans could invent lenses in the XIII century because they had *not* gone to school to learn that lenses alter truth to the eye); of the appearance, near the Prince, together with the Physician and the Astrologer, of the Engineer (whose skills usually went from the military arts to much higher attainments: Leonardo, offering his services to Ludovico Sforza, duke of Milan, listed in 1483 ten skills of which he deemed himself capable: nine of them concerned military engineering). These and many other occurrences were handed down and accreted from century to century: this type of hard historical facts is what I resume under the name 'evolution'. A single man stands shoulder high amongst all, to incarnate for us the struggle and quest of his time: Leonardo da Vinci. His achievements in every path open to man have become myth; he cannot be classed by any simple standard, his praises of mathematics or his statements on the fall of heavy bodies or on the concept of force have been variously interpreted as the farsighted illuminations of genius, or as abstract, platonic remarks not implemented into concrete action. Him we cannot simply judge, if for no other reason, because the meaning of terms such as 'force' has been vague and changing for centuries later, and we cannot know what he meant by them. Nor did he generate a school, he stood aloft but alone. Any normal meter, though, would be improper and irreverent: the only way to approach Leonardo is that of the humble, who revere him as the symbol of his age and look at him for inspiration, not criticism. Leonardo represents an essential element in our discourse: not for what he found, but for what he ever, untiringly, *searched* in all aspects of Nature. Nothing more than the vision of this giant to whom science, technique and art were one and the same thing, struggling against the mists of a dying yet still dominating mentality to snatch out of them

Sforza, Lodovico (1481 – 1499)
The Sforzas were an illustrious family under whose rule the city of Milan prospered during the Renaissance. The name Sforza, meaning "Conqueror", was an honorary title accorded to the founding father Muzzo Attendola (1369 – 1424), who, despite his humble beginnings became Condottori (leader of mercenary troop) and led successful campaigns on behalf of the queen of Naples and the Roman pope. Lodovico Il Moro (1451 – 1508), who was initially the regent for his nephew eventually wrested the ducal title from him, to become the fifth Sforza to reign over Milan.

glimpses of light toward horizons yet too remote, can make us aware today of the immense difficulties, of the centennial work that was ahead of any who would abandon two thousand years of tradition for a new, truer philosophy of Nature. Only the man Leonardo can give us a measure of what evolution and its inner torment do really mean.

Galileo, on the contrary, must interest us here not as a symbol or myth, but as the actual originator of the new physics and methodology: we are focusing on him to discuss 'revolution', which is something drastic and definite, punctualized so to say. We must imagine Galileo at work, see him dispel with strenuous perseverance and lucid clarity the mists from a horizon rendered tangible of a sudden by his own efforts; we want also to realize how things obvious to us (such as Kepler's non circular orbits, or the fact that we cannot describe 'Nature in itself', but only 'models of Nature') were for him unthinkable. Copernicus's re-proposal of Aristarchos's system (that he learned in Italy from Archimedes) was or not accepted by his contemporaries, on academic grounds: Reinhold's astronomical tables, computed after the Copernican system, were used by supporters and opposers alike. His aim had been to supply aids to navigation; the preface to his book (written by his friend Osiander) declares that it deals with hypotheses useful for computation, not with reality. Whether Copernicus really thought so is a matter for debate; the relevant point for us here is that considering his theory a 'model' to get numerical results (a similar stratagem would have spared all persecutions to Galileo, who strongly refused to comply with the suggestion) meant, at that time, *no* philosophical revolution: 'model' meant then a tool, mathematical trickery good for practical purposes, not a step toward a deeper knowledge. It is the most recent acquisition of scientific thought that the actual way to improve our knowledge of Nature is through series of models of increasing degree of approximation to reality. This new conviction takes us as far from Galileo as he was from Aristotelianism. It is a matter for meditation that the whole fight of Galileo centered around an issue that is dead for us,

Kepler, Johannes (1571 – 1630) *German astronomer. Celebrated for his formulation of Kepler's Law on which the discovery of universal gravitation was based, and which became the eventual key to unravelling the structure of the solar system.*

Erasmus Reinhold *(1511–53). German astronomer, Copernicus's disciple, completed a time-table of celestial bodies based on Copernican theory in 1549.*

though at his time, in his world, it was the necessary and courageous thing to maintain: for, even if we think now otherwise, it was then vital for the triumph of the new natural philosophy that *either* Ptolemy *or* Copernicus be right: each pretended to a *true* description of Nature itself, not of a model of it; a plurality of descriptions was utterly inconceivable. Such were then, inescapably, the terms of the fight between the principle of authority and the new method of scientific enquiry.

Galileo's travail was immune, mainly because he never refused to compromise: thus it would have saved him all troubles writing in Latin rather than in Italian, but he wanted Italian to awaken the widest audience to the foul prevarication of false doctors who opposed the true and free knowledge of Nature. A study of Galileo's life and ordeals is a rewarding and revealing experience: the adversity of the times, the way he used 'thought experiments', his brilliance and impact on scientific thought even when he was wrong. We cannot speak of this here, nor need we describe what Galileo achieved: it is all built in our minds and bones, the way a scientist thinks today is radically different from that preceding Galileo (him we take now of course as the epitome of the whole revolution started and symbolized by him): just recall the brief mention made before of the Aristotelian world. Mathematics has become since Galileo the language of science; Archimedes, Democritus and Copernicus, Galileo's guiding lights, have been through him revived to us. And Galileo dared trust his eyes rather than holy books (against all scholastic teaching — how could you believe a sense that told you were *behind* your mirror, an obvious untruth? etc.).

We have seen how little time the revolution from old to new took in asserting itself; it is equally important to remark, obvious as it may be, that without the preceding millennial evolution this revolution would have been highly improbable, if not unthikable.

Thus far I have spoken only of society and history and cultural patterns; this is our topic of interest, and it is fitting that examples be dramatic to be effective. Let us look now at

the same things, with the cooler mind of the impassive scientific observer of the twentieth century. We set thus to understand things by making models of them (in our present acception), and soon discover that the working of a model — its 'physiology' so to say — is independent of its actual implementation — its 'anatomy' : the same model may describe a society, a nervous system, a living organism, a communication network — names and figures may change and not the essential picture. A social system can be described, in this view, by two sets of mathematical laws: one for instantaneous action, the other for the (much slower) change of system structure as a consequence of past actions, as well as of external influence. The time is not yet mature for an exhaustive application of this method to the unfolding of history; some of the consequences and results it would have can be inferred, though, from experience gathered in other fields where the thing has been done. I shall try to condense a few here.

The operation, instant by instant, of the first set of laws — let me call them 'decision equations', I have called them 'neuronic' in a different context — corresponds to every day life and to that part of the evolution of the system which is dynamic in character, such as cyclic changes of state that, if stopped, would die away. The second set — I call them 'learning' or 'mnemonic equations' — changes instead constantly, at a much slower rate, the structure of the system. An effective comparison: our moving through the streets of Tokyo, as against the change of the topography of the town that occurs through the years.

When men increase in number, their actions deversify ever more, and something new and seemingly strange happens: the system acquires, in all known cases, a *hierarchical structure;* should this not happen, the system could not 'live'. The mathematics of it would be entirely out of place here, and is still at its early stages; to understand 'why', though, is quite intuitive. Just think of a crowd and of an army: only the latter is capable of strategy and tactics, that is of 'intelligent' action, because it has hierarchical levels. I have shown elsewhere with not much technicality that a simple and plausible criterion of economy accounts for not only the basic features of level formation, but also for the relative population of each level. The formation of new levels is what I call a 'revolution', and is brought about by factors such as mere

numerical growth, or by 'innovation', that is by changes induced by spontaneous activity or external influence. The name in physics for this phenomenon is 'phase transition': you may compare the slow heating of water with 'evolution', its change, from ice to liquid to steam, with 'revolution'. I believe that the main reason for having hierarchical levels in a society or an army lies in the fact that a man can communicate efficiently only with a small number of other men, between, say, five and ten. But then the computer, taken as a symbiotic part of the new society, may destroy the very foundation of its present hierarchical structure! This may well be a major cause of the next revolution in our culture.

A last remark on levels: each must have its own logic, or 'Weltanschaung'; the carpenter has nothing to learn from the nuclear scientist. It is *not* true that a few fundamental equations of basic physics could contain everything, if known: a TV set could *never* be read spontaneously out of Maxwell and Lorentz's equations. Finally, 'forgetting' is as important as 'learning'; we learn most new things by forgetting old ones, the extremely subtle skills of stone-age tool makers are forgotten, most of the mathematical skill of past century is lost except in books, yet we have become more powerful because we can operate at new higher levels, and this more than compensates for our loss of knowledge at lower levels; loss of memory and formation of new levels imply greater parcelization of work and guarantee that the amount of individual work does not increase.

To conclude, I have only to ask the reader to compare these statements with the historical scenario which I have presented before: he will no doubt understand my plan, which was to present a well known situation, analyze some of its logic, and then use it as material to render intuitive things of which the mathematical discussion is not advisable here, or possible yet. If our concern must be with future society, then we must understand first the old; if it is change, we must know first about the major changes that already took place. What can we learn? Perhaps something: prejudice and irrationality and blind belief had to be swept away, and it took two thousand years plus Galileo. But here we live in a world

where, on equally irrational grounds, there are countries that are ridiculously small and others monstruously large; contending beliefs, when all men need the same facts, irrespective of beliefs — I better stop here. I want just to say, that we do not have to search far to identify the counterpart of Aristotelianism in our time: the way to tear it down is, rather than to fight it, to start planning a world in which harmony may find finally a rôle. To do so we must be aware of at least some of the laws that, by necessity of Nature, govern our society.

COMMENT

Toshio Kitagawa

Arguments were frequently made, particularly in Japan, several years ago about what sort of society would follow the agricultural society and the industrial society in man's societal evolution and whether that might not be what could be called an informational, educational or intellectural society. Images of various sorts of future society and reasons for their emergence were presented. Such arguments are not so active as before, but it seems that the serious and extensive question of what was once referred to as 'future shock' has not really disappeared.

In his present report, Caianiello is conscious of this question of future shock, describing it in terms of a society in which the man and the computer live in symbiosis and the communications therein. Caianiello and we stand on the same ground in this sense. Under the title, 'Evolution and Revolution,' he presented a view concerning how to approach and understand this question. And I would like to comment mainly on the approaches he used.

As is known widely, Caianiello is a physicist who was born in Italy, the birth-place of Galileo who founded the modern science, grew up in the profound and extensive tradition of Western science and studied theoretical physics in Copenhagen and is, at the same time, one of the world's leaders in cybernetics who has been developing this science under its founders, Morgan and Eagle. His present report, therefore, must be understood in the context of his academic background and endeavors.

His report brings two points to my attention at first. The first of them is that he follows a methodology of natural perception in describing the changes in the historical images of civilization. Secondly, he presents patterns of historical changes as an alternation between evolution and revolution.

I would like to point out strongly here that the essence of his report is rooted deeply in his study of cybernetics which dates back almost 40 years. Since 1961, when he announced a paper entitled 'Outline of a theory of thought process and thinking machines,' the focus of his study has moved to natural language and pattern recognition and, now, to "system" and "structure." It is important to understand, therefore, that Caianiello uses words such as "system" and "organization" in his theory with clear mathematical images and that he conceives of them not just on the basis of their similarities to physical phenomena but in the framework of cybernetics.

I would also like to give a couple of personal views on my own position and terminology in connection with Caianiello's report. First, concerning terminology, I think what Western scholars call 'cybernetics' corresponds to 'informational science' in our present conception in Japan. And when we examine the direction indicated by Caianiello's report on the basis of this concept of 'information,' it presents a proposition as to whether historical images of civilization might not be pursued from the standpoint of informational science.

Secondly, Caianiello's approach to a problem, as was discussed earlier, lies closely in line with his accumulative study. His report gives an impression that he has departed from his past study and presented a common view; this is not true and I hope that he will continue to stick to his own approach.

Having a field of specialty close to Caianiello's, I am greatly interested in discussing images of future society from the standpoint of information theory. In this regard, I would like to state that, as there are many models such as dynamics models, ecological models and models of games theory, there can be many views of history, each with its own significance and latitude and I, for one, do not insist on one view but that to discuss informational society, an approach from the standpoint of information science provides, nonetheless, a basically important method.

COMMENT

Kiyoshi Okada

Asia and Europe, it is said, sometimes have completely contrasting proverbs dealing with same subjects. While water gathers into a big river in Asia, for example, no amount of water becomes hot water in Europe. Translated into Caianiello's terms, the former deals with accumulation or evolution and the latter with revolution.

Caianiello suggests, in brief, that innovation is common to any field, be it science, technology, culture or society, that innovation emerges from an alternative process of evolution and revolution and that it is restricted by language expressions and predictions.

Caianiello says he finds in Leonardo da Vinci a synthesis through continuing search, that is, an identity in science, technology or art. In other words, he sees in da Vinci an attitude which identifies one certain thing amid intangible diversity. And in Galileo he finds an attitude which tries to reach a core through abstraction, formation of a model or resolution. In short, Caianiello

describes da Vinci's approach as synthetic and Galileo's as analytic and, in a way easy and interesting for us to understand, he contrasts the two men to be somewhat revolutionary (Galileo) versus evolutionary (da Vinci).

How much validity or similarity does this hold in my areas of specialty, economics and transportation problems? Let us look at some examples. In his population theory, Thomas Malthus pictured a society with a very simplistic notion that starvation is unavoidable in the future and wages are naturally determined by costs of living because population increases by geometrical progression while the means of subsistence grows only by arithmetical progression. It was, of course, partially erroneous, but it continues to be correct in part. The fact that he presented a view which tied an oversimplified essence to a world outlook despite the restrictions of its predictive power was a contribution; at the same time, it seems to indicate the necessity of thinking in terms of evolution and revolution as suggested by Caianiello.

Let us next take up Keynesian economics. What is revolutionary about the so-called Keynesian revolution? Keynes pointed out to us, first of all, that contrary to the traditional views economy could be controlled and, secondly, that contrary to the traditional concept — which led to the depression in the 1930s — that there was always a market for goods, production or supply had no use without a market or demand. Keynes, in essence, reversed the traditional ideas completely and, interestingly here, this conceptual reversal was brought about under pressure from outside.

Another example in economics concerns an extremely abstract theory called general equilibrium concept in which the central concept of equilibrium tries to explain everything. Recently, however, J. Kornai has come up with an "anti-equilibrium," arguing that the concept of equilibrium alone cannot explain everything and that the concept of system should be introduced. This, too, can be considered as a revolutionary step moving outside the traditional framework of economics.

These three preceding examples seem to show that the concept of evolution and revolution presented by Caianiello applies to economics as well.

Now, what about transportation problems? Transportation has been traditionally considered in terms of technology, that is, technological system. Attention was focused on means of transportation or technology to produce them. The attention, however, has to be shifted now to the harmony between transportation and society or between transportation and environment. In other words, when technology reaches certain stage through evolution or revolution, it is always asked to search systematic harmony in order to avoid conflicts with society. To comply with that necessity, it is

essential to work beyond the traditional technological system in the transportation field as well. In this regard, Caianiello provides us with a very important suggestion.

These comments have been summarized by Editor Miyauchi. The same applies to the other comments that follows.

A Model of Interdisciplinary Research in order to Make Prediction

Torgny T. Segerstedt

Science of future must be about the expected conditions of man in society and the likely development of society. We do not claim to predict the future of individual man, but we believe it to be meaningful to predict possible futures of society if alternative conditions are created by scientific discoveries or applied technical results of research. According to our view, the future of man in society is depending on those fields of research which are given priority.

If we accept the idea that the object of futurology is man in society, our next step must be to determine the nature of society. My definition implies that I regard society as a group in sociological sense, but I admit that it is possible to describe society from other aspects as well. I regard society as a group in sociological sense and by group I mean *two or more interacting persons with common social customs, obeying social norms emanating from one and the same norm-source.* This definition implies that a group must be a system of communication, that is, a group is two or more persons in symbolic interaction and cooperation. When we study a group we can observe the activity of the norm-source, when pronouncing or when sanctioning social norms. Furthermore we can observe norms as linguistic phenomena and we can finally observe the uniform behavior and interaction of the members of the group, that is, the social customs of the group. These elements form a system and are independent, and that is the reason why we talk about a social group. The group may be of various structures and have different functions but all groups must have a norm-source, common norms and uniform behavior. *Society is a group in this sense.*

There are different kinds of groups. Society may be called an inclusive group, because inside society there are several

specialized groups with norm-sources, norm-systems and uniform behavior of their own. There are groups which do not belong to a single society. Such a group is the scientific community. It has got an international structure. We have a universal body of knowledge and a common language which makes it possible for a scholar to communicate with colleagues all over the world. The scientific or academic community can be described as a communication system, that is, a social group in the sense I have given the concept group. The unique quality of the academic community is that its norm-system always is international and the norm-source can, consequently, never be national rules. That is the true basis of academic freedom.

My ambition is not only to make a morphology of groups, I also want to introduce the dynamics of social reality into my theory. In order to do so I have to ask the question: what are the goals and basic functions of society as a group? In all groups we can point out three basic functions which must be fulfilled if the group is to survive. (1) reproduction, (2) socialization, and (3) production of goods. That does mean that new members must be recruited to the system and that that recruitment, in society, ultimately must be done by biological reproduction. Furthermore new members must be socialized, that is, introduced in the common system of symbols and learn the common social customs. And finally in all groups a goal must be realized. In society that does imply that food, shelter and instruments of various kinds must be produced. In an agricultural society the three functions are carried out in the same group, the family, and such a society may be called a one-group society. In an early industrial society the productive function is separated from the family and carried out in a special work group as, for example, the factory. Such a society may be called a two-group society. In a modern postindustrial society we have got three groups as most of the socializing function is taking place in schools, colleges and universities. The postindustrial society may be characterized as a typical three-group society with the emphasis on the educational group. It is important to observe that there is a constant interaction and interdependence between the three basic functions and the groups surrounding the functions, that is, between the family, the educational group and the work group. This interaction may be illustrated

by the following example: If a country is industrialized, the consequence is, that there comes into existence a particular work group. Because of this new group the family loses one important function, the productive function, and will for that reason be less stable and less autonomous, its norm-source has less power and there is less homogenity in such a society. Industrialization means furthermore that new sources of energy are being used. And because of that new instruments of production, you must be trained to use new instruments and new ways of communication. Industry creates new and wider markets and demands, and for that reason, people trained in foreign languages. All this implies that the family is gradually loosing its socializing function and education is being taken over by schools, colleges and universitites. So there will be specialized functions around the socializing function as well as around the productive one. That is the same as saying that if we start to industrialize and technify a society, the whole cosial structure will change: there will be a development from extended families to nuclear ones and the educational and productive groups will increase in importance. My belief is that the development may be said to be subjected to a kind of social natural laws. The laws may be expressed in the following way: If you change one of the basic functions of a group, it is necessary for the group to adjust all its functions to new situations in the biological and physical environment as well as to the internal organization.

In a modern postindustrial society we may, as we have said, notice an increasing demand for skill and highly qualified persons. The increasing demand for skill means a growing importance of the educational group, which implies that more persons are employed in the educational group as teachers, technical assistants and administrators. The educational group is to an increasing extent, because of that, an occupational group for many people. It is also evident that more children are going to school and the time they are spending in school is increasing. By these illustrations I want to point out the interrelations between the different functions and that interference with one function that will be of consequence for other functions as well. I have pointed out that changes in the biological and physical environment of the group make it necessary to adjust society to new situations. In every difinition of society you must underline that

society is an organization for human survival. The time dimension is always present in society. Although you may say that society is turned towards the future, the past is present in our ways of meeting the demands of expected events. The link between the past, the present and the future is education and scholarly endeavours. All social behavior may be said to be future-oriented and that is in particular true of scientific research. That creates obligations, as we may assume that our growing mass of knowledge to an increasing degree will determine the structure of our future.

It is evident that society is getting more and more dependent on research and scientific facts. That does mean that the borderline between basic research and applied research is getting very flexible. There will be a rising demand of highly qualified people to carry out applied research, as applied research must be done by first class scholars. I believe it to be a very dangerous misconception or prejudice to think that applied science is less demanding with regard to design, methods and theory than basic research. I should rather claim the opposite, as the result of applied research is going to be used in society and consequently will be of great importance for all citizens. On that account it is meaningful to ask the question: what is thee essential difference between basic applied science, that is, what is the difference between autonomous and nonautonomous science?

By autonomy I mean the right of scholars to decide and choose (1) the object of their research, (2) the methods to be employed in their research and (3) the right to estimate the value of the results obtained, that is, the value of the results from a scientific point of view. The value of the results for applications may be decided by others. But I think we must remember, however, that a result may be quite correct from a theoretical point of view but of little interest or value from a purely scholarly viewpoint, because it does not imply anything really new either with regard to methods or facts obtained. It may however be useful from practical or applied aspects in some planned survey. If a result on the other hand is dubious from a methodological point of view or not quite verified, it can never be said to be good enough for applied projects. I think we can state that two factors are common requirements of all scientific research, basic and applied: (1) a general theory and defined concept as a frame of reference

(without comprehensive theory there cannot be any accumulation of knowledge, only scattered bits of information), (2) a generally accepted method and research technique which permits verifications of the derived hypotheses by all competent scientists in the field. No legal, administrative, political or economic authority could induce scholars to accept the results of research that does not qualify in these respects.

An important principle to which not enough attention has been paid in social science follows from this: The level of the theoretical system of science, in terms of inclusiveness, coherence, etc., determines the degree of autonomy of the science. No politician of today would try to influence a scientist working in the field of physics or chemistry inasmuch as these sciences have developed strong theoretical systems. But as long as only miniature theories or theories of middle range are available in social sciences, a considerable risk of exertion of outside pressure remains. Therefore, I find it dangerous that social scientists have so little concern about theoretical and epistomological problems. From this fact, I draw the following practical conclusions: the stronger the theoretical framework of a discipline, the less will the autonomy risk be for the scientist participating in applied research. In a context such as this, aspects of theoretical interest will be present in problem-oriented science or applied research, and highly theoretical research will be valued because of the significance of its results for applied research.

With regard to futurology, this means that the theory and the evaluation results must be carried out by scholars according to the international norms of the scientific community. Politicians and administrators can never establish themselves as norm-sources of scientific futurology. With regard to the object of research, the situation is a bit more complicated. A national government has got the right to decide if it will give priority to atomic research or cancer research and make funds available for such purposes. But with regard to futurology, there is no sense in discussing the future of Sweden or Japan apart from the future of the rest of the world. I think we have to admit that the future of mankind is dependent on the science policy of the superpowers. That is, there will be another future for all of us if they give priority to atomic

research or if they give priority to research in life sciences. I believe it to be the duty of scientists to make that clear. Consequently: although the aim or goal may be said to be a practical and applied one, the scientists must regard it as their duty to choose and determine on an international level the objects of future research. For that reason it may be important to discuss the relation between research and the future. It may be fruitful to talk about different levels or strata in our knowledge about the future: (1) the first and basic stratum is the one described by established laws of nature. We know for certain that the sun will rise next morning, that water will boil at the same temperature next year as today, that electric currents will behave in the same manners as before, that there will be a total eclipse of the sun on the 11th of August 1999 and so on. (2) The second level or stratum is formed by human decisions in the past. The decision 10 years ago to exploit certain natural resources will influence life for generations. The same is true with regard to our educational or agricultural policy. (3) The third stratum consists of our decisions of today and their consequences. If we really could control all the results of our actions of today and predict their consequences, the importance stratum (2) would gradually diminish. With regard to stratum (1), our possibility of making predictions is dependent on our knowledge of the laws of nature. But it is really stratum (2) and (3) which are creating the problems of forecasting and predicting. When we are discussing our possibilities of making predictions we often say that we have traces or signs of the past, but that there is no sense in saying that there are signs or traces of the future. But is that really a correct statement? We certainly have signs and traces of the past. Such signs are buildings, monuments, inscriptions and documents. But I think that we may regard buds on the trees, the roots in the soil, pregnant animals, as signs and traces of future events. They may be described as elements on the future, but they are not causes (or they are not the only causes) of the future. We would perhaps make the following statement: All conditions being equal, these trees will, because of the buds, be green next spring. On the other hand it is possible for us, if we have sufficient knowledge, to manipulate the buds or the roots and in that way change the future. It is evident that man, because of his basic needs, has changed his natural and social reality and he

can, if he has got sufficient knowledge, manipulate the roots, seeds, animals and his own biological dispositions. He is in that sense communicating with the future and structuring it. He sends messages about his present hopes and demands and how he hopes to get them realized and satisfied in the future. There is furthermore a feedback on his present situation. His expectations or predictions of future events influences his present decisions. There are two elements determining his decisions and actions: the knowledge of his present situation and the expectations of the future. His knowledge of the present situation and of the future is determined by his scientific progress and endeavor, that is, by his knowledge about the true relations between phenomena. It is important to understand that the future is not just something passively expecting us; it is partly created here and now by our actions.

The problem with regard to our predictions of the future and our adjustment to future life is the difficulties of coordinating and surveying our rapidly increasing knowledge. For that reason it is necessary to work out and develop a theoretical system by which we can formulate hypotheses about future consequences of scientific discoveries with regard to our physical and social reality. If we do not have such a general frame of reference, research may just be one instrument for creating social and environmental catastrophies. The frame of reference must be international, since that is the only way of influencing decision-makers of the scientific superpowers in their setting up a priority list of different fields of research. I have already pointed out that it is the science policy of the superpowers which will determine the future of minkand. For that reason it is an urgent duty of the international scientific community to create a theoretical frame of reference which makes it possible to make predictions of the most likely results of priorities given to different fields of science.

My suggestion is, that we can use my concept of society as a starting point when trying to build a model of interdisciplinary research in order to make predictions. I have already said that there is an interaction between the three basic functions and between the three groups in which the functions are embedded. I have pointed out, for example, that if we change the structure of the work group because we have introduced new sources of energy, that will probably

also change our expectations with regard to the functions of the educational group. That may in its turn be of consequence for the family group. Work may demand for instance, more geographical mobility, which will influence family life. There are other illustrations of my thesis: Science has made it possible to control the birth rate. That means that the size of the family is, or may be, reduced. The consequences will probably be smaller classes in school or an overproduction of teachers. We may have to face new demands with regard to housing and there may be a lack of labor force, and because of that factories must be still more mechanized. We know for certain that in the postindustrial society there are an increasing number of people employed in service work and less people in direct heavy production, which will be of importance for our educational policy. But this knowledge has never been systematically analyzed from different aspects of knowledge; that is, it has never been interdisciplinarily studied from a common frame of reference. Such an interdisciplinary approach is to ask the question: what does, for example, the possibility of manipulating the genetic code mean with regard to family life? If we can improve the technique of transplantation, what would that imply with regard to the average age of man in the future? What does the manipulation of the genetic code and new knowledge with regard to transplantation mean for medical care etc.?

We must try to find out not only the biological consequences of such scientific innovations, but the social implications as well. If we make further progress with regard to the electronic science we have to ask: what does that mean with regard to communication, with regard to social control, to international understanding? How does it influence our economy, our social policy, our political life and our way of educating?

We know for certain that we can expect a lot if new discoveries in life science, in physics, in chemistry and physiology. For that reason I believe that we ought to ask prominent scholars, as already has been done by Rand Corperation (U.S.A.), what new discoveries they expect in their fields of research during the two, three or four coming decades. After that has been done we ought to try to find out what such breakthroughs would mean with regard to the basic some functions and their groups.

How would a breakthrough in brain research influence education? Does such an influence on education mean anything for the productive function and could that be of importance for family life? In such a way we could discover alternative futures and we could have a chance of making priorities with regard to our valuations.

I call such an approach *scientific strategy.* We know that military staffs are playing what they call war games, that is they try to plan their future actions with regard to possible alternative war situations. In the same way scholars should try to predict what is going to happen with the basic functions and their groups and consequently with society as a whole if priorities are given either to life sciences, or to atomic physics, or to electronics, or to some other field of research. But such a scientific strategical game can only be playyed if representatives from various academic disciplines are taking part. That is why it is so necessary for interdisciplinary research inside a common frame of reference.

COMMENT

Yoshikazu Sawaragi

There are conflicting opinions about how useful systems science are in fact. As a supporter of systems science, I would like to propose that systems science be part of Segerstedt's "interdisciplinary strategy for making predictions." The systems science that I am suggesting is not the conventional systems science but a comprehensive and flexible one that could be called a modern systems science in which analysis and synthesis or reductionism and holism are harmonized well.

Segerstedt's report could be summarized into the following three points. First, in a postindustrial society, the mutual interaction of functions among three groups — the family, the educational group and the work-group — increases and the interdependence among them intensifies. Secondly, society is getting increasingly dependent on the development of science and technology. To predict the future society, we cannot ignore that development. In future scientific endeavors, therefore, theoretical research and applied research must be well harmonized. Thirdly, society is getting so knowledge-incentive that no one field can be studied without the knowledge about research in other fields; for this reason, what he calls a "general frame of reference," which makes it very easy to acquire knowledge about other specialized fields, becomes vital.

These three points could be further rephrased as follows: society will become more and more complex and uncertain, values of individuals and groups comprising society will be further diversified, and conflicts will be serious social problems.

To deal with the problems of conflicts, I think a systems approach is being gradually developed. I think a systems scientific approach can be very useful in dealing with such problems and is quite suitable for what Segerstedt calls interdisciplinary strategy.

A systems analysis can also provide a common language and common concepts covering different fields which are necessary for employing interdisciplinary approaches. If what we are dealing with contains very complex and uncertain factors, I think we must use a systems analysis as a means to quantify them.

The systems analysis has a problem resulting from the fact that it is based on a model. Since the model is formed on a very limited set of assumptions and scenarios, it inevitably has some gap with reality. The systems analysis, however, is what might be called a hard science to be used for various kinds of simulation or for

forecasting impact; it cannot be directly used as a means for decision-making. The decision must be made by a human being based on his judgment; the systems analysis only provides and influential supportive system to aid human judgment.

I think the systems analysis should not remain as a hard science like this, for those involved in the systems analysis must have a very wide mental horizon that cuts through various conventional disciplines. Only with the use of knowledge about various specialized fields can the systems analysis be effective. While there have been many academic discoveries and we have powerful tools such as mathematics and calculators, I think the present systems science must develop into a soft science or an art which would first demand human judgment, human skills or human creativity.

Along the same concept, there have been experiments lately to quantify human psychology or inclination. There are some people who believe that it is not desirable to quantify psychological aspects of people. But quantification is only an attempt to make subjective judgment as much objective as possible. At Battel Research Institute in Geneva and several other research institutes in the United States and other countries, there are budding methodologies to try to solve conflicts by following a very complex path of a system. Actual methods are formulated through the free use of computers and mathematical means such as graph theories, but that is not all. The problem of how to measure human psychology or sentiment becomes very important. How to input the data obtained by measurements is also very important. Regarding these two points, I feel a strong necessity of linking the informational science and the systems science. Not only that, I also believe that those who have been involved with each of the heretofore separate disciplines in natural sciences and social sciences and those of us who have been engaged in the systems science must cooperate to pursue our studies in this direction.

COMMENT

Akira Tezuka

Japan's science policy is pursued by the Ministry of Education, to which I belong, for the promotion of basic research and by other relevant departments for the promotion of applied research to meet the needs of the industry and the others. Unlike the other departments which promote research development around the needs of the industry and the society in general, the Ministry of Education has concerned itself with basic research mainly at universities. The

Ministry's principle is to promote research on the basis of academic freedom, for we believe that the science policy should be concerned not only with the promotion of research but also with the maintenance of a system to assure academic freedom which forms the basis of research. In other words, we are trying to carry cut our science policy on the premise that scientific developments are guaranteed only by academic freedom and that the two are inseparable. Such being our concept, our central concern is not how to proceed with research ourselves but how to coordinate and adjust proposals put forward by universities and research institutes.

But the changes in the social situation have caused environmental problems, serious energy shortages and, consequently, problems about nuclear energy or nuclear fusion and these "big science" problems have made the traditional academic policy quite inadequate. We have come to need an overall perspective which would enable us to decide priorities with a far-reaching view concerning various demands and to determine how much consideration each of the demands should be given. It leads to a question of how, while fully guaranteeing academic freedom, the government should take initiative for academic research and development.

Segerstedt, dividing the functions of society into three and discussing various predictions of the future, provides a very effective clue to answer this question. He also provides a theoretical basis concerning academic freedom and freedom of research. Many people with different political persuasions have discussed academic freedom in Japan and the government, in its science policy, considers it essential for the development of scientific research. There has been no fundamental theory to support academic theory in Japan, however, I would, therefore, like to think about it further with Segerstedt's theory as a starting point.

I am particularly interested in the freedom of academic research following the argument that, with problems about research on rearrangement of DNA and the like having come to the surface, assessment of science and technology, more than technology assessment, is needed. To a question how this sort of assessment can be made, one might say that people like sociologists will conduct the assessment. But can they make the assessment? Could problems at the scientific forefront be understood so easily? At any rate, it seemed to me that only casual consideration had been given to what might essentially affect the freedom of research, what might at its worst lead to the control of research activities, such as indicated by assessment of scientific research itself. When I discussed this sort of problems, I have always felt that we have only an inadequate theoretical foundation to deal with them.

In promoting scientific research, we must minimize any pains or drawbacks that might result from it, as somebody else in the

panel has noted. Science has grown beyond expectations for the human society. Because of its formidable impact, it has potential to cause unreasonable hardships to many people. The traditional science people has only had to pursue the promotion of scientific research, but now there are some people who suggest that certain aspects of science be controlled and other aspects be paid more attention, that a balanced science policy be formulated and that effective guidelines be made for the future science policy.

Under the circumstance, I think it would be desirable if the trend toward comprehensive research was supplemented by the kind of academic research that would cover the entire influence that science might have on society. This, of course, requires a basic theory encompassing them all. Segerstedt's report, I think, is somewhat suggestive of its potential to develop into such a theory.

Develop dual foci for all complex societal systems: the total entity and the unique individual.

H.A. Linstone

In the methodology of dealing with human beings or societies, the analytical process must be generalized and objective. But the conclusion derived from them must be elastic with concomitant width and depth.

T. Terano

You will give credit to scienfific discoveries only if they are duly formulate in the universal language. On the contrary, even fine "interdisciplinary" ideas will remain totally private and unknown unless you convey them to others with language or other media. They are not yet a science.

Sciences begin in the form of free conception and observation of human beings and become complete with methodology and methods. A good example is the "systems science," the champion of soft technology.

Human beings have developed systematic thinking over a long period of time. They did so in the process of discovering and generalizing various things around them. It was the case with the systems science. Aside from artificial designing that is part of it, the systems science began when human

beings discovered and formulated facts with scientific methodology and methods. Such discoveries were made in connection with organisms — that, in adaptation to nature, made morphogenic development — social rules, environment and international custom.

Thus, the systems science dates back to the primitive ages when human beings started to use intellectual power. Rather, it was the driving force behind their intellectual activities. The systems science was made the subject of scientific research and development and became as it is today due, chiefly, to strategic and tactical researches during the second world war.

Let's take a look at the systems science in light of scientific thinking. When it comes to human beings, what the system means is, physically, the inside of body which is covered with skin. In other words, the system of human beings is the dynamic space inside their bodies. There are bones, veins, bowels, bio-energy and nerve information.

We are now aware of the importance of "space as the starter of systematic thinking. This is a holistic approach, that is, the collective understanding of subjects. The fact that there are various elements in each subject brings about the concept of "total". In the sense that elements are located and rounded up, this is also an atomistic approach.

"Time" is the third concept that affects both "space" and "total." Thus, the systematic thinking in modern science consists of three physical concepts: "space," "total" and "time."

Indeed, it is the basis of the Oriental thinking to look at nature from the three principles. The Chinese character "gen" means the point of origin in this sense. I meant to say that there was a systematic concept in the Orient but, before they could fully digest it, the Orientals were exposed to the rational and physical science-oriented systems thinking developed speedily in the West.

As human activities expand in scale, the system we formulate grow complex. It is called "problematique." When we attempt to make a systematic observation, therefore, we have to think of problems in observation, therefore, we have to think of problems in four categories collectively. They are:

(1) the spiritual aspect of human beings,

(2) problems related to economic activities,

(3) problems related to environment including the sense of value on the part of human beings,

(4) problems related to ecosystem.

In order to collectively understand and solve those problems, we will have to invent a new systems science that is a combination of atomism and holism.

H.A. Linstone made a very significant point in this respect. He emphasized the need to establish the systems science that supported, from within, modern civilization on the verge of vicious cycle. He said human beings had to inject the real spirit of human beings into modern civilization.

It was with this understanding that Mr. Toshiro Terano advocated the "hazy" system. He thus challenged the methodology and methods of the systems science that developed by eliminating haziness. He called for the introduction of haziness, saying it was necessary to observe the formation of systems in progress without separating "total" from "elements." His theory is as unique as that of Mr. Linstone. **(S. Aida)**

Breaking the Chains of Traditional Systems Science

Harold A. Linstone

The systems approach is historically the brainchild of scientists and engineers. As such it is hardly surprising that it has inherited the paradigms and inquiring systems which contributed so much to the triumphs of modern science and technology. The stress is on compartmentalization and analysis, on data (or observations) and models. Even recent endeavors such as system dynamics, cross-impact analysis, and technology assessment, which deal with complex and multidisciplinary concepts, reflect this orientation.

System dynamics, *a science for understanding the dynamic action of social and other complex systems, developed by J. W. Forrester and others at the Massachusetts Institute of Technology.*

Technology assessment, *weighing scientifically beforehand the effects and social impacts, both favorable and unfavorable, expected to be brought about by actual applications of a new technology to be introduced or developed.*

Nine years ago the Dean of the School of Electrical Engineering at the Massachusetts Institute of Technology said:

> 'I doubt if there is any such thing as an urban crisis, but if there were, MIT could lick it in the same way we handled the Second World War.'[1]

He meant that the analytic approach which helped to develop radar and fire control systems should work just as well in solving social systems problems. This attitude may be labeled self-confident by his friends and naive by his opponents. The scientist's belief in analysis is as strong as Billy Graham's in religion and Mao-Tse-Tung's in Communism. The technology student is imbued with certain paradigms no less than the seminary student or party member; nearly all become convinced of the 'rightness' and 'truth' revealed in their texts.

1. Quoted in W. I. Thompson, *At the Edge of History,* Harper & Row, N.Y. 1971, p. 48.

A. Four Scientific 'Truths'

1. Objectivity on the part of the analyst is vital for good systems work

The concept of the 'objective' observer or analyst should be laid to rest once and for all.[2] If, in complex systems, 'everything interacts with everything,' then the analyst is related to his model or to the subjects of his experiment. This is particularly significant where human beings are elements in the system or its relevant environment – which is the case in virtually all interesting problems today. Mitroff and Blankenship have proposed guidelines for holistic experimentation, such as the following:

> 'The subject (general populace) of any potential holistic experiment must be included within the class of experimenters; the professional experimenters must become part of the system on which they are experimenting – in effect the experimenters must become the subject of their own experiments.
>
> 'The reactions of the subjects to the experiment (and vice versa) are part of the experiment and as such must be swept into its design (e.g., conceptualization).'[3]

From Adam Smith to West Churchman there have been expressions of concern with the danger of ignoring the individual, losing him in the system view. Smith said 200 years ago:

> 'The man of system...seems to imagine that he can arrange the different members of a great society with as much ease as the hand arranges the difficult pieces upon a chessboard. He does not consider that the pieces upon the chessboard have no other principle of motion beside that which the hand impresses upon them;
>
> 'but that, in the great chessboard of human society, every single piece has a principle of motion of its own altogether different from that which the legislature might choose to impress upon it.'

Churchman paraphrases Kant:

> 'Two things fill my heart with never ending awe: the

2. cf. I.I. Mitroff, *The Subjective Side of Science,* American Elsevier Publishing, N.Y., 1974
3. I. I. Mitroff and L. V. Blankenship, 'On the Methodology of the Holistic Experiment: An Approach to the Conceptualization of Large-Scale Social Experiments,' Technological Forecasting & Social Change, Vol. 4, p. 345 (1973), Elsevier, N.Y.

complexity of the total system and the self within.'[4]

If the analyst himself has not focused on the process of individuation, i.e., understanding of the self, he will not be able to model social problems meaningfully.

2. Data and models form the basis for systems study

Man has always striven to understand the world around him and created models which reflect his perceptions to aid in that process. Modern man insisted that data are 'objective' and that a model validated by data forms an excellent means to predict system behavior.

Physicists have already learned that apparently contradictory models may be useful in explaining a simple phenomenon (i.e., particle and wave theories for propagation of light). Furthermore, the choice of variables and data is, in fact, anything but objective. The use of GNP/capita as a measure of national status, the choice of variables in world dynamics model, and the definition of QOL (quality of life) are highly subjective. Measurability, i.e., quantifiability, is an important consideration in their choice.[4a] The extensive use of computers underlines the tendency to stress quantifiable information. Workable models require structures, a very limited number of variables, and simple interactions among them. The modeler therefore abstracts the perceived situation until it fits this schema. The number of variables is reduced, nonquantifiable variables are scorned, and stochastic formulations are introduced. A simplified structure, preferably hierarchical, is postulated and nonlinear interactions are linearized. Heinz von Foerster's First Law expresses this process in another way:

> 'The more complex the problem which is being ignored, the greater are the chances for fame and success.'

The usefulness of models is indisputable; it is their misuse which is deplorable. Like Pygmalion, the modeler falls in love with his creation and construes the artifice as a reality. At one time Euclidean geometry was accepted as the 'truth,' later it was Newtonian mechanics. One would think

4. C. W. Churchman, 'A Philosophy for Complexity,' Lecture at Conference on Managing Complexity, Portland State University, Portland, Oregon February 27, 1975.

4a. cf. Gresham's Law of Systems Analysis: Quantitative analyses tend to drive out qualitative analyses.

that we have learned from these experiences; yet, we make the same mistake with economics and world dynamics today.

The emphasis on data leads us directly to one of the problems in technological forecasting: the excessive reliance on trend extrapolation with its inevitable bias on the past, i.e., looking at the future in the manner of driving a car forward with one's eyes on the rear view mirror.

3. There is a best solution for a system problem

The formulation of a 'problem' virtually presupposes the existence of a solution; a problem for which it is not possible to envision a solution is usually accepted as a 'condition.' Most human beings fear death, but mortality is rarely identified as a problem; instead, it is accepted as a condition. Schools inculcate the idea that problems must have solutions: unsolvable problems rarely appear in textbooks.

Furthermore, there is a striving for the 'best' solutions. Classical mathematics has devoted vast resources to this goal (e.g., calculus of variations, game theory, and linear programming).

It is widely assumed that suboptimization is a valid process in complex problem solving. If a 'best' solution cannot be found for the whole system, the suitable response is to find best solutions for the components or subsystems. Unfortunately, a set of optimal subsystem solutions may well constitute a very poor total system solution.

It is a fascinating exercise to construct a problem-solution relevance tree. Consider unemployment/underemployment as the problem. Viewing it in the context of the Maslow hierarchy we identify various aspects of this problem:

survival	—	minimum income
security	—	assured income and stable job
self-actualization	—	satisfying work

Taking any one of these we construct a relevance tree. The first level denotes the problem, the second possible solution concepts, the third indicates new problems raised by these solution concepts, and so forth.

It becomes evident that solutions alternate with problems *ad infinitum*. We immediately recognize that this exercise echoes the saying: 'new technology creates new problems.'

Problem: 'assured income and stable job'
↓
Solution: seniority and tenure
↓
Problem: obsolescence of individuals and organizations
↓
Solution: education for change without generating insecurity (refocusing)
↓
Problem: psychic limits to change

This sequence is analogous in mathematics to an infinite divergent series and is similarly intractable, a situation which presents us with the one justification for applying a discount rate to future problems.[5] The discounting process transforms a divergent into a convergent series and permits us to compute the relevance tree, i.e., to determine preferences among solution concepts at any one level. However, Churchman argues that application of any positive discount rate is immoral.[6] If our children are more important than we are, we should be using a negative discount rate: a problem in the far future is thereby more significant than the same problem in the immediate future. Under this definition the orbiting of nuclear waste and any depletion of resources are immoral acts. Their effects on future generations should be viewed as more serious than the near term impacts since they appear to reduce the options of our grandchildren. So we are caught in a quandary.

If we *do not* use a positive discount rate, we become immobilized, unable to make decisions, like Hamlet we are paralyzed into inaction. If we *do* use a positive discount we appear to be immoral in the eyes of future generations. Our refuge is unbounded faith in our ability to brilliantly improvise a series of short-range decisions and to invent new options.

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5. For a discussion of discounting, see H. Linstone, 'On Discounting the Future,' *Technological Forecasting and Social Change,* Vol. 4, p. 335 (1973), and H. Linstone Review of 'Mankind at the Turning Point,' *Technological Forecasting and Social Change,* Vol. 7, p. 331 (1975), American Elsevier Publishing, N.Y.
6. C. W. Churchman, op.cit.

4. Specialization is essential in effective system study

The explosive growth of science and technology has been accompanied by a flowering of bureaucratic institutions. The organization and management of science have been accomplished by bureaucratic compartmentalization and specialization. A new subject of inquiry may originate as a naked, unlabeled topic, but it quickly assumes the garments of a discipline. The disciplining process occurred with engineering in the nineteenth century and is happening to technology assessment and general systems theory today. The process is facilitated by the use of unique languages and jargons. Communication is easy within the discipline and discouraged with outsiders. Peer review of publications and financial resource allocation help to build a veritable Tower of Babel, protecting disciplines from each other.

Weinberg was acutely aware of this when he recently wrote:

> 'The general systems movement did not start out as a discipline but is probably ossifying into one.'[7]

Unfortunately, the critical problems we must address do not fit the compartmentalization. They are not merely interdisciplinary, but increasingly transdisciplinary.

B. 'We Shall Overcome'

These deeply ingrained 'truths' illustrate the biases and illusions which enchain the systems approach and restrict its usefulness. The future does not lie with 'more of the same.' The preceding discussion alludes to some means to effect change and we will briefly outline them.

1. Develop dual foci for all complex societal systems: the total entiry and the unique individual

As Churchman has stressed, this does not mean that the unique individual is placed into the societal model.[8] Rather, it means that we must maintain two *Weltanschauungen* simultaneously, an inner and an outer view of the world (which may actually be in conflict). An understanding of the

7. G. Weinberg, *An Introduction to General Systems Thinking*, Wiley-Interscience, 1975, p. 46.

8. C. W. Churchman, op.cit.

inner self affects the modeling of the outer world and this dialectic interaction is of distinct benefit to the task of dealing with complex systems. Individuation generates a spiritual, animistic awareness which forms the core of new religious and cultural systems. It provides a nonrational, nonanalytic counterweight to the traditional 'scientific' approach which is absolutely essential.

2. Use other inquiring systems

The value of a dialectic inquiring system was implied in the preceding paragraph. Churchman has stressed the potential of the Singerian inquiring system for interdisciplinary systems application. It encompasses data based, model based, dialectic, and multimodel inquiring systems and provides the broadest possible modeling of any system.[9,10] It should minimize the tendency to get 'hung up' on one model or one structure as happens so often. Singer views Truth as pragmatic, i.e., dependent on the objectives of the inquiry, and a system model is explicitly goal-oriented. Another useful concept is based on the work of Merleau-Ponty. A particular reality is created by 'bracketing' an event or idea out of the mass of experience, truth is defined as agreement that enables action, and reality is the product obtained from intentions and actions.[11]

3. Recognize that complex system problems have no 'best solutions' in the classical sense

The search for 'solutions' is not merely elusive, it is also illusive. We do not really solve complex systems problems, rather we *shift* or *transform* them. Forrester noted in his *World Dynamics* that action to reduce population growth would avoid a population crisis but stimulate a pollution

9. I. I. Mitroff and M. Turoff, 'Technological Forecasting and Assessment: Science and/or Mythology?', *Technological Forecasting and Social Change,* Vol. 5, p. 126 (1973), American Elsevier Publishing, N.Y.
10. C. W. Churchman, *The Design of Inquiring Systems,* Basic Books, N.Y., 1971.
11. D. S. Scheele, 'Reality Construction as a Product of Delphi Interaction,' in H. A. Linstone and M. Turoff (eds.), *The Delphi Method,* Addison-Wesley Publishing Co., Reading. Mass., 1975, p. 43.

crisis.[12] Avoidance of Mitroff's Error of the Third Kind, i.e., solving the wrong problem,[13] must therefore be related to the concept of *homo ludens* — man as a game player.[14] We shift problems in accordance with our individual and societal needs or predilections (e.g., ethical standards, creativity, survival). Thus war has historically been a tragic, but acceptable, game in transforming problems. Science/technology represents another proper game — we will come back to its problem transformation capabilities in the next section.

Our love affair with the computer may well be traceable to its nature as a near-ideal game tool. A mature attitude toward holistic system design recognizes that (a) we cannot grasp any ultimate solutions to complex systems problems and (b) we need illusions as well as faith to survive. So it is with considerable humility and awe that we perceive the continuing evolution of human societal systems in spite of our ignorance.

4. Work for a better balance between analysis and synthesis or between reductionism and holism

I should like to conclude this discussion with an urgent plea. We can and must implement the principle that a system cannot be separated into components or subsystems without losing essential characteristics of the whole system. To do so we should now focus much more intensively on holistic approaches to system understanding.

Let us look at one facet — communication. The written language has provided the primary mode for technical communication since Gutenberg's time. Communication of nonlinear information in a linear mode obviously presents a handicap to most of us. There are those exceptional talents who have used the written word in a truly holistic way — we recognize the poet and novelist by their use of language to communicate emotions and a holistic 'feeling' for a situation. Kafka and Orwell are representative of this ability; science

12. J. Forrester, *World Dynamics,* Wright-Allen Press, Cambridge, MA, 1971.
13. I. I. Mitroff and M. Turoff, 'On Measuring the Conceptual Error in Large Scale Social Experiments: 'The Future as Decision,' *Technological Forecasing and Social Change,* Vol. 6, p. 392 (1974), American Elsevier Publishing, N.Y.
14. J. Huizinga, 'Homo Ludens,' Beacon Press, Boston, 1955.

fiction writers generally are not.

It has long been understood that 'a picture is worth a thousand words.' Images have also successfuly added the concept of time (i.e., television, motion pictures). It is now possible to study the design of a highway visually by use of computer-drawn time-variant images on a remote terminal. The designer can 'see' the proposed road as if he were driving on it. Pilot training simulators provide a considerable degree of holism to aircraft landing and take-off operations.

The key is that the person is not a passive observer but an active participant in a dialog. Sensory and motor modalities are integrated to expand the information transfer rate enormously. The mutual reinforcement of multiple modalities is far more effective than an increase in precision of any one modality. And this proves to be feasible with computers used in a time interactive mode.[15] Another technique to enhance holistic communication is the concept of mind games. Developed by Robert Masters and Jean Houston, mind games facilitate altered states of consciousness which enhance images, subjective realities, and new space-time orientations.[16]

Jantsch suggests that holism can be approached in modeling by concentrating on the levels beyond cause and effect models (e.g., Newtonian mechanics) and statistically preprogrammed system models (e.g., econometrics). He reveals three higher levels:

(a) adaptive, evolutionary, morphogenetic dynamic models
(e.g., role playing, ecological models, Prigogine's 'order through fluctuation' principle)

(b) moral action models
(e.g., learning games, inventive system models, 'live' simulation)

(c) creativity or *Zeitgeist* models
(e.g., new cultural paradigms, generation of myths,

15. A. Johnson, 'Organization, Perception, and Control in Living Systems,' *Industrial Management Review,* Winter 1969.
A. Johnson, 'Information Tools that Decision-Makers Can Really Talk With,' *Innovation,* No. 10, 1970.

16. R. Masters and J. Houston, *Mind Games,* Viking Press, N.Y., 1972. A workshop in our Systems Science Doctoral Program at Portland State University provides training in this approach.

religions, ideologies).

We cannot expect to be successful at all these model levels, but they point the way toward holism in human system design. A small, but instructive, clue is provided by a recent study of the Parthenon, long considered a model of symmetric perfection. It was found that this edifice was built for the human eye, not the calculating brain. Departures from uniformity were intentional, yet 'deliberately casual and designedly unsystematic, having been taken at random for a purely aesthetic purpose, in order to temper lifeless mathematical rigidity with those minute irregularities which distinguish the living organism from its abstract generic pattern.'[17] This adaptation of technology to man clearly represents modeling at a more holistic level than practiced by traditional scientists and systems planners.

Medicine provides another illustration of the insights gained by holistic thinking. In the United States research has focused with considerable success on the conquest of disease. Organ replacement and life extension are popular fields of activity. Today there are 22 million people aged 65 and older; in 2000 there may be 28 million. As medical advances increase life expectancy, the retirement age is moving down. A man retiring in 1970 at age 65 could expect to live another 13 years; a man retiring in 2000 at age 55 can expect to live another 28 years. Thus the retirement period is increasing more than 100% in one generation! With childhood and school attendance growing longer we find that a man's life will consist of three roughly equal periods: 20 to 25 years of youth activities, 30 to 35 years of 'work,' and 25 to 30 years of 'retirement.' While the biological/physiological aspects of the aging problem have been addressed in strength, sparse effort has been devoted to the social/cultural/economic phases. The quality of life and function in society for the aged deserve equal attention in holistic systems design. We are beginning to search for a balance among the dimensions of life maintenance, quality of life, and societal role for the last third of the life span.

Communications and transportation technologies have shrunk the earth drastically in the past fifty years. We find,

17. R. Carpenter, *The Architects of the Parthenon,* Pelican Books, 1970, p. 14.

however, that the movement of goods and people requires far more energy than the movement of ideas. There are, therefore, trade-offs between transportation and communications which holistic systems analysis is starting to take into consideration. The impact of these technologies on the human psyche itself is of profound significance. The average American household spends 8 hours per day watching television and the average individual spends 27 hours per week. Children raised in a television era become accustomed to passive entertainment; Jean Houston refers to the 'switching society.'[18] With one channel depicting news footage from a Middle East war and another a science fiction story, the distinction between fantasy and reality is blurred for the young child. Sensory overload and inundation lead to an inability to cope and an urge to drop out. The high degree of mobility not only means a break-up of the multigeneration family but higher degree of discounting of the future (and past) by the individual. The rootless offspring is not interested in maintaining the continuity of home and tradition or of family history. We also observe an increasingly overstressed and overtranquilized society. Tranquilizer sales have been growing at an annual rate of 9%.

Finally, worldwide cultural homogenization and creeping cyberveillance[19] of individuals are possible consequences of communication capability which give rise to grave concerns.

Like a child playing with fire we find that the game of communications/transportation technology may have extremely serious unintended impacts. Our concepts of morality may well dictate a change in the rules of the game.

We have here clues that a truly holistic system approach should be fruitful for environmental synthesis. Obviously, we are still very far from achieving a *balance* between reductionism and holism, analysis and synthesis, yin and yang. But that is the hope which nourishes us.

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18. J. Houston, 'Prometheus Rebound: An Inquiry into Technological Growth and Psychological Change,' *Technological Forecasting and Social Change,* Vol. 9, No. 3 (1976), American Elsevier Publishing Co., N.Y.

19. Cybernetic surveillance.

COMMENT

Atsunobu Ichikawa

Linstone, in his report, challenges the validity of the concepts 'objectivity,' 'models,' 'best solutions,' and 'specialization' in the conventional systems approach. He then proceeds to suggest four alternative approaches: 'dual foci, the total entiry and the unique individual,' 'use of other inquiring systems,' 'recognition that there are no 'best solutions',' and 'a better balance between analysis and synthesis or between reductionism and holism.' If I may expound upon what he says, the first four concepts concern the interpretation of 'rationality' and the second four approaches the action to settle the conflicts resulting from that interpretation.

I see the matter this way. Both natural sciences and systems involving man have a common logistic approach: it first establishes a hypothesis, a predication or a paradigm, applies some logical operation to it and reaches a conclusion. In a natural science, 'observations' are added to the process; the results of the observations win universality through the 'Law of Large Numbers.' In a system involving man, however, what Jung called the sentiment, intuition or desire of irrational man himself restricts and modifies the established and underlying system of principles. When, following this modified logistic cycle, we can still make some explanation, we say that we have attained rationality.

In other words, the 'Law of Large Numbers' which serves instrumentally in obtaining universality in the case of a natural science proves ineffective in a system involving man as man himself does not follow this law. While one gram of water contains molecules to the 19th power of 10, for example, the people of the world — supposing they are homogeneous — have the density of only the 9th power of 10 and the number will become even smaller when they are limited to a region or a race. We can hardly expect anything of the 'Law of Large Numbers,' therefore, in a system involving people. Moreover, each man is an organic compound system, a distinctive machine assembled in precision of acquired and inherited characters. 'Rationality,' therefore, differs from one individual to another as each has his distinctive traits. It means that rationality in a system involving people must necessarily be subjective and it acquires scientific objectivity in appearance only when it has very strong persuasiveness.

When we review from this perspective the four concepts Linstone has made issue with, we could say that a 'model' is a way of getting what can be logically inferred in a particular hypothetical

system and, by nature, it cannot grasp the entity including people, the concept of 'an optimum solution'' is, needless to say, only just one of these hypotheses and it offers no guarantee of having universality, and 'specialization' is something in which each individual develops his logics within a particular set of axioms.

Rationality, as we have observed, operates with different prepositions. As Churchman says in his book, for example, there are cases in which when B is preferred to A and C is preferred to B, C is not necessarily preferred to A. This is cited as an example of irrationality. Appear as it may as irrational, it could still be interpreted rationally in terms of a more fundamental system of principles. In other words, rationality is basically dependent upon each individual.

When rationality is determined by each individual, people cannot make a decision as a group without causing a conflict. Making decisions or synthesizing them is, therefore, nothing but a conflict resolution itself.

There are three ways of resolving conflicts. The first is to make rules such as a majority rule. Rule-making is a matter outside the frame of rationality. Since the rule-making is itself a process of formulating a consensus, however, it could cause a conflict and, therefore, we cannot depend on this alone. This brings us to the second approach, which is to attach greatly influential power to a decision-making process. This technique is used frequently to affirm solidarity between nations. In our present case, we could place an emphasis on technical aides. The third approach is to present a new viewpoint or a new paradigm; it is imperative that it has persuasive power in some sense and it does not necessarily have to be only holistic.

Personally, I believe — and hope — that, notwithstanding the various criticisms of the traditional sciences, we should do our best in each of our fields. The development of the traditional sciences will expand the scope of our choices when we need to make them, as exemplified by the technological efforts concerning restrictions on exhaust gas. Traditional systems sciences, likewise, are very influential in terms of predicting or foreseeing what will come out of a system of principles. And the new systems science that Linstone and I have discussed must also work as a means to resolve conflicts in certain sense.

In short, we live in a society in which we have to devote all of our knowledge in order to predict the future and to formulate our concensus.

COMMENT

Takemochi Ishii

Having been educated in medicine in the beginning, I have a strong sense of attachment to an approach found in the fields such as biology and medicine, which is different from an analytical approach that is typical of physics at present. And having moved from the department of medicine to the department of engineering where I belong now and having learned the two approaches, I think both of them are necessary, each complementing the other. I believe, therefore, that the physical way of thinking or the analytical approach will not lead to the truth in the true sense of the word and will not be very persuasive unless it works together with the biological way of thinking. Having said this, I would like to make a couple of comments on some interesting aspects of Linstone's report.

Linstone says first that it is extremely important to show the entirety. It is a systems approach to try to grasp the entirety at once instead of segments. An organism cannot be comprehended well either when it is broken into lifeless pieces or when it is left alive in its entirety; the approach has a similar dilemma. To overcome this dilemma, it is very important to show it in its entity all at once. I think that the feeling that we understand something is a good starting point. It seems that our Eastern or Japanese culture has a great tendency to show things in whole and at once. Haiku and waka, for example, are based on the idea of putting an entire and complex feeling into the minimum of words. Kanji, too, contains a great amount of information in a tiny space. The Japanese culture, I think, has a very strong tendency to try to show various things in very compressed or shortened forms all at once.

Linstone also frequently refers to the question of objectivity versus subjectivity, maintaining that the object and the subject who experiments with it cannot separate from each other. On this point, too, efforts have been made actively in the traditional Japanese culture to obscure the border between the subject and the object. This has been so probably because of the all too mild nature in Japan. The Japanese have been so helplessly accustomed to the mild nature and obscured the border between the subject and the object so much that, on the bad side of it, they have destroyed the nature and caused pollution, leaving problems for the future.

The Parthenon, contrary to my earlier belief that it must have been designed precisely, is in fact deliberately somewhat distorted for the same esthetic reasons as the Horyu temple is built some-

what unsymmetrically. The similarity is interesting. I would like to tell two tales in connection with this. One concerns a Zen mondo (catechetic dialogue) in which a high priest at a temple told one of his disciples, a priest himself, to clean the yard. The disciple cleaned the yard as well as he could, but no matter how many times he cleaned it, he was told each time to make the yard more beautiful. Lost as to what he should do, the disciple finally asked the high priest what would satisfy him. The high priest then walked down the yard, shook a tree and made two or three leaves drop on the spotlessly cleaned garden. Here is a Zen way of esthetic pursuit, a concept that the true beauty lies in the deliberate partial destruction of symmetry at the end. The second one concerns a study of voices that I have been conducting for a long time. I have been trying to synthesize various kinds of sounds using a computer and the like, but it has been very difficult to synthesize them into a sound similar to a human voice. Most of the resulting sounds sounded like a flute. An investigation found a noise-like sound at a tiny spot near where the voice originated. When that is a little added, the sound becomes exactly like a natural voice and becomes very distinctive. When that is changed at random, the sound becomes close to the voice of one person or to that of another.

That there is something somewhat heterogeneous somewhere is extremely important to man. I feel that there lies one way that could accomodate and harmonize the interface between man and machine, man and things that are rigid.

Individuals and Society

Toshiro Terano

1. Introduction

The human society is formed in order to protect the interests of members, but it often happens that individuals' interests are adversely affected by the societal constrains. This conflict has been taken up since ancient times in the fields of humanities and social sciences but the solutions are not yet attained. Especially the rapid developments of technology have enhanced the awareness of rights on the part of individuals. As a result, the conflict between individuals and societies or between groups are being intensified more than ever before. If this trend should continue, the world will be ruined by psychic disputes before material shortages.

At this juncture what we scientists ought to do is not to pursue the truth regarding the problems existing between individuals and societies, but to work out rational rules in order to discover points of compromise regarding any concrete problems existing between individuals and societies. That is to say, social sciences ought to be goal-oriented and must focus upon synthesis rather than upon analysis. In this sense it is desirable for social sciences to be an engineering rather than a science. According to my own definition, systems science is nothing other than the application of the methodology of the systems engineering to the variety of problems in social sciences.

Engineering methodology is superior in terms of its goal-orientation, rationality, precision and positivism. If this type of methodology could be applied to the problems in social sciences, it will without doubt become a very powerful tool for social sciences. However, the objects of engineering and those of social sciences differ widely. For example, in the recognition of an object in engineering, there are practically

no individual differentials and it is not so hard to work out generalized theories. On the other hand, in those fields dealing with human societies, the objects are too complex to establish even a basic cognition of objects, and there are a variety of interpretations. It is also very difficult to prove anything by measurement or experimentation. Therefore. if engineering methodology should be introduced without fully considering assumptions or data which are the premise of theorization, there is a danger of imposing wrong conclusions unintentionally.

After all, in the methodology of dealing with human beings or societies, the analytical process must be generalized and objective. But the conclusion derived from them must be elastic with concomitant width and depth. In particular, in order to deal with the claims on the part of the individuals and the demands of the society simultaneously, it is necessary to develop new methodologies which can cover the multifacetness, self-contradictions and ambiguities inherent in the object. As examples of such methodology, I would like to take up "Fuzzy Set Theory" and "Structural Model." The former is adapted to deal with individuals' behaviors and thinking; the latter is fit to handle societal systems.

2. Analysis of subjective evaluations through Fuzzy Set Theory

Set theory is a field mathematics, which presupposes a group of elements with similar qualities and discusses the relationships among such groups. A set is a concept which is very abstract, qualitative and macroscopic. L.A. Zadeh[1] has expanded the scope of such set theory to work out theories to deal with an ambiguous boundary (Fuzzy Sets). This is very flexible and comprehensive in contradistinction to the conventional mathematical expressions which are assertive and unifaceted. Set theory does not presuppose infinite trials, nor focus upon average values as does probability theory. Therefore it is convenient in expressing subjective ideas and behaviors of human beings. For examples, the concept of "Young Woman" differs widely from one individual to another. and thus, very ambiguous. It can be expressed by, as in the case of Figure 1. to indicate age on the horizontal level, and to indicate "Grade" of belonging to this category (Set) on the vertical axis.

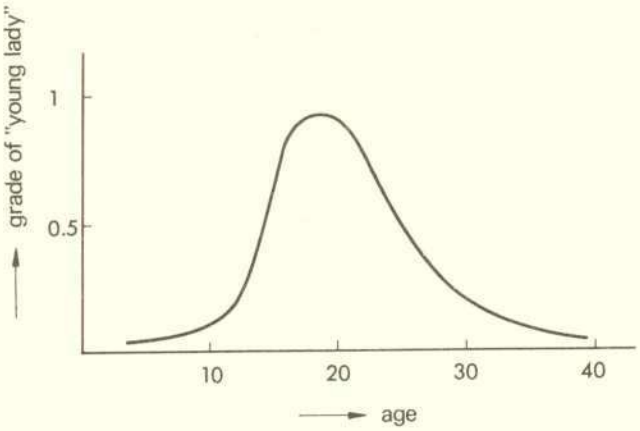

Figure 1: An illustrative example of a fuzzy set

Fuzzy Set theory has a relatively short history behind it. Therefore, its applications are not yet very well developed. However, it is drawing attention in such fields as artificial intelligence, behavior science, sociology, etc.[2][3] It is expected to bridge the gap between engineering, on the one hand, and humanities and social sciences on the other. Here I would like to indicate, as such an example, a mathematical model for subjective evaluations by individuals.

In the contemporary societies, many problems have their roots in the gap between individual's evaluations and the average evaluations of a society. The difficulty involved in evaluation problems can be summarized on the following two scores. The first is the fact that the criteria and the numerical scales of evaluations are not clear. We rely exclusively on the sensitivities of the evaluators and it is difficult to grasp them in a quantified manner. The second problem arises from the fact that the objects of evaluation usually consist of many parts, and the values of evaluation for each component must be synthesized to get evaluation scores of the whole. The degree of importance which the evaluators have for each component differs from one individual to another. Also, the method of synthetization varies. Accordingly, even if the evaluation scores of each component should be identical, the synthesized evaluation scores would differ widely from one individual to another.

Let us consider, as an example, the evaluation the of human face.[4] A human face consists of such parts as the

eyes, the nose, the mouth; in other words, many components of evaluation. The evaluation scores of these parts are extremely ambiguous as indicated before, Therefore we would like to express them in terms of the "Grade" which represents belonging to a fuzzy set of "Beauty." On the other hand, in evaluating the face as a whole, the subjective preference which the evaluator has for each part can be expressed in terms of the "Grade" of ascription to a fuzzy set of "Relative Importance." In this problem, we must make an overall judgment of ambiguous amounts by ambiguous criteria. As a mathematical model of this kind of problem, the fuzzy integral[5] developed by M. Sugano is most suitable.

We divide the human face into five parts, i.e., the eyes, the nose, the mouth, the chin and the profile as shown in Figure 2. These are denoted by $S_{i(i=1\sim5)}$. If the evaluation

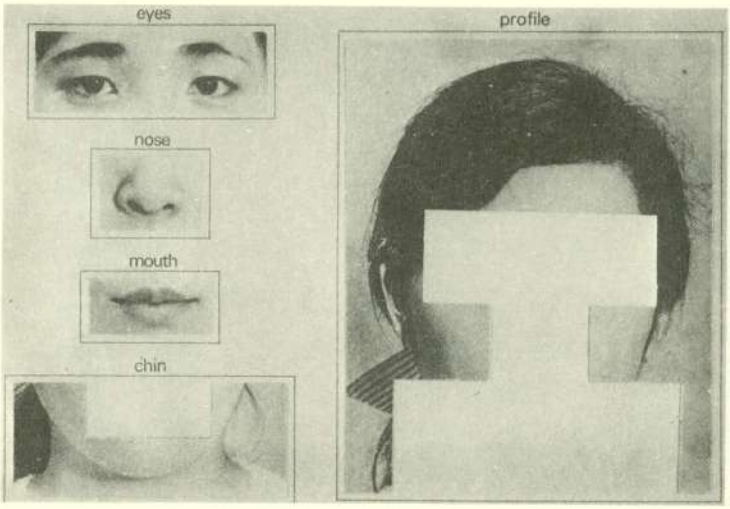

Figure 2: Evaluation of facial components

score of each part is expressed by $h(si)$ and the relative importance by $g(\cdot)$, the fuzzy integral is defined by the following formula.

$$f_{\Lambda} h(s) \cdot g = \overset{n}{\underset{i=1}{V}} [h(si) \Lambda\, g(A \cap K_i)]^* \quad \ldots\ldots\ldots\ldots < 1 >$$

If we compare this with the formula $\sum_{i=1}^{n} h_i \times W_i$, which is a weighted mean formula conventionally employed, we can see that $g(\cdot)$ replaces the weight W_i and the operation min. and max. correspond to multiplication and addition respectively. In other words, the formula $< 1 >$ expresses a

macroscopic calculation of expected values.

In this formula. $g(\cdot)$ satisfies the following equation.

$$g(si \cap sj) = g(si) + g(sj) + \lambda g(si)g(sj) \quad -1<\lambda<\infty \quad . \quad <2>$$

* In this formula, f stands for fuzzy integral. V and Λ are operators which select max. and min. respectively. Λ stands for integral area and S_i is numbered in the order of $h(s1) \leqq h(s2) \leqq \ldots\ldots \leqq h(s5)$.

$$K_i \triangleq \{S_{i+1}, S_{i+2}, \ldots\ldots S_5\}$$

This indicates that the weight of overall evaluation is not merely the total sum of the partial weights. Rather, the cross effect between these components should be taken into account. If λ is positive, this means that the combination of the components is quite important. If negative, it shows that there are some duplications among the partial evaluations.

The author prepared a picture such as shown in Figure 2 and asked students to make partial evaluations and overall evaluations through the experiment. We can determine the values of $g(si)$ and λ so that the result of the calculations by formula $< 1 >$ agrees with the experimental scores as much as possible. Then we can tell a student which part of a woman's face is most important for him. This can be considered as a mathematical model of mind. Figure 3 shows

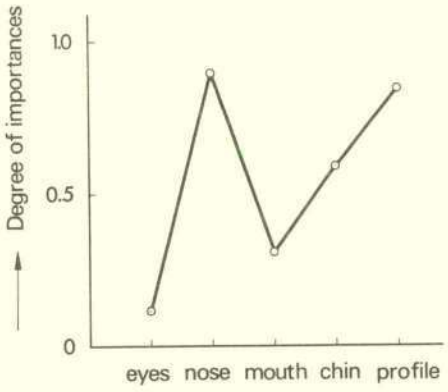

Figure 3: Degree of importances attached to each part

such an example. And Figure 4 shows the experimental values and the calculated values of synthesized evaluation in this case.

As has been shown so far, fuzzy set is a very ambiguous

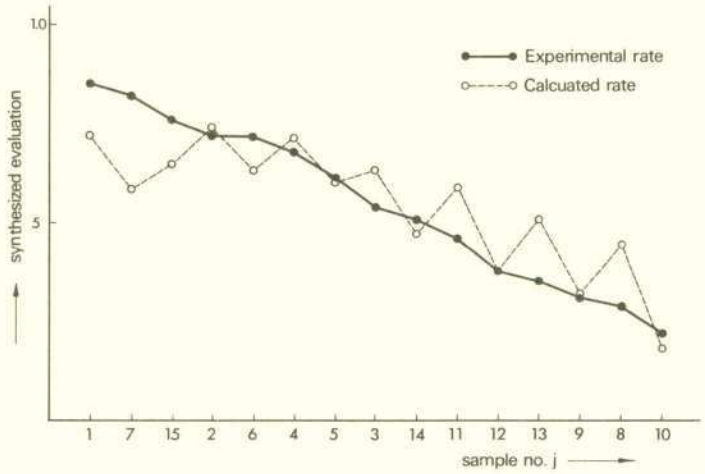

Figure 4: Comparison of calculation and experimentation in the appraisal of a human face

mode of expression. However, it seems to express essential attributes better than precise mathematical formulas in providing a model for complex human traits.

3. Social structural model

Another method to express multifaceted systems qualitatively is a structural model. In this, we take into account very basic elements comprizing the system, and their interrelationship is expressed by a network graph. If we select an appropriate number of elements, it is possible to express concisely and exclusively the essential structure of any complex system.

A structural model can be made exclusively by experiences and intuitions of the model builder without having to deal with the numerical data or to conduct complex analysis. It is also possible to make a model by coding the average opinions of a great number of people, using questionnaires. The structural graph itself is very qualitative. Therefore its interpretation has latitude. The more macroscopic a given structure, the greater the latitude. In this regard, it is very suitable as a social system model. To further enumerate the merits of the structural model, it can be intuitively understood by anybody so that it is suitable as a means of obtaining the basic common recognition. If the interrelationship between elements is given quantitatively, it

immediately leads to concrete conclusions through simulation or numerical calculations.

As a method to establish a social structural model, DEMATEL [6] and ISM [7] , both developed by Battelle Research Institute are most interesting. Neither of these employs an analytical technique. They make people use experiences and intuitions exclusively. The characteristic feature of these methods is to make the structure of consciousness latent in the mind of the model builders manifest. The major difference between the two is that the former deals with the structures of worldwide problems. Thus, questionnaires are sent to the influential people of the major powers. By so doing, it tries to work out solutions through making visual the structure of consciousness on their part. Whereas, the latter concerns itself with social problems which are immediate to us every day, and tries to explore optimal policy by making explicit the structure of the problem through group discussions and learnings among those who are affected by problems.

These are effective when problems are so complex that it is impossible to determine where to begin in analyzing them or in working out their countermeasures, or when there are divergences of views among the plurality of the parties involved so that the differences in their understanding or evaluation of the problem, which are the cause of these disagreements, are not clear.

Here as an illustration, let us consider the structural identification of complex factors which present in the administration of local cities. First we select three hundred keywords from the materials dealing with local administration. When these keywords are classified and codified, we obtain the following 22 items.

(1) Improvement of electricity, gas and water service
(2) Promotion of industries
(3) Vocational training
(4) Promotion of education and culture
(5) Provision of good leisure facilities
(6) Problems related to sex
(7) Demographic problems and problems resulted from age distribution
(8) Problems related to the overdensity and sparcity of population

(9) Pollutions
(10) Protection of the natural environment
(11) Prevention of disasters and crimes
(12) Peace of mind
(13) Health and welfare
(14) Integrated development of transportation
(15) Comprehensive plans to cope with social problems
(16) Making municipal finance sound
(17) The residents' participation in local autonomy
(18) Dissatisfaction with lacunae in legal systems
(19) Regional egoism (Attempts to satisfy the self-interest on the part of residents in a given region in a self-serving manner)
(20) Urban renewal
(21) High quality housing construction
(22) Rationalization and streamlining of distribution processes

The second step is to consider these items as the elements of a structure, and to discover the interrelationship between these elements. For this purpose any two given items are selected, and considerations are made as to whether or not casualness exists between these items. If there is a causal relationship between these items, these will be connected with an arc. This judgement must be done intuitively. By so doing, we can obtain a directed graph where vertex represent element and arc represent interrelationship.

Table 1: Vertex Matrix dealing with urban problems

The above example is considerably complex in terms of its structure. Therefore, it is represented in a vertex matrix, as is shown in Table 1, instead of graph. In this matrix, for

example, the fact that the element of column 9 of the line 1 is one indicates that unless good utilities are provided, "pollution prevention" is impossible. The blank space signifies that the element is zero, that is, the interrelationship is weak. The structure obtained here is very complex, and does not lend itself to a graphic representation. Thus, it becomes necessary to further reduce the structure. In so doing, we enlist the help of the bottleneck method. [8] As a result of such an operation, the items which are closely interrelated are combined to form subsystems. And the whole structure gets simplified as is shown in Figure 5. If we consider the physical meanings of

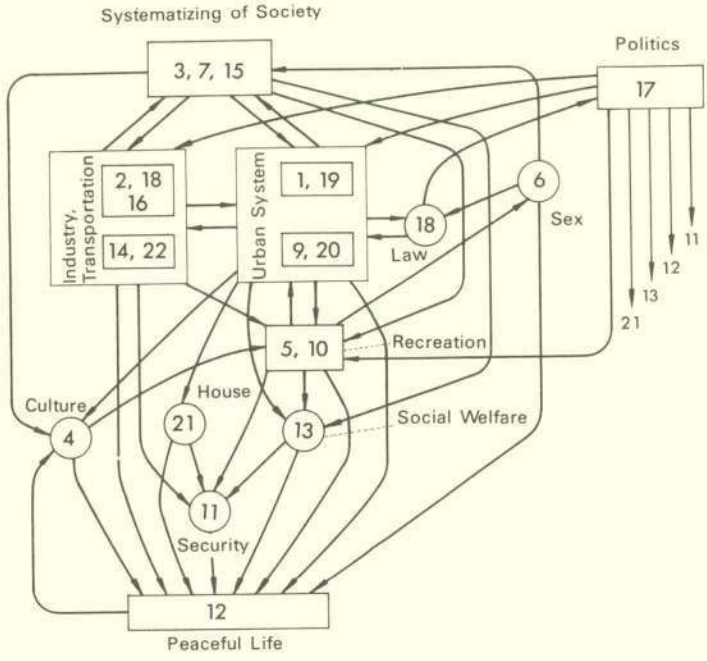

Figure 5: Struction of urban problems

the subsystems and integrate them into larger subsystems, a more simplified structure is finally obtained, as is shown in Figure 6.

Thus, when a great number of minor problems are integrated into a comparatively few subsystems, and when the interrelationship between these subsystems are explicitly and graphically represented, it becomes very easy to make decisions as to which policies should be given priority. Also, when there is a disagreement between two or more policy

makers, each policy maker will build up a structural model in keeping with his judgment. When these models are compared, it is possible to identify the causes of disagreement visually. The introduction of visual mode, there, will deepen mutual understanding, and is effective in preventing futile disputes.

4. Conclusions

If we want to solve the problems between individuals and societies through scientific methodology, it is imperative in the first place to create a common cognition. The two theo-

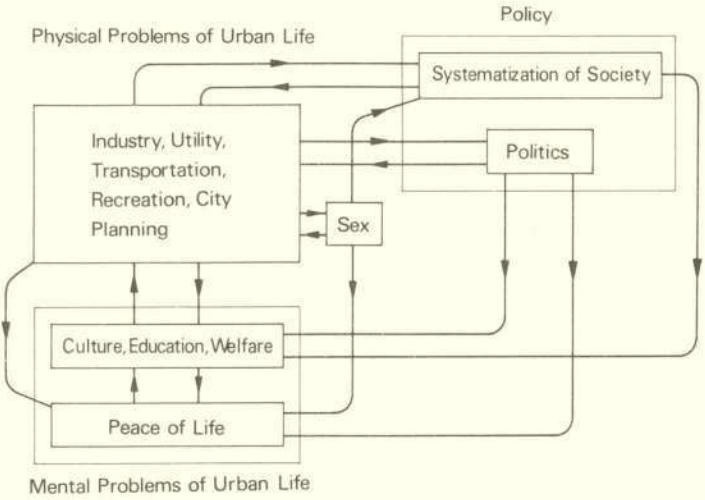

Figure 6: Simplified structure of urban problems

ries described here will be of great utility in the future as a model to grasp human behavior, due to their flexibility.

As indicated at the outset, since systems science is a goal-oriented discipline, it should not content itself with analysis of problems. For this purpose, all the methodologies now being developed, e.g., simulation method, technology assessment method, evaluation technique, systems analysis method, decision making method, should be employed in order to provide some concrete solutions. I believe this is possible only through interdisciplinary cooperation.

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COMMENT

Akihiro Suzumura

I am a doctor by profession, so I thought in the beginning that I would not be very suited to make comments on Terano's report. As I listened tohim, however, I found, quite delightfully, that there was something that I shared with him.

Many years ago, when I was very young, an internationally recognized scientist said that medicine was not a science. It was at a time when analysis was rapidly developing. He said what he did probably because of the slow progress of analysis in medicine and it was not without reason that medicine was not called a science at that time.

Terano, on the other hand, pursues to find some compromising point amid ambiguities or in what he calls a 'fuzzy set.' This is exactly the approach the modern medicine is taking.

Not everything is known in medicine. A question, for example, arises as to whether there should or there shouldn't be a surgery. A diagnosis of the present symptoms is obviously important. But the symptoms alone do not provide the answer as to whether, say, the ulcerous stomach should be operated on. For, a physician might conclude from the symptoms that medication alone will be sufficient, a surgeon might judge that a surgery is imperative, and the patient himself would like to believe that everything will be all right without an operation. How should, say, the doctor in charge make the decision under the circumstance becomes very important. Many things are still ambiguous in medicine in this respect. An X-ray and various other examinations may be helpful, but they do not clarify everything. In addition to the symptoms, moreover, other factors must be taken into consideration before deciding whether a surgery should be conducted or not: among them, the patient's age, his physical strength, his family composition which might cause his wife to object a surgery, his social status which might cause his surgery and the resulting period of hospitalization to make some sort of effects, the values and economic problems.

It is not as simple to find various compromising points there as Terano suggests in his report. In sumo, the judge follows a set of rules in declaring one of the two contending wrestlers a winner. In our human society, on the other hand, we must synthesize various things instead of simply following rules and we must make a major decision at some point before proceeding further. It is extremely difficult to make that decision.

There is an infinite number of factors or data in making the

dicision. And they change from time to time in terms of their necessity and importance. We in the medical profession are constantly reminded that man has such factors or data *ad infinitum*. And we must provide treatment while such data or factors are being accumulated with no possible end.

Under the circumstances, a collection of various factors from a systems engineering standpoint or through the establishment of fuzzy sets might lead to new problems in terms of the conditions for collecting these factors or in terms of the fuzzy sets themselves, presenting many problems difficult to solve and theoretically impossible to define.

The final judgment, therefore, must come from intuitions. It is an art, as Terano says. Without something excellently intuitive, it seems extremely difficult to achieve the final goal.

Let's take a student who asks what part of a human body he should pay special attention to in drawing a painting. The question, trying to find a general outline, is understandable. But, the nose, for example, does not stand alone; it exists in relation to the eyes, the complexion of the skin and various other factors.

Or take Mona Lisa. A legend in the medical world has it that it is a beautiful masterpiece because, as somebody measured the painting, the model was found to be squint-eyed. She appears to be looking at somebody who is watching the painting, wherever he is. This imbalance, it is said, makes her look very beautiful.

In medicine, took, something miscellaneous sometimes leads to a major clue. A skilled physician is someone who can make good use of it. This is outside the realm of science or the discussion in a group.

While I share the intention of the Terano report, I feel that it will be difficult to put into effect and there will be problems in terms of its approaches.

COMMENT

Akira Tsujimura

I think there are three important points in Terano's report and I would like to focus my comments on those three points.

The first point concerns his argument that social science should be goal-oriented. I agree completely. The other two points concern the fuzzy set theory and the structural model that he presents from the standpoint of systems theory in order for social science to become goal-oriented. I have some questions about these two points which I shall explain here.

As an example to illustrate the fuzzy set, Terano cites the beauty of a human face. Is it necessary, however, to break up a whole face, as he does, into various parts such as the eyes, the nose and the mouth? In our daily experience, it happens very often that we cannot recall when the person we have just met had glasses on. We might subconsciously perceive impressions of some part of the whole, but not consciously in relation to the whole. This corresponds to the argument in Gestalt psychology that the vision (perception?) of parts changes depending on the conditions of Gestalt of the whole. In sociology, Emile Durkheim of France said society indeed consists of individuals but differs from individuals. Or, more simply, water is a compound of hydrogen and oxygen, but its characteristics differ completely from those of hydrogen or oxygen. The same can be said about society and individuals. Society, to be sure, is made up of individuals; the individuals, to express somewhat mythtically, transform through certain particular combination into a totally different phenomenon called society. I think we should not ignore the thinking that society and individuals belong to a different level.

The structural model is certainly beneficial in terms that it enables visual conception of a structure. We already have a methodology called sociometry in socielogy and socio-psychology, which has proved very practical and effective. The structural model, in this sense, will be equally as effective. Even if the structural model discovers where the opinions disagree and even if the identification of problems is the first solid step toward solution, they may never solve the problems in some cases. This is illustrated by the problems facing the construction of the new trunk line and the new international airport.

My belief is that there is conflict between the interests of individuals and those of the whole that cannot be solved, even by the most modern techniques, and that a politician's determination becomes extremely important in such a case, particularly when it involves international issues. The late Prime Minister Shigeru Yoshida's determination to conclude the San Francisco Peace Treaty (1952) is a good example. A politician might lose his *raison d'être* unless he sometimes acts arbitrarily on his own authority.

In brief, there is a problem in the fuzzy set theory in terms of how to deal with the conflict between social realism and social nominalism in conceiving society, and the structural model also provides two main streams of thinking: to view society with an emphasis on conflict or to view it as a total, harmonious system. We should, therefore, try to find out what to do with the fuzzy set theory and the structural model on the basis of our knowledge of their two respective underlying main streams of thinking.

If the advice of a carefully selected panel of different disciplines had been sought, San Francisco would not have built BART. Cities are for people, and people have many needs. Transportation is only one of them.

W. Owen

Law does not have a rigid structure which deprives the society of the free elbow room to move in. It has a flexible structured system which swings within certain boundaries in keeping with the social changes. Thus law has attributes with which it can contribute to the progress and innovation of society.

M. Miyahara

To put it simply, civilization was born from nothing but wisdom. It may appear, on the surface, that sophisticated civilization of today has nothing to do with simple wisdom human beings possessed in the primitive days. If we take a closer look, however, we will see there is no substantial difference between them. Human beings labor for foods, chase opposite sex and raise children. This is exactly what other animals do. Human beings only do things in a complex way. Roughly, we can classify "shallow" wisdom into three categories: (in order) foods, clothes and houses. Immediately after the war, we sought for foods much more than houses or sex. Not to mention the post-war era, animals clearly show what is priority. In other words, human beings use their wisdom trying to get foods, clothes and houses in an easier

and more comfortable way. There are two types of wisdom — one being related to tools and the other is related to strategy. The former is called "hard technology." To make tools is an act of science and subject to the natural rules. On the other hand, the latter falls in the category of "soft technology." Since human beings live en masse, any strategy employed by individuals will essentially influence others. Consequently, they need to have rules and limits in making strategy.

The first tools were stonewares to kill games and earthenwares to serve foods. Tools have since seen no pause in progress. As human beings diversified and increased tools, they found it necessary to have another technology: distribution. What it means is to reallocate tools in terms of time and space. Thus, wisdom was firstly for the acquisition of foods, clothes and houses. In modern era, however, it is more for distribution and added value.

Since human beings live together, the process of distributing tools has to be formulated. (Those who use tools are not necessarily the beneficiary of tools.) Take lions and lionesses, for instance. Lionesses hunt in groups, a soft technology they developed over a long period of time. When the females bring games back, however, lions quickly eat the best chunk of the meat. We have difficulty understanding such a rule but, obviously, it is their "wisdom" for survival. Unlike the fierce animal, human beings conceive rules in mind. Naturally, some violate them. So, rules have to be imposed one way or the other. In addition, rules are after all written expressions and open for individual interpretations. There are occasions when various interpretations have to be weighed. Hard technology poses no such problem because it has to comply with the natural rules and the God gives the verdict. Man-made rules are hardly perfect, however. They should change according to time and place. Except for the basics, therefore, human rules have to be as flexible as possible. In fact, law leaves much "hazy" parts for judges to intervene.

It appears that our civilization is highly sophisticated and our social life is complex. If we think twice, however, although the elements of our life influence each other in a much complex way, we lead a life which is not so different from before. Take computers, for instance. They look like a terribly sophisticated calculator if compared with abacus. In

essense, however, all computers do is to add and subtract. Abacus do both. Amazed at the overwhelming appearance of them, you might even think that computers think by themselves. This, of course, is wrong.

We are perhaps caught in a similar misunderstanding about modern civilization. Today, human beings are trapped by a complex web of human relations. We have produced "tools" hoping to improve our lives and yet the tools now pose a threat to our lives — foods, clothes and houses — in the form of "pollution." We are scared and confused. Desparately, we try to make the prior assessment of measures we want to take. We put as many possible "relevant factors" into computers and attempt, uselessly, to figure out what impact such measures will give on our system. The more factors we put into computers, the more (blind) relaxation we get. New methods thus worked out, we are easily fooled, are always correct. This is a dangerous illusion as much as our illusion on computers. We will have to take a "naive" look at this. Without understanding "low level" problems like that, we won't be able to solve "high level" problems.

After all, civilization we have today is the mere accumulation of simple wisdom of ours. Seemingly sophisticated civilization is another wisdom to acquire foods, clothes and houses. Now, we are expected to answer a very basic question; which is better, a life with all kinds of tools and a polluted air or a life under a blue sky with less tools.

(I. Emori)

San Francisco's BART System

Wilfred Owen

San Francisco has completed its 118-km Bay Area Rapid Transit System (BART) which connects the city with outlying communities to the north and south, and eastward across the Bay to Oakland, Berkeley, and other inland points. It is the first large automated public transport system built in an American city.

The project was conceived in the 1950's as a means of overcoming the congestion and pollution of automobile traffic and of assuring the vitality of San Francisco. The city, it was believed, could maintain and strengthen its position as the focal point of the region if good access could be achieved by a modern public transit system of sufficient quality to compete with the automobile. As the project progressed it was promoted as a way to save energy, reduce highway requirements, create new growth centers, overcome suburban sprawl, and enhance the environment.

BART has not lived up to expectations. Travel on the new trains is half the projected volume; most riders were not lured from their cars but are former bus riders; bus systems that once gave good service are now financially embarrassed; the system has not added appreciably to the centralizing of functions in San Francisco, but has encouraged decentralization; costs are so high that fares cover only a third of the operating costs; the environment has not been improved nor has energy been saved; and the volume of automobile traffic on the streets has not been reduced.

BART is accommodating only 2 percent of the daily trips taken in the Bay Area and 5 percent of peak hour trips. Altogether patronage on the system is 50 percent below the forecast, though hopefully the figure can be doubled once the mechanical difficulties of the sophisticated electronics system can be worked out. Even so, costs will remain high

because the total investment was 150 percent of the amount projected and operating expenses are 475 percent of what was predicted. A trip on BART costs an average of twice what it costs to ride a bus and 50 percent more than it costs to operate a standard American automobile. The cost of buying a fleet of buses to carry all of BART's projected 1980 patrons would be $40 million compared to the actual BART system cost of $1,600 million.*

Other cities in the United States and throughout the world are now planning or are in the process of building costly rapid transit systems. They include Washington, D. C., Atlanta, Baltimore, Sao Paulo, Rio de Janeiro, Singapore, Manila and Teheran. How might the experience of BART help to guide these projects toward more effective results? How might rapid transit or alternative solutions be more helpful as a means of improving the standards of living and moving in the metropolis? Some answers may be indicated by analyzing what went wrong with BART.

One approach to such answers is to call upon the expert opinion of specialists from a variety of disciplines, and from citizens living in the area. The purpose will be to discover viewpoints that together may shed light on the fortunes and misfortunes of BART. The panel chosen for this exercise includes a city planner, economist, sociologist, demographer, transport specialist, historian, political scientist, technologist, and housewife. What does such a panel of witnesses tell us about BART, now that it is built, and what might it have told us before the project was begun?

The City Planner

It could have been predicted that BART would never reduce traffic congestion. Man persists in the belief that the urban traffic jam can be resolved simply by adding more transportation capacity. It just is not true, as anyone in Los Angeles, Tokyo or New York knows. There are two sides to the transportation problems of cities. One involves the supply of transportation and the other the demand for movement generated by the location and separation of places where people live and work, the number of people concentrated in a given amount of space, how many walk instead of ride, where they shop or go for recreation, and how much material is transported to factories and consumers over the

city's streets. Supplying transportation is half the problem, and it only half solves the problem. The city must also provide good housing and neighborhood services within easy access of employment, and it cannot overconcentrate jobs without risking the creation of traffic jams that no transportation solutions could remedy. The tendency in cities is for private investors to make most of the location decisions, with the result that the public sector is forever trying to compensate for the resulting traffic (and other public service demands) that often exceeds the supply of facilities.

It could also have been predicted that BART would not result in strengtherning downtown San Francisco as the focal point of the region. Good transportation allows people to escape the city as well as to gain access. They will escape to the suburbs as long as the city fails to offer an attractive living and work place with amenities, services, variety and esthetic appeal that people are now demanding of the urban environment. Transportation will not save the cities. It may, without simultaneous efforts to improve the quality of life, help to destroy them.

The Economist

Economics has been called the dismal science because it tells us that, given a specific amount of resources, their use for one purpose precludes their use for another. So the testimony of the city planner is disturbing. He tells of the need for better housing and recreation and and for a general upgrading of the environment, all of which takes money. But because BART is such an expensive method of transportation it absorbs much of the avilable tax revenues of the area. Fares will cover none of the capital costs and only a third of the operating costs. Revenues will have to come from sales taxes and property taxes, which hit low-income people the hardest. Actually the people who ride BART are mostly higher income people who live in the suburbs and commute at artificially low fares. The difference is made up by regressive tax levies. The rich ride and the poor pay.

The Sociologist

It is no surprise that a commuter rail type of transport facility like BART would be avoided by low-income people. People who are poor cannot afford even the subsidized fares

for long-distance commuting. Low-income people walk to the job if they have one, or they prefer to use the lower-fare local bus. Since they have no car they find the bus more convenient. It covers the entire city and makes frequent stops. It is a kind of public automobile that supplies service more suited to the spread-out automobile dominated metropolis. Remember too that the transportation needs of the household are not limited to travel from home to work. Families must also shop and visit friends, go to the doctor and look for recreation and entertainment. A rail system that involves a long walk to the station and then makes infrequent stops is no way to go shopping for groceries and other household needs.

But there is another reason why BART has not been much benefit to low-income residents, and on the contrary has been a disadvantage. Citizens inconvenienced by the noise, vibration and other negative environmental impacts of a transportation facility on an elevated structure are usually those who live in the poorer neighborhoods. Land value and damage costs are likely to be lowest where poor people live, and right-of-way can be purchased more cheaply in such locations. All the more reason, then, that BART is criticized on grounds of equity.

The Demographer

Let me say a word at this point. People think they are 'discovering' things about BART that were known before BART was ever built. For example, San Franciscans should not have thought, in the light of recent population trends, that the downtown center could be maintained as the focal point of the region. In the United States population has long been moving out of the central cities to suburbia, and now from suburbia to small nonmetropolitan towns and rural areas. In the process the center has diminished in importance and the regional city has become one of many centers. Nothing that BART could do would be capabie of supporting the primacy of a single center. In fact it appears to have strengthened the position of Berkeley and of Oakland and other growth points away from the center.

The Political Scientist

I would like to respond by saying that no region should

simply allow the trends to take over unless this is what is wanted. Urban regions such as the Bay Area need to develop plans for their future and to use transportation to help achieve them. But the obsolescence of government organizations and public policies often stand in the way of any rational growth plan or efforts to carry it out. In the field of transportation, for example, we have heard that the supply of transport capacity is only half the problem of assuring adequate transport. The other half involves land use. So the transport agency is in no position by itself to engage in transport problem-solving. It is in charge of only half the problem. In the same way, the future of downtown San Francisco depends in part on plans and actions in other cities of the region, and on office location policies and public investment strategies. The absence of a regional approach has led to the creation of a Metropolitan Transportation Commission and to the Association of Bay Area Governments, but there is a long way to go before there can be consistent and effective regional policies for the Bay Area. If it is true that transportation is a means to other ends, the ends should be made quite explicit. Only then could a regional transport investment of the size and cost of BART be expected to work out the way they were envisioned.

The Historian

Let me say that transportation throughout history has determined the size, shape and location of cities. It is a means to other ends, but it has also dictated what the ends would be. The size of a city was limited for many centuries by the number of people the transport system could feed. Transportation was primarily a constraint. With modern transport technology, however, almost any size city can be supported. We can no longer afford to accept whatever density, sprawl or environmental pollution the transport system happens to make possible. Man is now in a position, through a wide range of choices and through the growing interest and participation of citizens' organizations, to decide what it is he wants in the way of an urban environment and then to use transportation and whatever else is needed to achieve his objective. The age-old cause and effect relationship between transport and the city has been reversed. We do not build BART systems in the hope that they will somehow bring about the

conditions we want. We decide first to create those conditions directly, and then to adopt transportation solutions that are consistent with the desired goals.

The Transport Specialist

Too many people are 'discovering' things that have been known for years. No rapid transit system in the world, to my knowledge, pays its capital costs through fares. Most of them depend on general tax revenues to pay part of their operating costs. All new subways are likely to attract more riders from buses than they entice away from their automobiles.

BART made the mistake of putting all its eggs in one basket – that is, it invested heavily in providing an automated high-speed (120-km per hour) rail line, but it allowed the overall trip speed for the consumer to be reduced by lengthy waiting for infrequent service and by poor connecting bus service or inadequate parking at stations. Many people continued to ride the bus or to drive their cars because it takes less time to get all the way by these methods than by the new high-speed train plus other methods. The value of time is lowest when people are sitting in the luxurious comfort of a BART car, and time is valued highest when one is waiting for the train or trying to get to the station. A system approach to travel should put less money into high-speed main line travel and save something for feeder lines and frequent service.

Feeder line, *or* **feeder system,** *a transportation service system providing access to other transit lines or systems; for example, a bus system linking up with a railroad in a relatively low-traffic area.*

The Technologist

A rapid transit line of the BART type, however sophisticated its control system and however elegant its wall-to-wall carpeting, is still an outmoded method of transportation. BART can never be a substitute for what is dearest to most San Franciscans – their automobiles – until a brand new technology permits public transport to more closely duplicate the privacy, flexibility and convenience of the family car. BART covers too little territory and is not convenient to the many origins and destinations of urban trips. It was supposed to provide a seat for everybody, as does the automobile, and its cars were originally designed without anything for a standing passenger to hold onto. The basic idea was sound. No one stands in an airplane or in a Toyota. Why should they stand packed like sardines in a subway? But now on BART at certain times of the day more people are standing than are

seated. Hand grips have been installed for the standees. We need a new technology that promises privacy, flexibility, comfort, safety, and a seat for everybody. It is called by various names, but mostly personal rapid transit. The experimental models are being tested in Japan, Germany, the United States and elsewhere. Some day it may be possible to return the city to its people, to eliminate the private automobile, and to introduce into the city and its buildings a network of guideways on which will operate the automobilelike capsules that will accommodate individuals or groups travelling together. They will merely push a button for a nonstop speedy trip to the specified destination. For central business districts like downtown San Francisco this may be the answer — with connections for long-distance travel by other guideway systems.

PRT (personal rapid transit) system, *a rapid transit system providing personal service, or an urban public transit system through which one can ride a vehicle comparable with a passenger automobile in seating capacity and get straight to one's destination as if in a personal car. Guided by a computer, the vehicle runs automatically through the system, and therefore can be used by people who cannot drive a car. Among PRT systems now being developed are Japan's CVS, West Germany's CAT, and Britain's Cab-Tracks.*

Guideway, *a runway along which vehicles are guided. Broadly, a railroad track is a guideway. But the term is usually applied to the runways of new transit systems other than conventional railroads.*

The Historian (again)

Automated personal rapid transit that operates horizontally as an elevator operates vertically sounds like a dream. But if transport history has taught us anything it has taught us the inevitability of change. This century that began with the horse and the ricksha now flies in supersonic transports and has landed a vehicle on Mars. It would be a mistake to suppose that traffic-clogged streets in today's cities represent the fashionable way to travel in the future.

The Housewife

There are still some discoveries that have not been mentioned. In the city it would be nice to have more opportunities for walking, less noise and dirt of traffic, cleaner air to breathe, assurance that people on the streets will be protected from death and injury by motor vehicles, and neighborhood streets freed from the visual pollution of cars parked at the curb. BART costs will continue to eat into household budgets for many years to come, and only 2 percent of Bay Area trip-takers will enjoy riding on it. Meanwhile the measures that hold the highest priority for citizens of the area do not involve greater mobility by BART for some, but rather greater ease of access and higher environmental standards for all. Instead of costly high-speed methods of travel to help us flee the city, let us have cities that enhance urban life and entice us to stay.

Conclusion

It will be noted that no one of the commentators has introduced a new discovery. But often the testimony of one witness is a fresh discovery for the others. And taken together, the whole body of evidence becomes a discovery that may lead us to the truth. For the sum of the experience of many different disciplines is greater by far than the separate knowledge imparted by any one expert or observer.

In this case the combined evidence leads to the conclusion that San Francisco (and other cities) should first decide on what its goals are, then its priorities, and then the transportation solutions that need to be taken to make the goals of the community viable.

Perhaps if the advice of a carefully selected panel of different disciplines had been sought, San Francisco would not have built BART but would have concentrated on a superior standard of bus transportation, partly on exclusive rights of way, aided by area-wide traffic management and pricing policies that would give priority to public transportation. The region would then have put its resources into better housing and neighborhoods for those who need them, and into more recreation, education and social services.

The great discovery is this: cities are for people, and people have many needs. Transportation is only one of them, and should be used in conjunction with other developments to help in the realization of urban goals. It should not be allowed to take precedence, to drain public funds from other urgent needs, to waste resources, or to deceive us into thinking that moving faster means living better.

* Melvin M. Webber, 'BART's OUTCOMES: An Early Appraisal', Institute of Transportation Studies and Institute of Urban and Regional Development, University of California, Berkeley, July 1976.

COMMENT

Namiki Oka

First of all, Owen's report seems to be very useful when we review the subway projects in Tokyo. He says the construction cost of BART was too high, but the construction cost of a subway system being built or planned by the Tokyo Metropolitan Government amounts to 30 billion yen or approximately 100 million dollars per kilometer, compared with about 4.8 billion yen or roughly 16 million dollars per kilometer for BART. Increases in the prices of commodities, the difference in the total length of tunnels and the difference in the number of passengers preclude any simple comparison, but nonetheless, it makes us wonder how to describe the cost of constructing subways in Tokyo if he calls the construction cost of BART 'too high.'

Now, Owen organizes an imaginary panel of specialists who report their discoveries. He could have added a traveller from Japan, say me, to the panel and that traveller would have presented a different view.

The traveller would have said, first of all, that it would be still a little too premature to determine whether BART had been a failure or a success. BART was first conceived with an objective of accomodating 200,000 trips daily, and it is true that it carries only 110,000 to 130,000 passengers a day which is quite far from the original goal. One reason for this, as the report points out, has been said to be the failure to overcome mechanical difficulties of a highly sophisticated electronics system. To me, this seems to be a very important reason why BART has not achieved its original objectives. BART operates with an interval of six minutes in the city of San Francisco, or four times as long as originally conceived, and with an interval of 12.5 minutes in the suburbs against 4.5 minutes as planned at first. The frequent services were designed as an important subsystem which would enable the prospective passengers to use BART without waiting and to ride it seated. The longer intervals became another reason why BART was not so extensively used as conceived. Although one panelist attributes the lengthy waiting time to an inadequate assessment of the original BART project, I think the problem was there from the start and it remains technologically unsolved. I think that, in this sense, BART now needs to be more sympathetically viewed.

Secondly, the BART project has various new viewpoints that cannot be found in Japanese transportation projects yet. It is true, as Owen says, that transportation is only but one means of satisfy-

ing the many needs in a city and that it is meaningless to set up a transportation project alone. But it makes a big difference in the transportation project, which is no more than just a urban subsystem, whether it has its own concept of system.

Seen by a traveller, the BART project at least has a viewpoint about how to promote it among the citizens. Such a viewpoint is quite rare, it not totally absent, in Japanese transportation projects.

I notice in the BART system an innovative attitude as indicated, for example, by various subsystems for access to suburbian stations, 'park and ride,' 'bus ride,' 'wheeled chair and ride,' 'baby-buggy and ride,' 'cycle and ride' and 'walk and ride.'

The system in which BART passengers can use connecting buses and streetcars at half fares is an interesting experiment despite the view that this adds to the high expenses of operating BART. I think there are many ways with which to make the concept operative without costing money.

My point is, in short, that it would work greatly against our interests if we saw BART as Americans see it. BART was conceived as one system with an objective of accomodating 200,000 trips a day and various subsystems were conceived to achieve that objective. This provides us with a very educational lesson. Even if BART fails to achieve its objective because of problems in its subsystems, its concept can be viable in solving Japanese transportation problems."

COMMENT

Masaki Koshi

So far at least, BART has not succeeded as Owen says. But as Namiki Oka points out, there seem to be some areas that need to be clarified about its future.

Before going into this, however, isn't it necessary to think in general terms about a rapid urban transit system and its quality? In other words, we should take the following point into consideration before discussing the success or the failure of BART, i.e., the Bay area that is served by BART consists of highly densely populated areas such as San Francisco and Oakland on one hand and sparsely populated residential areas, on the other, which are fully equipped with a network of freeways and parking facilities in downtown and elsewhere. Hypothetically speaking, therefore, it should be obvious that BART would be undoubtedly successful and attract a great number of passengers if San Francisco and Oakland had only insufficient parking facilities in downtown areas, if these facilities

were very expensive to rent or if, without a network of freeways, roads were extremely congested. If, in the future, the population density of the Bay area increases and the downtown area becomes very active, it will no doubt become inconvenient to commute by car and, with the resulting decrease in the usefulness of automobiles, BART will clearly become increasingly competitive.

Now, let us turn to Tokyo. The quality of services in the railway system there, particularly the commuter train system, is obviously lower than that in the BART system. But almost everybody uses it. The congestion in the train gives rise to occasional complaints but these complaints do not lead to a demand for construction of better quality railway systems such as BART.

What is important here is to come round to the recognition that, as Owen points out, people have many needs and transportation is only one of them. In the case of Tokyo, the housing condition is very bad, recreational facilities and roads are poor and parking facilities are virtually non-existant. Amid such situation, the railway enjoys extensive use despite its very inferior services. This, as Owen says, boils down to the question of distribution of resources. And when a new transportation system is conceived that would replace the existing transportation system or the railway system, or when other needs are considered, they are weighed against the quality of daily living.

It was for this reason that BART did not succeed in the Bay area, where the people live in good environment and comfortable homes and do not find automobiles inconvenient. Excellent passenger coaches and various additional services such as park and ride had to be provided to compete with such high quality of life, this increases the cost of BART and the high cost rebuffed the people, thus falling into vicious cycle.

Could there be any place where a high-quality rapid railway system like BART could be effectively used? This again becomes a question of balance, i.e., how well the system could compete with other elements of city life in terms of quality. There might be places where the quality of the competing factors is just right to enable BART to accomodate itself very well. (I wouldn't know, of course, which cities of the world might be suited for BART.) I think that what can be said about BART holds true also with other transportation systems such as CVS.

Thirdly, Owen's report interests me particularly in connection with the financial measures to be taken for the construction and management of a railway. BART has ended with the poor paying and the rich riding, but this has been only caused by a difference between the social class of projected riders and that of actual riders and I do not think this is an essential problem. What interests me more is the fact that an object tax — sales or property — was estab-

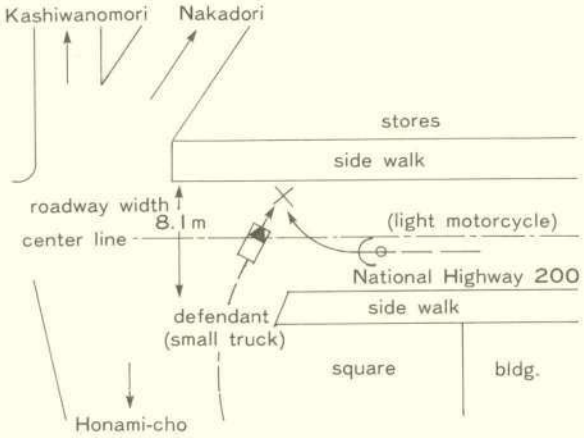
lished in the beginning and a referendum was conducted on the assumption that revenues will be drawn from the taxes. I do not know whether this method will work effectively in Japan. If it is found to work effectively in Japan, I think it will be a very clear and excellent method.

"Flexible" Structure of Law

Morio Miyahara

1. The court trial of a certain traffic accident

Defendant A was driving a car, and attempted to turn right, that is, from south to east near the center of an intersection. However, then the engine stopped for a moment, but it started again soon. A was about to turn right at a low speed of 5 km. per hour (the speed of a pedestrian). At that moment, B was driving a light motorcycle and was going straight from east to west crossing over the center line, and was about to cross the intersection, right in front of the automobile driven by A. A did not pay any attention for the sake of safety regarding eastward or the right-hand side as seen



from A, that is, the eastward from which the light motorcycle driven by B was approaching. A paid attention only to westward, that is, the left-hand side. Therefore the first took notice of the light motorcycle, at the close distance of about 5 meters, and applied the break immediately, but it was too late. The front bumper of the motor car bumped into the left-

hand side of the light motorcycle and the light motorcycle fell over on the spot. As a result, A caused an injury which would require one hundred day treatment. A was sued and was tried as to his responsibility for possible misdemeanor. In the first trial held at a summary court, A was judged to be responsible for the misdemeanor and was sentenced to pay the penalty of 20,000 yen. The second trial held at the court of appeals endorsed the first ruling. Thereupon, A made a final appeal to the Supreme Court. The Supreme Court judged A not to be responsible for misdemeanor and revoked the decision of the lower courts and referred the case back to them. The Supreme Court gave the following reasons for the judgment. "In such a case as this, it is sufficient as far as A is concerned to drive, trusting that the other vehicles heading westward would observe traffic rules and to take appropriate actions to avoid the collision with the automobile driven by A. A is not under an obligation to take notice in the conduct of business to anticipate a possible approach of a vehicle trying to recklessly cross in front of his car daring to violate the traffic regulations like B, and thus, confirm the safety regarding the right-hand side, that is, eastward, so as to prevent the occurence of the accident. (The judicial decision in the third Petty Bench of the Supreme Court dated the 30th, February, 1966. The Collection of criminal Precedents Vol. 20, No. 10, Page 1212)

The judge (singular) of the first trial at the summary court decided that A was responsible for the misdemeanor because he had to observe the duty of taking notice both to the left and the right in starting a car. The three judges at the court of appeals for the second trial held that A was under an obligation to exercise precautions to confirm the safety on both left-hand and right-hand sides. They admitted that victim B was also responsible for misdemeanor and B's misdemeanor was a factor for the occurrence of the accident. However, they ruled that this did not free A from the responsibility for the misdemeanor.

However, the four judges at the Supreme Court unanimously agreed that A was under no obligation to exercise precautions to confirm safety on the right-hand side. In other words, it was sufficient for A to confirm the safety on the left-hand side. They judged that the primary factor of this accident was B's reckless driving so that A was not responsible for this misdemeanor.

This is a case in which the judgment of the judges of the first and second trials and that of the judges of Supreme Court were diametrically opposite. The judges of Supreme Court, in contradistinction to those of the first and second trial, have introduced what is called "the principle of trust" (Vertrauensgrundsatz). This principle is one which evolved in German traffic accident precedents. According to this principle, the driver of a car, as long as he drives in keeping with the traffic rules, is permitted to behave trusting that the other drivers of cars would also observe the traffic rules. If, contrary to trust, the other party should fail to observe the traffic rules, and should drive recklessly so as to cause a traffic accident, he would not be used for his responsibility for the misdemeanor.

In the above-mentioned case, we can point out three problems regarding law.

The first is "what is the function of law?" The second is that legal interpretations are fluid. The third is, in the application of law, there is a room for the judges to be creative.

2. The function of law

In the first place, law is a set of criteria of judgment for judges to settle disputes. At the same time, law is a means of rationalizing the validity of a given judicial decision. In actual trials, it is not an exaggeration to say that the law is performing the function of justifying judicial decisions through rationalization rather than functioning as a set of criteria for judicial judgment.

The father of Dr. Gentaro Suehiro, one-time a justice at the prewar Japanese Supreme Court is said to have made the following remarks to his son.

"You try to think exclusively in terms of theories in applying law but that is a great mistake. When I handle a case, the decision occurs naturally to my mind in terms of years of imprisonment or the amount of penalty without thinking about legal theories. Three decisions spontaneously occurring to my mind will subsequently be rationalized in reference to legal stipulations and precedents, and I discover that these are exactly in keeping with theories. You may think that a judicial judgment is born from theories in terms of syllogistic reasoning but that is not what we do, although the novice judges may do so. Law is being taught at the universities in a

judges. Thus the judges are entitled to exercise the rights and the authorities to make creative choices.

The value judgment as to whether defendant A was under an obligation to take precautions or not differs from one individual judge to another, according to the "standpoint" taken by a given judge. The judges of the first and second trials took a stringent view regarding A's duty to take precautions, whereas the justices of the Supreme Court took a lenient view.

Since legal concepts have open textures with uncertain peripheral parts, their interpretations differ from one judge to another depending upon the "position," or the "standpoint" of a given judge. Justice Holmes of the United States Federal Supreme Court stated that a judge has to view the law from "the standpoint of a bad man." This "standpoint of a bad man" means that a judge should not take the position of a good man who considers that those acts which are to be accused morally are also illegal. Rather it is a position to have a narrow view of, and make curtailed interpretations of the boundaries of illegality. That is, to admit the existence of a "gray-colored intermediate area" which is to be accused morally but which is not to be punished legally as being illegal. The "bad man's standpoint" is also a posture to exercise authorities as much modestly and reservedly as possible. The principle of criminal law that gives a defendant the benefit of the doubt is in the same line as taking "a bad man's position."

"The principle of trust" is also a matter of "the standpoint" of a given judge towards law, that is, a standpoint which is modest and reserved which attempts to interpret A's duty to precautions in a restricted and a curtailed manner. The precedent which admits of the "principle of trust" is a noteworthy actual example of the judicial law-making by judges.

5. The "Flexible" structure of law

Dr. Kiyoshi Muto made the dream of erecting skyscrapers in Japan come true through the introduction of the "flexible architectural structure." He discovered by means of computer simulation analysis that the "flexible structure" gives super-high-rise buildings susceptability to earthquakes. That is to say "the more flexible a given

Although the content of the duty to exercise precautions is being clarified by the accumulation of precedents, as long as it is expressed verbally, an uncertain fringe, the so-called "penumbra problem" is always present. In the above-mentioned case, the judges of the first and second trials decided that defendant A's duty to exercise precautions involved confirmation of safety on both left-right-hand sides. On the other hand, the judges of the Supreme Court declared that A was under an obligation to confirm safety on the left-hand side, but the content of his duty did not involve confirmation of safety on the right-hand side. This indicates that the boundaries of duty to take precautions are really fluid.

Functionally this problem of uncertain fringe inherent in legal concepts makes the boundary between legality and illegality considerably fluid. As there is "twilight" zone between day and night, there is a buffer zone between legality and illegality in which a person may be accused morally but will not be punished by law. Mr. Kokichi Kurosaki states, "the actual society does not divide good and evil by one single line. The demarcation line is like a spectrum from black to white." In other words, there is an intermediate "gray" area which may seem illegal apparently but is not to be punished as a crime by social conventions. The so-called "gray colored high-officials of Lockheed scandal" is the case in point.

4. The creation of law by judges

In the third place, there is the creation of law by judges. That is the judges of the Supreme Court, contrary to the judges of the first and second trials, judged A not to be responsible for the misdemeanor, and introduced "the principle of trust" for the rationalization of this judgment. This "principle of trust" is not a traffic rule for the drivers of cars to observe, but it is a technique on the part of judges in passing judgment in a given concrete case for the sake of rationalizing the conclusion that a given driver is innocent. The justices of the Supreme Court made a creative choice by introducing "the principle of trust."

The fact that such legal conceptualizations as misdemeanor, or the duty to observe precautions have an open texture means that the boundaries of the duty to exercise precautions are fluid. Such boundary lines are drawn by the

judges. Thus the judges are entitled to exercise the rights and the authorities to make creative choices.

The value judgment as to whether defendant A was under an obligation to take precautions or not differs from one individual judge to another, according to the "standpoint" taken by a given judge. The judges of the first and second trials took a stringent view regarding A's duty to take precautions, whereas the justices of the Supreme Court took a lenient view.

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skyscraper is carefully worked out to be, that is, the softer the scrapers are, the safer they are against earthquakes."

There is a legal maxim "Summum jus, summa injuria." If law should loose its elasticity, irrational results are brought about. Law is interpreted and applied through the personality of a given judge. However, since it has an "open texture," judges are accorded rights and authorities of law making. Thus, flexibility is attributed to law. Law does not have a rigid structure which deprives the society of the free elbow room to move in. It has a flexible structure system which swings within certain boundaries in keeping with the social changes. Thus law has attributes with which it can contribute to the progress and innovation of society.

COMMENT

Shinpei Takuma

For those who are involved with traffic safety education or pedagogy, Morio Miyahara's report is suggestive of an extremely revolutionary point. This is that the social structure, too, is becoming 'flexible'; i.e., the diversity of values is permitted and, among the values, the sense of legal norms is becoming diversified.

In the Japanese educational system, 'a course of study' has primary importance. One of the courses taught at school is morals and it is impossible to introduce diversity into it without a revolutionary determination.

A teacher is required to educate children, with consistency, solely on the basis of his beliefs. Particularly at the elementary educational level, it is not reasonable to let the children choose courses they like.

Now, how could the consistency and the diversity be made to conform with each other? We must start with the fact that the patterns of development of norm consciousness progressively differ from one age group to another. The children up to 7 or 8 years old, for example, obey the authority without necessarily knowing right from wrong. Those between 8 and 11 years old develop a notion of equality and the 11- to 12-year-olds develop and notion of fairness. Put differently, the children under 8 to 9 years old are still at the stage where heteronomous morals or moralistic norm consciousness are something that is given by somebody else, sacred and monolithic, while those over 10 years old develop into a stage where they have 'autonomous' morals with rules that can be changed upon mutual agreement and without any likelihood of unilateral obedience to take place. Seen yet from another perspective, the 7- to 8-year-old children make moralistic norm judgment by its results and the 9- to 10-year-old children by its intention. A development model of children's moralistic norm consciousness has been presented in educational psychology to show stages of their mental development, but its actual application is made extremely difficult by the fact that moralistic norm consciousness falls into the area of consciousness, attitudes and the like.

The difficulty is furthered by the fact that 'regression' could take place in this area. Those which fall into the sentimental or emotional area such as moralistic norm consciousness are prone to regress by one or more stages. Such a phenomenon does not occur in intellectual educational fields, particularly in mathematics or sciences.

This means that traffic safety education must be conducted scientifically, in accordance with the stages of development of children's mentality and, particularly, their moral consciousness. Regarding law, too, various stages of mental development should be taken into account in, say, making traffic rules, instead of providing blanket rules covering both children and adults.

COMMENT

Shigeru Watanabe

My specialty is technology, or machinery to say more specifically. I am a complete outsider to the field of law and, therefore, my comments are those of someone who knows nothing about law.

In the process of making a machine, we first design it, make, say, an automobile of it and operate it. A machine is not 'soft' at all; to the contrary, it is 'hard' and it must be 'hard.' "Law must be equally as hard or rigid, I think. In his report as a low scholar, however, Morio Miyahara observes that law has soft, or flexible, aspects and it should not be very rigid. He sounds reasonable. But I would like to challenge him from the standpoint that to be flexible is bad in many ways and that is not very good.

Flexibility implies 'anything will do.' It seems to be the authorities who benefit from this sort of flexibility. Those with power will have their way if interpretation is flexible. The powerful here can be the president of a company, a cabinet minister, a value or social justice. Values differ from one era to another and it would be unbearable for people if what was once considered to be a right value is not judged wrong.

Let's say we have the 'principle of trust.' If a judge makes judgment using his personal perception or an 'appropriate' principle based on his private sense of values without it being made clear whether there are contradictions among the principles that are many, in other words, if one man's sense of values is used to control somebody else, that somebody else must feel it to be extremely unreasonable.

Take a traffic regulation. It is, obviously, made by man and the 'trust' there is based on a commitment among people, not on their natural behaviors. Since there are many kinds of trust, each must be rigidly defined by law.

Actually, however, law is filled with ambiguities and we are daily faced with many problems resulting from such ambiguities or irrationality.

The reason for this, as I see it, is that while the concept of law being 'hard' — 'rigid' — as it was imbedded into the Japanese people since Prince Shotoku announced his ordinance, 'Taiho Ritsuryo,' combined with the feudal system to turn them into an extremely law-abiding and obedient people, the authorities made many ambiguous, that is, 'soft' regulations so that they could interpret them as they wanted.

What should be done? The answer, I think, is to make law a 'hard,' not 'soft,' structure. When it becomes a hard structure, we will need too many regulations and precedents to remember. So we can turn to computer for help. We have developed technology that can process far more information than the three billion cells in a human brain possibly can. Why can't or shouldn't we use, for the operation of law, the computer than can process information so speedily on the basis of such a staggering memory capability?

I do not think this technology can be put to use right away. But the times are changing rapidly and the existing laws will very soon become unable to cope with many problems such as the increase of automobiles, pollution, the population explosion and possible food shortages. Why shouldn't we change these laws continuously? As long as we have a tool that we can trust, they can be issued and scrapped on the same day. What is needed is the formulation and preservation of precisely worded laws that would be devoid of human errors.

This might require an improvement on the part of human beings themselves. Already there have been cases where an absence of appropriate law made impossible the social application of newly developed useful technology or systems. There is a time lag between legislation and technical innovations. Officials have been trying to simply explain it away or to shy away from it, but it seems the time is fast approaching when such an attitude cannot be tolerated any longer.

A great deal of care must be taken to consider if the optimization being considered is not really a sub-optimization that could have some negative consequences on the system as a whole.

M. Turoff

We should decrease the extent to which each member of a society is inflicted with pains out of those whose responsibilities need not be ascribed to him or her – "absurd pains."

S. Ichii

With the evolution of science and technology from the research and developmental stage into the present stage of widespread use, there have arisen unexpected phenomena in our society one after another. One of them, with direct impact on us, is the urban transportation problem. When the automobile was still being studied and developed, no one perhaps imagined that, with the development of automobile technology, production process and automation technology, it would be produced so quickly and become so popular as it is today. And it must not have occurred to anybody at that time that the destruction of urban environment might entail this motorization.

This brings home to us that it is now impossible for scientists and technologists to be involved only in their own fields.

Today, like it or not we must conduct our human activities, always giving consideration to how to develop science and technology and spread it in society.

We must recognize that technology is part of our human activities in society and grasp the philosophy inherent in that technology from a synthetic viewpoint as a problem for all of mankind. It is on this basis that technological forecasting and technology assessment become indispensable and, in conducting them, it becomes necessary to grasp their philosophical meanings and make effective use of methodologies and techniques within that framework.

Generally speaking, the basic question in forecasting the future of the activities of civilization is not how precisely we can perceive the future. It is how much philosophical and scientific substantiation we can place in the matter of how we can forecast the future of mankind and how we can control and manage the activities of civilization on the basis of what we know about the present.

The real question in technological forecasting is what it is that we can know about the future or, more precisely, how we can substantiate this.

There are the following five basic, philosophical pursuits inherent at the root of the assessment of civilization, technological forecasting and the like.

1. Leibnizian pursuit

Basic to many theoretical sciences, this rests on the idea that "truth is analytical," which means to say that the Leibnizian pursuit is used to solve the various problems in physical sciences. Various simulation techniques using computer and the operations research technique are good examples of this.

2. Lockean pursuit

Basic to many empirical philosophies, it rests on the idea that "truth lies in experience." A systems model, therefore, is an empirical model in this view, and it is always constructed on direct observations. Specifically, various forecasting models based on statistics and the law of certainty are good examples.

3. Kantian pursuit

A theoretical system with the idea that 'truth lies in synthesis." This considers that the truth of a system is contained in both theory and experience, not one or the other. The cost effectiveness analysis by the Planning-Programming Budgeting System (PPBS) and the Delphi method are good examples.

4. Hegelian pursuit

This is a dialectical pursuit that rests on the fundamental idea that "truth lies in conflict." The truth of a system emerges through a complex process of conflict between diametrically opposing plans. Data are all meaningless by themselves. They become meaningful "information" only through combination of conflicting data. The author of this chapter, M. Turoff, has proposed a "Policy Delphi method" which takes into account conflicting concepts.

5. Singerian pursuit

A practical philosophy which revolves around the basic idea that "truth lies in practice." This is a concept most needed for "interdisciplinary research." Specific methodologies and research techniques are yet to be developed.

With these fundamental concepts about human activities in mind, we have selected the following two reports for this chapter. Both of them discuss the relationship between "human activities and environment" along with people's sense of values, serving insight that are indispensable for the creation of a new civilization. **(S. Aida)**

Assessing the Future Impact of Computers and Communication

Murray Turoff

Introduction

Not so very long ago it was more or less taken for granted that any technological change or advance was inherently good. This has changed in recent years to the point where each new item of technology or each new application is being subjected to what is commonly referred to as a Technology Assessment. In essence, this is the process of trying to determine, a priori, the future impacts of the technology upon society. Often the emphasis is on trying to delineate the indirect consequences. For example, when the automobile was first introduced, writers of the time pointed out the elimination of the street pollution caused by the horses as a major benefit. No one seemed to foresee the pollution problems the automobile would generate. Yet, today, this is the foresight that is expected of such efforts.

In the U.S., these activities take place under the various titles of Technology Assessment, Future Research, Technological Forecasting, and Systems Sciences. What can be said is that an assortment of methods have evolved or have been utilized to deal with this goal. However, there is no established set of axioms or philosophical premises that can guide the choice of approach or clearly establish the criteria of validity that one would expect in an established scientific discipline.

Therefore, it is extremely important that in attempting to delineate these future alternatives and consequences, one must consider the inherent limitations or weaknesses of the methods which can be utilized.

We will look at the essence of what is involved when one relies upon the extrapolation, normative, prescriptive vs. descriptive, operations research, and expertise approaches to

technological forecasting and assessment. In order to illustrate the processes and possible pitfalls involved with each method, this paper will focus on specific examples drawn mostly from computer technology, which is the area with which I am the most familiar. I hope, however, that you will be able to think of parallel examples or applications in your field.

It should be noted that technology in the area of computers promises to continue its rapid rate of advance with respect to significant increases of performance and reductions of cost. While there is little doubt as to the magnitude or degree of impact these advances will have on society as a whole and upon such specific areas as energy and transportation, there is a great deal of uncertainty as to the manifestation of the impact and the exact nature of the resulting society.

Extrapolation

Probably the most common approach to hypothesizing the future is the process of extrapolating current trends. One formal representation of this is regression analysis, which, for example, forms the basis of most economic models. Probably one of the most widely extrapolations of current trends is the steep line which shows the earth's total population now, and what it will be in a hundred or two hundred years if it keeps increasing at the current 2% annual growth rate. A population forecast made by projecting such *current* trends shows that whereas there are approximately 4 billion people now, we would have almost 29 billion people on the earth by the year 2076. Now one of the few groups which might find this prospect to be attractive, is your traffic safety engineers, who certainly would have a great deal of work to do to keep the resulting mass of humanity from being stalled in a permanent traffic jam.

As I am sure you are aware, what is wrong with simply extrapolating current trends is that one is implicity assuming that there will be no changes in the underlying complex mechanism, processes, and technology which have produced the trends, and no feedback process which slow and stop growth when it gets out of control.

Extrapolation, by the way, is what most people implicitly engage in when they think about the future, unless they are

forced to examine the underlying factors, values, and the consequences of these projections.

A good example of extrapolation which ignored the possibility of a fundamental shift in underlying factors occurred in the computer field in the late sixties and early seventies. The tendency in the sixties was to centralize computer operations in terms of increasingly bigger computer systems. When hardware represented the principal cost of a computer operation this was the logical or "cost-effective" choice. One spoke of the decreasing cost per instruction with increasing machine size. As a result of this, those who were concerned about providing computer capability to the public evolved the concept of the "computer utility." There are a tremendous number of articles and a good number of books published in the late sixties and early seventies that forecast the computer "utility" for the general public and drew analogies with electric utilities. Almost everyone was looking at current trends and extrapolating what was taking place. What actually occurred was something else entirely — the emergence of the calculators ("the little things that count"). The calculators emerged as the first direct delivery mechanism of computer technology to the public. Today the microprocessor is clearly emerging as the next mechanism of delivery with a fast growing computer hobbyist movement. Instead of what was forecasted by the majority of those in the industry, a completely different line of development has occurred.

In the area of computers, change is the rule rather than the exception; hence, extrapolation is a dangerous tool to use. More subtle than the numerous changes in technology is the changes in the way people do things as a result of the use of computers. Much too often the computer people design systems to replicate what people have been doing without computers. What really happens is that the experience people have with computers cause them to realize that there are new ways they can do things. One example is the potential for effective decentralization of management functions. Most of the current efforts in the design of Management Information Systems have largely been based upon continuing the pre-computer trends in most organizations toward greater centralization. The ultimate fantasy implicit in numerous current designs is the concept of a single chief executive running a world-wide operation from a single computer terminal

keyboard. Sometimes the case is made through extrapolation by analogy. There can be little doubt as to the success of centralized computer control systems for utilities and transportation systems; but to argue that these situations are analogous to a management situation is fallacious or at least involves a high degree of conjecture.

Centralization of control in organizations has lead to severe problems in communications between levels of management. The computer system acts as a further filter on the details of a given decision situation such that those at the top have less and less of the details of the situation available to them; these people are overburdened from dealing with far more day-to-day decision matters and so have less time for major policy considerations. Contrary to popular usage, the computer is an ideal technology for fostering the coordination and communications necessary in a decentralized organization emphasizing delegation of authority to managerial levels where the issue under consideration is the primary concern. This has become particularly evident with the work in both the Delphi and Computerized Conferencing areas (see references).

These areas involve utilizing computers to structure the process of communication among a group of humans so that a large group of individuals can effectively contribute their knowledge and wisdom to the examination of a complex problem.

Normative

Another method of approaching an examination of the future is to hypothesize the environment that should exist at some future time. Then one examines what set of circumstances, actions, or policies would lead to the conjectured situation. This future situation is considered a priori a desirable one. However, it is in the setting of the normative goal that the potential fallacy lies. What is desirable depends implicitly on some assumption of values. Many attempts at this type of approach utilize today's values in specifying a desirable future state. By far, one of the most difficult areas to deal with is the potential changes in values, and yet we know this can have a tremendous impact on future environments.

In the computer area, the most relevant example is the

change of values taking place with respect to the view people have of computers and the use of computerized information about individuals. It wasn't too long ago that planners seemed to be acting under assumptions that the average citizen would accept the computer as infallible. Designers would implement systems with little provision for correcting errors or dealing with exceptions. One of the most amusing examples was the unemployment insurance system in Canada where the identity card is utilized by Canadians for cashing of checks. One poor individual, whose stolen card was being used to cash bogus checks, had become a criminal, or bad credit risk, in the eyes of the government's computer. When this individual requested that the government correct the situation, he was officially informed that he should change his name, at which time he could be issued a new identity card. Apparently, they had no other way to correct the situation. Examples of this sort now seem endless. They have led to a great deal of skepticism on the part of the public, which is resulting in laws — federal, state and local — that are, in effect, adding major requirements on information systems dealing with information on individuals. Today a large proportion of the public has come to look upon the computer as an evil demon and the result is a demand for protective laws.

An example on NORMATIVE approaches in the traffic area is the city of Stockholm where a number of years back a policy decision was made to seek the reduction of automobile ownership, by improved cheap public transportation, creating auto-free street areas and increasing various fees tied to automobile ownership. Recent years have begun to show a decline in the ownership of automobiles in the Stockholm area. Many claim the ultimate goal is now an auto-free Stockholm. Although not universally ascribed to, it appears to be the current working doctrine.

In western societies there are very significant current value differences as represented by different interest groups in the society. This makes normative approaches even more difficult.

In the area of traffic planning a good example of value differences are seen recently in one very large American city when the traffic planners presented a plan for a very large and elaborate elevated highway to replace the old, deteriorated

highway which ran along the waterfront at the edge of the downtown area. There was no question that this proposed new highway would solve the traffic congestion and safety problems presented by the old deteriorating highway. However, the residents of the city protested that they did not want more cars moving faster along their waterfront: What they wanted was a place for more people to move slower — more green space and more park land. They succeeded in pressing their views over those desiring the highway so that for the first time in modern U.S. urban history, an urban highway was actually torn up and replaced by grass, trees, and pedestrian walkways, rather than by a bigger and better complex of concrete and steel.

Prescriptive versus Descriptives Systems

This is the classic philosophy problem of the distinction between the concept of "is" and "ought." The emergence of computer systems had added a new and dynamic example of this issue. In hard science areas such as physics, the goal is a law that represents a truth in the sense of describing what "is." However, in opposition to hard science areas, the information system or simulation model on a computer has a possibility of acting as a template and forcing society to conform to its description of it — specifying what "ought" to be. It would be as if someone wrote $F = -MA$ and after that all apples flew up from a tree instead of down. Clearly, if a major economic model of a country predicts a downturn in the economy, enough individuals, might as a result, withhold spending or investments in sufficient quantities to actually be the cause of bringing about the predicted downturn. While this is a well-known example, consider a more subtle situation.

There is a definite movement today to the computerization of the hospital medical records on patients. Because of various needs for clinical data and federal requirements it is very likely it will be possible to gather statistics on a national basis. It will also be possible to reorganize this data to form a data base on the performance of every physician. The rising cost of malpractice insurance may influence the insurance companies to foster this development so that they can tailor insurance rates individually by physician. If this were to occur, then many doctors might start to shy away from taking

high risk cases. What we have here is a supposedly "descriptive" data base having a "prescriptive" impact at a third order level in the chain of possible causal relationships.

The ability to delineate and examine these indirect consequences where the real difficulties may occur requires a good deal of creativity on the part of those doing Technology Assessments. This has become extremely important because the use of computers has resulted in a situation where a model or data base designed to describe what "is" can end up prescribing what "ought" to be. In other words, instead of measuring the real state of society, the system ends up regulating the society to conform to the ideas of the designers of the system.

Operations Research

Compared to Technology Assessment and Futures Research, Operations Research can be considered an exact science. Unfortunately, many people have assumed that some of the standard OR approaches can automatically be used in these new areas. Each technique borrowed from this field must be understood in terms of its limitations.

Optimization

OR has relied heavily on finding optimum solutions to specific problems. Unfortunately, the scope one must deal with in the TA area is usually so broad that no single optimization criterion is possible. A good example of this is in the area of inventory systems. One of the most "successful" applications of computer systems over the last few decades had been the computer monitoring and control of inventories. The net effect has been that individual companies and corporations have been able to save considerable sums by reducing warehouse capacity and inventory stocks compared to previous manual operations. In a social sense this has been a series of suboptimizations by individual organizations, which may not be optimum for society as a whole. This was demonstrated in the United States by the oil embargo. Computer inventory models were constructed to be effective for normal delivery delays and their expected deviations. The oil embargo threw many logistic chains completely out of shape with no adequate stocks to account for such a perturbation. In some cases, electronic components

dependent on high-quality plastics from the petrochemical industry went from two-week to six-month delivery delays. A great deal of care must be taken to consider if the optimization being considered is not really a suboptimization that could have some negative consequences on the system as a whole.

Measures of Effectiveness

The above example was, from another perspective, the conflict between two opposing measures of effectiveness: the profits of companies, and the stability of the society. We have no theory that can tell us how to weight the trade-off between multiple or conflicting measures of effectiveness. This is still a judgemental choise too often made by the analyst and not by those who should be involved. More importantly, it is not often clear what is a measure of effectiveness and in some instances, what direction of impact is desirable. To take one extreme, suppose we consider the possibility of a cashless society, probably a very real possibility in the U.S. in the next decade or two. By a "cashless society," we mean a computerized electronic funds transfer system which automatically debits the account of a buyer and credits the account of a seller whenever a transaction is made, anywhere in the nation by eliminating the need for actual money to change hands.

One measure of effectiveness one could hypothesize for the benefits of a cashless society is a reduction or even elimination of all forms of crime involving cash. One would tend to assume that this would be good. However, looking from a different perspective, one can consider that type of crime to be a signal to society that something is wrong since it is the easiest for people to turn to if they cannot find a living within the law. A rising crime rate forces society to react. If one removes this signal of trouble without having another signal just as effective, the resulting might be a revolution instead of a rising crime rate.

Cost Effectiveness and Discounting

Even if we assume we can measure the effectiveness of a system and know how to weigh different measures applied to the same system, we are still faced with the problem of making a decision. There are a number of standard approaches,

the most popular being picking the system which maximizes the Benefit-Cost ratio. (This used to be called the Cost-Effective choice before the term fell into disrepute with the ending of the MacNamara era). It can be shown that the mathematical nature of this choice is such that the more optimistic a situation is, the less effective the decision will be that is based upon this criteria. In fact, if it is a very easy thing to do from a cost standpoint, the decision will be to do nothing. In terms of what one would consider the desirability of a scientific law to be general, the cost effectiveness criteria is extremely unsatisfactory. The most common impact of this in the computer industry is for software systems to be built that do not have the flexibility to deal well with errors. While the cost-effectiveness criteria is a useful one for making relative comparisons among system alternatives that are already acceptable on numerous other considerations, it is an undesirable approach to use on an absolute basis. Also, attempts to apply it to societal issues quickly raise the issues of who receives the benefits and who bears the costs which are the heart of the real work of the analyses.

Other decision alternatives that are also utilized in operations research are:

Maximize net gain
Specify minimum effectiveness and minimize cost
Specify maximum cost and maximize effectiveness
Minimize risk (e.g. maximize product of effectiveness and efficiency).

The choice of any one of these alternatives is in essence a value judgment and almost impossible to justify for examining future societal alternatives. In some of the attempts to utilize these techniques in this area, one finds, for example, attempts to estimate the value of a human life.

The application, or the presupposition, that a specific criterion will be utilized to pick an alternative also has a psychological impact on the analyst in terms of pre-influencing what options will actually be examined.

Related to the area is the use of discounting future costs and benefits, which is almost taught as a cookbook procedure to be used without exception. Many analysts don't seem to realize that it is based upon the rather severe assumption that the cost and benefits are independent from year to year. However, there are many societal areas where this is not the

situation and effects and costs are accumulative, e.g. education, medical care. In addition, computer systems in many cases exhibit compounding or dependent effects over a span of years and great care must be taken in using any discounting techniques.

For example, the rather significant resistance to the introduction of Computer Assisted Instruction into the school systems in the U.S. is possibly a result of looking too narrowly at short-range impacts as measured by comparatively short-term experiments so that long-term accumulative benefits are never exhibited or considered in the tradeoffs. Even if examined the use of discounting would wipe out their impact from consideration.

Expertise

It is not clear that our historical concept of utilizing "expert" opinion or judgment on technological issues carries over into TA and future studies. In recent years the Delphi Method has become popular for balancing expert judgment from imputs of those who might be directly affected from technological change. For example, a recent Delphi by Bell Canada on the Future of Home Communications involved not only experts in computer and communications technology but also housewives. The process started with the experts emphasizing the likelihood of computerized home shopping. Quite clearly, the ability of the technology and the involvement of the experts with the technology drove them toward a very biased view of the desirability of this application. On the other hand, the housewives emphasized that such a system would take away their primary excuse for getting out of the house and further remove their ability to determine the quality of the products they purchase. After a number of rounds where these views were exposed, the "experts" began to comprehend that such a service might not be as popular as they had thought.

Today there is a significant trend to involve those who are to be affected by the technology in the assessment efforts. In my own view this is healthy, as I feel that those of us who tend to become engrossed in the delights of the technology and its developmental challenge can easily lose sight of the end user's reaction.

Reductionism

The classical approach to complex problems is to break them up in components so that individuals with different expertise can solve their piece of the problem and the whole can be pieced together. This is referred to from a philosophical standpoint as "reductionism." This has proven to be impossible for biological and ecological systems and it is now becoming apparent to many people that it does not work for social, economic and political systems. The result has been an attempt to evolve new disciplinary areas such as General Systems Theory or Systems Science. There is as yet no clear paradigm for these areas, at least that I can detect. There is however a growing understanding of what the problems are in looking at a system as a whole. A traffic system is not separable from a public transportation system, and neither is it separable from the social and economic aspects of the areas they serve. The problems in integration of all the aspects of such systems is largely human bandwidth and the fact that individuals trained in different aspects of such systems many times have difficulty in communicating different prospects. My own hope is that the right communication and information systems can go a long way to overcoming these barriers. They must be less rigid than those we are familiar with today and ultimately allow a group of people to obtain a "collective" intelligence capability where the performance of the group in dealing with a complex problem is better than any of its members.

Reflection

The process of studying the future without understanding the philosophy underlying the techniques used and their resulting limitations, is the exercise of a mythology. However, approaching these problems with this understanding is to engage in the practice of a science. This process of understanding and seeking the most appropriate match between problem and approach I would term "reflection." It involves determining what question needs to be asked. By the time we have formed the question, we ahve also dictated the approach and very often implied the answer.

Computer technology has advanced so rapidly that many professionals in the field have come to believe it is the driv-

ing force for societal change. In reality, it is no more than a new tool which may be used in very alternative ways which will be determined by the values of the society. We certainly know that various direct consequences will occur, for example:

> Newspapers will largely disappear, to be replaced by electronic information services.
> First class business mail will be reduced conservatively by 50% over the next decade and be replaced by electronic versions.
> The opportunity for working at home a significant part of the time will be available via computer terminals and networks.
> Recreational and home use of computers will be a major market for the technology.

What we can't predict is whether computers will be used to dictate to us what we can or can't do: where we are allowed to live; what job we may have; what education we can obtain; where we can take a vacation, etc.

Computers can be used to substitute information for energy and resources. If the latter continue to get scarce, the desire of society to survive can increasingly force the use of computers to utilize information to regulate the use of these resources at both the collective and individual level. Whether computers are ultimately used to foster a rigid or a flexible society depends on how we proceed to examine our options for the future in all areas and how we arrive at our alternatives and choices.

References

Further explanations on approaches to Technology Assessment and their philosophical foundations and limitations may be found in:

> Mitroff, Ian, and Murray Turoff, "Technological Forecasting and Assessment: Science and/or Mythology?" *Journal of Technological Forecasting and Social Change* Vol. 5, No. 1, 1973.

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> Linstone & Turoff (editors), The Delphi Method; Techniques and Applications, Addison Wesley Publishing Co. 1975.

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Some examples of reflective forecasts in the computer area may be found in:

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COMMENT

Yoichi Kaya

In his report, Turoff discusses assessment of, and techniques to assess, various problems that might occur in the future, with an emphasis on information systems. I agree with him in more than a few points; here, however, I would like to present mainly my critical views.

In discussing the problem of measuring the effectiveness of a technology assessment in his broad sense, or the question of how to measure the effectiveness, Turoff points out that the concept of the cost-effectiveness analysis ceased to be popular following the ending of the MacNamara era. I think it is true. It seems nearsighted, however, to say that the concept itself is wrong. I think it to be far more meaningful to interpret the concept in a broader sense.

To illustrate what I mean, let us examine a cost-effectiveness analysis of family planning, a field I am familiar with. Effectiveness is assessed in the following manner. When family planning is successful, the number of new births declines and, therefore, the costs required by pregnancies and child-rearing drop accordingly. The sum of them all is effectiveness. Such an approach, which is used in Turoff's discussion, only has a narrow view of effectiveness. The cost-effectiveness analysis was rated badly because, I think, this was how the effectiveness was often viewed. What we should be concerned about in family planning, instead, is indirect (in a broad sense) effectiveness of a certain decrease in the rate of population increase that might enable, say, a developing country, to end a vicious cycle of population increase and economic stagnation, improve its economic development and, thereby, benefit itself. A cost-effectiveness analysis that does not take this sort of thing into account is meaningless. True, it is difficult to measure effectiveness of this kind. But in any case, I think that the cost-effectiveness analysis would be more meaningful if it is viewed in a broader sense than in the past when it was defined very narrowly.

What I have said concerns indirect effectiveness. In a technology assessment, indirect damage often becomes a problem. From this arises a question of trade-off, a question of where to find a compromising point when effect and damage occur simultaneously. We must keep it in mind that, unless we study very carefully who benefits and who suffers, the matter of trade-off may not occur at all in a technology assessment.

Let us take the construction of an electric power plant as an example. The people who receive electricity, companies and

general public, from the power plant — be it a nuclear or thermal plant — obviously benefit from it. If the plant generates any damage, it will be limited to the residents around the power plant. In other words, the power plant benefits the general public but causes damage to some people. There might certainly be a question of trade-off in the sense that one side benefits and another side suffers, but it becomes a matter of either all benefits or all damage for individuals, which does not easily lend itself to trade-offs. In other words, what is normally considered as a trade-off matter is often found not to be a trade-off matter when closely analysed. So we are still yet to solve the question of how to cope with such a situation.

Concerning normative approaches, Turoff says they cannot be used casually because they depend on values and changes in values would drastically change the results. I think this is again too narrow a view of normative approaches. By taking a broader view of them, however, I think normative approaches could be more effective than extrapolations in hypothesizing the future. For one thing, normative approaches restrict the range of ambiguities in a forecast. It is for the same reason that economist Jan Tinbergen supports normative approaches for forecasting the future. Secondly, while it is too difficult to simplify or generalize problems we deal with and which often form very large systems because we have to take all too many elements into account, an establishment of certain norms makes it possible to simplify the problems within the conditions necessary for those norms. Results change with changes in values, but it will be possible to revise a scenario by changing original norms in various ways. Normative approaches, therefore, could be very effective under some circumstances.

COMMENT

Kaoru Noguchi

The development of computers might be considered as the biggest technological achievement for the last 20 years. Computers are, despite our attempts to control them, now rapidly pushing forward a wide-range of activities which once only our hopes. We draw the following five benefits from computers other than in the area of massive computation.

First, computers are frequently used to make a comparative study of plans and policies by forecasting measurable results, although their forecasts are often wrong. Secondly, they are used by researchers in various fields to classify and process their data. This

is what we routinely benefit from computers, but we have not come to a point where we can determine how successful we are in this field. Computers may be reducing our intellectual activities just as much as we feel we have read abstracts by photo-copying them and simply file them away. Thirdly, they are used to enhance the efficiency of economic or practical services. We have been considerably successful there, but we are yet to determine the strategic effectiveness of such a use of computers. The fourth benefit of computers concerns simulations of human behaviors, such as seen in recognition models or recognition robots, thinking robots, motor robots and voice robots. The fifth benefit concerns development of new communication models or systems.

It is this fifth benefit of computers that Turoff's report has relevance to. Let us briefly discuss from a behavioral scientific standpoint what such an application of computers presents.

We must first recognize that the present society is changing from a transportation society into what might be called an informational or communication society and, at the same time, evaluate the major contribution that system engineering has made to that change. Take urban transportation planning, for example. Attention was paid only to transportation itself in the past. Today, however, transportation is not considered simply as a movement of people and material and transportation studies are conducted with a heavy emphasis on what they move for. This new concept is dramatic in terms of levels of engineering.

But the question is whether sufficient consideration has been given to how those individuals who are directly affected by the change react to it. There would be no problem if, say, Shannon's proposition — he is well-known for his communications theories — that the transportation of information is equivalent with the transportation of goods or people is discussed within the frame of communications theories or adjacent theories; it is problematic, however, that this proposition has been directly applied to the scene of our life. In other words, although we have to recognize that we are moving from a transportation society into an informational society, we should given more consideration to ecological or psychological aspects of the change.

What impact, then, is the computerization of our society having on the behaviors of the people?

First of all, computer-operated images or electronic images make human relations indirect; more bluntly put, they turn us austic without our knowing it. A famous experiment on a substitute mother, entitled "Motherless Mother," shows that a monkey who has been brought up without knowing the kind of comfort that can be gained through direct contact or skinship with his or her mother tends to be extremely austic and, as a child or after she herself

becomes mother, she cannot copulate. She has happened to become a mother by accident and she shows no maternal behaviors; when her child opens his or her mouth wide, the mother runs away. This happens not only to monkeys but to human being as well. A human child often stops communicating with his mother and starts communicating with television when his contact with other people decreases. Moreover, contact with a visual human being or a "manless man" with the absence of a real human being causes problems in non-verbal communications. Non-verbal communications are more important than verbal communications for the formation of our emotions and personality, as indicated by recent theories in prokinetics.

Secondly, very vague allergy against science will develop in the informational society. Already, there is a term "informational pollution." This sort of social allergic phenomena or psychological rejection symtoms is not likely to simply disappear.

Thirdly, there is a question of who controls computers. Communications by computers are potentially capable of making all sorts of controls by human beings extremely powerful. Therefore, we must have firm perceptive power to understand how the control of human behaviors by information is related with the direction of the "domination."

Environmental Problems and the Value Principle

Saburo Ichii

1. Preface

The development of industrialization in modern times has brought about the so-called environmental disruption on a scale and in phases never anticipated heretofore. The cluster of problems related to transportation and safety forms a part and parcel of the overall problem of how to cope with this pollution. Especially, depending upon how a traffic organization is evolved, the environmental problem which arises therefrom involves sedentary or stationary residents who are not involved in traffic at a given moment, and causes many conflicts which are difficult to cope with. I, for one, as a philosopher, deem it necessary to work out a new value principle to deal with this kind of dispute, and that the rules for its practical application be worked out.

With the development of bourgeois society, a variety of the citizen's consciousness of rights has become further diversified, and those rights are incessantly clashing with one another. The 'progress' of transportation has made this kind of collisions manifest and complicated. For the better solution of this problem, the above-mentioned self-conscious value principle and the rules for its practical application — in one word, what could be called 'the theory of societal equity' — must be established.

Since more than a decade ago, I, for one, have been proposing, as such a value principle, the following formulation. "We should decrease the extent to which each member of a society is inflicted with pains out of those whose responsibilities need not be ascribed to him or her — absurd pains." The principle thus formularized I consider to be that of social

equity in a broader context. In this symposium, I would like to discuss the mode of application of this principle in relation to several concrete transportation problems.

2. The Characteristic Features of the Value Principle

In order to answer the question of on what grounds the above-mentioned value principle can be justified, one must make an extensive argument based on the history of ethics for the past several centuries. The time does not allow for this sort of argumentation here on this occasion. I hope that you would refer to my treatises already published.

However, the following must be made clear here at the outset as the bare minimum. (1) The principle that I propose negates the principle of utilitarianism which has governed the so-called 'advanced' industrialized nations. (2) The principle I propose is one which approximates itself to the 'maximin rule' in the fields of the theory of the game or cybernetics. (3) It, therefore, points out the apolia (self-contradictory difficulty) of aiming for the maximization of what are considered to be positive values. Thus it can be deemed as the most rational value principle in the real situation with its shortage of information and its limitation of various resources. I would like to elaborate on these points in this order in the following.

(1) The value principle of utilitarianism makes a point of maximizing the overall utility or pleasure of the society. Therefore, it endorses a policy which increases the overall, societal utility or pleasure, even if such a policy might increase non-utility or non-pleasure and pains in a certain segment of the members of the society. This has frequently manifested itself in giving priority to public benefits. The 'public benefits' in this context, has often been conceived in a simplified manner as being identical to the efficiency of industrialization, which is, by definition, good. It has been believed that the victimization of the interfacial residents by inflicting non-utility or non-pleasure and pains upon them, is more than compensated for by the increase of social utility through realizing public benefits.

This sort of optimistic value principle of utilitarianism of the past, is forced to reconsider itself closely in the face of the generation of pollution far exceeding anticipations in its scale, the depletion of resources, the widening of the gap be-

tween the North and the South, and the resulting intensification of international conflicts, demographic problems, etc. The warning by the Club of Rome is just one example of such a trend. Therefore, the kind of value principle to be agreed upon in the future must be one which will more explicitly advocate the fundamental human rights of the victims of the evolution of industrialization, and the least advantaged in its process.

(2) What is called the 'maximin rule' in the theory of the game or OR (operations research) is a specific rule to be applied in those theories to a certain, specific state of affairs. That is to say, the 'maximin rule' is applied only when information is scant as to in what probabilities the respective upshots of a number of possible policy decisions will come to materialize. To put it in extreme terms, it can be said to be a rule for minimizing victimization, rather than maximizing benefits. The value principle I propose has an affinity with the 'maximin rule' in the above-mentioned sense.

In the first place, the technique of environmental assessment which measures in advance what kind of positive or negative outcomes will result from a certain technological or entrepreneurial project on the part of the interfacial populations when it is implemented in a dense, societal phenomenon, is itself extremely insufficient. That is to say, there are many cases in which the information as to the probabilities of the materialization of such outcomes is deficient. Therefore, the value principle hereafter, as opposed to the principle of utilitarianism, should be formularized on the basis of the necessity of adopting the 'maximin rule' in reality.

(3) In the past, the various principles of socialism sprung out of the soil of the Western ideas, aimed at the maximization of some sort of positive values. For example, Marxism claimed that the kingdom of freedom (as ideal society imbued with freedom) would be brought about by the infinite realization of material production. Now, however, the finiteness of material resources on the global scale has to be discussed. In such a situation, the illusory and utopian nature of some of the above-mentioned socialistic values and ideals has become evident.

That is the reason why a more humanitarian and realistic value principle is necessary. And the fact that the formulation of the value principle that I propose, is oriented toward

the negative minimization of 'reducing the absurd pains,' is due to the foregoing reasons. Also in the same formulation, the expression, 'not to be held responsible' is used. That is because, for its verification, a far less amount of information will suffice in comparison with its opposite, i.e., the verification for holding someone to be responsible. In this case, what I mean by 'responsibility' concerns itself only with whether an action on the part of the party involved forms a decisive factor in the chain of scientific causality.

If we start discussing what moral or legal responsibility is, we would be drawn into a bottomless quagmire. The value principle I advocate puts a brake upon such a discussion, and aims at the minimization of victimization.

3. The Rules for Application

With the diversification of the consciousness of bourgeois rights, such as a consciousness tends to clash with one another increasingly more. To take traffic administration as an example, the actual cases of such collisions often take the form of a conflict between 'public or official' decision on transportation policy and the consciousness or rights on the part of the residents affected.

Therefore, we must start by discussing in the first place what a 'public or official' decision should be. Can a sort of decision made under the cause of 'public benefit' without any consultation with the residents involved be called a bona fide 'public' decision? The answer is obviously in the negative. The reason is, in such a case, in reference to the value principle I advocate, the possibility of increasing what can be regarded as 'absurd pains' is great.

It goes without saying that there are clashes of interests among what is called as 'the residents affected or involved.' There is an argumentation going on that a new plan for traffic system has to be worked out in secret by public agencies, because to leak such an information beforehand will bring about drastic fluctuations in the price of land and other assets under the market economy. I would like to point out, however, that a plan for a new traffic system which denies the residents' participation comes across obstacles far exceeding anticipations, and ends up in a state of deadlock. If I dare refer to the concrete examples, I can enumerate the plan for the Narita New International Airport or the plan for the

freight line of the Japanese National Railway (cutting across the traditional commercial areas of Yokohama).

The problem of the drastic fluctuations of land and other assets can be coped with in some way administratively or legally, apart from the prior consultation with the residents affected. A larger problem lies in the increase of the 'absurd pains' which may arise when a given plan is implemented.

In other words, the value principle which I advocate, as one of its logical conclusions, to a certain kind of priority rules. A 'public' decision is based on some consciousness of rights. But when it collides with the consciousness of rights on the part of the residents involved, the value principle that I propose, provides an ordering of to which conflicting demands, the priority should be given. This is an ordering which holds that a decision should be made so as not, at least, to increase the 'absurd pains.' It must be said that this is only natural in view of the maximini rule I referred to in the foregoing. The fact that one is refused to participate in a consultation prior to a given decision means that there is no need for the same to be held responsible for such a decision. Therefore, the pains inflicted by such a decision, all become 'absurd pains.'

It was a step forward that the plan for the Osaka New International Airport provided for a prior consultation with the residents involved, in view of the deadlock of the plan for the Narita New International Airport. If one wishes to avoid the increase of environmental disruption (that is, 'absurd pains') under the phenomenon of increasingly more dense urbanization, there is no other option but to site an airport on the sea distant from heavily populated areas. There exists a sufficient technological feasibility to carry this out.

To enumerate the concrete examples in addition to the above, there exist such problems as the photochemical smog which may be ascribed to automotive traffic, the destruction of the natural environment due to the expansion of highway networks, the contamination of the atmospheric sphere by SST, etc. Although we would have to rely heavily on new scientific and technological studies in solving them, the problem of how the collisions of the consciousness of rights should be settled in terms of social policy, is also of utmost urgency. I have stated some ways in which the value principle that I propose, can be applied, and suggested the rules for its

possible, ample applications.

NOTE (1) Reference works by the author:

"Meiji Ishin no Tetsugaku" (The Philosophy of the Meiji Restoration). Kodansha, Gendai Shinsho, 1967, Chapters 1 and 10.

"Gendaishi to Kachirinen: Oboegaki" (The Contemporary History and Values or Ideals: a Memorandum). Iwanami, 'Shiso'. February, 1970.

"Rekishi no Shimpo towa nanika" (What is the Progress of History?). Iwanami Shinsho, 1971. Chapter 6.

COMMENT

Chikashi Nakanishi

As I see it, there are two types of research of "conflicts." One is called the micro-theory, an approach to conflicts from the interrelation between individuals and from differences in individual characteristics. Psychology, biology and the decision-making theory employ this approach. The other is the macro-theory. Conflicts are taken as phenomena that stemmed from the interrelation between social methods. Sociology, ethics, communications and political science use it to analyze conflicts.

We don't believe that we can properly solve conflicts or arm ourselves with any useful theory without combining both micro and macro approaches.

I generally agree with the priciple Saburo Ichii put out in his report. However, I also have to raise some questions.

Firstly, we will have to give a second thought to the relations among government, corporations and inhabitants or citizens. Among others, there is a fiction in parliamentary democracy given to the post-war Japan. The fiction holds that "inhabitants" and "citizens" are equal and that "inhabitants" are consisted of "citizens". However, citizens are the ones who develop character rationally. In connection with conflicts, they can precisely calculate the relative advantages of themselves and others and take rational actions accordingly. It is open to question if "inhabitants" are as rational as citizens. When it comes to government, under the ruling party system which Japan takes, may bills are rammed through the Diet with the sheer force of seats. Citizens or inhabitants do not sincerely believe that the Diet — local assemblies included — represents the public as it is supposed to. On their part, corporations have always been practical. Under a mixed capitalistic economy Japan maintains, corporations cannot cease to be practical. And yet, they began to realize the need to correct their practicality one way or the other. They are not fully aware of the necessity, however.

In Japan, conflicts can be classified into two types in terms of locality or space. One exists in rural farming and fishery areas where collective control system collapsed in the wake of high economic growth. Many conflicts arise among those who want to preserve the traditional system. The other exists in urban areas. Due to rapid progress in urbanization, many rural villagers turned city dwellers and found themselves in an atmosphere where they could freely express their "private" rights. In villages, such rights

were oppressed. This trend brought about the burst of egotism, a problem which has something to do with that of citizens and inhabitants.

From the standpoint of inhabitants, therefore, Japan's conflicts will have to be considered as those of the central government vs. local autonomy, corporations vs. the central government, corporations vs. inhabitants and inhabitants vs. the central government and local autonomy. As Saburo Ichii reported, it is desirable if we could shoot such conflicts without bloodshed by employing a fair principle. But, I have to ponder if Japan or other foreign countries has successfully formed "citizenry."

Another point I like to make is, as Saburo Ichii also mentioned, that if government tries to meet every individual demand, then its finance will have to swell. On the part of corporations, they have to raise prices in order to pay anti-pollution facilities and others. The above indicates that conflicts have to be solved as part of social system with due consideration on the cause and effect among various social elements. In other word, having heard about the philosophical fair principle or the total denial of practicality, I still have to say that we can solve conflicts without giving the full thought to money.

COMMENT

Shunpei Kumon

I agree with some of the points which Saburo Ichii has made in his symposium report and his books. At the same time, however, I cannot help but have a number of questions.

I agree that if the social fairness which Saburo Ichii called for is established, then it will be very much useful. Saburo Ichii's principle of value is a fairly interesting thought. In other words, his value principle attaches virtually no value to pleasure or other positive values. He puts much emphasis on "pain" — particularly, "absurd pain" — and I agree that it is quite a normal sense of value for an affluent society or the latter half of industrial society.

And yet,a thought remains to be a mere thought unless it is specifically applied to the reality. As I see it, utilitarianism is not defective because of its form as a thought. Utilitarians are unable to agree on rules so that they can apply their thought to the reality. That is why. In other words, they cannot agree on the way to appropriately weigh various "components" that consist of an individual. Also, they cannot agree on the way to compare and weigh different "utility" different individuals have. Thus,

utilitarians cannot apply their thought to reality.

In a way, Saburo Ichii's value principle is a special form of utilitarianism in question. It is utilitarianistic for him to attach zero value to "plus" factors among other individual utility factors and attach value to "absurd pain" among other pains. There are two problems here. One is how to collectively see various absurd pains. The other is how to weigh different absurd pains which are traded off among difficult for utilitarians to find an agreement on the above matters.

If I defend utilitarianism, I won't say it is responsible for pollution or dwindling of natural resources. If utilitarianism could ever be applied in those fields, pollution must have been the way to compare individual utility. If utilitarians can ever appropriately compare such different utility, then the protection of the rights of victims which Saburo Ichii advocates could be applied under the utilitarianist principle.

The second question I have, is that Saburo Ichii's principle is said to be similar to the Maximin Rule. I don't think it is. Because the Maximin Rule does not conflict with utilitarianism. The rule only adds a new dimension to utilitarianism. Saburo Ichii's principle, which is utilitarianism or a special form of it, and the Maximin Rule overlap or, at least, do not necessarily conflict each other.

The third question I have, is about the rule of application of his principle. Suppose we can specifically define the absurd pains, Saburo Ichii argues that you feel the absurd pains because you have nothing to do with the generation of such pains or you are not part of decision-making to generate the pains. In other words, he implies that if you are part of decision-making process, you have solved most of the absurd pain problem. Is that right? Suppose it is, we are still participating in almost every process of decision-making in this democratic society. Of course, it is an indirect participation by sending our representatives to the Diet and giving them the right to make decisions. Therefore, Ichii will have to philosophically prove that direct and indirect ways of participation are different and that indirect way is not right. Should we employ direct way of participation, then we still have to decide by majority. We will have another problem; doesn't minority who were denied think it is an absurd pain.

The purpose of the Center is not merely to summarize the twentieth century, nor to speculate about the future, but to assert that by means of its futility, and even its contradictions, creativity in all its palpable forms has become the most complete and direct means of expression of our time.

G. Pompidou

The latter half of the century will witness another set of major changes. ..... today is the age of technology. It is quite conceivable that the technological progress or breakthroughs of the future will change the course of international relations and a great deal.

M. Kosaka

The world has become smaller due to the development of modern sciences including telecommunications such as telegraph and telephone as well as transportation. In the area of telecommunication, advanced countries have developed a network of almost instant communication.

It is still vivid in our memory that the U.S. shocked the whole world by satelliting the scene of men's first landing on the moon.

In such circumstances, however, human groups do not abandon their traditionally peculiar culture and life style. In public, people talk about the goodness of modernization and, in fact, they make efforts for that purpose. Privately, however, they cannot stop feeling emptiness about the ongoing mechanization. We see, in the attitude of the mechanical

age intellectuals, the kind of philosophy which Ogai Mori, that "foreign-educated conservative," possessed.

It may appear that the symposium only put out different and irrelevant themes. When we study them more closely, however, then we will realize that the themes had a certain awareness — the sense of time — in common. The symposium participants came up with the common recognition or consciousness although they did not intend to. We can perhaps say it happened because they were doing jobs — different sciences in different countries — on a universal scale. What is important is that the sense of "contemporaries," which has long been barred by national boundaries, made the global — at least in Europe, the U.S. and Japan — progress as modern civilization grew ripe and technology, communication and transportation developed. We can perhaps start from the awareness or consciousness which the "contemporaries" all over the world have in common concerning modern civilization.

With this in mind, we put internationalization at the end of this book. It is fairly important for us, inhabitants of today's world, to discuss the pros and cons of internationalization. It is also an important research and development scheme to work out methods for the presentation of culture or civilization toward people in different culture or civilization. We thus have to ride over barriers such as race, national boundary and language.

The "interdisciplinary approach in international politics," by Mr. Masataka Kosaka, is the basic thought we will have to have when we attempt to look upon ourselves in a global perspective. When we think of problems — difficult problems — related to international relations and cultural contacts, we will feel the need for practical "interdisciplinary" research more strongly.

We are yet to invent the presentation technique of culture and civilization. It is one of big questions kept unsolved in modern civilization. In this regard, G. Pompidou Center of Paris appears to be a pilot farm to create a new civilization based on human beings. We feel so from the way the center was conceived and realized and we can expect much out of it.

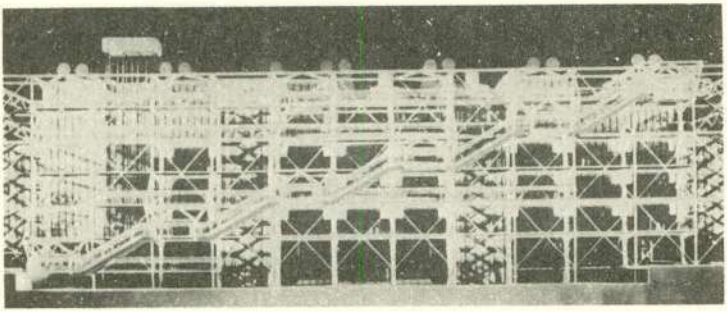
(S. Aida)

Reflections upon the Reasons for the Creation of the Centre Georges Pompidou

Sébastian Loste

The subject of the Symposium International 'DISCOVERIES' is based upon the nature and process of creation. As it is said 'our mental and behavioral activities may be divided into five areas : imaginative, innovative, inventive, productive and expressive.'

This analysis can be applied to the main fields of human knowledge or activity. But in my opinion, it is interesting not only to describe how the human being develops his power of creation imaginative, innovative, inventive, productive and/or expressive faculties in such fields as politics, economics or



science, but also how he is led to conceive new ideas and new standards in the cultural field.

In this regard, the Georges Pompidou Centre, which will open in Paris in the beginning of 1977, offers a good illustration of this creative power.

First of all, we have to stress these two main ideas:

1. There is no epoch-making creation, without a long preparation even if this preparation is as unseen as the underground stream before the springing of water from the earth.

2. There is no fruitful creation, which is not the result of a connection of various methods, ways of thinking and so on.

Let us try to illustrate these two ideas.

Georges Pompidou *(1911–74), second President (1969–74) of the fifth French Republic.*

M. Georges Pompidou, nearly as soon as he had been elected *President de la Republique Francaise,* made clear, in November 1969, that he wanted a cultural Centre to be erected in the heart of Paris, near *les Halles.*

This project touched his imagination for many, many years, before he decided to realize it. We must remember that, during his whole life, he had been a wise and keen *amateur* of modern and contemporary art. He was very frequently in touch with artists, writers, painters, sculptors, composers etc. To quote his own words, he *passionately* wanted that Paris, who already had scores of Museums or institutions devoted to modern art (not to mention the private galleries), could be enriched, in the end of the twenties century, by a big Centre of a new conception.

His conception prevailed. But, to explain the birth and development of this idea, we have also to remember that, for

years, in these fields, ideas, dreams or projects of this kind were scattered in the writings of many people interested in the progress of culture.

Some of these people emphasized their favor on the extension of culture to the largest number. Therefore, their sympathies went to the so-called 'maisons de la culture,' created by André MALRAUX, writer, novelist, art critic and then in charge of cultural affairs in the French government, for instance in Grenoble, Rennes, St Etienne, Bourges and so on to help the creation and development of the interest in culture in important French towns outside Paris. Other peo-

André Malraux *(1901–77), French novelist and politician, served as a Cabinet member in charge of cultural affairs in 1958–69. Among his books are "La voie royale" (1930), and "La condition humaine" (1933).*

Le Corbusier *(Charles Edouard Jeanneret-Gris, 1887–1965), French architect, applied cubist means of expression to architecture in a variety of ways. Aiming to reform cubism, he launched "L'esprit nouveau" with Amédée Ozenfant (1886–). Le Corbusier's essay, "Vers une architecture" (1923), published in this periodical provided the guiding spirit for the twentieth-century architectural movement.*

ple, among whom the famous architect he Corbusier supported by André Malraux then 'Ministre des Affaires Culturelles' worked on the project of a large museum devoted to the twentieth Century – 'Le Musée du XXème siècle.' Some recent institutions, like the Centre National d'Art Contemporain, proposed to the public exhibitions of French and foreign living artists who, previously, were very seldom shown. A hard period was over for France and larger parts of the young public had more time and more money to devote to works of art and 'cultural goods' in general. On the other hand, at many levels of French society, men and women felt a great concern : to be in pace with one's time so that obvious blunders committed in the past could be avoided (contemporary artists completely ignored by 'officials' of their time). So, the ground was prepared for new institutions.

However, this does not mean that the people who had to push forward this new project, did not have to strive for its realization. If all these ideas paved the way for the new concepts, the creations had nevertheless to avoid that banality which turns everything to insipid silliness and eschew also the search for an utmost originality, which obscures the essentials and aims at childish novelty.

But, at the outlet of this adventure, there is also an attempt to reverse the trend of modern architecture, to perform new achievements, to avoid gloomy and monotonous buildings, offered to the visitors like stately palaces or pretentious sepulchures. Obstacles in this way are real. However, we can quote, for instance, such realizations as Utzon's Opera House in Sydney, Aalto's Culture House in Helsinki (Finland), Tange's Stadium in Tokyo, or the museum in Minneapolis (USA) etc...

In a way, all these creators tried in their work to reconcile two contradicting statements : they intended to lead the greatest number of people they could to culture art or sport but, at the same time, they were prone to preserve the individuality of the creator, the artist or the actor. This, as I said, is contradicting, but where would art or literature be if creators did not start from a chaos of inner contradicting to bring some of them to a clarifying achievement? In this spirit, the architects who were chosen, in July 1971 through an international competition, even if they conceived a power-

ful and original building – which will be described hereafter – were not unaware of this long series of researches, which aim is primarily at serving the masses and preserving humanism.

It is impossible to deny or to ignore that, as innovative in its conception or in its architectural form as it is, the Centre Georges Pompidou is related to a long series of thoughts, dreams, or enterprises.

Next to this, a precious contribution of the past has been that a few basic ideas converged to the same goal. There lies the true originality of this innovative Centre.

Aimed toward a vast public, it has to present a *total* view of contemporary civilization by means of its various approaches. Its architectural conception, on the other hand, is that of a 'Live Centre of Information' covering Paris, and beyond, a meeting place for the people, a centre of constantly changing information. The key of its originality lies in the convergence of these two trends, up to their meeting point.

The conception of the Centre is new, as it is devoted to the contemporary arts, which could include a public library of all-encompassing scope.

The national museum of modern art, a centre of industrial design, an institute for musical research, various halls for theater, poetry, music, dance, cinema :

More precisely :

The public library will be of a new type (1,000,000 volumes, 3,000 to 4,000 visitors a day). It will have the cumulative advantages of an encyclopaedia and an anthology. Readers will be able to consult freely the works and documents which will be kept constantly up to date in relation to the progress of knowledge and of current events.

The museum of modern and contemporary art will have varied functions: the conservation, exhibition, enrichment and study of collections from 1900 (painting, sculpture, drawing and engraving) or approximately 3,000 works, a third of which will be sculpture; the preparation and display of temporary exhibitions in the centre or elsewhere; establishment of a documentation centre on the museum's collections and a new generalized documentation on modern art; and so on.

In the permanent gallery of industrial design, visitors and professionals will find a selection of constantly renewed

objects, kept up to date with the evolution of industrial design: industrialized construction (prefabrication), contemporary architectural and urban design; industrialized products: parts, and/or equipment signs, and other urban equipment, machines, vehicles; interior furnishing equipment, and furnishing material related to private and collective dwellings; visual communications, graphics, catalogues, signals, environmental design; new industrial materials and their use, etc.

The institute for acoustical and musical research, headed by M. Pierre BOULEZ, will be an extraordinary experimental centre, conceived for the cooperation of varied scientists, musicians, composers and engineers.

Indeed, the entire centre, which will also house spaces for dance, theater, cinema, etc. has been inspired by an original perspective, that of constantly renewing information: news of artistic creations in its many forms, news of industrial design, and especially the constant keeping up to date of those institutions, library and museums, which may be considered the memories of ideas and forms.

According to the intentions of President Pompidou himself, 'the purpose is not merely to summarize the twentieth century, nor to speculate about the future, but to assert that by means of its futility, and even its contradictions, creativity in all its palpable forms has become the most complete and direct means of expression of our time. The reunion, in one place, of books, works of art, architecture, music, cinema, and industrial design — which has not been yet recognized as an art form in our culture — is an idea of great originality. This confrontation should enable a far greater public to realize that although creativity offers an appearence of liberty, artistic expression is not inherently autonomous, its hierarchy is merely fictitious, and that there is a fundamental link between today's art forms and the productive relations within society.'

Moreover, the centre should not stay isolated, its activity will necessarily overflow the limits of the building, leaving its mark on the district and spreading throughout France and other countries by means of travelling exhibitions, televisions broadcasts, publications, etc.

On the other hand — but in the same way — the architectural conception of the centre is also new, and as never

before has the conception and the execution of such a complex been the object of an international competition.

1. The building offers 5 large, flexible, *uninterrupted* floor areas (varying between 5,500−7,500 sq. m.) housing books, works of arts, architecture, cinema and industrial design, etc. The Louvre was a royal palace. It was not meant to be a museum. There... ... the size of the rooms is felt being limited. Decorative paintings or architecture itself are often felt as 'fighting' with the exhibited works of art. The Centre Pompidou has it pillars and even it pipes outside itself, if one may say so. The space is totally open, ready to welcome new ways of displaying and new works of art (let us think of previous museums and things as different one from the other as a cloister, a mobile by Calder or Tinguely's machines).

2. In front of the building, there is a large sunken square, which, including the open area under the building and the area around the edge of the square, is the horizontal continuity of the façade and will have mobile exhibitions, live theatre and music, games, meetings, parades, competitons, etc.

3. Around the edge of the square are shops, cafés, art galleries, etc.

These areas act as filters and links with surrounding pedestrian environment.

To summarize it, the architects not only designed a very original building, but also extended their conceptions to the whole surrounding district.

The newness of the construction fit in with the newness of the conception. That is why there is not a single way to realize a true innovation. It proceeds always from the convergence of reflections on specific fields of creation or knowledge, in order to bring forward new schedules or new ideas.

This effort, however, would be aimless if there is not, at the same time, a deep and spectacular revival in the whole country. Without any intentions to be chauvinistic, it would be sheer hypocrisy to deny or to ignore the importance, in the past years, of French contributions to linguistics, structuralism, semiotics, biology, anthropology, psychiatry. According to France's recovered dynamism, visitor, in the Goerges Pompidou National Centre of Art and Culture will be urged

to participate in vanguard theater manifestations, hear the results of the research activities of the Institute for Acoustics and Music, headed by P. Boulez, watch young artists at work, or see the most recent acquisitions of the Museum (a well-known late Pollock, the *Deep,* several Yves Kleins, a Mondrian), or exhibitions devoted to Marcel Duchamp or to the relationships between New York and Paris, from the beginning of this century.

It is sometimes good to leave abstract heights and to try to foresee an average day of an average man of, let us say 1980, in the Centre Pompidou. Let us say this visitor comes for a Braque exhibition. He notices some links between the paintings and photography. The library is here to answer his questions. But, on his way out, a poster of the Design Centre catches his eye : a computer can give him advice on the choice of a camera. He takes a leaflet giving the film program for the week and... decides to begin, next time, his visit with a moment at the musical department. Fields of interest are no longer separated as they were in the classrooms of traditional schools. The unity of all this is in the visitor himself, the links are created by him, in himself. This is innovation.

The risk of our society is to become a mosaic of slightly cramped worlds, unable to communicate, prise of conventions, you have to belong to a clan, to wear a label, to make history and be conscious of it. But the contact with the real invention inspires us with confidence. For there is no real invention without alliance between knowledge and wisdom. As an English poet of the eighteen Century, William Cowper, wrote in *the Task* (VI, 88−91, 97−98)

> Knowledge and wisdom, far from being one, have oft times no connection. Knowledge dwells in heads replete with thoughts of other men ; Wisdom in minds attentive to their own
>
> .....
>
> Knowledge is proud that he has learned so much, Wisdom is humble that he knows no more.

No great innovation without knowledge and even, without a capacity for foreseeing the future. No durable innovation without wisdom, through which you can meet with the real and overlasting needs of the human being. Our goal, by erecting this centre, was to match with the audacity of modern knowledge the wisdom which will be so badly wanted in years to come.

Jackson Pollock *(1912−56), a leading artist in action painting, was the first to venture into the field. Action painting is an artistic movement based on the metaphisical idea that paintings are not independent, ultimate objects of esthetic value but that the process of painting is a means of cognition.*

Piet Mondrian *(1872−1944), Dutch painter, went to Paris in 1910, did cubist work under Pablo Picasso's influence, later joined the abstractionist movement, and advocated new figurative art with Ozenfant, playing a leading role in the movement.*

Marcel Duchamp *(1887−), French painter. His work, based on mechanical, inhuman material and methods, is considered a new challenge to the value of art itself. Among his well-known works is "Nude Descending a Staircase" (1912).*

Georges Braque *(1882−), French painter, originated cubism with Pablo Picasso.*

William Cowper *(1731−1800), English poet, studied law and became a lawyer, but began to write poetry after 50. Among his well-known works are "The Task" (1785) and "Castaway" (1799).*

COMMENT

Shuji Takashina

The Pompidou Center may have some problems architecturally or for the urban planning in a historical city, but I would like to comment on the concept of the center itself.

First, the center is extremely integral. Traditionally, museums, music halls and theaters each have had their own specialized functions. Take museums, for example. Their history is only about 150 years; they came out in the 19th century. Before that, kings and lords had their collections but there were no museums for the people in general. And the 19th century was an era of specialization or departmentalization in the field of art or, perhaps, in other fields as well. Man's cultural and artistic activities — or, broadly speaking, man's civilization itself — were classified into various specialized areas. The specialization obviously led to furtherance of pursuit and research in each field, but it also resulted in the severance of mutual contact between neighboring fields. In the world of art, the artists tend to pursue the fields they each consider most important to them, with the painters painting, sculptors pursuing sculpture and architects pursuing architecture.

An attempt to integrate what has now specialized seems to be one very strong characteristic underlying the conception of the Pompidou Center. There is an acute need in the artistic or cultural area to consolidate what has branched out into various specialized fields. The attempt of the Pompidou Center to consolidate sculpture, painting, design, music, film, theater and all other cultural activities in one place is, in this regard, extremely interesting.

Secondly, the Center is integral in terms of its operation as well. While the Center has been built as 'Le Musée du XXème siècle,' it has been conceived to be a repository of the latest artistic activities even after the 20th century turns to the 21st century, not as a repository of a century-old activities. Artistic activities from the turn of the 20th century to the present, such as books, documents and works, will be collected for the time being. As the time goes by, however, the old exhibits will be moved to the traditional museums to make room for new ones. This is a completely new approach to the management of a museum.

Not only in France, but also in many other countries, there are already museums and modern museums. Artistic works collected there become historic objects after many years and the museums fear that they may become 'modern' historic museums.

The Pompidou Center, on the other hand, is designed to keep up to date all the time and to stay integral and active. This is what makes the Center profoundly interesting.

In essence, then, it is a center not only in the sense that it is a building where artists can demonstrate their activities, but also in the sense that it is an information center for various artistic activities, open and integral unlike a traditional museum which encloses its exhibits inside its walls. It seems, therefore, that the Pompidou Center is a live center of man's cultural activities, which will try to keep up to date and continue its operation with a broad perspective. This is what makes the Pompidou Center significantly different from conventional museums, music halls and the like and, I think, this is what we hope the Center to keep up through its operation.

COMMENT

Kisho Kurokawa

The Georges Pompidou Center demonstrates a brilliant and unique orientation toward creation. The basic idea, one of the two, about the opening of the Center that 'there is no fruitful creation which is not the result of a connection of various methods, ways of thinking and so on' conforms excellently with the direction pursued by modern architecture.

For, as pointed out by Charles *Lenx,* who said to the effect that the better a piece of architecture is, the more pluralistic, the more complex and the more ambiguous it is, we architects are constantly struggling with the acutely up-to-date problem of how to integrate complex and often contradicting factors into one creation.

Another important point is that this cultural center doubles as an information center in character. I, myself, had an opportunity to design an National Museum of Ethnology where folk data of the countries around the world would be exhibited. Various countries in the world, particularly those which had colonies in the past, already have excellent collections folk material. The Japanese folklore museum, however, is only starting to collect material and it is quite doubtful that it will have exhibits that are comparable with those in other countries. A great number of 'information capsules' are, therefore, conceived for this museum so that the visitors can always see exhibits at museums around the world via photographs or information. The museum may now be better called 'haku-jo-kan' (house of multiple information) instead of 'haku-butsu-kan' (house of many objects), which contains information instead of

material. Isn't this all right, though? Why should we continue to compete for material? This great emphasis on 'information,' I think, will increasingly continue. The Pompidou Center itself is trying to unfold this factor of information on a worldwide basis. The Center, in this sense, is built on on a very new concept.

Moreover, related to what Shuji Takashina has already pointed out, we have been building various specialized facilities in line with the specialization of our activities. This is not only true in Paris. In a Japanese prefecture, we have, say, public halls, libraries, youth halls, women's halls and various other facilities. They are not very different from each other; in fact, they look very much alike inside. Each local government, therefore, is now starting to think that these facilities must be organistically related to each other. This is exactly in line with what the Pompidou Center is trying to do. This may signify a turning point where the process of specialization is now evolving into a new stage of specialization or a new stage of creation.

The Center building is strongly reminiscent of a factory or a petro-chemical plant. I was very impressed with the line of people's flow: the line of people's movement, including the information traffic, is all contained in the skin of the building. The hollow inside is a space that can be managed in whatever. The nerve system, the information network and the line of people's flow are all arranged in the outer shell or skin of the building, in such a way that they can be seen from outside. This is an architectural theory that we now call 'exposure of flow lines.'

Exposure of a movement inside a building or the line of people's flow makes the city very joyful, safe and dynamic. Furthermore, the space outside and the flow line can communicate with each other. Most of the traditional buildings look like boxes enclosed by glass panes or concrete walls and activities inside are not visible from outside. This harbors a danger that could make the city very difficult to understand and inhuman. In this connection, I think the concept of the Pompidou Center building should be highly evaluated for its very new design of communication, communication in the broadened sense of transportation."

An Interdisciplinary Approach to International Politics

Masataka Kosaka

In the last half of the 20th century, mankind has experienced a host of "revolutionary" changes. Among others, particularly notable were the emergence of nuclear weapons which changed the quality of power politics, the sophistication of transportation and mass communications systems which enabled mankind to engage in transnational activities, and the advent of the "mass society." There resulted enormously diversified interactions among the countries of the world. The latter half of the century will witness another set of major changes. After all, in the past, changes were brought about by rapid technological progress — this is the age of technology — and it is quite conceivable that the technological progress or breakthroughs of the future will change the course of international relations and a great deal. Such are the origins and reasoning for interdisciplinary research rather than conventional international politics, which focused on power politics.

To begin with, nuclear weapons, a means of mass destruction, made it inevitable that power politics undergo changes. In the past, military strength had always proved the "ultima ratio" in international relations. Military superpowers were predominant. But after nuclear weapons came into being, all countries found it impossible to fully exercise their military strength. Nukes destroy too much and are no longer a reasonable means to achieve political goals. Since it is of the absolute necessity to avoid escalation to nuclear warfare, this, in return, deters conventional wars as well. Given limited military exercise, any country has to rely on softer ways to force and influence others. In other words, the level of violence has been diversified and repressed by an inhibition on the total use of coercive force. Accordingly, super-

power control has weakened and smaller countries have obtained more freedom of action. Now, the world's countries deal with each other in diversified levels and more "actors" of different kinds participate in the game.

Probably, I won't have to say much to explain that sophisticated transportation and mass communication helped diversify international relations. Not to mention closer interactions among the world's countries which resulted, and which connected individuals and groups over different countries who were otherwise partitioned by the borders. Transnational activity, did exist before, but it was never as broad or as thriving as it is today. This is of different nature from so-called "international relations." In that sense, we can say that international relations were diversified. Moreover, "transnational relations" influence "international relations" and vice versa.

As for the birth of the mass society, we should take note of its two major effects. On the one hand, an international affair now holds deeper consequences for domestic affairs than the past. On the other hand, however, national leaders are requested by the mass society to pay more attention to the lives of the masses. In a way, the mass society is "nationalism-oriented." As a result, more national interest is represented in global politicking, adding complexity to it.

Now, it is clear that those changes created the kind of situation which requires interdisciplinary research. Let me pinpoint some examples:

(a) Lately, economic and political — in the narrow sense of the word — affairs are interlocked with each other so much as that it is impossible at this time to think of one without taking the other into account. Such interconnection creates important international issues. To analyze such interdependence, one will have to take a politico-economic approach.

(6) Today's world is culturally diversified. International relations inevitably cause interculture contacts and yet the political and economic pattern of a certain type of civilization is only "valid" in a limited geographical area. It is necessary, in this regard, to take an anthropological approach.

(c) Without knowing what impacts technological progress will possibly entail, it is impossible to predict the development of international relations in the longer run. Apparently, however, technology is not everything.

(d) When international relations are diversified and "actors" increase enormously, it is necessary to process massive data to understand them. We know, however, that mathematical data processing is not without problems as a means of explaining political phenomena. We have to realize both the necessity and the limitations of such a practice.

Obviously, I won't be able to discuss every detail here but I would like to center on the category "a".

When it comes to the diversification of levels and forms of interactions, I, first of all, believe that economic relations play an increasingly large role. U.S.—Soviet relations shifted from "cold war" to "detente" in the fifties and the sixties. The most important change in that period was, however, that the world's economy grew very much interdependent under the free trade system championed by the U.S. and started to operate on a global scale. People often fail to realize that their lives, too, are heavily influenced by that change. East-West relations were also influenced considerably. The understanding of economic relations is essential to grasp international relations. For instance, the old international relations theory will never be able to define Japan and the role she plays.

I do not necessarily mean, however, that international relations shifted the focus from politics to economics. For, after all, economic activities are not determined by economic logic alone. In a period from the late sixties to the early seventies, we can see that politics and economics started to get interlocked in terms of both policymaking as well as actual activities. I find one example in the "linkage" policy advocated by U.S. Secretary of State Henry Kissinger. He apparently used food exports as a weapon to pursue "detente" with the Soviet Union. The U.S. Secretary of State also asked his Western allies to cooperate with his economic policy in return for security protection. I assume that, given smaller the role of the military, his linkage of economics and politics was an appropriate response. We should not think that it was an isolated, abnormal act; that kind of thing will continue to take place.

Significantly enough, the world's countries pay more attention to economic relationships nowadays and try to politically manipulate them. Until recently, economic relations were perfectly welcome because the "double track" viewpoint cut economics off from politics. Today, however, every

country controls its economic relationship so that they serve national interest. We can clearly see such a trend when we look at multinational corporations. Many countries are thinking how to control them. Another good example is "resource nationalism" which demands higher prices for natural resources, attempts to take back management from multinationals, and asks for compensation for resource development.

The above phenomena can be interpreted, as Stanley Hoffman says, to show that nationalistic states are calling for the new "legitimacy" in contrast with the development of cosmopolitan tendencies such as transnational interdependence. There are two basic reasons behind that move. First, the developing countries realized that the international economic order was established to work against them and started to make political attempts to reorganize that order. Second, the swelling number of international interactions increased the wealth of the world. On the other hand, however, this trend destroyed the domestic balance of wealth. The mass-oriented states cannot afford to leave people's lives at the mercy of economic fluctuations. National governments respond to a groundswell in economic exchanges with an effort to maintain or recover the domestic balance of wealth.

Thus, international relations are currently beyond understanding unless economic relations are well understood. And, one can understand economic relations only if with a politico-economic approach. This sort of interdisciplinary research is not unprecedented and may even sound easy. The fact is, however, that it is suprisingly difficult to conduct really fruitful research. It seems to me that this is partly because the two sciences engage in disciplines which are closely related. One may even assume that, with one of the two sciences as a tool, he can understand almost everything. For instance, an economist may contend that one phenomenon created by politics is only a short-term confusion and conclude that economic logic will regain its reign in the long run.

But, politics and economics are subtly different in approach. That is, politics puts an emphasis on troubles in international relations and takes it as a "zero-sum" game. On the contrary, economics stresses the merits of cooperation and the mutual profits, and regards international relations as a

game of cooperation. In reality, international relations is a "variable-sum" game which everybody can understand intellectually. The two sciences continue to have a traditionally built-in bias, however. It will be useful to understand this before beginning the interdisciplinary research.

What I have stated is related to the tendency that economics advocates one world while politics emphasizes borders. Obviously, economics is more universal; a fact which can be either an advantage or a disadvantage. Since economics is measurable, it can always become unrealistic when statistics are employed to make precision models. There is no such thing as a universally applicable statistic. In one area, it is simply impossible to obtain and in another it may prove to be only unreliable. And yet, statistics imply different things in various political and social settings. A view of the entire world economy can be drawn only when such a fact is taken into consideration. Politics can be employed to fortify the validity of such a practice.

Finally, I have to state that international economic relations does not represent itself in political and economic phenomena alone. It also involves intercultural contacts. IIn fact, some of what people believe are troubles over economic exchange really concern intercultural contacts. Many troubles Japan has had in the process of economic development and the expansion of economic exchange fall into this category. For instance, Japanese trading companies and other firms are criticized for their overseas operations. This chiefly stems from the fact that the Japanese attempt to introduce to foreign countries the work ethics, organization and order they have in Japan. A similar cultural problem is observed in criticisms of Japan as a protectionist trading partner. Until the end of the sixties, at least, Japan adopted a predominantly protectionist policy, which justified some criticism. Behind the difficulty foreign firms had in penetrating the Japanese market, however, there were quite few cultural barriers as well as Japan's trade policy.

The so-called "nontarrif barriers" were a good example. They were a hot issue, and among others, the MITI's "gyosei shido" or administrative guidance earned it a bad reputation. The nontarrif barriers were not something conceived artificially by the government. They were problems created by differences in standards of business behavior and social

background. Every country has a similar difficulty which, in one way or the other, puts strangers in an awkward position. On her part, Japan is so different from others, in terms of society and culture, and this makes things harder. Again, Japan's problem was derived from both the government's economic policy and its social and cultural uniqueness.

Understanding such problems requires an anthropological approach. For anthropology places an accent on the complex history of cultures and the impact of circumstantial conditions, movements and contacts on promoting unique cultural development. Moreover, anthropology is based on a recognition that it is necessary to compare closely precise samples of racial history and other conditions before working out a general theory. This is not accomplished without difficulty, however. Anthropological research no doubt helps understand international relations. But it is difficult to go beyond using it as reference material, and systematize the anthropological contribution.

COMMENT

Yukihide Okano

In commenting on Kosaka's report, I would like to focus my discussion mainly on the approaches of political science and economics toward international relations.

Noting that political science attaches great importance to the factors of conflicts in international relations and views international relations as a "zero-sum game," while they are seen as a game of cooperation in economics, Kosaka says that the difference is related to the tendency that while economics sees the world as one unity, politics regards national borders as very important.

It is true that economics deals with regional relations in one country and international relations on equal terms, albeit for the sake of simplification, and regards profits from an increasing exchange in both regional and international economic relations as of a kind.

Actually, however, it is not necessarily true that an increase in regional economic exchange causes no conflict while international relations are prone to conflicts. Conflicts occur when, for example, a facility to desulfurize exhaust gas is built to reduce pollution and sulfur is obtained as a by-product but as a result, the companies which have been producing sulfur out of sulfide ore are competed out of business, or when vegetables are directly transported from a remote area to a city, benefitting both the city-dwellers who are provided with inexpensive vegetables and the producers in the remote area who can make some profits but, as a result, the consumers in the producing area have only poor-quality, expensive vegetables available to them.

Conflicts rarely come to the surface, however, in regional economic relations within a country. Why, then, do conflicts occur in international relations? This is because, while there are certain common rules and the government as a judge within a country, there are few common rules, the rules differ from one country to another and there is not a mediator to settle conflicts in international relations.

Secondly, it was pointed out that an expansion of international economic exchange increases the international wealth but, at the same time, frustrates the domestic balance in each of the countries. The question is not so much whether the domestic balance is frustrated as how fast it is frustrated. There won't be any problem if it is slow; there will be a problem if it is drastic. The fact that Southeast Asian countries have taken over the production of artificial flowers

and Christmas tree bulbs from Japan has not developed into an international issue, partly because the internal balance has changed only gradually. This sort of change could be made drastic by the development of information and transportation.

Thirdly, regional relations and international relations differ so much as regionalism and nationalism. In economics, too, it is not necessarily considered that economic nationalism is viable in international economics. According to an economist who is trying to explain why a closed economic policy is ever adopted even at the expense of economic benefits, the social utility of a country is determined by a function of economic welfare measurable by real income and of psychic income and their relationship is one of trade-offs. In other words, there is a possibility for political involvement or room for interference by what might be called political rationality. The presence of psychic income is, basically, often founded on nationalism, and politicians frequently expand it strategically through persuasion. Even in such a case, however, it seems that some of the conflicts can be solved if correct information is given and it is correctly understood.

Finally, there is a question of cultural uniqueness. It is quite likely for this to cause conflicts. But, again, I think this will decrease with the expansion of economic and cultural exchanges among the countries.

Kosaka further points to the difficulty of an interdisciplinary approach. I do not think it easy, either. But if one tries to control one's discipline too consciously, results may not be very good. I think that when we argue on the basis of our own discipline and gradually narrow the border with other disciplines — in economics, for instance, "given conditions" are always established and they always belong to non-economic areas — we have inevitably to cooperate with people in other disciplines and, this way, we can establish an interdisciplinary approach.

COMMENT

Yoshitatsu Tsutsumi

I would like to comment on the various factors of diversification of the present international community discussed in Kosaka's report.

We have an example of the diversification of interaction in the development of Japanese history itself. Japan was closed, completely isolated from the international community during the 300 years of the Tokugawa period. Its economy was a self-sustaining

closed economy and its population was relatively stable at about 3 million. A little over a century since the Meiji Restoration, 550 million tons of goods were brought into Japan last year alone and 70 million tons of finished products were exported to reach every part of the world. The scope of Japan's political and economic relations or interdependence with the rest of the international community has uncomparably expanded.

In terms of cultural diversification, a samurai in the Tokugawa period had only to study Chinese characters and the officially sanctioned Doctrines of Chu-Tzu for education while, today, more than 100 years after the introduction of Western studies during the last years of the Tokugawa shogunate, we have developed relations with 140 countries of the world and we are required to be conversant in not only English but in various other languages or with various religions, for that matter. In other words, the Japanese are now required to have a wide-range of cultural knowledge: about peoples, about histories, about geographies, about religions, about languages .....

Thirdly, I would like to discuss shocks of technological innovations at some length.

The advent of weapons for mass destruction has drastically changed the world's situation, as Kosaka points out in his report. The world is said to have about 50,000 megatons of nuclear weapons at present, or an equivalent of 3 million times as much as the bomb dropped over Hiroshima or Nagasaki. Divided by the world's population of 3.8 billion, the volume comes down to 13 tons of TNT per person. Every one of us can be killed over and over again: we are living in an age of over-kill.

Moreover, with the nuclear weapons, the ballistic missiles and other mass-destructive weapons having proliferated as a result of competition of each side to have what the other side has, the major powers have come to develop mutual deterrent potential and the capability of intercepting the first nuclear strike. The quantative increase, therefore, has caused an impasse.

Similarly, defense at the border-line has become meaningless with the development of MIG fighter planes which can fly past a three-mile territorial water in 5 seconds at Mach 3 and a 20-mile territorial water in 20 seconds. And 19 years after the Sputnik started space development, thousands of flying objects are constantly crossing the ultra-high skies between 200 and the maximum of 36,000 kilometers above the ground, a height inaccessible by airplanes. These objects are now taking meteorological and aerial photographs, making exploratory surveys for resources or spying military situations.

These problems in the world, brought by technological innovations, do not necessarily disturb international politics; they can

serve as a stabilizing factor. A good example is the Moscow-Washington "hot-line" which helped thwart the Cuban crisis. And the emergence of super-tankers, the use of computers which proved it still profitable to route around the Cape of Hope, and the fact that the prospect for making a commercial use of nuclear power as an alternative energe source came in sight are said to have worked as stabilizing factors which helped prevent the Suez crisis from developing into a major conflict.

Technological innovations in the transportation and communication fields, such as jet planes, space communications and data communications, have rapidly narrowed the physical and time distances among the countries, thereby reducing gaps and deepening the mutual understanding among them.

Diversification is, at any rate, historically inevitable. This is why an interdisciplinary approach is called for. Diversification might contain factors for solution. I think, perhaps very boldly, that history could be used as one way of finding a solution. History is a treasure house of voluminous data and innumerable precedents and I wonder whether we cannot make an effective use of the knowledge and date accumulated there for international politics. Like an individual who grows up while learning from experiences, isn't it useful, necessary and perhaps possible now for a nation or the international community to progress while learning from the knowledge and experiences accumulated in the past history? Isn't man now faced with the necessity to repeat the desirable parts of history and not to repeat the undesirable parts? To meet that necessity, isn't it possible to advance the study of history as an objective, descriptive science and experiment with what might be called applied history or historical engineering on the stage of international politics?

Accumulation of an individual's experiences cannot cover more than a generation; no scholar, however able he may be, cannot live longer than one generation. If "applied historical science" can be established, it might be able to overcome gaps between generations and borders between countries.

Specifically speaking, developing countries perhaps have more than a few things to learn from failures and successes in developed industrial countries. A particular or approximate solution — not a generalized solution — is sufficient there and I believe that even such a solution will be very effective.

Chapter 7

GENERAL DISCUSSIONS

The DISCOVERIES Symposium International on its third day, proceeding on the basis of the past reports by ten participants and comments and discussions on them, had supplementary remarks and free discussions on how the proposed ideas should be developed further or materialized in the future, by way of finding proper philosophical attitudes or approaches.

Before opening the discussions, the moderator provided the following "scenario" to help the participants to approach the subject in question: (1) What has modern civilization done? (2) What does it lack? (3) What to do in order to revitalize it? (4) What can the DISCOVERIES do?

Speaking up first, Owen talked about what modern civilization has done so far as transportation is concerned, as follows:

"What has modern civilization done? What has it done to us? That is the question. So far as transportation is concerned, it may be said that modern civilization has changed the essential nature and functionality of our community — changed it so radically that it now makes communication difficult rather than facilitates it, as it should.

"The city has become a complex, huge community, because transportation has made urban concentration possible. By helping the city grow, transportation has made it less useful for human communication.

"How can we turn back this trend? First, we have to consider what we are required to do now to improve the lot of the future generations, our posterity.

"Referring to mass transportation systems such as BART, we have to tackle two questions. One is, what overall strategy should we adopt? We have to provide transportation within the

framework of the existing city. Whether it is San Francisco or Tokyo, the city exists as it is, and the question ultimately is, what can we do on the basis of the existing city, what can be done to make it more accessible, what should we do to give its inhabitants more freedom of movement, to provide them equitable and fair opportunities and means for enjoying the fruits of urban civilization? In tackling this question, we should not concentrate our resources and attention on transportation systems alone but try to look at the whole picture. Also, we should not leave to our posterity systems they might find unnecessary for their existence. We should leave them room for applying new technical innovations.

"The second question is, how should we change the essential character of the city, and how should we use transportation as a means of urban life. By reorganizing the city, I think we can save the unnecessary time, unnecessary effort, unnecessary energy we are daily spending in transportation today. We can then facilitate future communication by using the means and methods of transportation and communication we now have, and create the kind of urban culture or civilization we want."

Miyahara followed by supplementing his own report with remarks on how the judicial system and its concept have changed, concluding that the modern trial is conducted on a theory of "fight," which is a new form of duel, in attempting to discover the truth and establish the fact, and that modern civilization has not made much progress in that respect.

Tezuka, with reference to Miyahara's report and remarks, talked about differnces between the Japanese and American concepts of contract, and advanced the view that, if modern civilization is to effectively meet increasing disputes expected in the future, it should have more laws and ordinances dealing with them, and actively use modern means of information processing in seeking settlements — an approach likely to prove useful for an efficient trial system in the future.

Ishii, commenting on Owen's remarks, said that although it is necessary to try to decentralize urban functions before talking about new transportation systems, it is also important to seek, simultaneously with such decentralization, improvements in the performance of urban transit systems and their hardware — a more reliable, diversified

approach.

Linstone followed with remarks about what modern civilization has done to us, to the following effect:

"Modern civilization has, first of all, enabled us to enjoy the triumphs of science and technology. It has brought us, or made possible, such things as paradigmatic laws, objectivity, the importance of models, the importance of data, a highly structured way of understanding problems, methods for finding solutions, the concepts of analysis and synthesis, structuring, modeling. As a result, we have come to see people in academia dedicated to what might be called a cult of methods — people who give precedence to methods rather than to problems.

"Secondly, modern civilization has changed the manner of transportation and communication. It has increased our control capabilities. It has stepped up appeals to our sensory organs. In addition, it has made our recognition of realities very speedy. It has made it possible for us to be where we want to instantly, at once, and to take in a reality with a genuine feeling. These things were not available to our ancestors.

"Another thing modern civilization has brought us is provision of great knowledge — vast knowledge, if not wisdom. But the problem, as has already been pointed out, is that new knowledge may give birth to new ignorance. A certain American humorist has said in effect that the trouble is not so much that we don't know something as that we think we know something which, unfortunately, may be untrue. What we believe to be knowledge may actually be false knowledge. The trouble with us is overbelief, the humorist says. Here we have something worth thinking about.

"For the future, we should consider and do what we should as collective responsibilities, but not in such a way as to limit the freedom of choice of the future generations. This means, as has already been pointed out, that we should more seriously think of "discounting."

"The second point I wish to make about the future is that we should learn much from natural systems. There are many things we can learn from ecological systems, from the living environment. I have heard of the expression, "fail safe," and I do believe we should incorporate in our living system a mechanism by which we can fail without much risk — fail but stop before incurring a real crisis. The more complex a natural system is, that is, the farther removed it is from the so-called "optimum," the more

redundant it normally is. Man is a good example. We can adapt to new developments with much flexibility because we are redundant. In thinking about a complex future society, therefore, we can learn a lot from nature.

"My third point is something we should never forget but are always in danger of forgetting: Individuals, individual human beings, are just as important as mankind or society as a whole. It seems to me that we have been thinking too little of the impact of technology on the individual. We should loudly stress that technology must be adapted to suit the individual.

"Fourthly, I believe that, to make these things possible, we should reorganize our institutions so that we can continue to adapt to changes in the future — modifying them in a problem-oriented way.

"Finally, let me add what has been said by a Japanese scientist I have learnt a lot from: we are heading toward a heterogeneous future society. It will be made up of interactive groups rather than stratified, diversified rather than uniform, qualitatively rather than quantitatively oriented, symbiotic rather than competitive."

Terano, referring to the systems engineering approach to social questions, argued that we should be interested more in goals than in methods per se, and take a more macroscopic view of man's complexity, adding that that was one reason why he stressed ambiguities.

Ichii agreed that we should give more attention to goals, but pointed out that a goal obviously presupposes a desirable image of the future, that by setting up a goal we invariably put some restrictions on people, and that emphasizing what Linstone called the collective obligation of not limiting the freedom of action of our future generations is tantamount to calling for some kind of morality.

With reference to methods and goals, Kitagawa further advanced the following view:

"With reference to approaches to scientific research and social questions, much has been said about methods an goals. In this connection, I would like to point out one angle of interest: A method exists for the purpose of achieving a goal, and it is essentially absurd to think of methods apart from goals. In the academic world we have "basic sciences." But a basis can be a basis when it has some superstructure to support, and we cannot think of a basis without thinking of something that stands on it.

"The next question is, what do we mean by a goal? Essentially, most of the things we speak of as "goals" are really nothing more than subgoals or subsystem goals. If we think of a goal for something as big as human civilization, the only goal we can conceive probably is man's survival and prosperity. This may appear to be rather nebulous as a goal. But looking back on the history of human experience, I do feel that mere legal control or increased wealth cannot solve our total probelm.

"And the fact is that man is really at a crisis today. I believe we are in a position to think of our viability in real earnest. Survival of mankind should be our ultimate goal."

Turoff spoke up referring to his own discovery at the symposium: In our civilized society there normally exist what people like economists, OR experts, and management scientists consider optimum solutions; but the planners of this symposium have succeeded in bringing together only those who object to such solutions; these heretics, who would have been burned at the stake in other historical periods of Western civilization, suggest that man needs much broader adaptability rather than straight optimum solutions or conditions; perhaps we need a new "sanctuary." In addition, he expressed an anxiety about the computer, as follows:

"There are theoretical games played with the computer, but they can be dangerous if they become real. I am rather anxious about the computer. We do believe that the computer enables us to find optimum solutions to problems which purely disciplinary approaches in other areas cannot solve, and we are convinced that we can build wonderful systems that way. By the use of computer systems, we will be able to establish optimum patterns in daily life and all other areas. This also means, however, that we may create very despotic systems with the computer — that is, create a system without solving a problem — and end up building a despotic society. As someone said some time ago, building a model or an information system by means of the computer may be tantamount to writing history beforehand, a process that requires a great deal of care."

Segerstedt, referring to the matter of methods and goals, pointed out that major scientific research goals must have specific methods and processes for achieving them clearly defined at the start. He asked Turoff what future possibilities the Delphi method had, and how the Delphi method and various other methods would be related to each other as they

continued to develop in the future. Turoff replied:

"I don't regard the Delphi method as a means of forecasting, but as a mechanism for designing a communication process. It is a way people can, not individually but collectively, work out an effective means of communication for dealing with complex problems. Therefore, recent Delphi research mainly concerns such subjects as policy analysis."

Segerstedt also asked Caianiello whether a choice between different scientific systems or models had ever been made in actual history. In answering him, Caianiello said that we ideally need absolute knowledge, that although scientists are not ignorant, their present knowledge is very limited, and that it should be their goal to improve on it little by little.

At this point, Soichiro Honda, Honorary President of the symposium, was asked for views on the meeting. He observed that it was a miraculous, human meeting where what had been taken for granted was no longer so, with everyone thinking and speaking freely like kindergarten children, and that he would like to be more childish himself. Hirao also expressed what he tought of the symposium, saying that he felt as if they were creating a new science religion; and Sawaragi, as a systems engineer, recognized that this sort of symposium would provide an interface between his specialty and a broad range of applied research.

Caianiello, expressing his view of the symposium, stated that the meeting was vastly more interesting than he had expected, and that at other similar meetings he would often get bored and fall asleep after talking with other participants whereas at this symposium he had the pleasure of listening to the others with genuine interest with his eyes wide open. He added that the beginning of future discussions was now beginning; that ethics is of basic importance in this world and indispensable if we are to achieve essential growth in the future; and that we should use what little true knowledge we really have to prepare true guidelines for mankind.

Tsujimura, criticizing Miyahara's previous statement that although the trial has changed from a duel to a dispute, it has made little progress essentially, argued that the change was important nevertheless, and that the change from the rule of brute force to the rule of the law was a very civilized process. He also spoke highly of the role of the press and other mass communication media in filling an existing gap:

the irrationality of trials which often take too much time and money.

Caianiello, referring to criticism of journalism, observed:

"I think we don't have to worry about the presence of the journalist in human society. Without requiring any particular proof, his necessity is demonstrated by the very fact of his presence. He may be arrogant, but so are the filmstar and the scientist. It is clear that society needs communication — needs it for structural reasons. There are various ways of communication. But an academic, an artist, or a corporation for that matter, needs a medium to communicate with the public. They need a specialist in the field of communications — someone who understands the position of one party and from his viewpoint explains it to another. An actor on the stage, for example, may be similar in function to a journalist. No one reads everything someone else has written, no matter how great he is, whether he is a hero or an artist. But when some of his words are uttered by an actor — delivered as lines, the audience knows the heart of the great man. In a similar way, journalism is the arteries, the blood vessels, of society.

"So, what does matter is journalism. To be sure, there are good journalists and bad journalists. But then there are good ones and bad ones in any field. If there is anything wrong, the blame should be put on those who use journalists. The present situation simply means that bad journalists are in demand in our society today, and they should not be called to account for supplying what the public wants. It is the educators who are to blame. The blame should be put where it belongs. We should not blame the media alone, which are largely innocent.

"It seems to me that the academic community is blamable in some respects. We cannot expect journalists to understand what even academic authorities sometimes fail to see clearly. We should try to explain such things in easier, more human terms. What academia can expect journalists to do is to cover the material supplied rather than to report it accurately. Thus we may be able to achieve symbiosis."

As the discussions drew to an end, the moderator, on the basis of the past discussions, brought up the question of what modern civilization should be headed for, or what path it should find to follow. In response, Ishii gave the following opinion:

"As a teacher in the faculty of mechanical engineering at a

university, I have recently noticed one thing in its curriculum: Although a machine essentially has a "coloring," the curriculum does not tell us to say anything about it in the classroom.

"I wonder why this is the case. Perhaps that's because mechanical engineering is a discipline representing the abstraction of only a part rather than the totality of the human process of making machines.

"Of course, there are many things that can be made much more effective by abstraction. But we have to realize that the process has considerable limitations of its own.

"A professor of pediatrics who was a classmate of mine when I was a medical student has told me that the human ability of abstraction reveals itself even in infancy. As anyone knows, you can cheer up a baby by doing a peek-a-boo. You cannot expect such response from other animals. The baby's excitement is based on a highly sophisticated process of abstraction, which seems to appear in him soon after birth before we teach him anything much.

"While this ability of abstraction is developing in a child, something quite contrary to it, an ability to act and think at the same time, seems to survive almost until he reaches school age. As a result, he cannot sit still in a barber's chair, for example. For, whenever he thinks of something, his body invariably begins to move; and if he stops the body movement, the thought in his head also stops. According to the same theory, he gradually learns to think without body movements as he grows. In a sort of differentiation process, he learns to exercise one function while suppressing another.

"Nevertheless, the direct connection or balanced relationship between thinking and acting is inherent in man, and even if the two functions differentiate from each other with growth, he had an innate inclination to revert to that old state.

"It is very important to bear this in mind. For, in modernized large chemical plants, power plants, and such other automated industrial installations, symptoms of such reversion are actually being witnessed. In the past, plant designers have believed in the principle of maximizing automation and minimizing labor — letting the "operator" just look on as a watchman in what might be called a "do-nothing" system. Recently, however, we are beginning to realize that such a system has defects of its own. It makes an operator emotionally unstable, causing him to do mischief in some cases, resulting in breakdowns. Therefore, designers nowa-

days make a point of developing "do-something" systems, in which operators are required to do something to keep themselves busy.

"Considering all this, I think what we have to seek in modern civilization is not the kind of machines or systems that ignore such essential qualities intrinsic in man, like the instinctive desire to do something of his own accord, but the kind of machines and systems that will bring out the best in man.

"It has been known, of course, that a machine like the automobile, once created, has the effect of influencing its creator, man. But we engineers, who are directly responsible for the creation of such machines, should always try to harmonize them with the physical functionality of man.

"This is easy to say — and quite reasonable too — but hard to do. Asked, "What, then, is the essential nature of man — or, at least, what is the natural condition of human existence?" we cannot come out with a ready reply. Before we can answer this question, we have to learn more about life sciences, behavioral sciences, about the behavior and ecology of animals.

"In this connection, it is important, in the second place, to have man's innate potentialities more actively released or developed. Recent research in genetics and molecular biology indicates that man has a great deal of inherited information; and as has been pointed out at this symposium, man is a highly redundant system, using only a part of his resources. For further growth of modern civilization, it will be extremely important to let such abundant potentialities be released usefully.

"Thirdly, to facilitate the effective release of such potentialities for the future development of modern civilization, what is the best environment? I think that is one in which different cultures clash with each other.

"It is well known that, where a warm current runs into a cold current in the ocean, you normally have a good fishing ground where lots of fish are found. Similarly, where different cultures mix, modern civilization, now increasingly in an impasse, will have "releasers" that may enable it to evolve into a new civilization at a higher level."

Enlarging on Ishii's remarks, Kitagawa expressed his view of modern civilization and spoke about what it would need in the future, as follows:

"When we talk about modern civilization, a question arises as to its definition. Apart from that, we can see by looking back

on history that all civilizations follow the process of emerging, prospering, decaying, and perishing. We have to realize that the fate of our own modern civilization will be the same more or less.

"While recognizing this, we should also consider what characteristics modern civilization has — what are its good features and shortcomings — that distinguish it from other types of civilization known in the long history of mankind. We should evaluate modern civilization in that light.

"It is more than a hundred years since old Japan, backward in many ways, experienced the Meiji Restoration and began to assimilate Western civilization, and we are probably beginning to forget its characteristics. But we have to recognize that our modern culture owes a great deal to Western science.

"I think what characterizes Western science is, in a word, "control" — control based on knowledge. Some disciplines have aimed at pure knowledge. Mathematics and physics are good examples, to be sure. But when we look at Western science as a whole, we find it dedicated ultimately to control. Take systems science, for example, which has been actively discussed at this symposium. Frankly, I have to say that its essential objective is control. In fact, I believe systems science has sprung from such roots as control theory and OR methods. Because the problem it deals with has grown considerably of late, various other methods have been incorporated further, and people are now saying it should link up with social sciences, or asking whether its methodology is really effective. But I think it is essentially a control science.

"In considering our civilization, it is very important to ask whether this control viewpoint is essentially adequate. Apart from this, I have been saying for years that we need two more concepts:

"One of them may be called "survival" or "viability." There are two approaches to it. However well man may plan and design his environment, he is always ignorant of some aspects of it, as Caianiello has pointed out. Man cannot plan everything. How can he make up for this ignorance? First, he can increase his knowledge further. Second, he can continue to adapt. From what Caianiello has said, I understand that evolution consists essentially in adaptation. The process of evolution of living things is a typical example of that. They don't need to know systems science to evolve successfully.

"In contrast, how should we conceive revolution? I would call it a process of "creation" — in human terms. The Japanese

equivalent of revolution is reminiscent of something bloody, such as the French Revolution or the Russian Revolution. In the twenty-first century and thereafter, creation without bloodshed will be the form of revolution desired by man.

"In summary, we need modesty and adaptability in dealing with the unknown while being highly active in creating things. Control is certainly important. For it is basic, and without it we cannot have any evolution or revolution. But along with control, we also need what I call "viability" for evolution, and creativeness. I think we should have these three things as we proceed in the future."

After some more discussions, the symposium closed leaving the participants convinced that it would help them as a new source of imaginativeness and creativity for days or months to come, with Soichiro Honda making the concluding remark that he had learnt one lesson at the symposium: What is now taken for granted may no longer be so tomorrow, and such change is essential to progress. The symposium thus paved the way for a new phase of activity for the DISCOVERIES Committee. **(Y. Miyauchi)**

Postscript

This book is the record of the "Discoveries" International Symposium published for the purpose of advocating the need and content of a new science "Discoveries" toward the whole world. We editors should have reproduced the symposium as it was but, after a series of discussions, we agreed on this style. We made our best to represent as many opinions as possible but, since the symposium was so vast in dimension, we had to drop some of fine opinions.

We believe, however, that we could somehow meet the objective and ideal of ours to put the existing sciences in practice and establish a "human science."

Let us summarize the awareness and consciousness which contemporaries share concerning modern civilization, again.

(1) The recognition of crisis: we recognize that human beings are now faced by the history's biggest change, crisis, turning point or deadlock ever in many ways.

(2) The elements of crisis: We recognize that we are led to crisis by what we, moderns, thought was the G.C.D. axiom or standard — modern thinking, modern sciences, rationalism, the systems science and technological innovation which resulted. And then, we will (a) ponder, question and reassess things modern, (b) suffer from the fact that we cannot escape from being modern, and (c) lose the universal sense of value or coordinate axis on which we can communicate each other.

(3) The reassessment of non-modernity: We recognize that it is necessary to reassess what has been left by modernization and to return to universality beyond ages. Such recognition of ours will manifest itself in the form of (a) reassessment of irrationality and ambiguity of human beings, and (b) emphasis on totality and unity against reductionism,

and (c) reemergence, though in abstract terms, of "return-to-human-beings" thinking. Furthermore, such tendencies develop into (i) approach to ambiguity and (ii) return to literalism or a "start-afresh" approach.

(4) The need for the redefinition of modern methodology and science or the need for the reconstruction of them: We recognize the need to have a new leading principle or a new sense of value instead of "modernity" but modern technology is essential for that purpose. This recognition manifests itself in the form of (i) emphasis on the process to form consensus and (ii) emphasis on the necessity of interdisciplinary studies.

(5) The need for trial and error: This is an attitude to try to get out of the established and authoritative methodology, sense of value and terminology and to seek for a new way to recognize facts or a new methodology to solve problems. This further developes into tendencies such as (i) secession from the existing methodology, (ii) denial of Scholastic terminology and (iii) discovery based on openess, unconceptionality and ambiguity.

In short, specified above are the methodology to escape from modern dilemma and the quest for a new sense of value.

As human activities become more powerful in a broader range, it is necessary to know what is really important, locate the gap between such importance and the reality of human beings, solve it from human point of view and build a well balanced society.

Not to mention international and inter-racial problems such as natural resources-environment and foods, our societies are faced by a chaotic situation. And yet, the sciences continue to make progress and give direct impacts on human societies as observed in the research of genetic codes. We see the uniform Americanization in every advanced country of the world, as pointed out during the symposium. We cannot avoid taking a straight look at the deadlock of modern civilization and seeking for a way to override it.

This book does not tell us how to enjoy mechanical civilization. It tells us what we can do for the creation of a new civilization from our own positions in terms of geographical area and expertise. Specific approaches will be

discussed in future symposium sessions.

Finally, we like to extend our deep appreciation to people concerned who offered their cooperation from the beginning to the end of the publication of this book. Mr. Yasuji Miyauchi of Diamond Service, who took charge of editing and publishing and also assisted us in many ways, Mr. Tatsuo Suzuki, who was in charge of the symposium's secretariat, Miss Chikako Kimura and Miss Keiko Yamane deserve deep appreciation. **(S. Aida)**

DISCOVERIES

Definition and Identification Studies on Conveyance Of Values, Effects and Risks Inherent in Environmental Synthesis

Symposium International

■ Participants' Profile

1st Session

Speaker ●

Eduardo R. Caianiello

Director of the Laboratolio di Cibernetica of the Italian National Research Council. Prof. of Theoretical Physics at the Univ. of Salerno. Born in 1921. Received Ph.D. in Theoretical Physics from the Univ. of Rochester, U.S.A. Formerly, Prof. of Theoretical Physics at the Univ. of Naples and Director of the Institute of Theoretical Physics of the Univ. of Naples. Has served concurrently as visiting prof. in various parts of the world. Author of many scientific papers (about 100) plus some books on various topics of Theoretical Physics, Mathematics, Quantum Field Theory, and Cybernetics.

Commentator ●

Toshio Kitagawa

Director of International Institute for Advanced Study of Social Information Science. Prof. Emeritus of Univ. of Kyushu. Born in 1909. Mathematical Statistics and Information Science. Successively held visiting Prof. of various universities in the U.S., India, Australia and Director of many academic societies. Author of "Statistical Inferences I,II," "Logics of Information Science," "Lectures on Design of Experiments," "The Recognition of Statistics," "Introductory Considerations on Quality Control," "Theory of Games."

Kiyoshi Okada

Prof., Faculty of Economics, Seijo Univ. Born in 1931. Economics. Concurrently serve as part-time lecturer, Dept. of Commercial Science, Hitotsubashi Univ. and Faculty of Politics and Economics, Waseda Univ. Member of Council, Japan Society of Transportation. Expert Member of Government Committies of Ministry of Transportation, Prime Minister Office, Economic Planning Agency and Land Planning Agency, etc.

Chairman ●

Shuhei Aida

Associate Prof., Univ. of Electro-Cummunications. Born in 1932. Systems Engineering. Formerly served in National Biomedical Research Foundation, U.S.A. and Laboratorio di Cibernetica, Italia. Received the 23rd Mainichi Publishing Prize. Author of "Introduction to Cybernetics," "Robot," "Introduction to Ecology," "Interdisciplinary Study," "Science of Prediction," "Systems Engineering," "Sampled Data Control System."

2nd Session

Speaker ●

Morio Miyahara

Lawyer. Born in 1928. Graducated from the Faculty of Law, Univ. of Tokyo.

Commentator ●

Shimpei Takuma

Section Chief. Dept. of Educational Technology, The National Institute for Special Education. Born in 1935. Education Technology, Safety Education. Received Ph.D.on Education from Stanford Univ. Has been engaged in the study on the calculum construction of the safety education in schools, a developmental study on the morality in relation to traffic and rules and an experimental study on the influences of traffic noises with respect to learning efficiency. Author of "Scientific Approach to Safety Education," "School Health in the U.S.," "Medical Sociology and Monotonous Labor Problems," "Safety Education for the Handicapped," "Safety and Life," "Traffic Safety Education in Elementary School," "Environmental Health of School Children."

Shigeru Watanabe

Prof., Faculty of Engineering, Univ. of Tokyo. Born in 1918. Systems Engineering. Author of "Recognition and Information" "Science of Bicycle" "System's World" "Mathematics in Life" "Mechanism" "Chinese Character and Figure."

Chairman ● Hiroshi Miyakawa
Prof., Faculty of Engineering, Univ. of Tokyo. Born in 1931. Communication Engineering Information Science. Have been engaged in the study of Information Theory, Communication Theory, Radar Engineering, Digital Communication, Television, Vehicular Electronics. Author of "Coding Theory," "Advances on PCM," "Information Theory I,II," "Random Process and Estimation of Dynamic Characteristics," "Statistical Phenomena I,II."

3rd Session

Speaker ● Wilfred Owen
Senior Fellow at the Brookings Institution that engages in studies of economics, government and international affairs. Born in 1912. Graduated from Harvard in economics. Active as a consultant for the World Bank, the United Nations, the Asian Development Bank, the OECD and the goverments of Japan, Pakistan, India and Brazil. Author of "Cities in the Motor Age," "The Metropolitan Transportation Problem," "Strategy for Mobility," "Distance and Development," "The Accessible City," and "Transportation for Cities."

Commentator ● Namiki Oka
Senior Editorial Writer, Asahi Shimbun. Born in 1926. Urban problems and transportation systems. Member of Board of Directors of Advanced Transit Association (Headquarter: Washington D.C.) Author of "Could the automobile survive eternally?," "Citizens and Transportation," "Living and Transportation." Articles in 'Wheel Extended(quarterly mag.).'

Masaki Koshi
Associate Prof., Univ. of Tokyo. Born in 1935. Transportation and Traffic Engineering. Formerly engaged in Public Work Research Institute, Ministry of Construction and studied in Institute of Transportation and Traffic Engineering, Univ. of Cal. Author of "Roughness of Road Surface," "Skid Resistance of Road Surface," and many thesis.

Chairman ● Kiyoto Takizawa
Prof., Dept. of Medical Science, Jichi Medical School. Born in 1926. Clinical Psychology and Psychiatry. Author of "Introduction to Contemporary Psychology," "Pathology of Humanbeings," "Introduction to Psychological Clinic," "Mind of Children and Society," "Introduction to Counselling."

4th Session

Speaker ● Sébastian Loste
Senior Administrative Officer to the French Councile of State and Section Chief with the public authority in charge of setting up GEORGES POMPIDOU National Center for Art and Culture. Born in 1936. Formerly Section Chief in the Department of the Edmond Michelet, Minister of State in charge of Culture Matters and advisor to the Prime Minister on problems connected with the circulation of French-language books outside France. Publications: articles in various prestigious French literary and cultural reviews.

Thierry De Beaucé read the paper on behalf of Loste who could not attend the Symposium because of illness.

Thierry De Beaucé
Cultural Counsellor for the French Embassy in Tokyo. Charged with cultural affairs under Minister André Malraux in the Ministry for Cultural Affairs. Served as Press Secretary of the French Prime Minister, 1969-1972, in charge of missions for the French Government in the South-East Asia and the Middle East.

Commentator ● Shuji Takashina
Associate Prof., Faculty of Letters, Univ. of Tokyo. Born in 1932. History of Art. Engaged in the study on Modern French painting and art of Renaissance. Author of "Art of the 'Fin de Siècle'," "Picaso" "The Light and Darkness of Renaissance" "Studies in Modern Japanese Painting."

Kisho Kurokawa
Architect. President of Kisho Kurokawa Architect and Associate. Director of Institute for Social Engineering Inc. Born in 1935. City Planning, Social Engineering. Advisor to Japan National Railway, Analyst of NHK Japan Broadcasting Corp. Author of "Urban Design" "Action Architecture" "Creation of Contemporary Architecture" "Homo-movence" "Introduction of Urbanology" "Concept of

Metabolism" "The Future of Information Archipelago Japan" "Works of Kisho Kurokawa" "World of Kisho Kurokawa."

Chairman ● Fuyuhiko Okabe

Cartoonist. Born in 1922. Received the 7th Bungei Shunju Cartoon Prize for his works "Atsu-chan" and "Baby Gang" Other works are "Atsukama-shi" and "Oyakama-shi" He loves every kinds of machines from trains and airplanes to rockets. His nickname among his collegues is "Okabe Science." Author of "History of JNR."

5th Session

Speaker ● Saburo Ichii

Prof., Faculty of Engineering, Seikei Univ. Born in 1921. Scientific Philosophy. Went to Univ. of Manchester and London for graduate study. Formerly Associate Prof., Aichi Univ. of Education. Author of "Philosophy of Whitehead" "Philosophical Analysis" "Philosophy of the Meiji Restoration" "Philosophical Reflection on Modern Times" "What is the Progress of History."

Commentator ● Chikashi Nakanishi

Prof., Faculty of Business Administration, Waseda Univ. Born in 1929. Transporation Economics and Logistics. Invited to London Univ. and Oxford Univ. and received M.A. on Economics from London Univ. Member of Government Committees of Ministry of Transporation, Trade and Industry, and Economic Planning Agengy, etc. Author of "Now's Physical Logistics in Japan" "Logistic System Planning" "Port Economic and Logistic System Analysis."

Shunpei Kumon

Associate Prof., Dept. of Social Science, College of General Education, Univ. of Tokyo. Born in 1935. Economic Systems Theory, Social Systems Theory. Received Ph.D. in Economics from Indiana Univ. Formerly Visiting Associate Prof. in Carleton Univ., Canada. Author of "Economic Systems" "Theory of General Systems."

Chairman ● Yoshio Ikeda

Chief Engineer, Wako R & D Co., Ltd. Born in 1924. Charged in the basic study on body structure of automobiles and motorcycles. Currently engaged in development of soft-wares with respect to traffic and safety.

6th Session

Speaker ● Harold A. Linstone

Prof. and Director of Systems Science Ph. D. Program Portland State Univ. Received Ph. D. from the Univ. of Southern Cal. Formerly Senior Member of the Rand Corporation, Associate Director of Corporate Development Planning of Lockheed Aircraft Corp. and Director of Center for Technological and Interdisciplinary Forecasting, Tel Aviv Univ. Active as a Senior Editor for international journal, "Technological Forecasting and Social Change" and a consultant to various businesses and institutions such as IBM, United Airline, etc. Author of "Technological Substitution" (in collaboration with D. Sahal), "The Delphi Method: Techniques and Applications" (with M. Turoff) and "A Technology Assessment Primer" (with W. Morsch).

Commentator ● Atsunobu Ichikawa

Prof., Dept. of Engineering, Tokyo Institute of Technology. Born in 1930. Control Engineering. Formerly Research Associate, Case Institute of Technology, Ohio., Visiting Prof., System Design and Institute for Optimization, Kanzas State Univ. Engaged in the study of System Synthesis, Human Factors in Engineering and Decision Making. Author of "Process Dynamics," "System Control of Complex System."

Takemochi Ishii

Prof., Faculty of Engineering, Univ. of Tokyo. Born in 1930. Industrial Machine Engineering. Active in the fields of social development system program and technical designs: CVS, Demand Bus, Dual Mode and Mixed Mode in the New Transportation System, and Environmental Regulation of buildings in urban areas, Digital Image Processing and Hospital-automation. Author of "Business and Information," "Safety Engineering," "Medical Science and Computer – Introduction to Medical Electronics."

Chairman ● Masaaki Asai
Prof., Dept. of Psychology, College of Humanities and Sciences, Nihon Univ. Born in 1929. Formerly engaged in Cross Cultural Studies of Affective Meaning System sponsored by Institute Comparative Psycho Linguistics, Illinois Univ. Author of "Psychology of Man," "Industrial Psychology," "Psychology and Behavioral Activities."

7th Session

Speaker ● Toshiro Terano
Prof., Dept. of Systems Science at Tokyo Institute of Technology. Born in 1922. Graduated from Univ. of Tokyo. Received Ph. D. in Engineering from Univ. of Tokyo. Formerly, Research Staff at the Transportation Technology Research Institute. Author of many papers and books.

Commentator ● Akihiro Suzumura
Prof. and Director of Opthalmology, Aichi Medical Univ. Born in 1927. Active as a Councilor of the Japanese Opthalmologists in Japan, Member of International Aerospace Medicine Congress, and Director of the Illuminating Engineering Institute of Japan. Author of "Eye and Road Traffic," "Eye and Industry," "Asthenopia," "Valuation of Visual Perception of Spapiel Objects and Development of Perceptual Aptitude."

Akira Tsujimura
Prof., Faculty of Letters and Institute of Journalism, Univ. of Tokyo. Born in 1926. Social Psychology. Engaged in the study on International Comparative Study of Mass Communication and Sociological Studies of Soviet Society. Currently active as a member of Japan and U.S. Joint Study Group on International Communication. Author of "Mass Society and Socialist Society," "Japanese Culture and Communication," "Beyond Ideology," "Criticism for the Press."

Chairman ● Yasuhei Oguchi
Associate Prof., Faculty of Engineering, Shibaura Institute of Technology. Born in 1937. Engaged in the study of lateral motion characteristics of men and vehicles and driving control mechanism of drivers by vehicle lateral motions simulator. Author of "Theory of Vehicle Performance," "Safety Driving Handbook," "Automobile Handbook" (joint authorship).

8th Session

Speaker ● Murray Turoff
Associate Prof. of Computer and Information Science at the New Jersey Institute of Technology and Associate Director of the Center for Technology Assessment. Systems Engineer for IBM, Member of the Science and Technology Division of the Institute for Defense Analyses, and Senior Operations Research Analyst for the Office of Emergency Preparedness in the Executive Offices of the President. Noted as a designer of a number of major Delphi studies and an originator of the Policy Delphi concept, computer-based Delphi and Management Information Systems based upon Delphi-like Communication concepts. Currently engaged in a major research program concerned with the use of computers to augment human communication capabilities. Author of "The Delphi Method: Techniques and Applications" (in collaboration with H. Linstone).

Commentator ● Yoichi Kaya
Associate Prof., Engineering Research Institute, Faculty of Engineering, Univ. of Tokyo. Born in 1934. Systems Engineering. Formerly lecturer, MIT and Research Associate, Univ. of Cal. Since an inauguration of Club of Rome, active as a chief of Japan Work Team and served for Battelle Institute (Geneva) to cooperate with research activities of Club of Rome. Author of "Automatic Control Engineering," "Random Signal Theory and Process identification," "Adaptive Control Process," "Probability and Statistical Theory," "Control Engineering," "Systems Engineering."

Kaoru Noguchi
Associate Prof., College of General Education, Chiba Univ. Born in 1935. Experimental Psychology. Formerly, served as a Research Associate, Behavioral Sciences, Dept. of Experimental Psychology, York Univ. Canada. Currently engaged in Human Perception and Performance; Behavioral Technology. Author of "Psychological Atlas," "Essence in Centemporary Psychology."

Chairman ● Motoo Nakajima
Director, Wako Center, Honda R&D. Co., Ltd. Born in 1928. Charged in design of body structure of automobiles and motorcycles and development of vehicles. Currently engaged in research and development of vehicle function with respect to traffic and safety and relevant soft wares.

9th Session

Speaker ● Torgny Segerstedt
Rector of Uppsala Univ. Born in 1908. Graduated from the Univ. of Lund. Formerly Associate Prof. in moral philosophy at the Univ. of Lund and Prof. of philosophy at the Univ. of Uppsala. Member of the Swedish Academy, the Swedish Academy of Science, the Swedish Academy of Letters, the Swedish Academy of Technology. Chairman of several royal commissions and president of the Swedish Social Science Research Council. Author of numerous publication in philosophy and sociology such as "The Nature of Social Reality."

Commentator ● Yoshikazu Sawaragi
Prof., Faculty of Engineering, Kyoto Univ. Member of Japan Science Council. Born in 1916. Systems Engineering. Engaged in the study on Theory Vibration and Theory Automatic Control and established the Theory on the Optimization of Non-linear Stochastic control system. Author of "Statistical Decision Theory in Adaptive Control Systems," "Statistical Studies on Non-linear Control Systems."

Kenichi Koyama
Prof., Faculty of Law, Gakushuin Univ. Born in 1933. Social Engineering. Author of "Introduction to Futurology," "Future Research," "Information Social Science." (joint authorship)

Kenichi Koyama could not attend the 9th session because of a sudden illness. Akira Tezuka served as commentator.

Akira Tezuka
Director, Research Aid Division, Bureau of Science and International Affairs, Ministry of Education. Born in 1923. Graduated from Faculty of Law, Univ. of Tokyo. Has been engaged in scientific administration in the ministry.

Chairman ● Yasuhisa Nagayama
Associate Prof., Faculty of Human Sciences, Osaka Univ. Born in 1932. Traffic and Psychology. Formerly, joined the Scientific Mission of Osaka Univ. to East Pakistan. Currently active as a member of the Japanese Psychological Association, the Japanese Applied Psychological Association and the Association of Traffic Science of Osaka, etc. Author of "Psychology of Traffic Accident," "Problems of Traffic Psychology," "Science for the Safety Driving."

10th Session

Speaker ● Masataka Kosaka
Prof., Dept. of Law at Kyoto Univ. International Politics. Born in 1934. Formerly, Research Associate of International Institute for Strategic Studies, and Member of Economic Council of Economic Planning Agency. Author of "Prime Minister Shigeru Yoshida," "Thinking in the World Map," "A Hundred Million Japanese-Postwar," "History of Japan."

Commentator ● Yukihide Okano
Prof., Faculty of Economics, Univ. of Tokyo. Born in 1929. Transportation Economics. Member of Council, Japan Society of Transportation and Japan Section of Regional Science Association. Member of Econometric Society. Author of "Public Economics," "Lectures on Transportation Economics" (joint authorship), "Citizens and Transportation."

Yoshitatsu Tsutsumi
Editorial Writer, Nihon Keizai Shimbun. Born in 1927. Author of "Nuclear Power," "Aero-space Industry."

Chairman ● Richard I. Emori
Prof., College of Technology, Seikei Univ. Born in 1924. Engineering Design. Formerly Engineer of General Motors, and Associate Prof., Faculty of Engineering, Univ. of Cal. Has been engaged in the study of Transportation Engineering and analysis on Automobile Accidents. Author of "Homologous Experiments-Theory and Application," "Automobile Accidents Engineering," "Manufacture Engineering System."

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