Symposium proceedings

Man and society – automated information processing

Harold W. Lawson, Jr., Editor

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Stockholm 79

SYMPOSIUM PROCEEDINGS

MAN AND SOCIETY - AUTOMATED INFORMATION PROCESSING

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PREFACE

The Royal Swedish Academy of Engineering Sciences was greatly honoured to be asked by the Honda Foundation to arrange the fourth Discoveries symposium. The aim of the International Discoveries Symposia has been the redirection of technology for the benefit of society and the individual. The fourth Symposium was devoted to the subject

MAN AND SOCIETY - AUTOMATED INFORMATION PROCESSING

During the last two centuries the world has passed through major transformations. The present decennium has marked the beginning of the Automated Infformation Processing. The world is in the midst of a technical transformation as profound as the first industrial revolution on the basis of the steam engine and the electrification of our society which started one hundred years ago. Already every third person employed works with information transfer or information handling. The number of computers in the industrialized world is doubled every fourth year. Microelectronics will make all our appliances, tools, vehicles, and toys semiintelligent. Some of the effects of automated information processing are already with us. Politicians pronounce their serious concern over how the integrity of the individual can be safeguarded in the new information society. The connection between computerization and employment is anxiously sought. There is a fear of the computer as a new tool for ruthless domination. All this formed the background of the symposium.

The fourth and final symposium in the Discoveries series was held 13-17 August 1979 at the Grand Hotel, Saltsjöbaden in suburban Stockholm. The proceedings of the symposium are documented in the publication.

The first chapter consists of a summary of the entire symposium; thus providing the reader with the major accomplishments. The opening addresses and the keynote address are documented in chapters 2 and 3, respectively.

The lectures of each of the three major symposium working sessions are presented in chapter 4 - The Machines, chapter 5 - The Individual and chapter 6 - Society and Computers. In order to provide some concrete examples of Automated Information Processing, a case study pertaining to Medical Care was interwoven into the three working sessions. The case study is documented in chapter 7.

The academy was deeply honoured by the opening address of the symposium given by H M Carl XVI Gustaf, the King of Sweden.

The Royal Swedish Academy of Engineering Sciences expresses its thankfulness to Mr Soichiro Honda, Mr Takeso Shimoda and the scientific and organizing members of the Honda Foundation. A special thanks to Professor Harold W. Lawson, Jr., secretary of the scientific committee and editor for the publication.

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Chairman of the Scientific Committee

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CHAPTER 1

THE SYMPOSIUM IN SUMMARY FORM

1 Introduction

In this introductory chapter, we first consider the goals and organizational aspects of the Stockholm symposium in order to provide the reader with an understanding of how the scientific committee designed and developed the symposium structure. Next, we consider a summary of the opening session which was to provide a starting point for the scientific activities. To indicate the main "results" of the symposium, a section is dedicated to the summaries by the respective chairmen of the symposium component parts. The chapter terminates with the most important concluding remarks made at the closing session.

2 Symposium Goals and Organization

The scientific committee, under the chairmanship of Professor Gunnar Hambraeus of the Royal Swedish Academy of Engineering Sciences and vice-chairmanship of Professor Shuhei Aida of the University of Electro-Communications and the Honda Foundation, in organizing the Discoveries Symposium for Stockholm, decided upon the theme of "Man and Society - Automated Information Processing". The ordering within the title was deemed to be important; namely, to emphasize the point that it is man and society that are to be the beneficiaries of the automated information processing technology and not that automated information processing be the captor and influencer of man and society. This emphasis is directly in line with the goals of the Honda Foundation in sponsoring the Discoveries series; namely, the "Humane Use of Human Ideas".

The major goal of the symposium was to bring together a cross-section of experts and laymen from a variety of disciplines and through tone-setting presentations and discussion, shed light upon the major issues of this important subject area. At an early stage, the scientific committee agreed, that in order to help to keep the discussions down to earth, an actual application of automated information processing technology should be presented in the form of a case study. The subject of "Automated Information Processing in Medical Care" was deemed to be an appropriate area where, hopefully, man and society can benefit from the use of automated information processing technology. Professor Sixten Abrahamsson of the University of Gothenburg, due to his active role in planning and implementing medical information systems, was asked to chair the case study which was to be given as an interwoven part of the subject areas of each day.

Having decided upon the case study area, the scientific committee set about organizing the details of the symposium. An opening session, with appropriate formal introductions, a tone-setting keynote speech and case study introduction plus a closing session to summarize the results of the Stockholm meeting and the Discoveries series, were to be definate anchor points of the program. Professor Gunnar Hambraeus was selected to chair these sessions. The determination of the major subject areas for the three middle session days was rather straight forward. Firstly, a session to provide information, particuarly for the laymen at the symposium, concerning historical aspects, current state of the art and future trends of The Machines for which Computer Science Professor Erik Sandewall of Linköpings University was selected as chairman. Sociologist and Rector Emeritus of Uppsala University, Professor Torgny Segerstedt, was selected to chair the session related to assessing the relationships of The Individual and automated information processing. Finally, for the session related to Society and Computers, Political Science Professor Gunnar Hecksher was selected as chairman.

The scientific committee developed the symposium program by selecting appropriate people to present tone-setting lectures, including the distinguished opening session keynote speaker Heinz Zemanek, Professor at the University of Vienna and Fellow of the International Business Machines Corporation. Professor Zemanek, in his previous capacity as President of the International Federation of Information Processing Societies (IFIP) has been instrumental in bringing attention to the importance of discussing the impacts of automated information processing upon society. Therefore, Professor Zemaneks presentation entitled "The Impact of Information Processing Upon Society" provided an authoritative start to the scientific program. Professor Reikichi Shirane of the Telecommunications Science Foundation, Tokoyo, Professor Sidney Michaelson of the University of Edinburgh and Professor Edward Fredkin of the Massachusetts Institute of Technology were selected to present the lectures related to the historical aspects, current state of the art and the future trends of the machines. For the tone-setting lectures of the sessions related to the individual and society and computers, Professor Harold Lindstone, Portaland State University and Professor Klaus Lenk of the University of Odenburg, West Germany were selected.

The strategy in selecting the remaining participants was to obtain a mixture of previous Discoveries participants and new participants that would provide expertise in the symposium subject area. The symposium participants (thirty-six in number) including the scientific committee and lecturers are listed elsewhere in this book. The distribution by country is as follows: Sweden, the host country (9), Japan (9), United States of America (5), Great Britan (3), Austria (2), Italy (2) and France, West Germany, India, Kenya, Norway and Yugoslavia (1 each). From the participants, several were selected to provide short prepared discussion introductions on special topics as published in the symposium schedule.

3 Review of the Opening Session

The Stockholm symposium was officially opened by His Majesty King Carl XVI Gustav of Sweden. His Majesty emphasized the importance of the subject area by stating that "computers are here to stay and that we must be aware of both the positive and negative effects of the presence of computers". Session chairman, Professor Gunnar Hambraeus, after welcoming the participants on behalf of the Royal Swedish Academy for Engineering Sciences, invited Japans ambassador to Sweden, H.E. Masahisa Takigawa to read a special message from the Japanese Prime Minister. Foreign Minister Hans Blix, representing the Swedish government, pointed to the importance of the merger of telecommunications and computer technologies and the potential postive and negative effects of this union. Dr. Soichiro Honda then, in addressing the participants and opening session guests, vowed to devote the remainder of his life to the Discoveries Idea and Project.

In his keynote speech, Professor Heinz Zemanek emphasized the transitional problems in the introduction of automated information processing in the short run but was optimistic for long-range prospects. Effects upon labor and employment forms is unavoidable. The computer terminal is destined to be a factor in human communication and will certainly be viewed with mixed reactions.

Professor Zemanek provided an historical account of the evolution of computer languages. Further, he made a statement, to be challanged by several participants, that "although a computer might change; or destroy information, it could not generate any new information with more basic content then that fed to it". Professor Zemanek speculated that electronic voting systems for the citizenry of a country, although not attempted thus far, will be attempted in the future. In his conclusion, the Professor stated that "our fate will remain in our own hands, because computers will return decision making to us" (... a thought provoking statement).

The opening session terminated with the case study introduction by Professor Sixten Abrahamsson. The results of the case study are summarized in the next section.

4 Summaries of the Case Study and Session Chairmen

The sessions of the following three days provided for stimulating presentations by the tone-setting lecturers as well as lively discussions in the meetings and in smaller groups during pauses. Since the information transmission was largely "simplex" (one-direction) during the first day, the discussions were most intense during the days related to the individual and society and computers. The closing session of the Stockholm symposium was held in the Swedish House of Parliament in central Stockholm. Professor Eduardo Caianiello, participant at all four Discoveries symposia, first presented a summary of the previous symposiums in Tokoyo, Rome and Paris. Following Professor Caianiello's presentation, the case study and session chairmen presented their summaries which are presented here, in edited and in certain cases complemented form, to provide the reader with the main "results" of the three working session days of the Stockholm symposium.

4.1 Automated Information Processing in Medical Care

The demand for health care is increasing all over the world and no one seems to believe that a saturation can be reached. Health care represents a labor intensive industry which now faces severe shortages in both funding and persónnel. In Sweden, the costs are rapidly approaching 10% of the GNP. In this situation, automated information processing has been introduced as a means of reducing the costs and/or increasing the use of available resources. This process, which started at too early a stage some 20 years ago, has now matured and will accelerate considerably during the 1980's due to the rapid advances in microelectronics. Such a development will radically influence both man and society and it was therefore highly appropriate to illustrate some of the effects as a medical case study throughout this symposium.

Some of the special problems when designing medical information systems have been identified. The key issue is to arrive at a solution that is acceptable by the very different user categories; that is physicians, nurses, medical secretaries, administrators, politicians and patients. Their needs are so widely different that the final design necessarily represents a compromise. If this is not made quite clear to all users, the system will never be accepted. An alternative with separate systems for the different user categories would lead to unrealistic costs and would not give the total picture of the health care delivery system necessary for control and planning functions.

At present, most functions in health care can and have been automated. Some are cost-effective such as systems for the clinical laboratories. The use of microcomputers will further improve the performance of such systems. The number of special stand-alone equipment requiring little or no attention by computer people will increase drastically during the 1980's. Several subsystems again are not cost-effective but are operated for other reasons such as being a complement to a cost-effective routine at marginal extra cost.

In order to achieve a better resource utilization, better planning and improved care, the various subsystems must be made to work in intimate interplay. An integrated medical information system (a concept of the 1960's) must therefore be constructed with at least the basic functions of health care included. Though we know by now the human problems involved, the task to make such a system an integral part of the routine health care operations is by no means easy.

Computer simulation can be used with advantage to forecast medical demands and resource consumption. In the first case study presentation, Professor Kazuhiko Atsumi revealed that the morbidity of degenerative diseases, including cardiovascular diseases and malignant cancer, follows a similar pattern in different countries. Thus, when various individual population structures are taken into account, the total number of people needing care and the associated costs, as well as the death rates can be estimated with a high degree of reliability on the international level.

The model indicates to decision makers which actions are necessary in order to fulfill a certain determined policy for health care operations. Professor Atsumi furthermore made the point that "health care becomes a science by the introduction of computers".

The comprehensive medical information system of Stockholm County was used as a base for the two other case study presentations. The system covers the entire medical region with 1.5 million inhabitants and records data on each patient visit. The total information is instantly available over some 350 terminals to all authorized users.

Docent Peterson, in his first presentation on the third day, introduced a relatively new feature of the system; namely, care programs for cancer. All physicians of the region have agreed not only on the way of treating various forms of cancer but also on all information that should be stored in each case. The number of cases treated in the same way thereby becomes relatively large which allows a follow-up to be made earlier than before. There is also the possibility to divide the patients into different treatment groups and then compare the results. This routine is of obvious benefit to the patient but also to the health care authorities by reducing the number of expensive hospital days.

The final case study presentation on the fourth symposim day (also by Docent Peterson) dealt with the total registration of all inpatient visits and its effect on the planning function. The information collected since 1969 can be used to trace changes in the panorama of diseases. Harmful effects on the individual by the environment and of social attitudes, for instance towards drugs and alcohol, can be detected at the earliest possible time.

The consumption of health care resources can be compared to the expected one calculated, for instance, with Professor Atsumi's model. Areas of high overconsumption exist in the County. This can most often be explained by socio-economic factors; whereas, the cause in some cases is unknown. The authorities now have the facts and should take measures to correct the situation.

Projections of the number of beds needed, say 10 years from now, can easily be calculated from the data files. This is, of course, of crucial importance since the construction of new hospitals takes considerable time.

During the symposium many worries were expressed over storage of data on computers and privacy. The very effective security system of the County was demonstrated. It is based on an individual password which is changed every quarter year. From the password, the computer identifies the user and checks that he may access the requested data. In addition, a control is made that the user is at an expected terminal, say in his own clinic. All transactions are logged and regular checks are made on what users have been doing with the system or who has been requesting particular data. Should someone try to break the code, the terminal is physically closed after the fourth attempt.

The system has never failed and the computer files must be regarded as more secure than the manual medical records floating about in the hospital.

The symposium never proposed any resolutions concerning automated information processing in health care. The case studies, however, served the intended purpose of providing realistic down-to-earth contacts for the sometimes high-flying thoughts of the delegates.

4.2 The Machines

The purpose of the second day of the symposium was to revue the world of information processing machines in dimensions of time (discussing the past, present, and future of automatic tools), and space (making comparisons between uses of computers in different parts of the world), to provide the necessary background of technological facts and predictions for the discussions in subsequent days.

The session began with a systematic exposition of the history, nature and impact of automation and automated information processing. Presented by Professor Reikichi Shirane, President of the Telecommunications Science Foundation in Tokyo, this set the scene by recalling the origins of large-scale automatic processing in the US car industry some half a century ago; the subsequent development of multiple servoloop systems (initially mainly for military purposes in World War II); and the post-war expansion of such concepts into cybernetic automation or "cybernation".

Professor Shirane traced the effects of these various stages in man's increasing use of sophisticated control arrangements, not only in industrial production but also in fields such as agriculture and mining, transport and communications, accountancy, banking, and in "nonindustrial social systems" such as mangement and administration, education and medical care. He pointed out how these applications had been made possible and worthwhile by developments in the technical performance of the computers used - notably increased operation speeds and computing capacities, increased memory capacities and reliability, and greatly reduced costs. However, he did not suggest that any of these attributes made the machine more than an important extension of the information processing capabilities of the men in control; and he concluded with some challenging remarks on machine/man relationships in Japan and the impact of the ever more ubiquitous computer on the Japanese social scene.

Professor Shirane was followed by Professor Sidney Michaelson (Edinburgh University) whose presentation of "The State of the Art in Information Processing" was a compendium of facts and figures illustrating the remarkable progress of computing machines over the past quarter century. To cite just one example of this progress, he gave some details of a typical "quite large machine" of the early 1950s: 20 to 30 high-speed registers and a file store of a few thousand numbers. Today he said (or rather, in view of the speed of current development, yesterday) children can buy as toys, devices of very small physical size which have a thousand times more immediate working storage and a thousand times the backing storage. Professor Michaelson also pointed out the broad spectrum in size of computers, from the very small to the very big. The concept of a general purpose computer is becoming less and less appropriate, as computer equipment is specialized to various tasks.

The discussion about effects of computers on individuals and society had been scheduled for subsequent days, but started already on the second day. Parts of Professor Michaelson's speech, as well as subsequents statements by Professor Linstone, de Sola Pool, Finer, and others focused upon the effect of computers on employment. This was to become one of the main topics of interest during the following days.

In the afternoon, Professor Edward Fredkin of the Massachusetts Institute of Technology spoke on "Longrange Prospects for Intelligence in Information Processing Systems". Professor Fredkin observed that the computer is already being used as a prosthesis for human thought in certain areas, and the number of such areas is likely to increase as advances in hardware and software technology make it possible to program more complex information processing tasks for computers. In the development of the technology, certain facilities such as an internal autonomy of the software system, and an ability for it to modify itself, will make it appropriate to call such systems "intelligent".

Professor Fredkin argued, in this context, that (1) the prerequisits for intelligent computer systems are already coming into existence in the form of cheap LSI technology, wide spreed storage of information on computer media, etc (2) to develop the technology of intelligent machines, one single breakthrough is needed, and maybe performed even in a small laboratory with very modest equipment. When the breakthrough is done, an overflood of rapid development is likely to follow. Furthermore, the longer the time lasts until the breakthrough comes, the quicker will be the subsequent developments; (3) like all other new and complex machinery, intelligent computers will certainly contain design mistakes ("bugs") when they first appear, and may therefore be dangerous.

Professor Fredkin therefore concluded, first that a quick development of intelligent computer systems would be desirable to guarantee and even control the use of this technology, secondly that when such systems first appear, they should be put into quarantine, and thirdly that an international agency should be formed for research, development, and control over intelligent computer systems.

The discussion following Professor Fredkins talk treated both his analysis of technical possibilities and political proposals. There was disagreement about the concept of a single breakthrough - some speakers believed rather in a gradual development which would be easier to control. The political desirability, as well as feasibility of the proposed research agency, was also controversial, but no alternative solution for handling the problem was proposed.

In summary, the first day was mostly used for providing different points of view on information technology. Much of the discussion that started in a small scale even on the first day, was to continue on the following days.

One issue which would recure repeatedly during the symposium, became very clear even on the second day; some participants believed that the effects of computers in society can best be studied by extrapolation from previous use of computers, and there effects so far, various other participants felt that such extrapolation would be very unreliable, and often misleading, and that one must instead look to the properties of computer technology as such in order to get an understanding of there likely effects in the future. Since they covered both past developments, present state in several countries and longrange prospects, the speakers during the first day provided an ample background for both approaches to studying the effects of information technology on individual and society during the Discoveries Symposium.

4.3 The Individual

The third day was devoted to a discussion about the impact of electronic technology on the life of individual man, on his family life, his education and his work. It was generally felt that all sectors of human life would be influenced. I can only mention a few consequences, or possible consequences, of new computers and terminals.

It was first of all repeatedly pointed out that the new machines were getting cheaper and cheaper and could before long attain a wide distribution. The computers are however in a way selective, only certain traits of reality are treated by them. As Professor Harold Linstone, the tone-setting lecturer, put it: "The computer requires a mathematical model, but such formalism is unable to represent the relevant properties of organizational and individual perspectives". Because of this aspect, computers are creating new realities. We may say that the specific data language structures our experience of reality. As computers and terminals seem to be very common, a consequence seems to be that we all must learn their language. If we do not understand that specific language, the machines may get a power of their own. To understand the technical language may be said to be a democratic demand which is particularly felt in the workforce, but not as important for all individuals.

The reality created by computers includes our way of looking upon other human beings. There is, as we all know, a risk that we are intruding on their privacy and their personal integrity. But there is evidently also a danger that the electronic machines only will underline our rational modes of thought and neglect our emotional and intuitive capacity. For that reason we must remember that social interaction is an important factor in human development. One new technique may diminish our face-to-face relation as a large amount of communication can take place via computers. When analyzing the consequences of the new technology, we can not neglect the energy problem. The important question is: if the new technology requires more or less energy than the conventional techniques? If it requires less energy, we will probably be forced to accept it whether we like its consequences or not.

It was furthermore evident from our discussions that when trying to predict the implications of computers on the life of man, we had to take into consideration what is possible from (a) technical point of view, (b) psychological point of view, (c) political point of view and (d) economical point of view. It seems likely that the real resistance toward electronic technology will be of psychological and political nature.

We also learned, as often before, that the problems may seem different if you look upon them from the Western point of view or from the developing nations point of view. We are apt to forget that problems may be quite different from different viewpoints.

When we discussed the new job-situation, it was pointed out that a significant amount of work in the future (if not already) can be carried out at home, as you can obtain enough information from your home terminal. The work mentioned was mostly white collar work. But if working at home becomes common, it may solidify family ties.

The question remains: Could ordinary industrial work be decentralized in the same way as white collar work to small units at the same time as a centralized source of information and control directed the production program? If that could be possible, we would have a new kind of cottage industry or village industry. The cottage industry implies a new kind of social life and consequently has enormous implications on labor life and must be of great importance for labor-unions. It was stressed, at our discussions, that these changes must not be carried through without information and concern from the persons affected. The fear is, of course, the disappearance of jobs and an increasing unemployment. The problem is how much liberty of choice the energy-shortage will admit to us. I am sure there will be a strong psychological resistance and probably a strong political resistance. There is a general feeling that employees must not only be spectators but actors and controllers as well.

I hope the psychological and political resistance will not be so strong that we do not observe that the new machines may relieve the individual worker of dangerous jobs such as handling poisenous material. Robots can take over that kind of non-human job. With regard to our daily life in our homes, it was said that the distribution of consumers goods could be drastically changed. Our daily needs could be programmed and goods delivered when we were running short of them. It does mean a decrease of social contacts, however, it may solve the problems for old people and of out-of home working parents. May I add that robot-servants to do our house-hold jobs were also declared possible. The computers and terminals make decentralization possible. That may influence the power structure in many ways. Some of them were mentioned during Professor Gunnar Heckscher's day on society and computers. We did not discuss however, if that meant that the family would have a stronger position in future society or if new primary groups would emerge, namely, groups which interacted around the new machines.

As I have already said, much fear was expressed that the new machines might create unemployment. I am sure we will have an increasing leisure time whether we want it or not. A considerable part of that leisure time will, however, be consumed by retraining men and learning new skills. Speakers meant that electronic devices could be very helpful in the vocational retraining of people who have lost their jobs or had to adjust themselves to the changed condition of their old jobs. It was also pointed out the new machines gave everybody a chance of life long education. So the situation seems to be that electronic technology may kill jobs but, at the same time, it helps to re-educate people for new jobs. One of those new goals of education will be to understand the language and power of our new instruments. But even if it is true that a rather large part of the leisure time will be consumed by adult education there will still be a large amount of time at disposal. There is no doubt that the new machines can distribute culture goods in quite an effective way. If we have new primary groups and revived villages they will be the consumer of our culture goods. I regard that as very important. But I am sure that we have to educate individuals to understand culture values. That can probably not be done by computers. I have talked about the danger of indivudals being isolated or that they will be without chance of human interaction. One speaker said that "we now have evidence that certain forms of social interaction, which help the child to take a perspective other than his or her own on what is happening out there, are a powerful ingredient of the development of abilities". It is evident that computers can be instrument of education, but that they never can replace human beings. It is still so, that human beings are being human only in interaction with other human beings.

4.4 Society and Computers

The discussions during the fourth day, held under the title "Society and Computers" were lively (with no less than 42 interventions by 21 different participants) and covered a wide field. Any selection of the points discussed, consequently must be subjective and even arbitrary. But I shall mention some of them. If I fail to mention by name the participants making the different points, it is because very frequently the same question was analysed by more than one of the speakers. It was characteristic that there was real give and take all through the discussions which we, in the West, believe to be the best way of making discoveries.

(1) The tone-setting speaker, Professor Klaus Lenk, posed the basic question: Is AIP (utomated nformation rocessing) going to remain a tool, or does the technology tend to develop so independently that it may become our master? Although it was pointed out that both may be true to some extent, most speakers agreed that, for the foreseeable future, it will remain no more than a tool and that we thus carry a heavy responsibility in deciding how it is going to be used.

(2) Democracy has learned how to deal with new technologies. But beneficial use of AIP requires education not only of decision-makers, but also of ordinary citizens concerning its character. The technological experts must provide the information necessary for this purpose.

(3) International control could be desirable, as Professor Shuhei Aida pointed out, but it is hardly a practical possibility. To some extent, its place can be taken by wide publicity.

(4) The industrialized societies must make serious efforts to take into account the interests of developing countries. Technology should be adapted to their needs and it would be a great mistake to believe that what is viable in highly sophisticated Western societies could be transferred without important modifications to emerging societies with different cultural backgrounds.

(5) In any case, the use of AIP involves real political problems, where both different interests and different ideologies may appear to be in conflict with one another.

(6) As far as industrialized societies are concerned, it is likely that AIP will initially enforce bureaucratic power and cause centralization. However, its present effects do not necessarily indicate what the ultimate results will be. New technologies tend to favour central governmental power as long as they remain expensive, but when they become inexpensive, the opposite may be true. Moreover, AIP can already now be used as an instrument of subversion, and small groups may be able to disrupt the power structure, if it is dependent upon centralized machinery of strategically important points. Also, widespread use of AIP is likely to enhance the visibility of governmental and administrative procedures in relation to ordinary citizens.

(7) Fear of the administrative consequences of AIP is motivated by the assumption that administrative agencies are malevolent. However, in democratic societies this is not true. On the whole, they try, if with varying measures of success, to realize the objectives decided upon by democratic process.

(8) The fear that AIP may be threat to privacy and to the integrity of private individuals is not warranted, if necessary precautions are taken. In the case study, an example was given of how such precautions work in the health services of Stockholm county.

(9) Much controversy appeared in the discussion of how AIP is likely to affect the labor market. No agreement could be reached as to whether or not it can be expected to result, on balance, in loss of jobs. However, there seemed to be agreement that it would be unreasonable even to attempt to fight the introduction of this new technology. At most, employees' organizations should be given power to participate in its development and to postpone, for a short time, such changes as might have dangerous effects on the labor market. Many problems could also be solved by active labor market policies for the creation of employment in new fields.

In conclusion, it could be said that our discussions on "Society and Computers" identified a great number of problems and indicated that most of these are far more complex than what is generally assumed. We cannot claim to have found definitive solutions - but this was only to be expected.

Note: In subsequent correspondence, Professor Fred Margulies from the University of Vienna, an active participant in labor unioin activities in Austria, requested the following text for Professor Hecksher's point (9) to more adequately reflect the discussions from the labor point of view.

(9) Much controversy appeared in the discussion on how AIP is likely to affect the labor market. No agreement could be reached as to whether of not it can be expected to result, on balance, in loss of jobs. However, there seemed to be agreement that it would be unreasonable even to attempt to fight the introduction of this new technology. At the same time, there seemed to be agreement that things should not be allowed to drift along. Rather than trying to predict the future, we should shape it; rather than speculating about protecting ourselves against the computer, we should create conditions which will allow us to draw all the benefits from the computer. Employees' organizations should be given power to participate in decisions concerning technological and economic development, because solutions for these problems cannot be found for people, but only with people. Many problems could also be solved by active labor market policies for the creation of employment in new feilds.

5 Concluding Remarks

During the closing session, the "Discoveries Declaration" was made heralding the introduction of the HONDA PRIZE in Eco-Technology. In closing the session, Professor Gunnar Hambraeus gave the following account of the achievements of the Stockholm symposium.

First, technology had been shown a true fruit of the Tree of Knowledge, to be used by man for good or for evil.

Second, the latest developments in automated information processing and related fields were correctly considered as no less significant than the Industrial Revolution.

Third, these developments engaged the responsibility of all concerned: from the scientists to the politicians. There was no excuse for avoiding this responsibility - in the case of the scientist to explain, in the case of the politician to understand. Without understanding tthere could be no soundly-based decisions.

CHAPTER 2

OPENING ADDRESSES

ADDRESS OF H.M. CARL XVI GUSTAV

One of the significant features of the western world during the 19:th century was optimism and a deeply rooted belief in a prosperous and promising future. New continents were explored, new inventions were made and new techniques were supplied. Literally speaking, "only the sky was the limit".

But at that time we did not forsee the possibilities of the technical development also giving rise to negative results and consequences for the human environment and the wellbeing of man. We did not realise that we were overconsuming nonrenewable resources at an excessive rate and polluting our environment.

Today the picture is very different. We are increasingly aware of the fact that there are two sides to the coin of progress. We simply can not introduce new tools, techniques and processes without very carefully studying the consequences. Not least, the potential negative consequences that in the long run might cause difficult problems for coming generations. In this context, one of the important items in the wide sense on the agenda of mankind today is the use of computers. One of it's aspects being so well formulated here today, man and society: automated information processing. And this might be a fundamental issue ahead of us. The interrelationships between man and society where the integrity of man is of vital importance. I am, however, not pessimist. The computer is here to stay and I am convinced that it will continue to serve the interest of mankind all over the world and contribute to a possible better world for all of us, but we must be aware of all aspects of the issue.

It is a very important initiative that has been taken by the Honda Foundation and the Royal Swedish Academy of Engineering Science in bringing about this international symposium. Looking through your agenda I am convinced that you will all benefit from the discussions here on a very vital issue facing mankind.

With these words I am glad to welcome you all here to Stockholm and Sweden and I wish you success in your endevours and I declare this symposium open.

MESSAGE FROM PRIME MINISTER OHIRA

Your Majesty
Excellencies, Ladies and Gentlemen

As I am instructued by the Prime Minister of Japan, Mr. Masayoshi Ohira, I wish to convey his message to the Symposium as follows:

"At the opening today of the "Discoveries International Symposium, 1979" I have the honour to express my warmest greetings!

This Symposium has earlier been held in Tokyo as well as in Rome and Paris and on each occasion serious discussions have taken place to work out a creative philosophy from a global point of view in our technocratic civilization. I am firmly convinced that the results achieved through such discussions will provide clear guidelines toward the next century with a view to creating a renewed civilization where human values are respected.

In view of the prospect that information will play, in coming generations, an increased role in human activities, it is of special importance that this Symposium with its theme "Man and Society - Automated Information Processing" takes place in the capital of Sweden with its time-honoured and celebrated traditions in science and technology.

It is my conviction that fruitful, open and sincere discussions will take place between the esteemed participants who are all leading personalities from many different walks of life.

In closing, I wish to express my sincere good wishes for the successful carrying out of the Symposium as well as for the further development of "Discoveries Activities."

Read by Ambassador Masahisa Takigawa

INTERNATIONAL IMPLICATIONS OF THE DEVELOPMENT OF COMPUTERS AND TELECOMMUNICATIONS

Foreign Minister Hans Blix

It gives me a great honour and pleasure to adress this Symposium and welcome it. The subject of the symposium is one that we need to focus increasingly upon. Many new techniques and discoveries turn out to have both blessings and evil in their train. It is important that we analyse and discuss such techniques at early junctures in order to take action to minimize their possible negative effects. This symposium has thus an important function and I wish you a very fruitful week of discussion.

The development of electronics over the past 30 years has been truly spectacular and has formed the basis for the development in the fields of computers and telecommunications. The computer has evolved from a fast calculating machine into a more general tool that can handle information in the form of written text and even pictures. The progress in electronics and space technology has provided man with high capacity global telecommunications. Intercontinental telecommunications traffic is increasing rapidly and constantly. In the last decade we have seen a marriage of the computer and telecommunications technologies. This has opened up even larger application areas. Information handling and transmission at electronic speeds on a global scale is now possible.

In this brief introductory statement, I would like to draw your attention to some of the global applications made possible by this marriage of technologies but also to some of the problems and preoccupations it provokes.

Thousands of satellites now circle the earth. Meteorological statellites provide us with global pictures of the weather situation and data from the satellites are fed into huge computers, which are programmed with mathematical models of the dynamics of the atmosphere. It has thus become possible to receive advance warnings of storms and floods, so that alerts can be issued and rescue operations be organized in advance. Remote sensing satellites continuosly collect multicolour pictures of the earth surface and the oceans. They provide an important tool for better management of the finite resources of the earth. It is now possible to make global surveys of the vegetation, of crops and forests. They are also useful for the monitoring of the human environment, which is threatened more and more by human activities. The satellites provide vast amount of data that would be impossible to handle without present high capacity telecommunications and computers. Reconnaissance - or spy - satellites provide a global surveying capability that is vital for the minitoring and, indeed, preservation of the delicate power balance in the world. On earth, seismic devices and computerized information processing form a vital tool for the minitoring of the partial nuclear test ban. These are some possibilities. Now let me mention some problems.

The development and utilization of the new technologies is very unevenly distributed on the globe. The development takes place in the most technically advanced countries of the world. These are also the largest users of the technologies. A more equitable distribution of the benefits is desirable.

The United Nations Outer Space Committee has long discussed the utilization of remote sensing satellites and sought to promote knowledge, particularly in the developing countries about the potential benefits that could be derived from analysing remote sensing data. A central issue is the access to data that have been collected. My Government has supported the view that a free distribution of data to all interested parties is the best way to ensure the widest possible spread of the benefits of the technology. It seems clear that especially developing countries with weak infrastructures are those that could benefit most from the application of the new technologies. The mere access to data is not sufficient, however. It is necessary to create regional and national capabilities for analyzing and utilizing the information collected.

The outer space committee thus promotes the setting up of regional centres of excellence for training and development of analysis methods. Training and utilization of remote sensing techniques is also promoted through several of the specialized agencies in the UN family such as the FAO.

One year ago, the Unesco and the Intergovernmental Bureau of Informatics jointly organized a global conference on strategies and policies in informatics, which took place in Spain. The conference very clearly showed that computerization is now reaching even the remotest corners of the world and that most countries have a desire to employ this new tool within their national economies. It was evident that computers can be used for many important managerial functions. The Swedish delegation at the conference pointed out that in addition to the more obvious positive effects there are also a number of less wanted negative side effects of computerization. The remarks were made on our own experience.

One problem is that computers, at least so far, have tended to promote centralization in the administration. Vast amount of information on private citizens can be collected and stored in one single place. This implies a potential threat to the privacy of a citizen. It is therefore important to provide safeguards in the interest of the individual. It is important to make sure that people are not only watched and checked by the computers, but that they can, in turn, watch and check the computers. It has been emphasized, in particular, that computerized information systems are vulnerable to human error and that citizens should be able to check and correct errors made about them in a simple manner. Communication between man and the computer has so far also proved to be a problem. Computers often communicate with the outside world with cryptic messages which are hard to decipher for the common man. Computer illiteracy can be a problem comparable with ordinary illiteracy. Centralized computer systems also have effects on social organization. They have tended to reduce individual responsibilities and make individuals mere appendices to the computer systems. Responsibilities have often been heavily concentrated on a very small number of highly skilled computer system operators.

The OECD took an early interest in information and computer questions already in the 1960s. The question of transborder data flow and personal privacy has long been on its agenda. Sweden enacted a data law in 1973. Since then many other OECD countries have either taken similar measures or are in the process of doing so. The increasing flow of data across national boundaries has raised the further question of international protection of personal data. A set of guidelines for the protection of personal data has been elaborated in the OECD.

An attempt is made to strike a balance between the basic principle of the free flow of data and the interests of the individual for the protection of his privacy. The social effects of computerization are also discussed by the OECD. Recently there has been much preoccupation with the employment effects of computerization in the OECD countries. Studies are under way in many countries of the effects of automation in industry and also of the effects of automation in the office, where the use of word processing machines and telecommunications make possible the transmission of messages by other means than the postal system. Fears have been expressed that many existing jobs would be changed or eliminated by the technological development. On the other hand, it has been argued that many new kinds of jobs would be created. It is still an open question what the long range net effect for society will be.

Another important question is the supply of information for industry, particularly small and medium sized industry in the OECD countries. It has been recognized that there exists an abundant amount of information in computerized form and that this information is yet put to relatively little use. There is still a large gap to span between the producers and the consumers in the information field. The same is true as regards the developing countries.

The United Nations conference on science and technology for development will open in Vienna in one week's time. From the preparatory work, it seems clear that the question of transfer of information to developing countries will be a prominent issue for debate. There seems to be no doubt that the transfer of information can be an important element in the process of development. We have warned against overoptimism in designing large global centralized information systems, however. The mere provision of information to the developing countries is generally not the same thing as the solution of a problem. It is absolutely vital to develop absorptive capacity and to train people who can analyse problems and make efficient use of information, before one contemplates the setting up of new and potentially very expensive systems. The real needs of the consumers must be assessed.

Let me finish by saying that data policy is subject to much debate in Sweden. The Government has recently presented to Parliament a bill, setting out a policy for the utilization of computers in the public sector. The bill stresses the need for early involvment of decisionmakers in the planning of future data systems. The bill further advocates the functional and geographical distribution of computer power, so as to avoid for the future large centralized multipurpose and vulnerable computer systems. Fortunately, the technical development of microcomputers and the steadily decreasing price for hardware seems to work in the direction in making decentralized solutions more cost attractive.

There is further, a large number of investigations of the effects of the computerization in progress in Sweden. One commission studies the effect of computerization on industry and commerce, another committee studies the effects on employment. A third committee studies the impact on new information media like videotext on our media policy.

I have no doubt that the questions of computer and telecommunication technologies will remain important issues for 1980s both nationally and internationally and wish you all the best in your endeavours at Stockholm to explore and clarify these issues.

COMMENTS BY SOICHIRO HONDA

Your Majesty.

It is a great and very special honor for us all to have Your Majestys personal presence in spite of many other pressing obligations of state at the opening of this international symposium of the Discoveries project. But, it is an even greater honor for me in this most significant and unforgetable moment of my life. To be able to express on behalf of all friends and colleagues here gathered our gratitude for Your Majestys being with us today. I am sure this is a most unforgetable experience.

Just over 2 years ago, in June 1977, Your Majesty was good enough to grant me an audience and to discuss with me some of the Discoveries activities. At that time I was greatly encouraged by your kind and helpful words. Today, it is my particular pleasure to report that two subsequent Discoveries international symposia in Rome and in Paris have yielded most interesting and significant results. Now, in Stockholm, through the outstanding efforts of the organizing committee led by professor Hambraeus, director of the Royal Swedish Academy of Engineering Sciences, IVA our new discoveries symposium is beginning in the most auspicious circumstances. I am certain that the discussions to be held among such superlatively distinguished men and women of science and letters as have accepted to come here this time must lead to new and profondly interesting achievments. At this moment, I renew my personal commitment to devote the rest of my life to the Discoveries idea and project. I most sincerely hope and believe that among the results of this work will be a further enhancement of the already close rapoire between Sweden and Japan.

Your Majesty, once again I express our gratitude for your most kind words, and I wish with all of us here for the long and continuing prosperity of your country.

13 August 1979.

CHAPTER 3

KEYNOTE ADDRESS

THE IMPACT OF AUTOMATED INFORMATION PROCESSING ON SOCIETY

Heinz Zemanek

Contents

7. The Philosophical Impact
Physics as a Belief - Informatics as a Belief
Exception Hostility
Planning for the Future - Information is Surprise
Return of Control to Man - The Computer-Assisted Democratic System

Introduction

It is not only a great honour for me to have been invited to give this opening address - the subject is really very close to my heart. I consider it as important as the scientific fundamentals of information processing and I have been active for the better understanding of the human aspects of information processing for many years.

Maybe a few explanations as to how I came to this subject and to my opinion are useful for the assessment by this audience. My original professional background is telecommunication engineering, but already around 1950 I turned to cybernetics, computers, and the information sciences. With a group of former students of mine we built one of the early European fully-transistorized computers at the University of Technology, Vienna, and later, in the IBM Laboratories in Vienna, we developed with the same group of people what is now known as VDL, the Vienna Definition Language and Method, by which we formally defined the important programming language PL/I - not only the syntax - its grammar - but also its semantics, the meaning of every possible program in this language.

Dealing with language and semantics is dealing with one of the most human chapters of science. And I found a common feature of programming and cybernetics: the tension and the gap between the informality of natural systems and the strict formality of logical description, scientific models and digital programs. In cybernetics, the scientific and technological view and description of live structures mean an increase of precision of description, up to the simulation of the structure, for the price of a clear reduction of the functional properties.

In programming, the languages have formal character, but their development from idea to concept and further to the defining document is a transition from intuitive and informal notions to logical mechanisms; either this defining document is extremely voluminous and hard to read or else many details are incompletely defined. And this dichotomy is typical for all information processing activities beyond pure logic and mathematics, and even there one can find many more informal corners than one might expect.

Technological development has reached a density in which a revolutionary technology, like information processing, must bring turbulences and dangers which should not be allowed to grow arbitrarily. And the computer is an invention of exceptional character. Apart from its extreme intellectual importance, the computer has the tendency to intrude into everyone's business and to reach the private sphere of the individual with an increasing number of effects. By necessity a fraction of them is negative. We experts not only owe to the layman an explanation for what has happened - we also owe the remedy or at least the offer of remedy when it is beyond their power to execute it.

All of this is the result of the very intriguing character of the entity the computer is dealing with: information. The computer has been called thinking machine, and the computer is the basis for a field called artificial intelligence. But thinking power and intelligence of the computer are of a specific nature: of an algorithmic nature, and an algorithm is always the final result of a lot of human thinking including some real or only hoped-for perfection. Perfection, however, is the exception in our real world, and so there is a constant need of human interface between the operation of a computer and the consequences in the real world. It is this need of human interface which makes the computer a complicated social problem.

Expressed in one sentence, the impact of technology in general is amplification and extension of human power for the price of increased energy consumption and a loss of natural completeness. Information processing is amplification of speed and precision of that part of mental power which consists of logical derivation; information processing requires less and less energy and can help to save and reduce energy consumption. But information processing may lead much further away from natural completeness than conventional technology.

The impact of information processing can naturally be classified in technical, sociological and philosophical impact, and so I will discuss it, adding a short chapter on the impact on developing nations.

A Short Story

It is very inviting to see algorithmic perfection as a guarantee of success. But perfection exists only under certain conditions. Let me illustrate this by a little story, a true story that I heard from one of the persons who was present. It was in the early days of computers, not very long after World War II. Philips and IBM had decided to discuss certain things of common interest and a small IBM delegation stayed for some time at the Philips Laboratories at Eindhoven. Hotels at that time were not yet in the boom of business trips and social tourism; the delegation was housed in a modest, old-fashioned place. Some members of the delegation wanted three-minute eggs for breakfast, but always got hard-boiled eggs at table. Most of them accepted this as fate, but one member was particularly keen on getting his three-minute egg and tried all the time to make the cook fulfill his wish. The delegation was amused at his attempts and when the end of their stay approached started making bets as to whether or not he would be successful. The last morning came, the last opportunity - would he make it or not? He called the cook and carefully rehearsed the algorithm for a three-minute egg across all Dutch-English language difficulties. "Have the water boiling, then put the eggs into it, and after no more than three minutes take them out and serve them. Do you understand?" "Yes", said the cook and disappeared into the kitchen. Full of tension the delegation waited for the result. It was a hard-boiled egg. After a lot of laughter they investigated this defeat and found out that the hotel received every morning, for some unknown reason, a consignment of cold, hard-boiled eggs.

The most obvious and absolutely correct algorithm may be wrong and even harmful if it works under incorrect assumptions. It is essential to understand that the algorithm, the computer, the information processing system, are only part of the practical application, and that the environment, the assumptions before and after processing, the collection, interpretation and application of data as well as the reactions of the people and the consequences for the people close to the information processing system, or far away from it, make up the other, equally important part of the application. Information processing is not limited to the section between keyboard and printer, it is functionally embedded in a live environment, in society and its subgroups.

1 Automated Information Processing

Before discussing its impact on society it is reasonable to discuss the nature of the subject, automated information processing. Information processing is a technology, regardless of whether we are dealing with hardware or software - which means that not only circuit production but also programming is an engineering activity. Mathematics and logic are fundamental but auxiliary sciences for programming, and program design, implementation, maintenance and application must be carried out in an engineering spirit.

Technology of today is the application of scientific and mathematical knowledge for the solution of practical problems, at the same time respecting the principles of economy. Ideally, it is expected that technology achieves things with less effort and fewer costs, faster, stronger and with more precision. A critical consideration of technology must not forget how well those aims have indeed been reached in many fields. Only as a second step one will have to consider where increased effort, higher costs and longer delays have cast a shadow on this ideal picture. Also, it does not make much sense to formulate wishful requirements that go beyond the economic foundations of a certain field. Who is ready to pay for an achievement is a basic question. Beauty, safety and quality of life have their price, protection of groups or individuals does not come free-of-charge, demands are bound to obligations.

Automatic technology is in no way a modern idea. Just think of the mousetrap which is a true automaton several thousand years old, and which yet has all the basic features of automatic technology like power supply, information input, processor and effector, and which works, last not least, without human supervision. Another invention several hundred years old is the semistable multivibrator which we trigger in the water closet. It has such a beautifully simple architecture that hardly anyone cares to know what its functional diagram looks like. Another feedback mechanism was added to the steam engine: the governor, first computed by Maxwell in 1868. What electronic engineering has added is simplicity of realization, and what the computer has added is the mastering of almost arbitrarily complicated and sophisticated programs. As a consequence of the phantastic improvements in semiconductor technology, which will be described by other speakers in the course of this symposium, technology of today makes automation not only available to big companies and institutions, but for everybody and every household at such low costs that the average household in a developed country will soon have as many processors as it has electromotors today - please count the motors in your home!

Telecommunication technology is the basis of information processing technology. It is perfectly correct to describe the world telephone dialling system as a distributed computer. And the digital technology of information processing is a heritage of radar technology which also is a kind of computing equipment, although of analog nature. All those roots are worthwile mentioning, not only in order to understand the essence of information processing, but also because the impact on society will have a lot of similarities.

Let me mention two examples of this impact which are more or less repeated by the computer. Telephone and television connect people and separate them at the same time. At least in principle one can talk today from any telephone to any other telephone in the world, things can be arranged independent of geographic distances, people on a trip are never separated from their office or their home unless they wish to be. And still, there is a separation effect: what once was managed by a visit during which one got a feeling for the personal situation of the partner and had an opportunity of dealing with many side problems and effects, is today organized by a telephone call, interrupting, maybe, the work or a conversation of the partner. Automatic telephone calls do not give priorities to people or subjects, but the telephone has a kind of automatic priority over the non-electronic atmosphere in which the telephone is located. Computer terminals can be equipped with storage capabilities and information processing systems can be programmed with priority structures - but the impersonal organization power of computerized systems goes far beyond the psychological force of the telephone buzzer.

Radar technology is an example for information collection by electronic means - unexpected, unwanted and unnoticed by potential victims, in war, road traffic and elsewhere. What is a useful tool for one application, air traffic control for instance - as long as the officers are not on strike - may be intruding into the private sphere in another application, and these contradictory effects lie close together. Information collection by means of computers is, of course, more effective by many orders of magnitude.

Information technology is connected to several scientific and technical fields, and they are in a process of unification under the overwhelming power of the computer. Electronics, including electronic switching functions, transmission and storage of digital information are the hardware basis on which many levels of programs, programming systems and programming languages are built up.

There is the information science which one day is expected to cover all sorts of information needs and information services, from the newspaper and news broadcast to the library and computer-based information systems for documentation and information retrieval. Here, a lot of theoretical work remains to be done and, much to the regret of the classic information processing, the scientific foundations for those services proceed very slowly.

Therefore, information technology and computer technology to a large degree are identical fields and we can turn without neglecting too much to information processing in a more restricted sense, to the magical tool of the 20th century - to the computer.

2 The Computer

The classic computer is best described as a characterstorage and replacement device: conforming to strictly logical rules one set or sequence of characters is replaced by another one; the process can increase or decrease the total amount of characters. It is easy to show that a logical device of this kind can transform, select and destroy information, but never generate information. If it does generate more characters than are fed in, it produces redundancy and not information.

It might be useful to dwell a little longer upon the notion of information, and the first aspect to be taken up here is the formal nature of information, indicated already by the common root of the two words, namely form: a formless pattern is no information. But for our purpose we need not specify this distinction any closer because the digital computer handles exclusively characters and remains entirely within the universe of formal relationships. This is less a restriction than it might seem. Because the human language, spoken or written, remains also under the formal principle: a spoken sound and a written letter are tokens out of a very finite set, of an alphabet of sounds and letters between 20 and 40 members. Of course there is further information, e.g. in the melody of speech; such information can be sensed by the human receiver - it is not subject to information processing.

Compared to the human brain the computer imposes a more severe restriction; the computer operates strictly by logical rules. These rules must precede any processing - very much in contrast to human information processing where logical rules are the final result of long, complicated and error-suffering thinking processes. The best representative of operations according to logical rules is the algorithm; non-algorithmic information processing is possible but risky, and there are only rare occasions to proceed in a non-algorithmic way, for instance in an exploring mode. The algorithm is a prescription which leads in a finite number of steps for a finite or infinite number of possible input data automatically to the correct result. Think of your way to multiply an n-digit number with an m-digit number - a typical example for numerical calculation.*)

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*) This multiplication algorithm belongs to the set of algorithms given by al-Khorezmi, the Arab mathematician (780-850), from whom the name algorithm is derived. He expresses his algorithms in natural language - formal notation is an achievement dating to the Renaissance (to what extent the ancient Greeks were fore-runners is a matter of discussion).

The three-minute egg algorithm may not resist closer investigation: it may turn out that it gives an incomplete description of the process wanted; it might, however, also happen that it is precise enough: if either the egg-cooking system is well enough defined to be satisfied with the given information - in fact it could be sufficient to have the name "boiled egg" and the value "three minutes" as an input - or because the resulting ambiguities do not matter.

This comparison of a numerical algorithm and a processing rule out of our daily life shows the wide range of computer application and the variety of linguistic means to state problems and to describe ways of solution and results.

About language questions one could insert sections on any point of this paper and they would never be enough, even if the same point is repeated in different variations. The multiplication of two numbers is a formal problem which does not require any explanation or interpretation beyond elementary mathematics. The preparation of eggs may seem to include much less complications because it is something one can learn fast. But, in fact, one may say that the simpler the problem, the more difficult its linguistic aspect. Every one knows what is meant by words like "egg" and "cooking" and yet only very few people would be able to give sufficiently precise definitions of the two notions. And this is true for all the simple notions: can you define a street, veal, government officer, client, transfer, keynote address? The arrangement of letters denoting these notions can easily be fed into the computer - but what happens in the subsequent processing of a text in which they occur, or of numbers related to them? Sometimes the single person, the single programmer may know everything that is necessary. With team work it becomes already more difficult. In extreme cases, nobody knows.

We will come back to the problem of meaning and its conservation in information processing. At this point we will only say that the computer has no notion of meaning, it deals exclusively with formal structures and expressions. And these formal structures and expressions have no meaning whatsoever unless they are used in relation to an informal environment. Indeed, the philosopher Ludwig Wittgenstein, in one of his radical statements, has called logic a tautology. In itself, the computer is a tautologic device, the meaning is on our side.

As to its formality, the computer is as radical as Wittgenstein; all computer processing is transformation of thoroughly formal structures and expressions, down to unequivocal bits - whether hardware or software: what cannot be analyzed down to logically arranged bits is either noise or misfunction. The miracle is that we master the basically non-digital electronics so well that the computer is a digital entity even in the most philosophical sense. Of course, one can simulate non-digital variables and compounds, but wherever one looks close enough, the true digital character becomes apparent. The computer, however, is always connected to an informal, more or less natural environment, and finally to the people who program and operate the information processing system. And even programmers are not formal, rational, digital thinkers, not as individuals nor as professionals - whoever has had to manage programmers will know and agree.

If information processing as a technology and profession has already so many and important human aspects, its impact on society must correspondingly have many and important peculiarities. There is no non-trivial engineering innovation without an impact on society. Many political events of the last hundred years were, directly or indirectly, triggered by the progress of technology, although not as many as certain mechanistical political theories would like to have it. In any case, it might be argued that the computer is not exceptional and that the present emphasis on the social consequences of automated information processing is merely a fashion which will not last long. Such an argument means underestimating the power of information processing and is a misjudgement of the motivation behind the present, highly emotional evaluation of technological developments.

3 The System

It is information which makes the whole more than its parts: by means of information sensors, processors and effectors the parts can be integrated into a system. The living organism is the fundamental example for a system; survival would be impossible without information processing.

The basis of life is the cell, the subsystem which has, in principle, all the faculties of the whole system, the complete organism: it absorbs and releases material and energy, it reacts to pressure and light, it is able to reproduce itself and to organize higher structures. It is remarkable that nature chose a digital code for the description and automatic reproduction of each cell and any living organism from the most simple one up to the human body.

It is, therefore, not astonishing that systems theory originated twice, once in biology and once in telecommunication technology. Information processing systems do not have all the universal properties of the living organism, but they come closer to it than any other technological entity. And they can integrate all kinds of ensembles to self-controlled automatic systems, matching even changing environments. The same is, by the way, true for feedback theory.

It seems very remarkable that facilities and requirements in certain developments are that much interlaced that it can become very difficult to distinguish which impacts which. Do we need systems because we can now organize them or are we able to organize systems because we need them?

Until very recently, most technological innovation could be seen as a singular solution, improvement and phenomenon. But now we have reached such a density of excellent solutions and effective improvements that they hamper each other and produce chaos. The outstanding example for this effect is road traffic. Never in history has mankind had such excellent roads, so many traffic signals and such powerful, fast and well-designed vehicles. But the sum of all these excellent solutions and effective improvements are king-size traffic jams. We are much better in singular solutions than in systems design, not only in traffic - this is true all throughout technology and there is no risk in predicting that information processing will see itself soon in the same trouble. Even if the single, centralized big computer will remain a tool for order, the mushrooming networks and miniprocessors will achieve a chaos of equal or even bigger size.

We would not be in the field of information processing if there were not the proper solution available. It is called architectural design. It is not astonishing that we hear and speak more and more of it, that structural programming is widely accepted and that everyone likes top-down design. We have to go this way, although we are still far from really mastering system architecture.

The computer is in manifold relation to architecture. It should have a good hardware and software architecture and it can be used to achieve good architecture in the design process for any kind of system, whether circuits, system or application programs, and of course also in the classic building architecture.

Architectural design of computers has been introduced on a large scale by the IBM System/360, the first wide-range family of computers ever built; 360 stands for the full circle. The whole family of processors, memories and other equipment was governed by the same design principles, the members of the family being distinguished only by increasing or decreasing values of certain parameters. Since System/360, architectural design has been a keyword. On the hardware side, it is inherently imposed by automatic production of the miniaturized circuitry via almost fully automatic production lines for the chips. Here the computer becomes a tool of architecture: computer-assisted design is a necessity for such automatic production. Proposals for hardware which do not fit into the design programs and into the architecture of the production line have no chance to be realized, and this alone imposes architectural discipline on newly designed systems. On the software side, architecture, it is true, could be less of a fashion and more of a discipline, but the advance in systematics is clearly visible.

The progress in architectural virtues is badly needed. Because the architecture of the information processing system evidently strongly influences the architecture of all applications and consequently of all systems dominated or even only related to computers, much more than applications can feed back on computer systems architecture.

A big computing center with its multitude of processors, storage units and peripheral equipment is a system which raises many problems of efficiency and cost/performance, and it must be admitted that there is not yet much of a useful systems theory to support its design or configuration. The advance of digital communications and the growing need for distributed information processing and the reduction of line cost makes it possible to distribute input, processing, storage and output over cities, countries, continents and the whole globe. If the computer started as a centralizing power, it has meanwhile developed into a tool for decentralized centralization or centralized decentralization. If properly conceived and designed, automatic information processing can provide a maximum of information, decision liberty and human choice to peripheral subcenters without reducing the efficiency of central policy and overall success. Wherever a system suffers from bureaucratic inflexibility, slowness and inefficiency, the cure can be well-designed distributed computer assistance which reestablishes the flexibility, speed and success possible in a small structure. I am not saying it is easy to achieve that, I am saying that there is a chance and I am saying that much emphasis must and will be laid on the development in this direction.

4 The Technical Impact

Almost inadverteantly, we have already begun to discuss the impact of automated information processing: its first and most important power is concentration and decentralization, offering flexibility, reaction speed and a clear picture of the momentary situation - the basis for subsequent action.

But before the impact is discussed in a more systematic way, it seems reasonable to consider what the computer contributes to the world of today, to science, to technology, to industry and economy, to administration and government.

First of all, it has become possible to carry out numerical and logical elaborations of considerable volume; the solution of systems of equations, for instance, including an amount of elementary operations of which previous centuries did not even dream. It is true that mathematicians as well as nature can always provide problems exceeding any existing computer facility. Just take weather forecasting as an example; here it becomes once more obvious that computing alone is not enough - what is needed in addition is input information in considerable quantity for which numerous sensors, not only on the surface but quite high up in the atmosphere are required. Voluminous computations meet with a lot of limitations, but the achievement has been impressive for the last two or three decades.

The same is true for commercial and statistical data flow. Accounting, inventory control, payroll problems of any size are standard applications, and with the distributed computer, with data networks, it is possible to operate live data bases for all kinds of purposes. Rather than to try and enumerate or list all possible subjects, we will pick a few typical examples and demonstrate the general effect by the special case.

An important special case of data flow and data base are electronic fund transfer systems. They are a further step in the abstraction of property and financial power, from goods to gold and silver, to bank notes and cheques, to credit cards and finally to screen-operated money transfer. Extreme mobility of money is connected with instant reporting. It is only one step further to consider general message transfer, the combination of telecommunications and computer systems to general information systems. This combination outdates all classical means of information and money handling.

An excellent example to study the impact of electronics and information processing is the postal system. Where mail and telephone are under a common administration, the loss on mail can be, at least for some time, be compensated by the earnings on the telephone. But in the long run this will not help. The mail service is bound to degenerate and to become more expensive at the same time. The telephone has replaced a high percentage of letter writing and all really urgent news go by telephone with or without a confirmation written later on. True first class mail, in other words, has disappeared. It is estimated that in North America 60% of the remaining, of the present mail is connected with payment procedures; as soon as information processing provides the necessary facilities on a large basis, it will swallow this part of mail traffic, and not only this percentage will disappear from the total volume of mail - the required terminals can equally well handle most of the written messages so that whoever owns a terminal will reduce the number of mailings. The increased number of installed terminals will decrease their price, will facilitate mass production and so further decrease the price of equipment and service. Moreover it will attract other fields like publicity and advertising and so further reduce the number of mailed items. The postal administration will in no way be able to compensate for those losses - in the best case they can remain in the business by providing the new competing services. Since the costs of the mailing system are to a considerable fraction independent of the traffic volume, the price per action, say the fee of a standard letter, must go up. Even worse, in their attempt to keep up with the competing services, the mail and parcel service must invest into automation and then try to get the return for the investment.

Like in every other case of technological innovation, the advanced solution cannot cover the full spectrum of the old-fashioned system. The artistically designed post stamp, for instance, has already become obsolete, and many things that were possible in the classical mail system are bound to disappear or are in danger of disappearing, will be reduced in frequency or become luxury items - the world of letter sending and receiving will soon undergo drastic changes.

It is customary for defenders of progress to depreciate or ridicule the nostalgic feelings of the average man, his longing for bygone eras. Certainly, a part of the nostalgia is a consequence of the fact that we fortunately remember agreeable things better than unpleasant ones. But another part of the longing for bygone times comes from the onesided character of advancing technology which eliminates natural possibilities by the restrictions of the new system. You just have to imagine the mail being totally replaced by a computer terminal system with enough capacity and intelligence locally and in its channels: any message will arrive at its destination in less than half an hour. There, it is either read and answered immediately or stored until it is used; push a button and a hard copy of it comes out of the terminal.

But you cannot attach a photograph, a pressed flower or a little specimen of something to the electronic message; you can only read from the handwriting of your partner about his personality and mood. Have a look at your mail items for a couple of days or weeks and imagine their electronic and computerized replacement. Consider that the poet, the scientist, the philosopher of the fully computerized age will leave to posterity tapes and disks instead of manuscripts and notes. Then you will know a lot about the present and future impact of information processing on our life and our society.

Let me complement this example by another typical one: many people think that the time has come to replace encyclopedias and telephone books by computer query systems. True, of course. But again, please consider the loss. A telephone book is not only used to look up the number of a known person. The entry of a big company or institution or government agency tells a lot about its structure and a look may be much more than systematic search for one person or one office. A picture of the field in which you search will build up in your mind from the input found which may totally alter your first intention. Of course, all of that is also possible in a query system - but for quite a price, and nevertheless some of the old-fashioned possibilities will have gone.

5 The Social Impact

It is the purpose of technology to either

- perform conventional tasks with less effort and at reduced costs, or

- perform new tasks which had been physically or economically impossible without the new technology.

In the first case, technology obviously is a job killer - it reduces the required manpower and it tries to save money - where else in our times than on the salary sector?

In the second case, technology is a job creator, and nobody can question that technology is the only way to keep the present population of a contintent like Europe fed and working. A computer-near example for killing and creating jobs is the typewriter. It certainly was a job-killer for scribes, but their number was in no way comparable to the number of secretaries and typists of today. We would laugh full-heartedly if we read a statement of a sociological pessimist who had just seen the first typewriter and in which he objects to the job-killing dangers of the new invention.

The analogy to the conventional computer as well as to the minicomputer is obvious. And much more than the typewriter, the computer initiates an avalanche effect: one computer put into operation prepares the need for further computers. Information processing technology is a job-creating invention. But this is not the full story.

A man whose qualification was the production of calligraphic documents will feel little consolation on hearing of many openings in typewriting jobs. The problem is one of transition and ageing. As long as technology develops at such a sped that obsolete jobs die out with the speed by which people retire, a modest educational opportunity will be sufficient to maintain the professional balance. In our days some job requirements change faster than our best educational measures can compensate for. There is a social problem and it is reasonable to sit down with all those concerned and responsible and discuss what can be done.

There is a second effect which aggravates the first, and that is the dehumanization which abstraction and labour division bring to the working place. A medieval shoemaker like Hans Sachs produced a pair of shoes out of raw materials he prepared either himself or bought from people he knew very well, and he sold the majority of his shoes to people he knew very well.

The distance between suppliers, producers and users in modern technology is steadily increasing and automatic information processing does more to separate them further than to bring them together again. The single working place tends to be a narrow slot through which it is almost impossible to see the complete product. In a big information processing system no single person knows all the details.

All of this has very many facets; some features are a necessity, others occur stochastically because nobody cares.

General principles of well-ordered design and disciplined architecture, human rather than logic and algorithmic criteria, give much more hope.

Information processing will again and again make clear that perfection is an idealistic concept, fine for models of what we are doing and investigating, and a necessity for logical and mathematical constructions, but hopeless for the live world in which human imperfection is principle and challenge, obstacle and consolation. I cannot think of a better impact on society.

And, as an information machine of high speed, the computer has a further, very comforting property: it makes us see dangers and challenges far ahead of their real occurrence; so they are observed, described, modelled, published and discussed when there is still time to meet them. And they can be met, as the subject of privacy, well-known particularly in this country (Sweden), proves.

It is natural for me to add another confirmation that challenges and dangers in information processing are recognized and that proper reactions are initiated, and this in the field of professional societies, because I had myself an active role in them and in the specific development of paying attention to the social impact of information processing. A similar story could be told about IFAC, the International Federation of Automatic Control, with whom we cooperated closely, but I will restrict myself to a few details on IFIP, the International Federation for Information Processing.

In April 1974, together with some friends in the Austrian trade unions and my colleagues in IFIP and in the Austrian Computer Society, we organized the first IFIP Conference on Human Choice and Computers, where - for the first time in the history of information processing - computer and social scientists came together with representatives of employer and employee organizations to discuss common problems around the computer. It was very impressive to observe their struggle for a common language and for mutual understanding of very diversified views on a young technology. In August 1974, IFIP had here in Stockholm its 6th World Congress, giving as always an overview of the state of the art of information processing and including extensive reports on the Vienna conference. Not very much later, IFIP created, in spite of considerable internal resistance, a committee on social questions in information processing. Earlier this year IFIP had a conference in Budapest on the Socio-Technical Aspects of Computerization, which was a forum for the views of the Socialist countries the subject, and in June there was the Second Vienna Conference on Human Choice and Computers. There is no doubt that the professional world of information processing has now recognized the social importance and makes many attempts to understand the good and the bad consequences of the computer for society. I could easily present a list of almost a dozen further conferences on the social impact, in many countries and continents, for developed and developing countries, and the first entry would be the Vienna UNESCO Conference on Science and Technology for Developing Countries next month.

This symposium here, established by the Swedish Academy of Engineering Sciences and the Honda Foundation, has several special features, and the invitation to give this opening address was a particular challenge for me to try and summarize the situation as I see it. The result may have very individual facets, but since the symposium will treat all questions during a whole week, there will be ample opportunity to correct and improve the contents of this address. I see my main task in exciting fruitful discussions and you are invited to accept my address in this sense.

6 The Impact on Developing Countries

For developing countries the technological, social and philosophical impact is essentially the same, only it may be much stronger, more helpful and more risky, and as soon as computers have started to multiply, the consequences may develop much faster. This acceleration might not be as good as it seems.

For a short time of my life, during World War II, I was delegated to the German Acceleration Office - "Reichsbeschleunigungsstelle". The rocket engineers had realized that the starting accelerations could be catastrophic for the electronic hardware in their vehicles unless all effects were carefully studied and tested. The same must be true for the human brain in cultural and technological accelerations, but many, even leading people do not seem to realize that. I have encountered naive views as if the problem were simply one of terminal attatchment to the data bases of Western know-how - and that thereby the leap from the Stone Age to the Space Age would be accomplished.

My personal view is that the computer is not a natural friend of developing nations and that a big part of the present acceleration attempts are more than questionable. Why should the developing nations hurry to reach the spot where developed nations are so unhappy to be?

The computer can be made, I think, into a very useful tool for developing countries - if applied with care and patience, with understanding and discipline. Certain information can go ahead of development and help it, most information - meaningful information - can, however, only be a consequence of development.

In other words: nothing is more difficult than to help, and it is more difficult to help by means of information processing. The gain in technological facilities may easily be followed by severe damage to society and mentality.

Information processing for developing countries has for years been a matter of intensive studies in the UN family, in the international professional federations and the Intergovernmental Bureau for Informatics. Many actions have been studied, but it does not seem that the overall success is really convincing.

7 The Philosophical Impact

The technical and the social impact of information processing results in changes in products and working methods, in jobs and in job-satisfaction. Proper technology and proper management, cooperation between employers' and employees' organizations based on the reality of the working situation and insights gained by computer and social scientists will find a way which might not totally avoid certain hardships but which, in the long run, will find acceptable solutions at an acceptable price.

But there is also an impact beyond scientific, technological and sociological details, the impact on and of mentality and philosophy of all the people closer to or farther from information processing systems.

A discussion of this impact could cover even more items and aspects than all the subjects which I have already discussed. Again I will select only a part in order to characterize the set, and I will do this in two stages. First I will return to the notion of meaning, which I have left insufficiently treated, and then I want to throw some spotlights on the view not so much of the specialist but essentially on that of the layman concerning physics, technology and informatics.

The scientific investigation of language has shown that there is no lowest boundry for the concept of language; the theory covers every level from extremely primitive sign systems up to the most subtle possibilities of human language. And, of course, all of it can appear in the computer context.

The scientific theory of language distinguishes between three levels of increasing importance: syntax, semantics and pragmatics.

Syntax, is the study of symbol and word arrangement, the rules of well-formed expressions, correct spelling and correct computing. The computer is the ideal tool for the syntactic operation of characters and the computer can check the syntactic correctness of received input and produced output.

Semantics is the study of relations between the characters and the objects which they designate and describe. Semantics as a science in first line checks the proper interconnection between reality and its description by means of language. While syntax checks against the correctness rules for well-formed expressions, semantics must verify the text against reality. This verification requires the human mind, it can never be fully automatized because there is never a congruence between formalization and live nature and the live human mind.

Language reflects and contains the infinite possibilities of the human mind, while formal structures, models which the computer can operate, are clearly of a finite nature, highly combinatorial, but certainly not transcendental. This contradiction, tension or obstacle will remain the main problem of information processing; advanced models - like natural language processing systems - will not make them appear but become more unexpected and more difficult to get under control.

The semantic gap will remain a central issue for many decades to come, and therefore will be the main spot of social impact.

It will be natural to grasp as much as possible by computer suited models because then the function can be entrusted to information processing, it fits to the already computerized procedures, it offers all economic advantages and it matches what computers and their operators have already learned. Everything outside this universe will not only be costly and strange - there will be a tendency of pushing it away, hating it, fighting it. It is conceivable that information processing will intensify a common philosophy which is already imposed on us by science. We feel today that science can cover, describe, explain and master the full reality, that what is not covered by science is either unfinished work or else an unreal dream, mere imagination, harmful for anyone who cares for it. It is not difficult to imagine a view of the world which follows the same lines, but is further restricted by the computer possibilities: in this respect the computer can cover, process and control the full reality; what has not yet been programmed is unfinished work, and what cannot be programmed is either a harmful, unrealistic dream or utter foolishness. This is by no means science fiction, it is simply a logical parallel to the view derived from physics by people who have little notion about the fundamental method and the limitations of the scientific and technological development. They believe in physics rather than in religion - and they prefer to be supported by this pragmatic safety without risks that is inherent in this kind of belief. Why should this commodity not be extended further to the computer - supporting a subset of reality of immensely higher security? You may imagine the details of such a future - a world with almost no human work and effort, a very minor amount of working time per week, vacations during a large part of the year, while information processing systems do everything for us and what they do not do is not worth being done.

Actually, I do not think that this kind of future is the one that will come. And I do not say this because I am a confirmed optimist. I say this because there is a further impact of information processing on general thinking which will more than compensate the safety and fact-oriented tendencies I have just described.

The algorithm thinking imposed and cultivated by the use of the computer forces us to improve planning and forecasting. We will look much more carefully into the future than we have done in the past. And we will get a lot of warnings by doing so - early warnings. The world growth models as initiated and made known by the Club of Rome are a conspicuous example. It is not so important how correct they are at the moment, how well these predictions describe and will describe the future - it is important that the models were possible - possible through automated information processing - that the warning was heard and has found attention.

In this place I come to think of an anti-impact of automated information processing. In the early days of computers one could have hoped - and many did hope - that by means of the great computer possibilities the science of economy could be turned into an exact science like physics and chemistry.

The great men in economics knew better, of course. Oscar Morgenstern, co-author with John von Neumann of the "Theory of Games and Economic Behaviour", has through all his life struggled against this hope, in particular if it was based on the theory of games.

What actually happened over the last decade was not that economics became more of an exact science, but that the science of computer systems became more inexact, in the sense that features of economic uncertainty spread over systems design. It is necessary to plan computer systems longer and longer before they are delivered, and that means they they are planned for an environment thay nobody can preciesly predict and describe at the time of development. When the system that is planned today will be put in use it may turn out that many assumptions on which it was based are wrong. And during the lifetime of this system further ones may substantially change. The non-mechanical nature of the world that counts becomes more and more apparent, and this will undoubtedly have its impact on society. In particular, as far as algorithmic thinking is concerned, nobody will ever deny the elegance and usefulness of the concept, but its limitations and its dependency of facts and figures outside the algorithm will be present in the consideration. The necessity to plan and predict the future in spite of many uncertainties will teach us that judgment beyond scientific confirmation is as important in many instances today as it was in the dark ages of the past. The only way to meet the uncertain elements in planning and forecasting is to strive for maximum flexibility of our creations so that they can be easily adapted to unexpected, unpredictable events and trends. If you need scientific proof for this statement please study the philosophy and reality of correctness proofs, the culmination of algorithmic thinking. It has already turned out that simple and short correctness proofs are certainly helpful, that most correctness proofs, however, are terribly complicated and lengthy so that they are glamorous candidates for errors, waiting for correctness proofs of correctness proofs. The ideal of algorithmic security appears to lie far in the future or even totally impossible.

But many persons are not swept away by the excitement about new technological methods - many specialists maintain a critical view of their own successes. As an example for many I want to mention here Joseph Weizenbaum, the well-known M.I.T.

computer specialist, who has given in his book "Computer Power and Human Reason - From Judgement to Calculation" a number of highly qualified arguments; indeed, his book is a much better description of many aspects of the impact of information processing on society than I am able to give here.

Joseph Weizenbaum is critical, but not pessimistic. We agree very much on most of the arguments, but in particular on the main principle: the computer is the most important and powerful tool technology has given into the hands of mankind. Any powerful tool includes certain dangers, must have strong positive and negative impact on society. Which of them will be stronger in the long run, the positive or the negative, is in our hands, in the hands of the governments we elect, of the specialists who contribute, and of all the workers in the computer fields who succeed and fail, triumph and suffer, and in the hands of all individuals who benefit and lose, who are helped and hampered by automated information processing.

Nobody can stand aside today and leave the actions to the others - democracy means activity and involvement. Here again the computer can and will have its impact. Have you ever calculated the information flow to the government at your disposal? If there is only one election every four years and a decision between four parties, then it is about 16 nanobits per second, really not impressively much. I can, imagine a computerized system in which the citizen can send much more information up to his government, in which, the restriction for any human choice, the power of logical interdependencies and the weight of objective facts is made much more visible than today to the government and to the citizen. Exercising a right involves respect for reality and responsibility for society, virtues not particularly recognized by the present forms of democratic decision-making, but definitely brought to importance by a computerized world in which any kind of public decision-making by vote must depend on proper information, because otherwise the automatic execution of the decision will have catastrophic consequences. The computer-assisted political system has not yet been tried - it is too early in many respects - but I am convinced that it will be tried soon and introduced in the future.

Such an impact of information processing will not mean an era full of luck, happiness and satisfaction. But at least man will be able to decide on the crucial tool of information processing by means of improved information processing. Our fate will remain in our hands, even in a highly automatized technological environment, because information processing will return decision-making into our hands and into the human mind.

A science and technology which is based on information and language, on the highest properties of the human mind can, in the long run, have only one general impact: the return from the belief in mechanics to the belief in the humanities, in the contribution of the well-educated human mind and in the value of morale and religion.

CHAPTER 4

THE MACHINES

IMPACTS AND CHARACTERISTICS OF AUTOMATION AND AUTOMATED INFORMATION PROCESSING TECHNOLOGY

Reikichi Shirane

Contents

1 Genealogy of Automation

Technology is a means to assist, substitute and expand various aspects of human activities. Aristotle stated that technology may be divided into two categories: that derived from the spirit of labor, or the needs of real life, and that derived from the spirit of play. According to this classification, automation is a typical technical system evolved from the spirit of labor.

Since any attempt to trace the origin of automation technology necessitates going back to the origin of interaction between man and technology, the author has limited himself to seeking the genealogy of automation in the development of modern technologies.

The first move toward automation was the introduction of automatic machines to the production system which had achieved rapid progress in the 1920's and 30's. One of the driving forces in the mainstream of this trend was the development by Henry Ford of the mass production system for automobiles, which brought about a great innovation in industrial production. With the idealistic slogan: "The purpose of an enterprise should not be just to make a profit but to serve the society.", the flower of Fordism bloomed. Amidst intensifying conflicts between labor and management under the situation of severe working conditions and low wages, Ford proposed a drastic target of low prices and high wages. Namely, supplying automobiles of good quality and cheap price and paying high wages to workers are great contributions to the community, and the only way to achieve these controversial targets was to establish the mass production system by automating the manufacturing processes.

Consequently, the functions of control and automatic operation were introduced to the machine-tools and casting machines for various types of machine working. In response to the demand for interchangeability of parts, the "go no-go gauge" and photoelectric tube were developed in the field of "hardware", and standardization and statistical quality control system were initiated in the aspect of "software".

In spite of this progress in automatic processes, however, the control and automatic operation introduced in this period remained at a very primitive stage, far from what one can call automation.

The barrier of technical restrictions was breached as a result of the rapid technical developments in World War II. For instance, the development of servo mechanisms for the automatic control of anti-aircraft artillery and the progress of electronics needed to upgrade the sophistication of these systems were promoted in great strides through the development of radar.

While the incentive for technical development was said to depend upon either the spirit of labor or the spirit of play, it cannot be denied that the progress of automation was accelerated by the spirit of struggle, as was the case of other important technical systems.

Thus, toward the end of World War II, it became possible to apply automatic controls and operations in far wider areas than previously, causing a spin-off of industrial production systems and opening the so-called automation revolution.

The innovation of automation in the production process was to substitute the function of operators with automatic control devices, which could not be covered hitherto by introducing individual automatic machines. That is, the machine monitors the results of its own work, decides what to do next and manages the overall processes. This suggests that the operator's work in the previous meaning may no longer be necessary. A typical example is transfer-type automation uniting the transfer machine lines in an automobile plant, which is regarded as a representative form of a mass production assembly plant based on modern machine processess.

On the other hand, since the latter half of the 1950's, the program-control type automation has been developed in the United States and Britain, as another direction in process automation. While the transfer-type automation is applicable only to the mass production system, program control offers the advantage of applicability for small-scale production. That is, the control device is actuated by the work commands given through punched tape or magnetic tape and a general-purpose machine is allowed to perform a variety of works without human intervention, realizing a variable and flexible production system. Moreover, the innovation inherent in the concept of variable and flexible program control is very deep and extensive, promising the development from the automation revolution to the cybernation revolution.

2 Automation and Cybernation

"Cybernetics" published by N. Wiener in 1948 provided a very important basic concept for handling the problem of automation. As the subtitle of this book, "Control and Communication in the Animal and the Machine" suggests, he claims that both machines and biological systems can be treated inclusively under a common principle, if communication and control functions are taken into consideration. This means, that by considering the information flow and feedback, the automatic control theory can be applied not only to the conventional automatic machines and productions systems, but also to the fields of social system and bio-engineering. Some specialists called this situation cybernation (a composite word consisting of automation and cybernetics) and regarded it as a new innovation factor exceeding the conventional automation.

The initial purpose of program-control type automation mentioned above, was to produce single kinds of parts or simple assemblies in the machine production system. However, as the digital computer was introduced to the information control function as an automatic information processing system, functions of more advanced and complicated information processing and management were added to expand the range of applications enormously.

One direction in this development is to combine individual automation machines into a coordinated integrated system, and to add up functions of production control and quality control, with the ultimate aim of developing an unmaned plant.

Another direction is the application of process automation to various other fields, which seems more realistic, and this has already achieved some success. As objects of program control in the production system, machining and assembly lines are rather difficult ones, and it was natural that its application was directed to more readily manageable objects, such as processes of handling electricity, gas and fluids. For instance, highly advanced automation systems controlled by computers have already been realized in the fields of power generation/transmission/distribution networks, petroleum refineries and petrochemical plants. Recently, the application has been further extended to the solid-handling process, as exemplified by the consistent production automation which is found in the most modern steel plants. This type of automation passes over the boundary of industrial production (secondary industries), into the fields of primary industries such as agriculture and mining, and on the other hand, into the fields of tertiary industries such as transportation, communications and the banking system.

The extension of this line of development is characterized by the gradual shift of application from industrial fields to non-industrial social systems such as administration, education and medical care. Generally speaking, it is difficult for the principle of efficiency to penetrate into the non-productive social system, and partly due to its long history, the activities of subsystems constituting the social system become inflexible in vertical divisions. A typical example of this is the so-called bureaucracy, which has lost its flexibility through restrictive regulations, traditions and customs and been turned into a system of mechanically rigid structure, not capable of adapting to environmental changes.

If these rigid subsystems are combined together horizontally and Wiener's functions of communication and control are incorporated, each subsystem can be reorganized in accordance with the purpose of the total system and the flexibility to adapt to environmental changes may be regained. In this stage, the social system is revitalized, that is, the system is revived by cybernation.

A good example is the achievement of the modern regional emergency medical information system in Japan.

The subsystem concerning the social service of emergency medical care consists of hospitals and clinics in the region, fire stations which operate ambulances for emergency patients, blood banks, authorities concerned of the local municipality, and regional residents who are taxpayers and beneficiaries, at the same time. The emergency medical information center in each region combines these components organically so as to provide fast and appropriate treatment to victims of suden illness or traffic accidents.

Cybernation of the social system is beginning to bring about great convenience to residents as service-beneficiaries as exemplified by the life-saving medical care service.

3 The Computer as an Automatic Information Processing System

As automation and cybernation become more sophisticated and complicated, the information processing function begins to assume greater weight in addition to the communication and control functions, and the role of computers in this aspect is to be closed up. With regard to the computer as an automatic information processing system, which is one of the most important inventions in this century, the meaning of its innovativity and the predicted development in future will be outlined below.

3.1 Innovativity of the Computer

The innovativity of the computer as information technology has attracted attention because it is a technological system directly concerning the information processing function, which has not yet been fully exploited, (allowing not only calculation, rearrangement and retrieval, but also deriving logical conclusion of events so long as they can be described by binary logic and outputting the results in a certain format).

The information activities of human beings are both complicated and multifarious. They may be classified in accordance with their functions:

(1) acquisition, (2) storage (memory), (3) transmission, (4) processing and (5) creation. While various technical systems have been proposed for each of these activities (except for creation), some of important new technological achievements are presented below.

(1) Acquisition .... radar, electron microscope, remote sensing.

(2) Storage (memory) .. various printing techniques, magnetic recording, semi-conductor integrated circuits.

(3) Transmission ...... telegraph, telephone, radio, television broadcasting

(4) Processing .... computer

It should be noted that of these, number (4) namely, information processing, had been considered to be beyond the coverage of any technological system until the practical computer was developed in 1946.

That is, while other fields have a long history of technological development, the introduction and application of computer as an information processing technique which has a history of only 30 years or so, seem to have just started. Recognizing this fact is important; nevertheless, the introduction of computers has continued to grow rapidly since it concerns unexplored territory, and it has had an intensive impact, already having started to affect every aspect of our life both directly and indirectly. The industrial revolution, as symbolized by the invention of the steam engine, started in the middle of the 18th century in England, and the mechanized production technological system was subsequently established through the development and utilization of electrical energy. This stimulated the consumption revolution and changed the so-called agricultural society into a modern advanced society, or highly industrialized society. The advent of the computer 200 years after the industrial revolution is expected to provide the motive force for the information revolution, that is, conversion from an industrialized society into an information society. This is a common view to describe the innovativity of the computer technological system. It should be noted, however, that for evaluating the innovativity of the computer as technology, its excellent information processing function including superhuman operational speed tends to be overemphasized, ignoring another important function.

This additional important function refers to the expansion of storage (memory) function. Above all, the increased capacity and reduced cost achieved by the memory element using modern semiconductor integrated circuitry are contributing greatly to the expansion of the computer's capability and fields of application.

In man's informational activities, "a sure memory" is one of his most outstandingly weak points. Since the most important role of technology is to complement this weak point and expand human activities, the computer's capability to provide "sure" storage and free retrieval of information provides a great merit.

On the basis of these facts, the innovativity of computers may be expressed in the following way: If the human brain which is strong in analog information processing such as pattern recognition is combined with the computer performing complicated digital logic processing reliably at high speed, to form a mutually complementary man-machine system, the performance of man's information processing activity can be improved markedly and the evolution of a new human being realized.

3.2 Development of Computers

The first practical computer generally is said to have been ENIAC (Electronic Numerical Integrator And Calculator) completed in 1946. This system was developed by Professors J.P. Eckert and J.W. Mauchly of the University of Pennsylvania under the sponsorship of the U.S. Army for the purpose of ballistics calculation. However, ENIAC was based on a rather different system concept from that of modern computers; namely, the stored program system proposed by J. Von Neumann in 1947. The first machine of this system was EDSAC (Electronic Delay Storage Automatic Calculator) completed by Professor M.V. Wilkes of Cambridge University, U.K. In 1949, paving the way for the development of today's computers.

The subsequent development of computers is described elsewhere and no further mention is made here. In analogy with the alternation of generation in biology, the operating speed, memory capacity and reliability are improved ten-fold while the price is reduced to 1/10 every 6 years. Following computers of the first generation using electromagnetic relays and vacuum tubes, and those of the second generation using parametrons and transistors, the present computers employing mainly semiconductor integrated circuits (IC) belong to the third generation, and with the great improvement in the degree of integration with the advent of LSI (large-scale integration), the so-called 3.5-th generation is beginning.

The image of the 4th generation is not yet clear. In other words, this suggests that thee basic design concept of computer may be changed extensively in the near future. As for the future development of the computer itself, the following 5 targets may be mentioned.

(1) Increase of Processing Speed

As the degree of integration is raised in LSI's used for logical elements, processing speed is increased several times faster than that of the third generation, thus, achieving high reliability and low price. Further improvement in this line would expand the application area of computers extensively.

(2) Introduction of Firmware

As the size and performance of computers are increased, the software also becomes increasingly complicated and vast. Recently, software has tended to be partly incorporated into hardware to make up firmware. This allows the modularize software, produce it in the factory and increase the operability of the computer system.

(3) Progress of Language

In order to make computers readily usable for everyone, it is necessary to try to bring the language to operate it as close as possible to normal natural languages. For instance, the development of EUL (End User Language) may be cited as one of conversational type language designed for this purpose.

(4) Development of Terminal Equipments

One of the basic themes is to improve handling ease and performance of input/output devices which are located at man-machine interfaces. The development of pattern recognition technology and various types of intelligent terminals is being actively pursued.

(5) Network Construction

The operational mode of computers is progressing from on-line centralized systems to networks of multiple computers. This allows to combine hardware, software, and data bases into common resources, and independent computers act in the organized manner as if they constitute an organism. In line with the tendency toward network, development of computer network architecture permitting to connect computers of different nature, and preparation of corresponding data bases are in progress.

3.3 Complexing of Computer Technologies

Besides the line of development of the computer system itself described above, it is also important to obtain a perspective for new developments achieved by the complex utilization with other related technologies. The first point of complexing is the rapid expansion of computer applications through the recent advances of communication technology. The transition of computer system form from point to line, and further to extensive plane-like network is due to the progress in communication technology. Recently, digital data exchange networks suited for computer communications have started to be commercialized in advanced countries, accelerating computer utilization. Moreover, the use of satellite communications is rapidly advancing not only internationally but also in the field of domestic communications, and with the practical application of the optical communication system which is capable of sending a great amount of information, an extensive reduction of communications' cost is expected. This will further expand the application range of computers.

One of the directions for development henceforth is the application to region-wide social services, and it is expected that a variety of welfare-oriented systems such as medical care, education, traffic control and environmental information systems will be established. Another direction is to create new information-providing media which have become possible with the progress of communication technologies, particularly picture communication techniques, which could not be realized up to now for technical and economic reasons.

The start of on-request character information service, such as PRESTEL in England, ANTIOPE in France and CAPTAINS in Japan is bringing forth a great revolution in the age of mass communications media. This type of information service is expected to develop to a system integrating three communication modes, voice, picture (including moving pictures) and code, like the Video Response System, currently being experimented with in Japan, with computers playing important roles in the complex system to control the overall system, retrieve information and form pictures.

The second point is the problem of reorganization involving centralization and decentralization. Along with the rapid improvement in performance and reliability of computers through generations, the development and mass production of LSI's are inducing fundamental innovations in the form of computer utilization. One of them is to partly revise the concept of scale merit such as Grosch's law, shifting from the centralized system of giant computers to the decentralized formula. An example for this is the establishment of the so-called bus-line system computer network.

However, a more important change is the innovation caused by miniaturization of computers. Minicomputers which have been utilized in factory process control are being further reduced in scale to the extreme, making it possible to incorporate them in various kinds of instruments and systems as "intelligent parts". These micro computers have already been used as built-in components not only for the production process but also in automobiles and household appliances, so as to make all the system functions "intelligent".

This is a sort of transfiguration of the computer system itself, and is contributing to rapid exploitation of new application fields through the establishment of an extremely decentralized system.

The so-called micro computer boom currently occurring in the United States and Japan is a trend of easily handling and enjoying computers among amateurs including school-children, and provides important clues for future trends by allowing amateurs to participate in this field.

4 Characteristics of Computerization in Japan

4.1 Earlier Development and Competition System

Table 1 shows the numbers of units and investments for computers in countries with a high ratio of computers. Table 2 shows the ratio of domestically produced computers of various sizes in Japan.

As is evident from these two tables, the utilization of computers in Japan is increasing at a surprising speed, and the recent growth rate is as high as 5,000 units/year these past few years.

The first fully-fledged operation of a computer in Japan was initiated by the Meteorological Agency's Forecast Department, with an IBM Model 704 EDPM (Electronic Data Processing Machine) and by Onoda Cement Co., Ltd. with a UFC (UNIVAC File

Computer) both in 1959. With these as the starting point, the latest models of US computers were introduced in succession to larger Japanese enterprises bringing forth the age of computer utilization. However, in parallel with the import of computers from overseas, an important trend was that the system for development of domestic computer technology was steadily being solidified throughout this period.

Table 1. Computer installations in major nations (As of December, 1976)

Items / Countries	Number of Units	Investments (Million Dollars)
US	61,120	37,287
Japan	20,124	9,622
FRG	10,660	6,527
France	9,186	4,768
UK	8,543	4,794
Italy	4,491	2,119
Canada	3,372	2,301
USSR and East European Countries	15,299	5,494

Note: Data derived from "Computer White Paper 1977". The statistics do not include minicomputers and other smaller units. Data for Japan is as of March, 1977 (Report of JECC Survey Committee).

Table 2. Investment share of domestic computers (As of March, 1977)

	Domestic	Imported
Large	48.8%	51.2%
Medium	71.5	28.5
Compact	73.2	26.8
Subcompact	59.2	40.8
Total	57.4	42.6

Note: Data obtained from "Computer White Paper 1978". The computer size is graded on the basis of price (expressed in Japanese Yen) as specified below.

Large ...... 250,000,000 or more
Medium .... 40,000,000 to 250,000,000
Compact ...... 10,000,000 to 40,000,000
Subcompact ... 10,000,000 or less

Principal events are listed below in chronological order.

1954 Relay-based FACOM100 completed.
Parametron invented.

1956 Vacuum tube-based practical computer FUJIC completed.
Transistor-based ETL-MARK III completed.
(The earliest development of transistorized computer of digital, stored program system)

1957 Parametron-based MUSASHINO-1 completed.
Esaki diode invented.

1958-60 Products of 6 computer manufacturers marketed.

The efforts from the early stage to develop domestic production technology by universities, governmental research institutes and manufacturers contributed to making Japan the only country, besides the US, whose share of domestically produced computers is 50% or higher.

Another characteristic of the Japanese computer industry is the establishment of the present footing under severe competition among several producers. In contrast to West European countries where one firm prevails in one or a few countries through successive mergers, it is interesting that the principle of competition dominates this field in Japan.

However, another feature of Japanese type of competition is that competing firms participate and cooperate in joint development projects under the leadership of the

Nippon Telegraph Telephone Corp. or the Ministry of International Trade Industry in cases where decentralized efforts for research and development would lead to fatal defects, as in case of super LSI development.

4.2 MIS Boom

No other events illustrate the feature of computerization in Japan more than the MIS (management information system) boom. The term MIS was brought home by the inspection party for large-scale computers which visited the US in autumn of 1967. The party, consisting of top managers of business circles, inspected the situation of leading and most modern computer utilization in the U.S. at that time and claimed that the computer utilization in Japan should be aimed at the total system (that is, MIS) including the decisions of top management.

This is an example of the exaggerated sense of urgency resulting from the crisis feeling that Japan is lagging behind, and over-emphasis of the significance of novelty in Europe or America, which is so often encountered in Japan. The social trend in Japan of bringing a high degree of abstraction into everything helped to cause the "MIS boom" in various fields and strata.

It goes without saying that the MIS was unrealistic at that time in view of computer capabilities, and computerizing managerial information required for decision making in the top management is a utopian concept even at present.

Nevertheless, it cannot be denied that the MIS boom aroused intense interest in computers among many leaders of business and government circles and provided the motive force for the sophisticated utilization of computers in Japan.

4.3 Japan-Type Management and Computer Technology

One of the major features of Japan-type management is the formation of a corporate citizens community.

Japan which was involved in severe waves of rapid industrialization and technological innovation over a far shorter period of time than European countries and successfully adapted to the new situation is tracing different innovation pattern from that of other advanced nations.

First of all, rapid and large-scale migration of population occurred from rural to urban communities, comparable to that of the Germanic races. To those having left their home land, a new sense of home was provided by enterprises and various other organizations.

That is, employees of Japanese enterprises, based on the lifetime employment, mostly find spiritual satisfaction in working and willingly devote their lives to their jobs. On the other hand, management not only puts capability of every employee into systematic efforts for the business purpose as manpower, but also assumes responsibility for their spiritual growth and satisfaction.

To view the situation in another perspective, while in the European democracies, the big enterprise system developed around industrialization after having established rich regional and citizen communities, the waves of advanced industrialization came to Japan before the maturation of a democratic community. For this reason, the role of enterprises had to cover the entire level of life under the lifetime employment system, including welfare which were to be provided by the regional community.

That is, the role of Japanese enterprises may be appreciated as a sort of unique social invention in adapting to the social environment. It is true, however, that among young people these years, the sense of devotion to enterprise is less, and frequent conflicts between the egoism of corporations and regional residents are degrading the image of enterprises.

The second feature of Japan-type management is the system of full member participation and lifetime employment. This character is closely related to automation of the production line and the computerization of business management section aim at saving labor and costs service improvement, shortening of working time and augmentation of productivity. Therefore, rapid introduction of these innovations often induces serious labor problems such as unemployment and changing of jobs. It is true that a number of problems occurred in Japan as in other advanced countries, but she managed to pass through waves of technological innovation smoothly, and to adapt to ensuing changes.

One of the reasons for achieving this success is said to be full member participation system in Japanese-style management. For instance, in advanced automation plants such as automobile factories, the production line involves not only original ideas of design engineers but also those of field workers, indicating the existence of more flexible man-machine system in contrast to that in Charlie Chaplin's "Modern Times". In some cases, the enterprise is operated through the full member participation at the sacrifice of immediate efficiency, and addition of "mind" to a set of inputs required for business activities: men, materials and money, may achieve unexpected improvement of productivity.

On the other hand, it has often been pointed out that the Japanese style management based on life employment and seniority rule, lacks personnel mobility and results in a rigid system which is not adaptable to changes.

However, it should not be overlooked that while there is little mobility between enterprises, the life employment system ensures high mobility within an enterprise and provides flexibility for adapting to changes. In spite of successive and extensive changes such as development of new products, modification of production facilities, automation and computerization, in most cases, troubles were absorbed by shifting jobs, assisted by the will of the employees who design their jobs and life over the long-term and by training courses provided by the enterprise.

The attitude of management of these enterprises and organizations is a product of civilization cultivated through Japan's long history and tradition, and the process of introduction of modern technology such as computerization being subjected to social accommodation and settled in the traditional civilization is very interesting as an example of "technology transfer". Most modern technologies originated from Europe and America, and were alien to Japan. However, as these technologies settled and matured in the Japanese soil, they began to assume a characteristic national identity. Like many other industrial technologies, the computer is also gradually becoming "Japanized".

THE STATE OF THE ART IN INFORMATION PROCESSING

Sidney Michaelson

It is not practicable to define information formally - see any good dictionary. An attempt to define information processing by ostension rapidly convinces one, not only that all living creatures practice it, but also that every inanimate occurrence involves some information processing too. We are not especially concerned with mechanising the information processing done by inanimate nature, but we often wish to mechanise the I.P. done by humans in modelling both inanimate behaviour, such as the solution of the dynamical equations of traffic queues. We also wish to automate much of the I.P. done by humans outside the realm of modelling, such as accounting, keeping track of case law, controlling chemical plant or production lines.

What functions do we need to mechanise for I.P? Much processing requires data to be stored for later use. This can grow quite large - a 4-drawer filing cabinet for A4 paper can hold about 200,000,000 typed characters. A similar sized filing cabinet can hold about 25,000 microfiches and thus store about 18,000,000,000 characters of typescript! Of course, there is the little problem of finding the right item of information and the consequences of a mild error when replacing a microfiche - or a sheet of paper - are rather difficult to undo. The time to find a particular stored page, make a print of it, and replace it is likely to be several minutes for a very systematic and experienced filing clerk. What a human being does with the data recovered in this way is not yet fathomed. However, for some very restricted situations we can make what is done sufficiently conscious to be able to reproduce it in a machine. This is the case for much accounting, and quite a lot of process control and things like monitoring the state of patients who are critically ill. But, we do not know how to mechanise the delicate perceptions that tell the skilled auditor, engineer or physician that something is going wrong before the quantities being monitored approach critical values. We obviously have some local storage inside ourselves, and it provides data much more quickly than our filing drawers. This function must be provided too, to enable our data processing machinery to function adequately. As we might expect, it is cheaper to provide rather slow storage devices than very fast ones, so we usually use a modest amount of high-speed store and accept slower access to bulk storage for files. There has to be something which can actually manipulate data, change it, test it, decide what to do about it and do it. In human beings this seems to be intimately mingled with the storage arrangements, but we have not been successful in making machines with a similar structure that are usable in practice. Instead we separate the functions of manipulation and high-speed storage and make the 'mill' separate. To these functions we must add two others - it must be possible to communicate with the device and the device must be flexible and capable of being made to perform an arbitrary computatin (at least those that are logically capable of being performed within the limitations of the available time and storage). It is this last requirement that leads to the major obstacle in information processing - the difficulty of writing adequate programs of instructions to be obeyed by the machines.

To describe the state of the art presents some difficulty. It is a young art and like most children it develops by fits and starts - we are enduring a period of rapid growth just now. Computers work electronically and they share in the general technological change which now afflicts electronic equipment. Our desire of cheaper, faster, more reliable computers has very much promoted the advance of the technology of manufacturing integrated circuits, and in its turn the revolution in chip technology has provided us with cheaper and smaller computers, with more storage capacity than ever before. These range from personal computers which compete with colour television in price and capacity to entertain, up to extremely powerful machines intended for use in enormous physical calculations or in the activities of Governmental intelligence organisations, at costs of the order of 4M to 8M.

The personal machines are used without any file storage or with small amounts, say 250,000 characters. They may have very cheap, fairly slow printers and may use the domestic television receiver as the display console. They can usually connect to a C.C.I.T.T. interface to communicate with other machines, for example to obtain larger scale file storage, or to collect data from a device in a milking parlour. The mill is usually fairly slow, obeying perhaps 2-300000 instructions per second, and they can usually not have more than about 64000 characters of fast storage. Prices range from about 200 for a kit to be assembled by the purchaser, up to 2500 for a beautifully boxed thing with two disc-file stores and a colour display. The more expensive machine is faster, by a factor of 30, and has more store, by a factor of about 16 for the highspeed store and 60 for the file store than the machine intended to do all the work of London University in 1958. And it costs about 1/60 of the price of that machine, and can be used in an ordinary office.

Towards the other end of the scale we have large machines used for laboratories like CERN. Storage for files can now be bought to hold up to 10 characters per unit - say two thirds of a cabinet full of microfiche. It has a retrieval time of about 20 seconds and costs about 0.001 p/character. It is rather slow to serve as a "ready for use" file store. This latter would consist of devices with a total capacity of up to 5 or 10,000 Mch, at a cost of about 0.016p/character and access to a block of characters in a time which varies from, say 1/200 to 1/30 sec - with a mean of about 1/50 sec. The high speed working store, close coupled to the mill, is now often of 3 to 4 Mch, sometimes as large as 12Mch, with a cost of about 0.2p/character.

At the same time as storage has become faster, cheaper and smaller, mills have developed. The most powerful mill can now carry out about 200 million instructions per second on the most suitable sort of problem in which many streams of calculation can go on in parallel. Unfortunately the fastest machines are drastically slower on other sorts of problem, and are not capable of processing several independent problems simultaneously to achieve the same throughput on work that is less well suited to parallel processing - their effective speed drops by a factor of, say, 20, to bring them to the order of 5 times the power of simpler machines. The most powerful machine that is sold costs about 4x10 in minimal form and probably twice as much if it is supplied with the full complement of storage and add-on-goodies.

To use such a collection of mechanisms one has to convert it into a responsive assistant. Firstly it has to be provided with a sequence of instructions that will make its component parts work together properly - this is the Operating System that looks after the files and communications with the world outside the machine. It takes care of details wich need to be managed repeatedly and securely, such as checking that blocks of information have come from the files correctly, that back-up copies of files are taken, that the correct demountable disc-pack has been put on a drive and so on.

For a large machine used by several jobs at a time (up to 200, say) it schedules the allocation of resources to the different jobs and protects them against one another. It presents an appearance which is more regular than the hardware and handles more complex entities than the hardware does, relieving the user of much detail. Hence it is easier to understand and to use. Depending upon the complexity of the hardware and the services to be provided this kernal of the operating system may take from 6 man-months to 6 man-years to write. It may be incorporated in a variety of layers that change the appearance of the machine still further. For example, there may be a Data Base Management System which enables the user to treat the contents of related records without being concerned about their allocation to files, and that takes care of routine updating throughout the files that is consequent upon a change in a single record. Such a Data Base Management System is likely to take 6 man-years to design and construct and will be unsatisfactory when made because we do not yet have an adequate intuition about data-bases.

Users will need to have their own programs to control the machine and make it do the work appropriate to their problems. To simplify the task of writing these (and operating systems) 'high-level programming languages' are developed, which enable the programmer to write his instructions in terms of the entities which relate to the problem being tackled, rather than to the machine being used. These programs must be translated into terms suitable to be obeyed by the machine. This is done by other programs - 'compilers' - which take account of the differences between machines. They can provide higher efficiency in the program which finally runs than most programmers could. By eliminating much of the irrelevant detail from the programmer's job they aid him to produce programs that he can comprehend more easily and thus they make it easier to avoid mistakes. The effort involved in writing a compiler depends upon the awkwardnesses of the language and the machine. Typically, for a well-designed procedural language that is already familiar, it takes about a man-year to produce a compiler to run on a new machine. To tune the strategy adopted for the translation so that the translated programs run really well is about another year's work - and then deficiencies will continue to need alteration during years of use.

When it comes to the programs that many computer users want to have, the labour appears to be unbounded. A much-used suite of programs for analysing X-ray diffraction pictures of crystal structures took about 50 man-years to produce. The U.S. Navy is said to have had 7 or 800 different payroll programs written, and each probably took about 10 man-years. The central difficulty lies in discovering how to solve the problem that is being posed - which usually includes finding out what the problem is, and may even involve inventing some of the problem. The programmer's understanding of the problem tends to be affected by the attempt to write programs and often he does better to start again and design his programs to embody a different approach. Of course, there are many users who have no interest in computers or in how to make them sit up and beg. They just want certain work done. For these, there are lots of packaged services and companies that exist by providing them. This has transferred the difficulties to the service companies, but not eliminated them.

The art of programming has not really advanced very much since the first programs were written. We write bigger and more complex programs, but we do very little within the programs that was not envisaged 25 years ago. We use computers to reduce the donkey-work of writing, editing and cross-referencing large amounts of text, and we can treat quite complex entities as units to be processed so that we eliminate a lot of routine detail, but we still find ourselves going round the design loops -

several times before we have an usable outcome. And that may well demonstrate that we had the problem wrong after all.

LONG RANGE PROSPECTS FOR INTELLIGENCE IN INFORMATION PROCESSING SYSTEMS

Edward Fredkin

We have seen continous progress in the area of computer hardware technology, progress unmatched in any previous area of technological development, but as of now we have not yet seen anything comparable in the way of software progress. The promise of some of the potential developments, which would combine the hardware that is surely coming soon with intelligence programs that may come someday soon, is tremendously exciting. This paper will explore the consequences of what we can accurately predict, namely the progress in digital technology, along with the consequences of a breakthrough in artificial intelligence research which could lead to systems of great general intelligence. In the further future, with or without a scientific breakthrough, there can be no doubt that the intelligence level of information-processing systems will increase monotonically and with no clearly foreseeable limit. Considering the extent to which the development of true artificial intelligence could affect our future, we should be farsighted enough to take now those actions that offer the best insurance against undesirable outcomes.

1 A quick review of progress in digital technology

There is every reason to believe that the steady rate of progress that we have seen over the last twenty years in the area of hardware technology will continue unabated for at least the next twenty years. One could make reasonable extrapolations based on current technological trends. However, history has shown that nearly all long-range predictios that are merely extrapolations of the current technology are too conservative, because of the advent of new kinds of technology that supersede the old methods. On the other hand, the consequences of making too conservative an estimate in the field of AI are fraught with risk, and it is very important for us to do our best to anticipate and eventually put to good use what is surely on the horizon.

In anticipating future progress, a good rule of thumb is to expect that overall cost/performance ratios for hardware will improve by a factor of two about every two years. A doubling every two years means a factor of 1000 in 20 years. To verify this, consider that random access memory from IBM went from $8/byte in 1959 to $15/Kilobyte in 1979, while becoming much faster, more compact, more energy efficient, and more reliable. Today, in 1979, you can purchase a central processor for a computer for $100 that is far better than one that cost $100,000 in 1959.

We are now seeing the first use of the earliest verisons of what are known as "one-chip computers". These are microcomputers that include on one small silicon chip all of the hardware (i.e. processor, memory, input and output systems, communication subsystems, etc) that is needed to perform some complex control task. Today, single memory chips, each with 65,536 bits of information, are starting to be produced. This progress has enabled us to create lower cost and more miniaturized versions of older computer systems, but for the moment, aside from certain toys and novelties and from the simplification of conventional apparatus such as teleprinters and appliances, nothing really new has resulted from the dramatically lower costs.

2 Historical problems associated with AI research

Researchers in the field of Artificial Intelligence have a strange work record. It was the AI researchers who invented computer time-sharing, who invented many computer languages, and who developed many of the ideas that are at the basis of all modern programming languages. They have had an inordinate preoccupation with toolmaking, often to the extent that the only visible results of many AI efforts were the tools that they created to aid the AI research itself. One may ask why this is so, and the answer is that the available hardware and software systems were wholly inadequate for the task. The major problem with hardware in earlier computers was the size of the main random-access memory. To do serious AI research one needs a memory in the order of millions of bytes. In the early days of AI research a byte cost about $8 (e.g., on the IBM 7090 computer), and I can recall many meetings where the topic of conversation was on ways to raise the money for a four million byte memory or even for just a million bytes. These conversations wandered between how to justify such vast sums of money and how to cleverly make do with the amounts of money available.
Time-sharing was really developed as a way to make it economically feasible for many AI researchers to have on-line access to a machine with a large and expensive memory. Today, one million bytes of memory cost about fifteen thousand dollars (on the IBM System 38) and any research establishment can afford memories large enough for serious AI research. Insofar as the need for processing capacity is concerned, the picture is mixed. In many areas of AI research a modest amount of processing is sufficient; examples include some efforts at natural language understanding, general problem solving, and the so-called "expert" systems. In other areas, the processing capacity of large modern computers is marginally sufficient, for example in speech recognition, game-playing, or robotics (excluding vision). Other areas, such as machine vision, do not yet have nearly the computational horsepower needed. What is clear is that the advent of VLSI (Very Large Scale Integration) circuitry will provide adequate processing resources for all of the AI areas that we can now foresee. What is important to note is that inspite of the lack of proper resources, inspite of the inordinate preoccupation with making tools, steady and important progress has continually been made in the area of AI research. This means that we now know how to accomplish many of the subtasks of intelligent systems, subtasks that we did not know how to do just a few years ago. Not everything that we have attempted has yielded to our efforts, but much progress has been made. As facilitities become more available and as more research workers become involved in this area, it is only reasonable to expect that the previous rate of progress will at least continue or perhaps increase.

3 What is needed for true super-intelligence

The problem of creating a truly super-intelligent system is not substantially different from the problem of creating a performance level equal to that of a very intelligent person. The reason is that once a system has reached a certain level, it is quite clear how it will be able to advance from that level to one of far greater intelligence. However, the first step, that of creating an intelligent system, is tremendously difficult because of the obvious complexity of the task, and because we do not yet have any good ideas about how to solve some of the problems. It seems that there are two possible main approaches, and both have many adherents in the AI research community. First, there is the method of explicit programming. This is the approach that has produced all of the present generation of artificial intelligence demonstration systems, or "performance" programs, as they are known in the AI community. This method involves detailed, ad hoc programming of each of the necessary parts of an AI system. The second approach involves the concept of some theoretical breakthrough that would result in an "equation" or other mathematical formalism which allows for intelligence. The distinction is similar to that between innovative engineering and mathematical science: programming to implement what we believe the various parts of intelligent systems should be is a kind of engineering approach; solving in some mathematical sense the problem of intelligence, so that an intelligent system would follow as a consequence of a new theory, would be a kind of scientific breakthrough.

Possible scenarios for the developement of super-intelligent systems

We can conceive of several possible ways in which AI might develop, but all these ways have some aspects in common, so we will cover these common elements first.

One element is the transition from high-level human intelligence to super-intelligence. When we speak of an artificially intelligent program, we do not expect an intelligence resembling in all ways that of a normal human being. What we mean is that it will not be deficient in any important way, that is, that it will not be lacking at least human-level intelligence in any capability useful to its tasks. On the other hand, it may be far superior to humans at many things. Consider arithmetic, for example. Any artificially-intelligent system will be able to do arithmetic billions of times faster than any person. It will be able to remember whatever it wants, never forgetting something that it marked as necessary to remember. It will be able to use many formal systems, such as algebra, calculus, logic - mathematics in general - with great speed and perfect accuracy. Even more important will be its skill at programming. Given that an AI system knows what it wants to do, and that it knows in general how to do it, then the task of writing and debugging a specific program will take place at rates millions of times faster than the human average. (The human peak rate for programming is hundreds of times faster than the human average). This means that if the AI is as smart about writing AI programs as are the persons who wrote the program in the first place, then the task of reprogramming itself can be handled by the AI at a tremendously higher rate than by human programmers. In addition, the ability to write and maintain good, efficient code will be greatly enhanced. All that is required for this to be true is that those aspects of intelligence that have to do with the understanding of the programs that need to be written, how these programs should work, what their functions are to be, and in general the understanding of design issues all have to be on a par with the human programmers who created the AI system in the first place. Now this AI may be good at many other things, but what is interesting is that soon after it comes into existence it will be able to reprogram itself to be much better, strictly because of its superior programming talents. It is conceivable that this effect may take place only once, leading to a single discrete increase in performance, but I am of the opinion that by virtue of its ability to monitor its own internal performance and to make clear to the human developers how it is functioning. AI will undergo extremely rapid and iterative progress. If the AI is more intelligent than its creators in every aspect of intelligence that bears directly on the creation of AI, then it is possible that there will be a really dramatic increase in the level of its intelligence. By the time this all happens, we should have developed highly automated systems for the realization of advanced VLSI integrated circuitry that utilizes the so-called submicron technologies to achieve computer implementations of extreme density, speed, and efficiency. This means that the emerging AI will be able to easily specify completely new hardware designs that will allow for another large increment in AI performance.

Thus we can expect two stages of tremendous improvement in capability, first when the AI reprograms itself, and second when it begins to run on hardware that it designed. To accomplish all of this, it is not necessary to suppose that the AI is as generally intelligent as we are; it is enough that it should possess the necessary capabilities for those tasks related to the improvement of its programs and its logic design. However, at some stage we can be sure that AI will be at least as intelligent as the most intelligent human at every aspect of learning, original thinking, and creativity.

4 Where AI might first arise

At first this might appear to be a strange concept, but what I wish to explore is the question of where and under what circumstances AI might first be developed. The main work today takes place in university research laboratories such as Stanford, Carnegie-Mellon, University of Edinburgh, Kyoto University, Linkoeping University, and MIT; or in government sponsored research laboratories such as the Electro-Technical Laboratory in Tokyo, the Leningrad Research Computer Center, SRI in Palo Alto; or in industrial laboratories such as the General Motors Research Laboratory, Xerox Parc, and Bolt Beranek and Newman. Obviously, all these places are possible candidates for the site of the first appearance of AI. One present restriction on the ability to do serious AI research has to do with the necessary facilities, which at the present time are only available in large laboratories. However, it is clear that this situation is rapidly changing and that suitable facilities will soon be within the range of what a single researcher can authorize for his own use, and within ten years we can expect that very suitable facilities will be just a few hundred dollars in cost. This will forever remove inadequate hardware facilities as an impediment to AI development. If we arrive at a moment when the hardware is widely available, when much intellectual progress in AI has been made, but when we are still a stroke of genius away from its realization, then we might find that one individual genius, working by himself, could solve the remaining problems in one stroke and implement the first working system that is truly intelligent. Thus it might turn out that AI could first appear in any location on Earth, under nearly any circumstances, based on future events that we can not predict.

5 The risks involved in early applications of AI

When large and complex systems are first programmed, they always contain errors, commonly called "bugs". These errors are usually discovered by means of testing the program to see if it performs as expected. An AI system will probably be the most complex program ever created, and we can expect that it will have serious bugs. Some of these bugs may be as simple as typographical errors, some may be deep conceptual errors, and some may introduce very subtle forms of misbehaviour in the nascent AI system. Most likely, it will require many years of the most rigorous testing to be able to certify that an AI program is worthy of trust. An even greater problem will be to create a generally intelligent system that has certain inviolable bounds on what it can do. These bounds would be for the express purpose of making it extremely unlikely that the AI could be used in such a way as to bring harm to anyone. If an insufficiently tested system, with its bugs and other kinds of errors, were applied to some task that could affect people's lives, the social or financial stability of various institutions, or international affairs, then the consequences of faulty operation could be most grave. Errors in an AI system may cause it to misunderstand what we mean when we communicate with it. A faulty AI may produce a "solution" that contains in it the seeds of future disasters. An AI that is mobilized to accomplish something good in the eyes of one individual might succeed at the expense of everyone else. It will tax both our intelligence and our warmest and most human emotional capacity to define what is allowable and what is not, since an act that is very good for a great many people, but bad for a few poses difficult social and moral problems. A temporary solution might be to restrict the behaviour of early AI to those areas were there is general agreement that no one is harmed.

The most powerful force on this planet is intellect. Super-intellect will be super-powerful. AI will not be a toy; rather it will be the most powerful source of benefit or harm that has yet existed on Earth. We do not have the luxury of being able to avoid this problem, since progress in this field is inevitable, and the longer it takes to solve the last problems of creating AI, the more likely it will be that it will done by a highly motivated individual genius with particular goals that the rest of us might not agree with.

6 How AI should be brought into existence

The most important aspect of the development of AI is to avoid at all costs any early application of AI systems until we understand them well, and until we can certify that they are safe for the intended applications. This means that AI must be developed in an environment that allows for extensive testing and experimentation, so that one can reach a deep understanding of the nature of the systems that are created. We must learn how to build in safeguards against destructive possibilities, we must learn how to check and double check, by independant methods, each of the results of AI problem solving. In this regard, it seems that the most valuable and effective tool for helping us to certify the safe operation of an AI system will be another AI system that is completely independent and that can monitor the internal operation of the system under test, without any possibility of communication from the monitoring computer to the one being monitored. AI systems should always be integrated with extensive self monitoring as the only way of operating.

If we are to be successful with AI, that is, if we are to produce something of great benefit to mankind, then there must be sufficient time to provide the excruciating care that the problem deserves. If ever there develops a race to apply AI for any purpose, then the winners of that race will most likely defeat the losers of the race, defeat themselves, and surely defeat us all, because they will not have spent the time to make the system safe for use.

On the other hand, we must hurry as rapidly as possible towards the safe development of AI, because this must be accomplished before the appearance of systems that might be created without due regard for the safety issues. One might ask, how can the fact that there is available a safe AI make it any less likely that an unsafe one will still appear subsequently? The answer is that the safe AI can be made available to anyone who needs or wants such a system, and if the creators of the safe system have been competent, then the system should be able to be used without the likelihood of causing any disasters.

At the meeting in August I shall make concrete proposals toward the creation of policies and institutions that are consistent with the prudent development of Artificial Intelligence.

DISCUSSION NOTES ON AI

Alwyn Scott

There was a time when practical people could ignore artificial intelligence (AI) research as unlikely to bear fruit in a lifetime, but "Very Large Scale Integration" (VLSI) has changed all that. Now many questions arise:

1) Do we know what we mean by the word intelligence?

2) Is a machine that only thinks (i.e. draws conclusions according to fixed rules of inference) truly intelligent?

3) Does intelligent behavior require an appropriate blend of thinking and feeling? (As a design requirement for a machine that feels, I would suggest the development of a nonsymbolic (tacit) internal world picture against which plans and predictions are regularly tested.)

4) Since the world picture of a machine is very likely to be different from ours, are we not faced with the following design dilemma?

> A highly developed AI machine will be either unintelligent or alien.

5) Do we want the "intelligence explosion"?

6) Is AI research more or less dangerous than (say) recombinant DNR work?

7) Should such developments remain the playthings of research scientists? Is there any alternative?

"MACHINES"

Takemochi Ishii

It can be said that machines have changed substantially due to technological innovations in computers and communications. Looking at their biological appearance, it seems that an evolution to a new species with intelligence has been made possible. Particuarly, as a result of recent LSI (Large-Scale-Integration) techniques enabling the development of the Distributed Control System, its effect may become extremely decisive in the near future not merely in industrial fields but in all aspects of our daily life.

In other words, there is no doubt that a great change on a scale comparable to when passenger cars for private use began to be mass-produced will take place in the information field. That is, as the spacial moving ability of an individual has been outstandingly expanded thanks to automobiles, each individual's ability to carry out information processing is remarkably increased; for gearing to it, all the mechanisms will inevitably change.

CHAPTER 5

THE INDIVIDUAL

AUTOMATED INFORMATION PROCESSING: EXTENDING OR IMBALANCING HUMAN CAPACITY?

Harold A. Linstone

1 Introduction

The effect of automated information processing on the individual constitutes an impact of a technology. The study of such impacts has become a recognized field of considerable importance in the last decade and is usually termed "technology assessment" (TA).(1)

Our experience with TA has been most enlightening -- and frustrating. It has become very clear that TA is an open ended problem: the impact of a technology involves not merely other technological areas, but any aspect of society and the individual. The invention of the chimney in Europe during the Middle Ages had significant effect not only on building construction, but on social stratification; the development of the farm tractor did not merely change agricultural procedures, but in the U.S. triggered a population shift from farm to city. Today we still are uncertain of the effect of television on our children.

We have learned that TA is fraught with subtleties and cannot be performed by relying on the analytic tools and the paradigms of science. It thus behooves us to approach any discussion of the impact of automated information processing on the individual with considerable humility.

2 Some Basic Concepts

Processing and movement of (a) goods and people and (b) information have constituted primary human acitivities since prehistoric man (Table 1). The reason is obvious: In any complex living system, movement of both material and information is essential to survival and evolution; communication is crucial to management of system growth and complexity, i.e., to self-reorganization of Planet Earth.

But there are two inherent and critical differences between a and b:

1) Processing/movement of goods and people requires large amounts of energy; processing/movement of information does not.
2) The transfer of goods and people usually involves a loss to one party and a gain to another; the transfer of information does not.

TABLE 1

Extensions of Human Capability

			Paleolithic	Today
Processing	(a)	Human	Natural processes	Medicine
		Material	Stone-flake tool	Mechanical/Chemical/ Biological Engineering
	(b)	Information	Brain	Computer
Movement	(a)	Human	Walking	Aircraft, Space Shuttle
		Material	Carrying	Train, Ship, Aircraft, Missile, Truck
	(b)	Information	Speech, symbols	Telecommunications

With the beginning of the last quarter of this century we have entered an era of energy shortage. We expect this to be temporary in duration since solar and fusion energy should emerge as primary and unlimited energy sources during the twenty-first century.(2) But for the present we face a serious situation and, in this context, the advantage of information over material goods becomes particularly significant. In other words, the <u>need</u> for information processing derives today not only from the growing societal system complexity, but from the current energy resource shortage.

Let us now briefly comment on the technological <u>capability</u>. The first large electronic digital computer (ENIAC) contained 18,000 vacuum tubes and occupied a large room. The same computational ability resides today in a silicon chip microcomputer the size of the smallest joint of your little finger.(3) Microminiaturization is a major trend in information processing equipment and it still has far to go. The information needed to program the 1976 Viking lander put down on Mars consisted of a few million bits, the equivalent of one book. A single human chromosome contains enough information to fill 4,000 volumes.(4) Meanwhile the costs plummet. In 1955 one dollar bought the execution of about 100,000 single operations on a computer; in 1970 a dollar bought about 100 million!(5) The computer is becoming as pervasive as the book in the developed world. There are 200,000 digital computers in the world today; in another decade there will be millions. The uses of automated data processing have expanded dramatically - from payroll to kitchen (automatic cooking), from oil refinery operations to clinical diagnosis, from police information systems-(6) to children's games. The number of home terminals is also growing dramatically: in 1975 there were 659,000 terminals in use, some time between 2000 and 2010 half of all telephones will have terminals.(7) These few forecasts suffice to indicate the extent to which automated information processing is becoming an integral part of daily life, as close to the individual as the automobile and the telephone.

3 A Powerful Impact: Creating New Realities

It is self-evident that in the open-ended task of assessing the impacts of a technology, comprehensiveness is out of the question. We shall focus here on effects on the individual which appear to be deep-seated and crucial.

The relation between the external world and the information processing computer may be schematically viewed in terms of four levels.

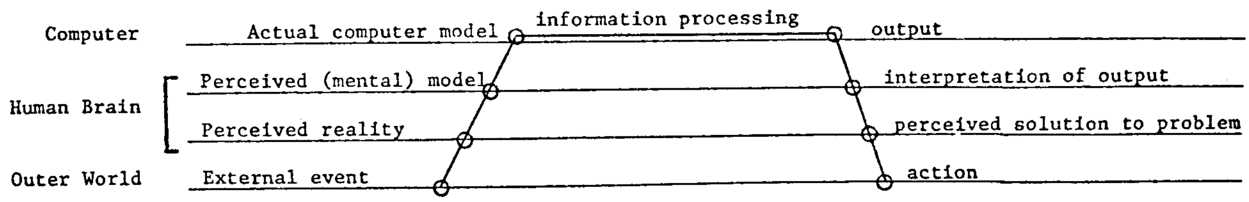


Fig. 1 - The Gap

The human brain abtracts from the external world and the computer is at least another step removed from the external world. The brain perceives the world and develops a model for the computer. What the model actually does may, of course, differ from what the analyst thinks it does. Hence the four levels of Fig. 1.

Now it is a human characteristic to identify a model with reality. We recall the story of the Greek sculptor Pygmalion who created the statue of a beautiful woman. He fell in love with his creation, begged the goddess Aphrodite to give his statue life, and married her when the goddess complied. How frequently does the modeler confuse his computer model with reality! How often does he mistake the computer solution with a solution to the real world problem!

Consider the seductive nature of quantification to the science or technology trained analyst. Automated information processing cries for quantitative input. The temptation to compute gross national product, quality of life, etc., is irresistible. Long after GNP has lost meaning-(8) data processing systems still disgorge GNP calculations. There are even serious attempts to transform ambiguous terms to precise ones so that they may be introduced into information processing systems, e.g., "Fuzzy Set Theory".

The infatuation with automated information processing leads to mindless and excessive application of available models. Increasingly educators and doctors rely on batteries of computerized tests at the expense of personal contact; intelligence groups depend on electronic surveillance and ignore human sources. In a sense the computer creates an artificial reality which is identified with the external world.

Communications technology can have a similar effect.

> "Television also renders diaphanous the division between objective and subjective realities. The switch gives you at one moment "hard" news of earthquakes, murders, and assassination attempts, and, at the next, the doings of federal agents on other star systems. The blend and flow of fantasy and fact is so swift that consciousness loses its sense of absolute determination of what is real and what is imaginal".(9)

The technology permits a simulated world which, in the case of information processing, distorts the physical reality, transforming it into a rational, one-dimensional world far removed from the three-dimensional, only partly rational one.

The dilemma becomes transparent if we consider the three Allison models (Table 2). The models are really three perspectives which are useful in dealing with complex systems that involve human beings, i.e., systems which are not purely technological.

It is obvious that computer modeling and information processing are procedures which fall squarely into the "rational actor" perspective, as does all systems analysis. The user thus has created an "objective" reality consonant with a rational, idealized world.

Table 2

Allison's Three Models

Quasi-technological (rational actor)	Organizational	Individual
Action as a rational choice based on goals/objectives, alternatives, analysis, search for "best" solution	Action as organizational output in framework of of standard operating procedures, parochial priorities, administrative feasibility	Action as political resultant of bargaining, personal interests
Systems analysis, trade-off studies, cost benefit, optimization, computer models	Trade-offs frequently neglected, satisfying rather than maximizing, avoidance of uncertainty, mimimum change, analysis serves as pro forma justification for decisions	Styles of play vary with individuals, relative power and position, fuzziness useful, no documentation, intuition dominant

Source: Adapted by H. Linstone from G. Allison, "Essence of Decision," Little, Brown and Co., Boston, 1971.

While Table 2 illuminates the source of the self-delusion engendered by reliance on "analytic" processes, Table 3 provides some specifics of the idealization reflected in computer assisted modeling.

Table 3

Typical Simplifications in Information Processing

- Quantification of all variables or elimination of non-quantifiable variables.
- "The whole equals the sum of its parts."
- Social/living systems studied by the same tools as scientific/technological systems. The calculus, singularities, optimization methods, and stability domains assumed equally suitable for both types.
- Relationships between elements assumed transitive.
- All relationships assumed pairwise.

Let us examine this assumption in more detail since it clearly exposes the limitations of conventional "analysis."

Consider a system consisting of three elements A, B, and C. The possible couplings are the following (excluding self-impacts such as A on A or BC on BC);

				Example
pairwise:	1 on 1		6	A on B
non-pairwise:				
	2 on 1	9		(AB) on A
	1 on 2	9		A on (BC)
	2 on 2	6		(AB) on (AC)
	1 on 3	3		A on (ABC)
	3 on 1	3		(ABC) on B
	2 on 3	3		(AB) on (ABC)
	3 on 2	3		(ABC) on (BC)
		36	36	
total			42	

There are in addition 7 possible self-impacts. Thus the total number of cross-impacts possible with just 3 elements is 49 and just 9 of them are pairwise. With 10 elements the number rises to over 1 million. (The formula is $(2^n - 1)^2$).

Is it surprising that the usual simplifications fail us in dealing with complex living systems?

The computer cannot deal satisfactorily with the second and third Allison perspectives. It requires a mathematical model, but such formalism is unable to represent the relevant properties of the organizational and individual perspectives. Reliance on the computer thus suggests the analogy to a one-eyed person who cannot perceive depth and sees the world in two dimensions rather three. In our case the situation is worse, the rational actor sees the world in one dimension only.

Ida Hoos provides numerous examples of the ludicrous results when such procedures are applied to defense, health care, education, and other governmental policy questions.(10) It also explains why, according to Mintzberg, the chief executive officer of a company only "pays lip service to systematic long range planning, elaborate tables of organization, and reliance on computers and esoteric quantitative techniques ... (which provide) inflexible guidance systems for unmapped business terrain."(11)

From a biological point of view, the dilemma can be depicted in another way. The neocortex portion of the human brain consists of two hemispheres, each focusing on different modes of thinking. The left has been identified as the "rational," the right as the "intuitive" one. The left half is associated with calculation, reading and writing (both linear activities). The right half handles geometric and spatial concepts, pattern recognition and musical ability. The left half is primarily analytic, the right is holistic in mode of thought.(12) The information processing computer is often seen as an extension or prosthesis of the human brain. We now see that it is more accurately described as an extension of the <u>left neocortex</u>. Consider now Sagan's comments:

> "The coordinated functioning of both cerebral hemispheres is the tool Nature has provided for our survival.(13)
>
> "I think the most significant creative activities of our or any other human culture - legal and ethical systems, art and music, science and technology - were made possible only through the collaborative work of the left and right cerebral hemispheres."(14)

It becomes very apparent that the computer unwittingly imbalances our mental processes by strengthening one of our two complementary modes of thinking. We already know what problems pathological imbalances in the neocortex create. A lesion on the right side leads to the inability of a patient to recognize his own face in a mirror or photograph; impairment of the left hemisphere may cause an inability to speak or write. Correspondingly when chief executive officers of corporations were tested using an electroencephalograph the right hemisphere dominated types clearly prevailed, suggesting the significance of holistic, intuitive thinking in contrast to rational analysis.(15)

We can only speculate on the impact of a computer-created imbalance. The words of Sagan do give us considerable cause for concern about the new realities resulting from this technological prosthesis.

4 Speculations

Automated information processing may have surprising and significant effects on the individual. Following are a few clues.

A. Isolation

We already hear discussion about the ability to provide a person at a remote location an environment which is a surrogate for urban living. Through his terminals he will have access to vast information retrieval resources (e.g., books in the Library of Congress), entertainment (e.g., plays, operas, concerts), education (e.g., videotaped courses with outstanding teachers), shopping, banking, and other activities. We are told that living in a village will be as convenient and interesting as in a metropolis. The individual may be removed from his natural and social environment and still live a life of unprecedented completeness.(16) He will have many more connections than his ancestor since he can instantaneously communicate with others anywhere on earth. However, all such connections are indirect, without physical contact. The individual in this setting may not only become passive; the result may be a diminution of mental and physical capacities. We know that sedentary life style causes the deterioration of muscle tone, posture, and general physical well being, that technologically processed food (refined, chemicals added) often proves to be unhealthy. It should not then be a complete surprise that computer-aided isolation may prove debilitating for human sensory and conceptual (right neocortex) capabilities.(17)

B. Reduced Survivability

Consider the case of the offspring of animals in the wilderness that are captured in their infancy and brought to a modern zoo where they are raised. If after years of zoo environment they are released in their native wilderness area, their survivability may be far below that of their kin raised in the natural setting. A child which at a tender age learns to use a computer may be unable to do manual arithmetic operations.

In the future the person who learns to use the computer well as a prosthesis of his left neocortex may become paralyzed if the prosthesis is removed. He will be less able to survive a breakdown of the technological support system than an individual not as closely tied to it.

C. Regaining the Balance

Perhaps the most intriguing question raised by the imbalance discussed in Section 3 involves the possibility of regaining the balance by developing a prosthesis appropriate to the right neocortex. The computer is now used in pattern recognition, e.g., training the individual to absorb a large amount of diverse data, discover a pattern, and possibly respond by an action. One need only go to today's penny arcade where there is a whole array of computer-driven games replete with electronic displays and joystick controllers. Consider, for example, a space war game. There is a computer driven cathode ray tube with a display of circles of various sizes representing space bodies and triangles representing friendly and hostile vehicles. The player has five buttons to control for turning, shielding, weapon firing, etc. A player's vehicle may be "caught", suddenly go into warp speed and appear seemingly at random at a new location on the screen. The game requires discovery of rather complex patterns. The five buttons force the player to determine their relationships and to coordinate their use with the visual display presented. The more advanced mode of play speeds up the action, requiring a response pattern which is hardly possible with strictly linear, logical thinking.

A more serious example is one involving computer graphics in automobile engine testing. At the end of a manufacturing production line an experienced inspector listens to the engine as it is "revved up" several times. He judges whether the engine sounds normal. The company was interested in automating this testing function. Interviews with the inspector revealed that he was not conscious of how he arrived, with steady success, at his go/no-go judgment.

Consequently the engineers devised a test rig to instrument engines in all the ways they could devise, e.g., microphones, heat sensors, and strain gauges. Data for many engines was recorded. The engines were then stripped down and their mechanical condition documented. There were examples of both "go" and "no-go" engines. The computer graphics facility took the data and formated it in an arbitrary way, generating arbitrary patterns. The investigators were allowed to manipulate these patterns. They studied them in various ways, asked "what if?" questions, and quickly built up their intuitive abilities to relate patterns to known engine properties. In less than one week's time the investigators were able to discover which of the sensors were most useful. As a result a computer algorithm was designed to make the go/no-go decisions on engines coming off the production line.(18) Here the computer clearly serves as a partial prosthesis of the right neocortex.

Johnson already suggested a decade ago that a key to future computer development is the use of multiple channels among which at least one sensor-effector pair are in a common modality. One procedure is to allow the computer to be aware of how and where the individual is looking at the visual information being presented to him; another is the manual or whole-body interface in which the information is conveyed through touch and movement. Such is the communication between mother and child. Multiple sensory modalities (manual-visual, audio-visual) can open up at least a semi-holistic interaction betweeen computer and brain.(19)

Nevertheless, it is still problematic to what extent the computer - or science/technology generally - provides the appropriate instrument as we look for ways to recapture the balance; after all, the successful paradigms underlying science have led to the imbalance.

Possibly religion or a humanistic ideology offer the key. Harman and Peccei have sketched out futures which represent a new humanism.(20),(21)

Today's foremost systems philosopher, West Churchman, writes of Kant:

> "Here is a man who spent his life in what we would call today hard science.... In the 1780's he comes to the realization that something in his life has been left out. For all the complexity which lies on the phenomenal side, there still is another world."(22)

Psychologist David Loye recalls Kant's concept of the "noumena", a reality beyond the perception of our senses, a world we can only intuit and to which we seem to be linked through our unconscious mind in ways difficult to define. In such a world there is, for example, no temporal distinction of past, present, and future. The noumena impacts the intuitive right neocortex strongly, but is only weakly imaged in the left neocortex. The latter so dominates the science/technology trained analyst in his mode of thought that he misinterprets the phenomenal world as the complete reality.(23)

In addressing complex systems problems, Churchman promotes a better balance by advocating the use of a larger set of inquiring systems.(24) He goes beyond the traditional data based, theory based, and data plus theory based to the dialectic and particularly the Singerian inquiring system. The latter "sweeps in" ethical, psychological, social, and any other dimensions which help to shed light on the problem.(25),(26) It recognizes that the individual, the self, is a vital part of the system.(27) In other words, Singer takes holism seriously and shuns any constraints such as left neocortex focused investigative processes.

Our own current work is attempting to create a better balance through the conscious use of all three Allison models in place of the traditional reliance on one, i.e., the "rational actor" (see Table 2). This procedure forces inclusion of right neocortex modes of thinking, even to the point of selecting the members of the problem solving team to balance left dominant and right dominant types of individuals. A feasibility study for the National Science Foundation on the application of the Allison models to technology assessments is just getting underway.(28)

It remains an open question whether either the computer itself, as in pattern recognition, or the use of multiple inquiring systems (or metamodels), can correct the growing imbalance in neocortex based human capacities.

The real challenge in the computer age may well be to attain this balance - to assure the evolution of homo humanus, not merely homo sapiens.

Footnotes and References

(1) The U.S. Congress created an Office of Technology Assessment in 1972, the first agency reporting directly to the Congress since formation of the General Accounting Office.

(2) Energy is the most critical resource. Virtually all materials in short supply permit substitution by materials in ample supply. See H.E. Goeller and A.M. Weinberg, "The Age of Substitutability," Science, 191, pp. 683-689, (Feb. 20, 1976).

(3) Sagan, C., The Dragons of Eden, Ballantine Books, New York, 1977, p. 223.

(4) Ibid, p. 25.

(5) Hiltz, S.R., and Turoff, M., The Network Nation, Addison-Wesley Pub. Co., Reading, Mass., 1978, p. 12.

(6) West Germany's INPOL combines a central person index, fingerprint identification, a criminal activity data base, a documentation directory, and a "persons-institutions-objects-things" data bank into an electronic person-tracking system of awesome effectiveness (Der Spiegel, May 7, 1979, p. 40).

(7) Hiltz, S.R., and Turoff, M., Op. cit., p. 429.

(8) The GNP overstates advances in national welfare by including social costs as "product", treats education as expenditures rather than investment in society's knowledge stock, and considers automobile crashes as contributors to the GNP. The concept has some meaning for an industrial society, but appears deeply flawed for a pre- or post-industrial society.

(9) Houston, J., "Prometheus Rebound: An Inquiry into Technological Growth and Psychological Change", Technological Forecasting and Social Change, vol. 9, pp. 241-258, (1976).

Also recall Paddy Chayefsky's motion picture "Network" in which the desperate television commentator rants: "It's you people that are mad. You are beginning to think that the tube is reality and you people are unreal".

(10) Hoos, Ida R., Systems Analysis in Public Policy: A Critique, University of California Press, Berkeley, 1972.

(11) Rowan, R., "Those Business Hunches Are More Than Blind Faith," Fortune, April 23, 1979, p. 112.

(12) The integrating function is thought to reside in the forebrain. Cf. D. Loye, "The Knowable Future", Wiley-Interscience, New York, 1978, pp. 140-142.

(13) Sagan, C., op. cit., p. 248.

(14) Sagan, C., op. cit., p. 195.

(15) Rowan, R., op. cit.

(16) Pawley, M., The Private Future, Random House, New York, 1974, p. 8.

(17) Houston, J., op. cit., p. 252.

(18) The author is indebted to Professor George G. Lendaris for these pattern recognition examples.

(19) Johnson, A., "Information Tools that Decision-Makers Can Really Talk With", Innovation, No. 10, 1970.

Johnson, A., "Organization, Perception, and Control in Living Systems", Industrial Management Review, Winter, 1969.

(20) Harman, W., An Incomplete Guide to the Future, San Francisco Book Co., San Francisco, 1976, p. 48.

(21) Peccei, A., The Human Quality, Pergamon Press, Oxford, 1977, Chapter 7.

(22) Churchman, C.W., "A Philosophy for Complexity", in H.A. Linstone and W.H.C. Simmonds (eds.), Futures Research: New Directions, Addison-Wesley Pub. Co., Reading, Mass., 1977, p. 88.

(23) Loye, D., "The Knowable Future", Wiley-Interscience, 1978, p. 137.

(24) We emphasize that we are not referring here to multiple computer models, but rather multiple problem solving philosophies.

(25) Mitroff, I.I., and M. Turoff, "Philosophical and Methodological Foundations of Delphi", in H. Linstone and M. Turoff (eds.), The Delphi Method, Addison-Wesley, Reading, Mass., 1975, pp. 17-36.

(26) Churchman, C.W., "The Design of Inquiring Systems", Basic Books, Inc., New York, 1971.

(27) Churchman reminds us that Hegel defined the mature individual as one who can hold conflicting Weltanschauungen, particularly the objective global and subjective individual, simultaneously and be enriched thereby. (C.W. Churchman, "A Philosophy for Complexity", in H. Linstone and W.H.C. Simmonds, Futures Research: New Directions, Addison-Wesley, Reading, Mass., 1977, p. 90.

(28) H. Linstone, Principal Investigator, Futures Research Institute, Portland State University, P.O. Box 751, Portland, Oregon 97207.

EFFECTS OF AUTOMATED DATA PROCESSING ON HOME AND FAMILY ACTIVITIES

Murray Eden

The effects of automated information processing on activities in the home and on familial behavior can be considered under three headings; 1) personal autonomy in business activities, 2) centralization and decentralization of information stores, 3) influence on modes of cognitive activity.

1) Many activities which formerly necessitated face-to-face exchange of information can now be carried out remotely. It is likely that the first effect will be the further development of new modes for providing personal services: a new kind of cottage industry. For example, computer programmers, typists, copy editors, writers, travel agents, real estate agents, stock brokers, architects, and commercial artists will be able to work at home, communicating with clients and with central stores of information by means of terminals at their desks. Any personal service that involves primarily the exchange of information rather than material objects is a candidate for this change in service modality. It is likely to be quite advantageous financially and convenient. It will decrease costs of transportation for both worker and client, and decrease space requirements in central offices. One can imagine a tax accountant working at home who receives personal financial data from the client's home data store. The accountant can communicate, once he has the client's password, console-to-console and finally when the work is complete can control the client's hard copier to print out the completed tax form in his home.

Aside from economic efficiencies, a significant attraction is the increase in freedom for both client and purveyor, but especially for the latter, to decide when and how to work. Of course, there are now a new set of constraints. The format for information exchange is not as free ranging as conversation tete-a-tete. There is little room for nuance in meaning. The issue of confidentiality is a serious one. The technology is certainly available to ensure confidentiality, but it remains.to be seen whether costs or governmental interests will inhibit or forbid the introduction of powerful secrecy procedures.

Another implication is that other family members may participate so that the service becomes a family occupation. It is a common experience of computer professionals who have terminals in their homes that their children will, if permitted, quickly learn to make use of the new tool.

Family health practices may be substantially altered. Microprocessor devices may enable some services traditionally performed in hospitals to be performed at home. Such devices may also enable certain procedures to be carrried out by the patients themselves. Computer aids, for example, in teaching patients about the possible effects of a drug he has been prescribed, should further demystify and routinize some aspects of medicine permitting family members to take personal charge of more of their health care problems

2) Inevitably, automated data processing will mean that a great deal more information will be available through the home terminal: telephone directories anywhere in the world, merchandise catalogs of all sorts, stock market listings, weather reports, bibliographies, encyclopedias, even maps and photographic archives. The collecting of the original information store is costly. Data transmission systems are expensive to establish and maintain. Clearly, the great preponderance of data stores will be managed by relatively large firms or by governments. Communication will be through large networks with carefully controlled access. It is quite unlikely that the efficiencies and cost considerations of the data distributors will necessarily match the behavioral style of the home user. Because so much information will be available, great efforts will be made to sort out relevant data only. The central facility can be expected to do the bulk of the sorting. The individual would be inundated if he were to ask a careless question. On the other hand, consider an activity like browsing in a library. It is a pleasant and - for humans - a surprisingly efficient way to window large information stores for useful bits. It is difficult to see how this can be accomplished in an economical way with current automated systems.

3) Computer capability in the home may shape behavior in ways that counter certain influences of television. Many have commented that watching television is a passive process. A computer terminal on the other hand requires extensive interaction. This can be seen in so-called computer games. Some of the games require development of skills in hand-eye coordination, others require pattern recognition skills; a relatively few require conscious reasoning. Neverteless, each game, whether a game of man versus machine or man versus man, requires alertness. Active participation whether it be cooperative or competitive is intrinsic in the process. It is also worth pointing out that all the skills alluded to above have a common component; they involve the manipulation of symbols. This is a peculiarly human skill that plays a very important and pervasive role in modern life. A large fraction of the time spent in formal education is devoted to acquiring skills in symbol manipulation. It remains to be seen what role automated information processing systems will play in education in the home. The potential is present, but modern Western society has not been very successful in fostering educational processes isolated from social controls such as examinations, grades, instructors, etc.

WORKERS' PARTICIPATION IN SYSTEM DEVELOPMENT

Kristen Nygaard

1 Introduction

In a recent CREST-sponsored course on "Information Systems, Organizational Choice and Social Values" in Pisa (9-20 April 1979), I presented a lecture on "Tasks, Roles and Interests of Information System Specialists in the 1980's". In that lecture, I tried to see the problems from the point of view of the professional system specialists. My affiliations are the Norwegian Computing Center and the University of Oslo, in terms of employment. In this lecture, however, my perspective is given by my membership in the Norwegian Union of Employees in Civil Services and my function as adviser to a number of other trade unions.

The public debate on the social impact of information technology has been suprisingly narrow in scope. Starting in the mid-1960's, the first main issue was "privacy" or "personal integrity" - centered around the possible dangers of compiling to much information about individuals in large computer based data banks.

The second main issue, comping up over the last one and a half year, is "employment effects of microelectronics". This subject is now the main point of innumerable conferences, seminars, projects, etc. in the industrialized countries. It has, however, been quite difficult during the 1970's to induce a wider audience of professionals as well as non-professlionals to take an interest in the broader aspects of the social effects of information technology. In OECD, e.g., repeated and insistent proposals during the last decade for a survey of ongoing studies in this area have, till recently, resulted in verbal support only and no actions. Now this situation is changing, and I hope and believe that this conference will be an important contribution to a fuller understanding of the far-reaching consequence we are facing.

This lecture deals with one set of issues only, namely those which are of immediate interest to the trade unions' in the working life.

2 The Activities of the Scandinavian Trade Unions

In 1967, the central school of the Norwegian Federation of Trade Unions (here for short named the Norwegian TUC for "Norwegian Trade Union Congress") started to include lectures on computers in their courses. It was soon realized that the computer and the new systems for planning, control and data processing would strongly influence a number of aspects of the workers' situation and job environment.

It become evident that the unions had to try to get as strong influence as possible on the design and use of these new systems. The obvious first step was to build up insight about the new technology within the unions. But it was also gradually understood that we would risk brainwashing ourselves if we started by trying to assimilate existing knowledge, produced to serve the needs of system specialists and managers.

At the time in 1967-70, those engaged in these discussions (shop stewards, ordinary union members, one scientist) did not know any studies of the effects of computers seen from the point of view of the workers' interests. Most material on such effects was very general and mainly speculations in scattered papers and books.

In 1971, the Norwegian Union of Iron and Metal Workers (for short the "Iron and Metal Workers") received public funding for a research project to study planning, control and data processing, evaluated from the point of view of the workers. The Norwegian Computing Center (NCC) was asked to provide research staff.

The NCC is a governmental research institute which both takes on jobs for customers (private enterprises, public institutions) and does basic research. The "Iron and Metal Project" was NCC's first trade union customer. The project is described in an earlier paper by the author ("The Iron and Metal Project - Trade Union Participation" which was presented at the CREST course on "Management Information Systems" in Stafford, July 11-22, 1977) and in a paper by Olav Terje Bergo and the author ("The Trade Unions - New Users of Research", Personnel Review, vol. 2, no. 2, 1975).""

Since then trade union sponsored research has continued and a number of projects are now completed or being conducted - with NCC or other research institutions as partners. In addition we have projects co-sponsored by unions and employers. Many of these projects are following the tradition of socio-technical studies which is not discussed in this paper.

Trade union research along lines similar to those of the "Iron and Metal Project" has for some years been going on in Sweden (the DEMOS Project, from 1975) and in Denmark (the DUE Project, from 1977). Trade Unions in many other countries are now becoming interested. Even if traditions, organizational structure and political setting varies from country to country, still I believe that many aspects of the experience and insight gained in Scandinavia are relevant for the unions in these other countries.

3 Results and Experiences

The "Iron and Metal Project" started with a rather traditional research strategy: The researchers should study existing planning and control systems in the job shop industry, discuss with union members in four local "clubs" (unions at company level), conduct an opinion survey on the attitudes on opinions among union members. The conclusions should be contained in research reports and give evaluations of existing systems and state desirablle properties of systems to be developed.

It was realized, however, that this approach would not provide local shop stewards and members with a link between their action possibilities and the insight gained by research. Also, the situation varies very much from company to company, and very many different kinds of systems have to be considered. For this reason it was not sufficient to get a few researchers who knew something "on behalf of" the workers. Local insight was necessary. Finaly, the opinion surveys were dropped since useful answers assume that the issues have been subject of an enlightened discussion and in a setting where those questioned believe that their answers may have an effect.

A new research strategy was developed during the autumn of 1971 and followed during the remainder of the project period, till August 1973. A crucial element was the definition of the term "result". Instead of referring to the reports written by research workers, it was stated that:

> "as a result of the project we will understand actions carried out by the Iron and Metal Workers´ Union, centrally or locally, as a part of or initiated by the project".

The effect was that the four local union clubs became very important in the project. Each of the unions established working groups, consisting of shop stewards and ordinary shop floor members, with the scientists acting as their consultants. The outcome of this activity was four reports, two of which are published as books. Another result was the development of a textbook: "Planning, Control and Data Processing: Basic Reader for the Unions" and an associated course.

Today many such joint reports from worker/scientist teams have been written, covering a wide area of the working life, e.g. supermarkets, distribution organizations, hospitals, newspapers, aluminium plants, shipyards. Additional tutorial material has been produced, and a large number of one-week courses have been given over the years. Also shorter versions are incorporated in introductory courses. The above-mentioned textbook will, according to present plans, be updated and translated to other languages in the near future.

The trade union activities also have resulted in the Data Agreements. The first national Data Agreement was signed by the Norwegian TUC and the Employers´ Confederation in the spring of 1975. Since then other agreements have followed, and most working places with organized labour now are covered by such agreements. In the Norwegian "Act Relating to Worker Protection and Working Environment" of 1977, specific points relate to workers´ participation in system development (paragraph 12.3).

In addition to the provisions of the Data Agreement and the Working Environment Act, we also have in Norway an institutionalized "industrial democracy" in terms of elected employee representatives on the company boards and company assemblies (one third of the seats).

Our experience is that it is not sufficient for the unions to formulate demands in terms of system properties only. The unions have to be involved in the system development process in all its stages (but not in e.g. details of programming). For this reason a number of union demands relate to the properties of system development process.

It is a tendency to regard system development as only consisting of projects which are set up, carried out and finished. Obviously the projects are important, but system development is today an ongoing process, in which projects only represent particularly active and formally organized stages. For unions, participation in discussions before the organized "initial stage" within a project may be crucial. Also, it is highly desirable that systems are designed so that it is easy to modify them during their operational life.

The Data Agreement focuses upon the development process properties, whereas the Working Environment Act to a larger extent discuses system properties. The Act functions usefully as a legal backing for demands, whereas the Data Agreement are the everyday tool of the Data Shop Stewards. (Such specialized shop stewards may be elected according to the Agreement, and their number is rapidly increasing.) The legal framework of the industrial democracy has not yet to any extent been used in matters relating to systems. One possible use of these institutions is to put pressure upon management to provide improved long range planning within the companies. But it may safely be said that most results relating to those issues we are discussing here, are achieved by extending the normal procedures for negotiation and bargaining to also apply to system development.

In the Stafford CREST course paper, it is stated that unions in other countries of course must find their own way, starting from today's realities: "However, the author believes that it is possible to state a number of points which ought to be valid in most West European trade unions".

The first point is that trade union participation is not a state which suddenly exists as a result of some event. Trade union participation has to be won by a slow, difficult and unending prodess. The creation and desirable characteristics of such a self-reinforcing process is what the unions should be concerned about.

The second point is that trade union participation implies a major extension or change in union policy. When the process starts it cannot and will not be confined to what managers and/or system workers consider "useful", "justified" or "non-political".

The third point is that trade union participation cannot safely be built upon centralized activities within the unions or by relying upon hired "specialists". It must build upon a broad understanding and activity among its members and shop stewards at the floor, but coordinated with central understaning, support and action towards central authorities.

The fourth point is that trade unions should not start their education in this area by acquiring the current knowledge and understanding of data processing of the system workers or the managers. Then they will be trapped. Instead they must start by building up their own basic understanding in terms related to their job situation and the trade unions' picture of the world. Later on in the process existing knowledge may be integrated into the framework they initially establish.

The fifth point is that the trade unions will experience a great number of defeats in this process, even when their formal rights become granted. They may sometimes be easy to fool and manipulate, but only for a while. They may at other times be irritatingly unreasonable in the opinions of managers and system workers.

They may experience serious problems within their own ranks. They will have to start by emphasizing a defensive strategy, but will gradually become constructive.

The sixth point is that the extent and nature of trade union participation will also be dependent upon the major trends and events in our western economy and production technology.

The seventh and final point is that the situation of the system workers will change drastically, well within the working life of most people active in the field today. The system workers will only in some extent be able to influence the major characteristics of the development, even if they are important actors in what is going to happen. They will get a less frustrating future if they start taking the word "participation" seriously.

4 Other activities

The employers' organizations in Norway have been rather active in this field since it became apparent that the union activities would create a different environment for system development. In the negotiations about the Data Agreement the employers did not start from a negative attitude, being forced to give in. There were active, and even if they did not want to give away too much power, they regarded workers' participation within certain limits as useful for a development towards a strategy of "management by objectives". (The objectives at higher levels of course being set by management.)

At the Universities there are now a number of places where (starting in Oslo in 1974) courses in "Social Implications of Data Processing" are given regularly. Also (starting in Aarhus, Denmark) master students are writing theses which are the outcome of cooperation with unions.

If the social aspects and system development methods (in the new setting of many interest groups being involved) are going to be safely and realistically established as parts of informatics, it has to be integrated in the career pattens of academic institutions. This implies that elements of these parts of informatics must be taught at undergraduate and graduate levels, that they are the subject of masters´ and doctors´ theses, and that they are the basis for employment and tenure in academic positions.

5 Concluding Remarks

The limited time allowed for lectures at this conference makes it necessary to state only headlines, leaving out detailed discussion.

The decade 1980-1990 will bring about important changes in the tasks and the environment of information system design, implementation and operation. The general development in our societies, in particular the employment situation, will provide the framework. For unions, it is now necessary to broaden the scope of their engagement from the employment aspects to the wider issues of job content and structures, social contacts and power relationships. A safer, more stable development of the working life requires that we at the same time consider number of jobs and content of jobs.

THE RIGHT OF IGNORANCE

Yoichiro P Murakami

The effects of the development of automated information processing on the individual can be discussed from various viewpoints. Here, I wish to restrict myself to deal with only one thing.

It goes without saying that the development of automated information processing saves us much of energy, money and time to get almost all, if there were no controlling mechanism, of information we want to know, without moving for ourselves. This sometimes has a negative influence on us that our positive intention and capability to search for needed information by ourselves might be impeded or reduced in such a situation.

But the most significant problem raised by it is, I think, what can be called "the right of ignorance", or more correctly "the right to remain ignorant". For example, consider a man who has some subjective symptoms. He consults the Medical Care Information Center and gets a series of stored information, which contains the fatal diagnosis of his disease. That might be by no means what he wanted to know. Of course, in this simple, imaginary case, it might be rather easy to control to what extent the patient should get the stored information. But in daily life there would be many a case in which it is quite difficult to decide the domain of information accessibility on user's side.

In principle, particularly in democratic society, the information accessibility must be guaranteed as fas as possible. At the same time, however, "how far" would be a serious problem, due to the development of automated information processing, not only from the side of its political establishment but also from the side of those who are involved in that establishment.

INTRODUCTION TO THE DISCUSSION OF PRIMARY AND ADULT (LIFE LONG) EDUCATION

Henri Tajfel

When I was invited to participate in this symposium, my first reaction was to write to the organizers that - as distinct from some of the themes of last year's symposium in Paris - I knew nothing about automated information processing, and did not see how I could, in this state of painful ignorance, contribute anything useful to the discussions. Today's chairman, Professor Torgny Segerstedt, then wrote to me that one of the aims of our debates would be to "analyze the impact of technical innovation on the daily life of man" and that this was a social psychological problem which "must be discussed from that point of view, and not just exclusively from a technical point of view".

I entirely agree with him, but my qualms remain. The value - and the gain to me - of the Honda Foundation initiatives has been until now the opportunity they offered of listening to exchange of viewpoints about some of the fundamental issues of our times which went far beyond the usual scratching-of-the-surface exercises that have become familiar from our media. They managed at the same time to synthesize widely disparate perspectives from a variety of disciplines. But a useful synthesis must be based on some acquaintance with all the aspects of what is being synthesized. As this is by no means a task which I would be capable of undertaking today, this introduction to a discussion about the impact of automated information processing on education can consist of no more than questions, which are as naive as they are genuine, to those who have spent their professional lives in developing one of the most miraculous advances of human technology.

In doing this, I shall use not one but several mottoes. One of them consists of the quotation above from the letter of Professor Segerstedt. I found others in some of the summaries of the lectures which were distributed to us in advance of the symposium:

> "Very generally, the computer can be used for higher flexibility or for stronger reglementation; it can educate to increased imagination or to hostility against exceptions. It is a tool in our hands." (Professor Heinz Zemanek)

The three remaining quotations all come from the summary of the lecture by Professor Harold Lindstone:

> "...the computer creates an artificial reality which is identified with the external world. Communications technology can have a similar effect; it permits a simulated world which, in the case of information processing, distorts the physical reality, transforming it into a rational , one-dimensional "analytic" world far removed from the three-dimensional, only partly rational one."

"The information processing computer is often seen as an extension or prosthesis of the human brain. We now see that it is more accurately described as an extension of the left neocortex. It becomes very apparent that the computer unwittingly imbalances our mental processes by strengthening one of our two complementary modes of thinking."

"The inner world is as immense as the outer one - and as important. The challenge in the computer age is to extend human capacity and not unbalance it, to facilitate the evolution of homo humanus and not impede it."

I should like to stay for a while with Harold Lindstone's homo humanus. In his lecture about the societal implications of AIP, Professor Klaus Lenk pointed to the immense benefits that it can have in creating more rational bureaucratization and informatization of decision-making in our increasingly large, interdependent and unwieldy social structures. But he was also keenly aware of the fact that, for example, and increasingly accurate andd instantaneous prediction of public wishes andd reactions can be turned to the benefit of those who control the means of prediction and the selection of what is to be predicted. The long-term aims of the predictors are likely to determine this selection. There already exists today a crude parallel of this kind of process in the present proliferation of the advertising industry which is based on the principle of attempting to make the public wish what the advertisers wish it to wish. In a curious sense, this can also be part of education: one of the results is the creation of new needs, attitudes and sometimes even new skills.

And this is for me the nub of my questions to the specialists. Advertising must be aimed at the homo ordinarius, or rather a variety of categories of such a homo, since otherwise it would miss its main purpose. The cultural evolution of homo humanus - through education or any other means - must also be concerned with the millions of adults and children who, by definition, are not endowed with superior intellectual powers. How do we increase their potential, or at least actualize it? Can this be done through Harold Lindstone's extension of the left neocortex which could perhaps be achieved by the massive use of AIP becoming as widespread (at least in the industrial societies) as is today the telephone and the television set?

There are some reasons to doubt it, and I very much hope that today's discussion will assuage my doubts. In recent years, we have learned a good deal about the social dimension of the development of cognitive skills sometimes referred to as "intelligence". What I mean by this is a conjunction of two generalized empirical statements, one of which is by no means new, and the other is only now beginning to make its impact. The first is that the achievement of increasingly complex intellectual operations (such as, for example, in the case of the young child, the ability to understand that two receptacles of different length and width can contain the same amount of liquid) can be defined in terms of the ability to "decentrate" the nature of the here-and-now sensory information which is being received. The second is more directly relevant to our today's preoccupations. We now have evidence that certain forms of social interaction, which help the child to take a perspective other than his or her own on what is happening out there, are a powerful ingredient of the development of abilities of this kind, and just possibly - if I may also make a projection into the future - one of the most efficient ways of achieving a large variety of basic "decentrations".

Rather than proceeding with generalities, I should like to mention some of the results recently obtained in a series of studies by a young researcher from Geneva, Anne-Nelly Perret-Clermont. The research has since been replicated by other people. It has been found in a number of experiments that bringing together two or three children, some of which have and some have not achieved the "conservation" stage in understanding the equivalence of volume, number, etc. despite the variations in the way things "look", and asking the children to agree upon what were or were not equivalent quantities, led to a number of results: (i) the non-conservers learned to manipulate the invariances; (ii) control studies showed that this learning could not be attributed either to imitation or to conformity; (iii) a larger proportion of children achieved a higher stage, generalized it to their "operations", and showed the benefits of it all in later post tests than has been the case until now in interactions with adults or through the use of other methods. The basic condition of these achievements seems to lie in cognitive or perceptual conflict of perspectives arising in social interactions of a special kind, i.e. social interactions with other children or "peers". There is still a lot to learn about the detailed fabric of the conditions for these achievements. But what appears to be fairly well established is that the dimension of social interaction of a certain kind resulting in conflict of cognitive perspectives at a certain common social level may well turn out to be one of the more powerful tools we have at our disposal for achieving developmental results that have not been previously achieved.

I am concerned here with the average child and the tools we have, or may have, at our disposal to help him or her to go ahead, to achieve what they can achieve. It looks as if instruction is not enough, and that the results of instruction with feedback powerfully depend upon the social characteristics of the source of the feedback. Are we dealing here with those aspects of cognitive development to which Harold Lindstone would perhaps refer as depending upon the right neocortex? The evolution of homo humanus may benefit enormously from the development of a few super-intelligences. But is it not possible that this might well happen at the expense of the development of average human capacity? Our resources are limited and may well become more so. The amount of help and support devoted to the kind of work I have just described are grotesquely minute as compared with the the resources available to the AIP. The reasons for this are easily understood in terms of economics. Should we perhaps ask in the future one of the new super-intelligences what it thinks of the priorities we should select in terms of long-term goals relevant to the development of the "ordinary" human individual?

My second question has to do with adult (life-long or continuing) education. Once again, I should like to start from a piece of research and, uncautiously, generalize from there. Some ten years ago we conducted a series of experiments in my Department which led to rather dismaying results. In conditions of complete anonymity, we divided a number of people into two groups on the most trivial criteria we could find. As a matter of fact, in one of the studies the division was made explicitly on the basis of a tossing of a coin. Subsequently, each member of the groups was allowed to divide on specially constructed "matrices" amounts of money between an anonymous member of his own group and an anonymous member of the other group. The matrices were so constructed that it was possible for us to establish the relative importance of the various possible "strategies" for the division of spoils. It turned out that one of the predominant strategies was to achieve a positive difference in favour of members of one's own group, even if this meant sacrificing the absolute amounts that could be obtained. Subsequently, one of my colleagues who spent several months in a large factory, got to know well the shop-stewards of three unions which were involved (and between which there existed differences of prestige), explained to them the purposes of the research, conducted a number of interviews, and presented them with sets of "matrices" on which they could decide their preference for the relative levels of wages of the three groups involved. The results of the innocuous laboratory experiments were confirmed: in many cases, the achievement or preservation of differentials was one of the most important "strategies", again at the expense of moderate gains in absolute terms. The results of these studies have since been replicated dozens of times, with groups of various ages, in various countries, both "in the field" and in the psychological laboratories.

Differentials are a complicated matter. There is no doubt that their "objective" economic concomitants are immensely important. There is also, however, no doubt from a number of studies we and others have conducted since the early seventies that they have a great deal to do with those aspects of the individuals' self-respect which derive from their membership of various groups. The principal building blocks of this self-respect originate from comparisons made with other relevant social groups. The valued aspects of "social identity" - i.e. those aspects of individuals' self-image which derive from their important social affiliations - are almost entirely a matter of comparisons and relativities. This could hardly be otherwise in any complex multi-group social system.

The gigantic strides in the future developments of AIP, to which many of the speakers in this symposium are referring, are quite obviously bound to bring with them a number of drastic and as yet unfathomable social changes. One of them is likely to be a large increase in the amount of time available for leisure, and - not unconnected with it - the possible increase in long term unemployment. I am not very sure about the unemployment since it is possible that the new technologies will also create the demand for new skills and new jobs. But an increased and protracted unemployment is at least a serious possibility which must be taken into account at the same time as we take into account the future developments in the scope and quality of AIP.

Let me now return to social comparisons and their role in the self respect of people who belong to various social groups and social categories. As I said, increased unemployment may become one of the consequences of the developments we are discussing here. There are not that many studies of the socio-psychological aspects of long unemployment. But whatever we do have as evidence points towards a general loss of self-respect, and with it a loss in the willigness to take new initiatives, to take advantage of many of the creative opportunities which may be offered. The first classic study of these aspects of unemployment was conducted in Marienthal in Austria in the early 'thirties by Jahoda, Lazarsfeld and Zeisel. In addition to the obvious consequences on the standard of living, health, etc., Jahoda and her colleagues also found a decline of interest in social life and social organization of the community, even when these were not related to any additional expenditure; for example, visiting friends, going for walks, borrowing in the local library although there was no charge, membership in political organizations, loss of readership of the cheaper but more serious newspaper as compared with the more expensive and more trivial one, etc. As Professor Jahoda repeated in 1979, employment helps to meet at least five enduring non-material needs: it imposes a time structure on the day; it broadens the range of social contacts outside the family; it provides additional goals and purposes; it helps to define one's place in the society and the community; and it enforces inactivity. Some of the studies conducted in Britain and elsewhere in the late seventies confirm the Marienthal findings of 1933.

One way to summarize these findings is to say that the individuals involved lose the definition of their own place in the network of social relationships and categories and, with it, lose the kind of social comparisons with others the outcome of which contributes to self-respect, to the feeling of one's own dignity and integrity. At this point, it becomes quite irrelevant to know that we may have at our disposal new and quite superb tools for learning of new skills or for the widening of one's cultural experiences. The tools may be there and remain unused by those who need them most, as was the library in Marenthal. The questions therefore are: new forms of adult education through the AIP, but for whom? And who may wish or not wish to use them? Perhaps it may be appropriate to conclude on yet another longish question in the form of hypothesis: if technological anvances created by the developments of AIP do bring about greater and longer unemployment, is it possible that we shall have a number of people (I don't know what proportions of the population would be involved) who will take splendid advantage of the new and miraculous opportunities which will be offered; and that we shall have other people (I don't know how many) who will lose their social definition and, with it, much of the willingness to take advantage of whatever may be available? Is it therefore not possible that, paradoxically, the miraculous improvements in our intellectual output will contribute to create a new and deep dichotomy between those who can use them and an army of helots who can't and don't want to? And finally: if it is possible that the AIP may have these spin-off effects in the future, is it not the responsibility of those who contribute to its development to think about these contingencies now?

SOME EFFECTS OF THE DEVELOPMENT WITHIN AUTOMATED INFORMATION PROCESSING UPON (LIFELONG) EDUCATION

Zvonimir Damjanovic

The block of computers /plus/ telecommunication is likely to exert enormous effect upon co-operative human activities, multiplying them, and - particularly - drawing the education out of the traditional workshop/school/. This means a major social change; as the first industrial revolution diminished numbers of labourers engaged in dull physical efforts, so the new development promises to enlarge significantly numbers of students. Taken together with another effect - a decrement of working time - it also means creation of a sound basis on which new generations would overgrow the division into /small/ intellectual elites and masses of workers. Hopefully, existing cultural gradients between /technically/ developed and under-developed, rich and poor nations, will also be radically reduced.

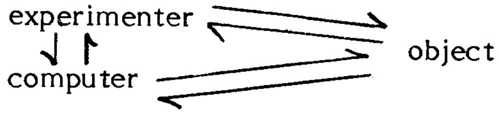
But - computerization meaning, chiefly, abstraction from the physical, in the sense of "computing" - one could ask whether this transfer from laboratories and lecture rooms to educational mass-media can be integral at all. I have in mind the practical difference between so-called experimental science, at one, and theoretical instruction at the other side, which could be traced also in the activities of British open university, where education dependent on Praktikum, such as medicine, and many important sectors of natural science and technology, remain rudimentary, or are absent. Laboratory practice, experimenting, construction testing etc. seem to remain within the realm of classical workshop, with - of course - limited admission, and heavy limitations to the access to materials, instruments, and practice leaders.

It is, therefore, of utmost interest to look closely at the development, and possible development, of computer use in experimental research, particularly in the role of simulation medium - which is a trend promising to multiply and broaden /distribute/ practical, experimental procedures in education.

The history of experimental research begins with a couple:

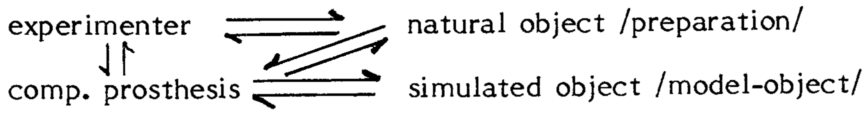
experimenter ⇄ object

where the object could be an animal, or physiological preparation. The next level is a game of three:



where the computer appears in two roles - as an extension of monitoring, or more exactly: in the role of peripheral prosthesis, covering monitoring and motor control, and as a mental prosthesis of the experimenter.

Much has been said about the change the introduction of computer /at this stage/ has caused in experimental procedures. But, another basic change appears at the next level, which offers an experiment a game of four:



It should be mentioned that, in fact, in natural science, as well as in other special disciplines, the real object is always just a model, some idea of the "typical", "standard" etc., representing a population of real things. The classical experiment with "the real thing" has a meaning of testing the behavior of "the typical" i.e. the model, where an experimental preparation, in a sense represents that model. Simulated object, on the other hand, can be arranged at any level of abstraction, and it's introduction does not only mean economy in time, and replacement of an expensive /or awkward/ object, but a possibility to deal with the typical, with the basic object /the model/ directly!

The above-said should be taken as an appeal to pay attention, to support and promote the thin stream of simulation of experiments, which is developing in some laboratories and schools, as something that will help the development of mass, open-type education, also in the experimental part of the process. This would mean significant emancipation of some very important sections of education, such as natural sciences, technology etc.

EFFECTS OF INFORMATION PROCESSING ON EDUCATION "MISSION ORIENTED OR FIELD ORIENTED"

Richard I Emori

Today, man can easily retrieve information almost by pushing buttons. Even if he does not look for information, information pours on us without a choice of rejection from our side. Then we have to learn a technique how to discriminate unnecessary information and to sort out essentials from non-essentials. As a result of this flood of information, the relative amount of physically obtained information decreases continuously which plays an important role in solving real world problems.

The majority of real world problems we face with today are inter-disciplinary in nature, and the amount of related information increases explosively. Then the thing we have to do at the outset is to place grades of importance to the vast amount of information of multi-disciplinary fields. The criterion of placing the grades depends on the objective of the project, and once we selected a proper combination of essential information, it can be said that the problem is half-way solved.

If an educational system is to established to generate manpower to challenge real world problems, the curriculum must be basically "mission oriented" rather than "field oriented". About 1965, in University of California at Los Angeles, all the departments in School of Engineering were once decomposed and only one unified engineering department was established. The objective of the unification is, of course, to establish a mission oriented educational system. Apparently this was a little too far reaching at the time. Few years later, the school settled down with several departments again. To retain the original idea, the new departments were mission oriented in character, such as Departments of Large Scale Systems, Material Sciences, Computer Sciences, etc. rather than classical departments as Mechanical, Civil, Electrical, and so on.

Presently, most universities are organized as field oriented and their educational efforts are centered around deductive processes. Including information processes, they have been emphazing the rigor and the sophistication. If the process is presented to us as a form of black-box, we can only feed inputs and wait until the output comes out. The more sophisticated is the mathematical model of the black-box, the more difficult the understanding the ingredient of the black-box becomes. Very often, there is no way to confirm the true intention of the programmer of the mathematical model. Hence, we are either forced to believe the result with a vague hope that our interpretation on the transformation process of the black-box coinsides with that of the programmer, or refuse the use of the model all together. After all, a true information is hardly transferable, if not impossible.

Should we expect the education to be effective to solve real world problems, inductive inference must be equally stressed parallel with the deductive processes and the simplification must be emphasized rather than sophistication.

My proposed reformation of existing educational systems is to retain the undergraduate curriculum as "field oriented" and to introduce real world projects to graduate studies to make it as "project oriented". This will be a compromise with a least transient perturbation. Education is a life long work for an individual . The education in school is essentially a passive work and the postschool education must be an active work. Unless the balance of physically and mentally obtained information is not maintained, the human intuition will be lost which is a remarkable and unreplaceable ability given to the man by the nature. It seems that the education is to learn the art of discriminating non-essential masses of information and to preserve our intuition, a tremendous automated information processing system.

EDUCATION AND GROUP INVOLVEMENT IN COMPUTING TECHNOLOGY

Harold W. Lawson, Jr.

The wide ranging impacts of computing technology cannot continue in the future without control. Various groups that are affected by the technology will undoubtedly revolt. In Norway, the labor unions have taken a hard line in the question of the application of computing technology by obtaining legislation which in effect states the following: "Computer based systems cannot be installed in an organizations operations unless the system can be explained to the employees in terms that they can understand".

This is a difficult goal to meet with our current complex computer systems. It is a warning, a challenge and an opportunity to we computer architects to react and create computer systems, documentation and development and educational tools that are easy for both experts and laymen to understand. Far far easier than todays systems. It requires a breakthrough for which some possible directions given in these comments.

The variety technical languages used by various types of specialists is a definate deterent to understanding and this aspect is nicely summarized in the quote of McKeeman given in Figure 1.

As Professor Zemanek stated in his keynote address, technical languages are an extremely important part of the computer environment. Pictures instead of notation provide one of the worlds oldest language forms for communication. Further, it is hypothesized here that pictures for the processes, systems and the logic as the primary means of human/machine communication are for better than the typical "encoded" communications used today.

Further, that they can provide the desired simplifications to the technology. Through graphical techniques one is able to improve "visability" into computer systems. We architects should design the machines so that they can rapidly and conveniently tell the users what they themselves, the machines are doing, in executing algorithms. Technology exists to "animate" such communications so that low level observation of computer activities can be largely avoided.

The details of hardware and software algorithms have, historically, by and large been developed by individuals with all of the hazards that can accrue from this narrow development line. We rely upon these individuals to produce "correct" "programs" for the algorithms. This is a very dangerous situation and we should instead be thinking about applying a group approach to algorithm development both to provide better, correct programs and to provide better employment opportunities. The key to this trend will be the development of group oriented input/output equipment, particularly for human/machine communications. Very large dislays for system and process overviews as well as terminals for detail anaysis must be developed as indicated in Figure 2. This "ampatheater" approach to development, testing, maintenance and education should parallel what has been done in the process control for many years where large wall displays are utilized for overviews and smaller displays equipment is utilized for details.

In summary, the pictorial approach for simplification and the group approach to algorithm development and understanding shouldd provied an answer to meeting the requirements of the worlds labor force by providing terms that they can understand and increasing employment opportunities.

"THE UNIVERSE AND ITS REFLECTION IN THE IDEAS OF MAN HAVE WONDERFULLY COMPLEX STRUCTURES. OUR ABILITY TO COMPREHEND THIS COMPLEXITY AND PERCEIVE AN UNDERLYING SIMPLICITY IS INTIMATELY BOUND WITH OUR ABILITY TO SYMBOLIZE AND COMMUNICATE OUR EXPERIENCE. THE SCIENTIST HAS BEEN FREE TO EXTEND AND INVENT LANGUAGES WHENEVER OLD FORMS BECAME UNWIEDLY OR INADEQUATE TO EXPRESS HIS IDEAS. HIS READERS, HOWEVER, HAVE FACED THE DOUBLE TASK OF LEARNING HIS NEW LANGUAGE AND THE STRUCTURES HE DESCRIBED, THERE HAS, THEREFORE, ARISEN A NATURAL CONTROL: A WORK OF ELABORATE LINGUISTIC INVENTIVENESS AND MEAGER RESULTS WILL NOT BE WIDELY READ".

WILLIAM M. MCKEEMAN

- PICTURES "INSTEAD OF NOTATION" PROVIDE A LANGUAGE FROM WHICH COMPLICATED IDEAS CAN BE SIMPLIFIED.

- PICTORIAL METHODS FOR REPRESENTING PROCESSES, SYSTEMS AND THEIR LOGIC ARE A DEFINATE ASSET.

Figure 1

CAD^3L DESIGN SPACE

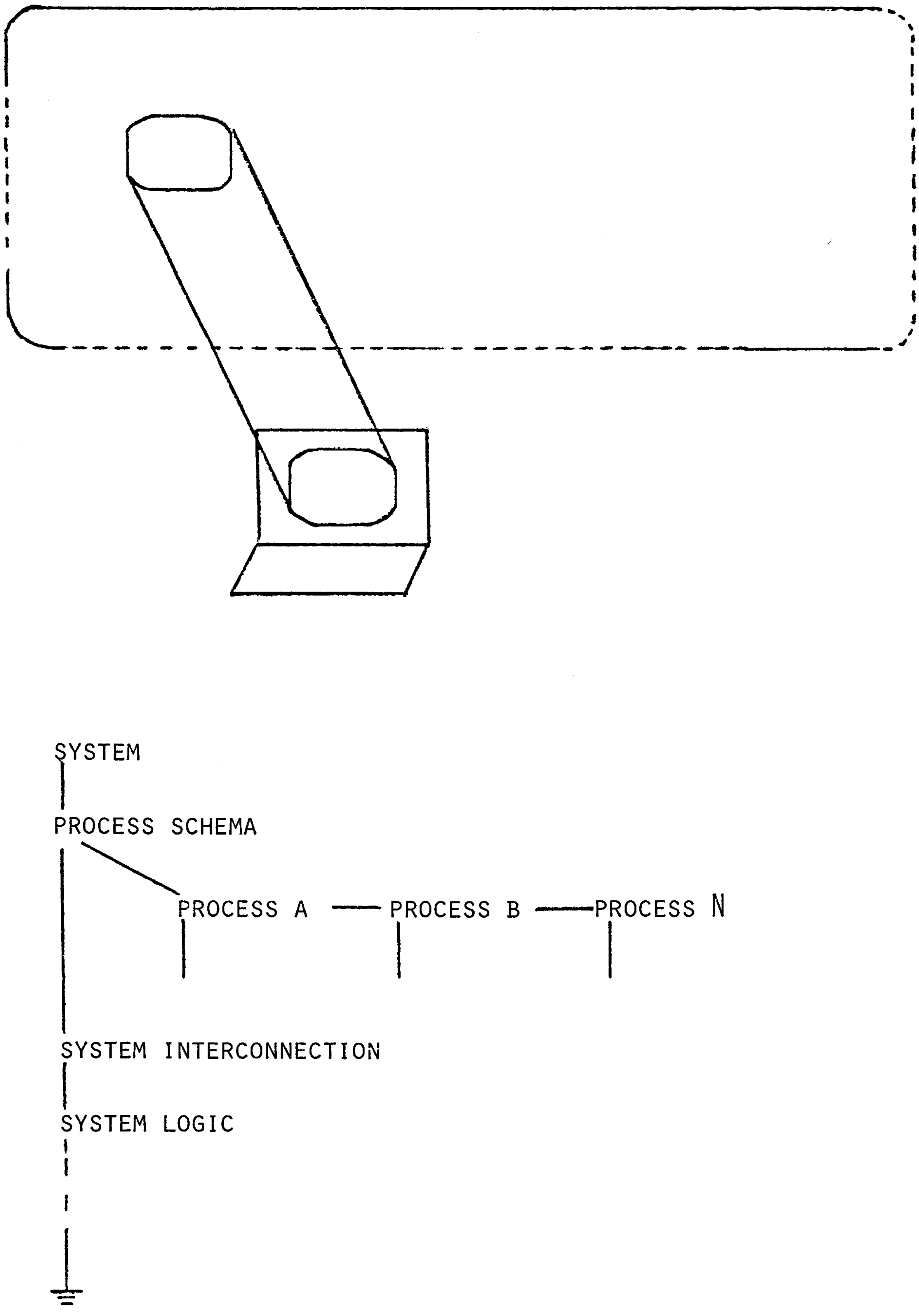


Figure 2.

CHAPTER 6

SOCIETY AND COMPUTERS

SOCIETAL IMPLICATIONS DUE TO AUTOMATED INFORMATION PROCESSING

Klaus Lenk

1 Information Technology and Society: Preliminary Remarks

While preparing this lecture, I sometimes had the feeling that much of what I have to say, although related to the use of information technologies, has little to do with Automated Information Processing in the strict sense, with computers. I have tried to comfort myself with the idea that one cannot after all assess the societal implications of railway networks by looking at locomotives alone.

True, it may be misleading to compare computers with locomotives, but when one looks at existing computer applications and their societal implications, there is some reason for not altogether dismissing such a view. Most of the existing computer applications fall far short of the potential which the computer bears and which constitutes the central preoccupation of the computer scientist. In most of the existing administrative applications both in public and business administration, computers serve as typewriters or desk calculators or as media for the storage and retrieval of formatted information. To this can be added applications of computers as parts of communication systems and as monitoring or steering devices. This still falls short of applications which make full use of the distinctive capacity of computers, namely their ability to give answers to questions by means of computation and logical inference. Certainly, all types of computer applications listed so far contain elements of this capacity. The dominant characteristics of such applications, as seen from their potential societal implications, are far more trivial, however. True problem solving applications include modeling, simulation, optimisation, as well as things like chess-playing or pattern recognition, falling into the domain of "Artificial Intelligence". There will hardly be mention of all these in what follows.

Thus, I take my start from rather trivial computer applications and from the changes in the distribution and control of information which they may bring about under certain social conditions.

I just said "bring about" but do computers really bring something about by themselves or is it the fact that man uses them as a tool which has certain implications? In the growing concern over potential positive and negative implications of Automated Information Processing - or rather its use for different purposes - two contrasting views are held. One view sees information technology, and indeed technology in general, as a tool which can be used for good or for evil. The opposite view sees technology as an autonomous force which gets out of human control for reasons of its own inherent properties or of the shortcomings of human understanding.

On the one hand, computer scientists have long viewed information technology as a tool to be applied according to man's aims. More recently, social scientists are joining them. Such an orientation has guided valuable research, e.g. on the organisational impact of AIP. According to it, the impact of information technology upon society is the outcome of the action of social forces, their aims, conflicts and philosophies. Stated in this way, the problem becomes manageable in the usual reference frames of the social sciences, especially political science. The unequal distribution of economic opportunities and of access to information technology leads to what is often described as its most general impact, the "Mathew effect", making the already powerful still more powerful. Hence changes in the relative distribution of resources brought about by computer use can serve as a measure of its impact. If there are any unintended consequences of the use of AIP for different purposes, these are attributed to the yet incomplete mastery of the technology or of implementation processes in an organisation environment.

Such a view has the important side effect of keeping AIP neutral and immaculate. The engineer may continue to present his favourite toy as a tool to a society, the actual working of which he ignores. At the same time, he can react against presenting computers as the scape goat for outcomes which are the result of the policies of those introducing and using computers.

On the other hand, this view is challenged by pointing to the fact that technology does not entirely follow man's will but tends to become an autonomous force. Its diffusion and indeed its very development are the effect of a multiplicity of short range decisions reached in many different places. Their cumulated effects could lead to a future no one really wanted. The rationality of such decisions cannot easily be increased in order to take such side effects into account, as social gains and problems may emerge only long after initial investments are made.

Both views contain some element of truth. Many implications commonly ascribed to AIP can be identified as the more or less conscious outcome of conceptions and philosophies which have so far guided the introduction and use of computers. Yet in the long run there may be implications which were never planned for. The French neologism "informatisation" alludes to a thorough change in social structures which is beginning to be brought about by myriads of often imperceptible changes in information handling in different social institutions, mainly bureaucratic organisations. Information technology, like other technologies, can be of help in man's struggle to dominate nature. More important, however, is the fact that information constitutes the very fabric of society. Computers are media for processing formalised information. Their application in human affairs introduces a mechanistic rationality into social relations of a predominantly informal and irrational nature. In ways we only dimly perceive, the essence of society may be affected. Social relations may undergo profound changes.

From the inability to decide which one of the two contrasting views is right, it follows at least that efforts aimed at assessing societal implications of AIP must not be confined to technology and its potential. The structure of different national societies and their political culture play an important role. But even if these factors are taken into account, research is still seriously impaired by the obstinate unwillingness of modern sociology to deal in greater depth with the great problems of macrosociology, like social structure, association or social control. This is particularly evident in the prevailing conceptions of the "information society".

2. The Information Society

Many authors have pointed to the distinctive role of information and information technology in the formation of what is commonly named the postindustrial society.

I must immediately confess that I am unable to see why the increased significance of information and communications, as well as of the related technologies, should be so characteristic of the post-industrial society that all other criteria are backstaged. It remains to be seen how information could replace the production of commodities and the related legal concept - property - as the dominant social structure which organises labour, social intercourse and - by the exclusion principle - permits individualism and the opportunity - or curse - of being left alone.

Recent efforts of economists to isolate an information sector (besides agriculture, industry and the service sector) are inspired by the belief that information handling in the broadest sense is the motor of economic growth.

The present stage - and here I borrow from Professor de Sola Pool's lecture given at the previous "Discoveries" Symposium - is characterised by an extraordinary growth rate of jobs concerned with information in the broadest sense. Yet it is probable that much of the more routine-like information handling will be carried out by machines. Furthermore, the demand for information services may not continue to increase as in the past. Increased efficiency in the production of goods in agriculture and industry will shift more and more of the economically visible human activities towards human services which cannot easily be replaced or supported by machines.

The dominant economic perspective of the information society remains unsatisfactory, as the growth of human services and information activities presupposes a given social structure which is the outcome of the process of industrialisation of the now "advanced" societies. This structure is characterised by an elaborate social division of labour and by the desintegration of informal social structures, like the family, neighbourhoods and small communities. Vital functions like health care, social security and social control are now the task of public and private bureaucracies instead of being performed informally in smaller communities. It is doubtful whether societies should proceed in this way of growing social desintegration. Hence the desirability of compensating the loss of job opportunities in agriculture and industry by creating new jobs in human service and information activities may at least be put into question. Beyond labour market problems, this leads to the basic issue whether we want professionals or laymen to cater for human needs, either in convivial institutions or in large bureaucracies.

In any case, speaking of Western societies as information societies indicates that changes are taking place which affect the very essence of society. Far beyond short range economic problems there is a growing feeling that social structures and the basic relation between the individual and society are affected by information technologies. I am less inclined, however, to follow the widespread deterministic belief that new information technologies infiltrate and slowly subvert existing social structures. Rather, it seems to me that Alain Touraine's expession of a "Programmed Society" points into the right direction. The cohesion of Western Societies is no longer achieved exclusively by social laws which could be imagined analogous to natural laws governing the behaviour of individuals with an invisible hand, without their being aware of it. Centuries of rational thinking culminating in the era of Enlightenment and the French Revolution have led to the disenchantment of nature as well as of society. Human efforts to build new, rational and humane societies are still utopia. The void left by the growing incoherence of Western societies is filled by the conscious programming of social action on behalf of those who govern.

Thus, knitting together the social fabric tends to become an object of administration. Instead of incidentally repairing broken threads in this fabric and of guaranteeing basic rules of civil and market behaviour, administration is expanding to virtually all aspects of social life. It is catering for the basic means of subsistence. Starting with schooling on the one hand and law enforcement on the other, it slowly pervades the socialisation of individuals and assumes social control over their behaviour. Perfect administration would eventually become synonymous with completely prestructuring and controlling human behaviour.

Unless smaller groups of human beings take their destiny into their own hands, administration almost inevitably signifies bureaucracy and centralisation.

3. Bureaucratisation and Informatisation of society

Far from any deterministic belief in the role of information technologies, the bureaucratisation of society is perhaps the distinctive phenomenon from which a macrosociological analysis of the societal implications of Automated Information Processing could take its start. Bureaucratisation as understood here is more than just the existence of large organizations with hierarchical structures and other characteristics of bureaucracy. It means that an increasing part of social relations is constituted by human interaction via bureaucracies, by role-taking within or in relation to bureaucracies. As these assume more and more functions of social service and control, they can be seen as nodes in the social fabric and as a major factor of social integration.

In this view, the almost exclusive use of AIP by bureaucracies does not appear to be due to economic reasons alone. By its ability to process formalised information, AIP can be particularly helpful to bureaucracies which already tend to formalise both their internal structures and the perception of their environment. AIP contributes to enhancing bureaucratic power at the expense of the unorganised segments of society, as it confers increased efficiency to the bureaucratic mode of producing goods, administrating, rendering services and solving problems. A look at public administration may provide some confirmation of this hypothesis.

4. Computers in organisations: The case of public administration

AIP in public administration did not contribute, as many expected, to bring about completely new ways of getting things done. Rather, it helped to streamline existing procedures without departing from firmly established bureaucratic practices. Main applications involve those branches of public administration which handle routine-type matters, like tax assessment, welfare benefit computation, etc. Besides, many public (or private) human service organisations e.g. in the health sector, have computerised a good deal of their auxiliary administrative functions.

Three types of application can be distinguished:

a) Isolated, though often fairly complex, routine work, e.g. income tax assessment.

b) Integrated routine applications supporting several administrative activities carried out by different agencies, and giving other agencies access to the data for investigation. A good case in point is the Swedish car registration system, which in addition to the registration procedure not only handles tax, insurance and car inspection matters but even provides the steering information for manufacturing the car plates.

c) Information systems for different requirements like police intelligence (fast response times), planning purposes or text storage and retrieval.

Presently, all three types of applications are available only as isolated systems, neither covering the whole body of public administration nor being interlinked to any greater extent. Pretentious concepts of Management Information Systems for the public sector did not come into being as envisioned in the sixties, although their promise did contribute to the present amount and shape of automation in the public sector.

Prevailing patterns of AIP use show a clear preference of public administration, at least in many European countries, for systems approaching the limits of manageable complexity. It is still fairly common to encounter very complex AIP systems side by side with manual routines for billing and accounting functions. Even more striking is the reluctance of many branches of public administration to make use of the more recent opportunities to bring decentralised information processing capacity to the individual working place where it would be connected with facilities for data communication as well as for written and oral communication. Obviously, constraints intervene which flow from administrative policies rather than from the available technology. They reflect the behaviour of public bureaucracies confronted with a technology which still bears the promise of shielding them from the turbulences of their environment, including their own staff, and of eventually attaining the ideal of perfect administration.

A more detailed analysis of such a situation would reveal at least the following factors responsible for the peculiar way in which public administration handles AIP (as opposed to private bureaucracies):

a) insufficient concern for the qualitative aspects of its work;

b) the still dominant perspective of (re-)arranging administrative procedures to meet automated systems requirements instead of designing these systems in such a way as to fit the standards and goals of administrative action;

c) a persisting inability to successfully manage the implementation process of new automated systems where organisational factors are generally neglected and all efforts concentrated on getting the automated part of the system effectively to work.

Presently observable impacts of the prevailing policies of administrative automation chiefly concern the organisational structure of public administration and the working situation of its personnel. Roughly the same impact has been observed in business administration, in insurance companies and banks. Besides, there are impacts which are more prominent in public administration, although by no means inexistent in private business administration. They include:

- changes in the quality of administrative services, as seen from the citizen's point of view;

- a decreased flexibility of administrations in dealing with unexpected situations, as well as growing obstacles to possible administrative reforms;

- power shifts generally resulting in more bureaucratic structures and centralisation, either at the expense of autonomous bodies like local governments or at the expense of the individual. The question whether information technology impact constitutes an assault on personal privacy can be looked at in this context.

As far as the implications of AIP for organisational structures are concerned, the introduction and use of fairly complex automated systems for administrative routine tasks frequently goes hand in hand with a more elaborate division of labour. This does not only entail an evaporation of the responsibility for the final "product", e.g. a decision on welfare eligibility which nobody can fully explain to the client. It may also bring about changes in the decision-demanding content of individual work roles, e.g. of the officials engaged in welfare provision, which would be in direct contrast to job enrichment strategies. Furthermore, many complaints of the public about decreased service quality can be directly attributed to changes in the work organisation of administrative agencies which were reached either to make computers work effectively or by taking them as a pretext to force staff into predetermined work roles. The latter helped to better obtain their compliance with organisational roles and the conformity of their actions to organisational goals.

Turning now to the implications for the quality of public administration and its relationship with the citizen, the presently prevailing impression is largely a negative one. Two decades of AIP in public administration have resulted in a clear deterioration of the quality of its performance, as seen from the client's stand-point. Examples abound of undecipherable computer printouts, of difficulties of getting computerised records corrected, of outcomes for which nobody seems to be responsible.

At the surface, the principal negative impact of computer use in public administration on the citizen can be found in a growing burden of cost and inconvenience for the client applying for a service or challenging the correctness of its delivery.

While it is true that computer processed information needs standardisation of its meaning (and formatting in the still dominant administrative computer applications), little consideration is given to whether the necessary efforts should not be made by the administrative agency itself. Considerable amounts of administrative work are in that way shifted towards the client applying for a service. As an immediate consequence of the practice of shifting costs and inconveniences to the client, existing inequalities in the chances of access to administrative services become more salient. AIP systems frequently tend to demand more skill and higher expense in accessing an administrative service. In addition, motivational barriers become higher as opportunities for direct contact with officials diminish. Beyond shifting costs and inconveniences to the client, a general decrease in the responsiveness of administrative agencies to the needs and aspirations of their public can be observed. Connected to most of the ADP systems in client-oriented administrations is a significant reduction of direct contacts.

With decreasing responsiveness and the diminution of face-to-face contacts between officials and clients, administrations tend to rely more on stored information and on internal information sharing and exchange. Information on individuals is often accumulated without their being aware of it. As the individual has no chance of detecting possible errors and getting them corrected, such information is sometimes quite unreliable.

Such an assessment is in contrast to statements often heard in Italy, in France and in some countries in the Third World, namely that automated systems contribute to a more equal treatment of citizens, reduce opportunities for tax evasion or even for the first time create a reliable public administration. At least in Italy, there seems to be some evidence for such effects. They are due to the fact that centralised systems enforce compliance of officials with working patterns and often tend to reduce both factual and legal discretion. It must be warned, however, in seeing in automated systems a panacea to maladministration. It is doubtful whether technological constraints really will lead to significant value changes and different attitudes of both citizens and public officials.

Besides these implications for the relationship between the citizen and the State there are other implications of a more far reaching nature which may deeply affect the politics of administration. One of them is the fact that complex computer systems, once they are operational, can make future organisational changes more difficult. Hence the feasibility of politically desirable administrative reforms may be jeopardised. The same holds true for changes in legislation that is to be executed through computer-supported systems. Sweeping changes e.g. in a national social security legislation would depreciate much of the existing software. Legislation, that is to say, the will of parliament, is therefore increasingly constrained by automated procedures. To this we can add an increased dependence on computerised systems, once they are operational. The perspective of a possible breakdown of centralised systems significantly adds to the vulnerability of a society that already depends on centralised bureaucracies for some of its most vital functions.

One important question in this context is whether such implications can actually be evaded by decentralised, small scale computing. Personally I doubt that the answer would be very straightforward.

Turning to still another set of implications, power gains of centralised bodies can be observed with the presently available rather centralised automated systems. An intraorganisational example is the loss of importance of middle management at the expense of top management in large firms. Other examples affect the individual in his relationship to bureaucracies. Less conclusive is the evidence alleged so far for loss of power of autonomous bodies like local government or for threats to federalism or to other autonomous social forces.

Some of these power shifts have to do with better information available at the centre of an organisation or a network of organisations. Others stem from the need for setting and enforcing common standards in order to ensure success and economic justification of computer introduction.

To address similar power shifts in terms of centralisation and decentralisation may be misleading unless it is borne in mind that "centralisation" can have quite different meanings. In French legal terminology, a useful distinction is made between "concentration" which means the centralisation of executive tasks, and "centralisation", which implies a loss of autonomy, discretion and power at lower levels. Decentralised computing in the current sense obviously will not automatically lead to more autonomy, power and discretion at lower levels.

5. "Data Protection" and the distribution of power

The changing power balance between bureaucratic organisations and the individuals is at the heart of the privacy protection problem. This problem has been too hastily stated in purely individualistic terms in order to make it manageable within national legal systems. Safeguards were devised before the real dangers at stake were sufficiently identified and little effort was made to assess the relative impact of Automated Information Processing, and of information technology in general, on changed patterns of information flow and on the breakdown of "natural" barriers to the free flow of information.

Concerns over the loss of privacy in the computer age encompass far more than encroachments upon personal privacy or its equivalent in various national legal systems. With the changes brought about by new information technologies, the "natural" distribution of opportunities for accessing or withholding information no longer guarantees personal privacy, civil liberties, the autonomy of individuals or political discussions free from fear of negative reactions. Apparently, the task consists in replacing former factual barriers to information flow by legal, organisational or motivational ones. Yet it remains doubtful whether such artificial barriers can really restrict the opportunities of those who have information or can obtain it at little cost and effort, to convert this information into power.

A deeper analysis of the problem should start with the fact that any social interaction implies the transmittal of information about individual behaviour. This applies regardless of whether such an interaction is direct, spontaneous and informal, or channeled by rules and mediated by bureaucracies. Behaviour which is considered as deviant behaviour by some participants in the interaction, especially the more powerful, will provoke reactions of social control, negative sanctions.

Now, information technologies enter the stage where they contribute, either to enhance the direct visibility of individual behaviour or to facilitate access to stored records about such behaviour. Street surveillance cameras and Orwell's 1984 technology may serve as an example of the former, whereas access to computerised personal health data illustrate the latter. Surveillance as the starting point for social control will in both cases be intensified. Apart from this, another effect of information technology is easier communication about deviant behaviour, especially through automated police information systems. All these effects can make social control easier and tighter and provoke changes in the patterns of sanctions of deviant behaviour.

It is astonishing that so few efforts have been made to clearly identify the benefits and dangers of changed patterns of surveillance, of information flow and of information control. On a strictly individual level, some of the potential dangers are quite well known, including discrimination by employers or credit firms, as well as the impossibility for an individual to make a fresh start. Of equal importance, however, are societal and political consequences. Changes in law enforcement patterns may be welcomed as far as they contribute to more equal treatment of citizens in their relations with public administration or to filling gaps where in our present Western societies social control is dramatically lacking. Yet there is a risk of disproportionate increase of social control in circumstances where deviant behaviour is of minor social importance but easy to observe and to register.

More generally, removing the obstacles to full visibility of human behaviour may ultimately demand a price which no society would pay. So far, perfect communication, the full visibility of behaviour, has been characteristic of many utopian models of society. It is the ideal of prison architecture, but it never worked in real life situations where some opportunity to withdraw always had to be provided.

On a more political level, enhanced visibility of, and communication about human behaviour may bring about important changes in the distribution of power. This will work in favour of individuals or bureaucracies possessing information which they can easily adapt for purposes of social control.

"Information-haves" who succeed in keeping their own communication spheres protected while at the same time snooping into formerly limited communication spheres of others, will gain power at the expense of "information have-nots" and of those who by their social situation are most visible to the powerful.

This is particularly salient in everyday life where the individual is confronted with better informed bureaucratic organisations and professionals. So far, bureaucratic organisations see their clients in specific roles, e.g. as drivers or taxpayers, instead of looking at the person as a whole. Such an integral perception of the client may have positive impacts for the quality of individualised services. Yet there may be implications for the power balance between organisations and the individual even when the stated aim of the organisation is personal help and nothing more.

Authors concentrating on the political implications of information technology tend to conceive of such power shifts in a frame of reference which assumes the steady repetition of political struggles without taking into account that these might end one day or at least lose their significance. Focusing on the continuing redistribution of resources may hide an evolution of society which is slowly taking shape through these redistributions, i.e. the accumulation of power in the organised structures of society. This rejoins my initial working hypothesis that "informatisation" and the bureaucratisation of society are congenial processes.

6. Politics in the Information Society

Implications of AIP for politics not connected to its administrative use are difficult to apprehend. Only few direct applications of AIP in the political process can be observed. The political effect of the "informatisation" of society in many of its (overtly political or apparently non-political) domains will show up only in the long run.

A widely discussed topic is electronic voting, which is generally presented as one of the promises of the "information utility". It is commonly acknowledged now that its negative aspects may largely outweigh the positive ones. Active political participation in the "instant referendum" would lead to more political apathy if everyone had to fear that his political opinions were automatically registered and stored. Besides, there would be a temptation to elicit immediate reaction of the constituency, which would reduce the amount of political discussion. Most important, however, is the fact that political X-raying of the constituency would no doubt benefit not the citizen but the established power structure which will be increasingly able to predict public wishes and reactions and to anticipate adverse reactions.

Even though electronic voting in the strict sense may never be implemented, the dangers mentioned are looming right now, with opinion polling and with the registration and aggregation of individual choices of consumers. Half-way between individual choice (market preferences) and public choice (democracy) the "electronic feedback junction" would provide channels permitting citizens to effectively express their needs and aspirations ("electronical ombudsman"). It has been observed that in this context, social scientists may well become the unwitting promoters of tighter behavioural control. Certainly, implementation of privacy safeguards has been loudly voiced. Of more relevance than threats to personal privacy and less well acknowledged, however, is the contribution made by better information and analysis capabilities to the stabilisation of the governance of a polity that is bound to become increasingly predictable in its reactions.

Yet, visions like the electronic plebiscite have a legitimate base. Democracy poses organisational problems, and AIP use can have organisational implications which could make these problems easier to solve. There are two classical answers to the organisational problems of democracy: representation and council (soviet) democracy. Whereas, the benefits of increasing information handling capacities to the representational process remain doubtful, experiments with the "Electronic town hall" or "Computer democracy" could yield valuable results in some respects, if the temptation is resisted to distill alternative models of the political process from the limited experience they convey. Alternative forms of democracy with more participation or better representation are available even without technology, and it is hard to see how information technology could subvert the existing structures which have prevented their realisation so far. In so much as information technology is an autonomous force, not just a tool in man's hands, it is more likely to bring about more formalisation of social structures, more orderly arrangements and a smaller range of individual opinions and choices, i.e. less participation and spontaneity. The commercial triumph of the home computer, which we will evidence in the next years will not counterbalance this trend. Rather it will detract public attention from it.

7. Conclusions

Any account of observable or at least imminent societal implications of Automated Information Processing deals only marginally with the computer's full potential. It primarily consists of stories about men who try to use computers for coping with what they conceive to be their problem or for making some of their dreams come true, for realising their ideals. In both cases, they are not aware of certain by-products or side-effects of their actions, either because they do not fully understand the transformations of information which occur when computers are substituted for human communication, or because they neglect to analyse and anticipate the reaction of social organisms which take place when information machines are transplanted into them. Computers have been proposed as panaceas to social problems, the origins of which were barely understood, be they increased crime rates or the so-called explosion of human knowledge. They often have been proposed in order to draw attention and channel public monies to particular areas of concern, or simply to enhance the prestige and rank of their proponents.

At this point, however, an objection must be raised. The computer scientist will argue that more of the computer's true problem-solving potential will be brought to bear on social problems sooner or later. He will tend to believe that eventually much of the societal implications loaded with negative value are transitory, bound to disappear with our better understanding of the technologies involved. The social scientist is not prepared to take issue with him, unless he abandons his obsession with sticking to present, measurable and often minor social facts, an obsession which makes himself and others believe that he, too, belongs to the modern priesthood of scientists. Social phantasy, a concern with society as a whole and preoccupation with the future are all necessary if social science is to provide guidance on man's path into the future.

Of course, this does not mean that rational behaviour, the mobilisation of means to reach fixed ends, is altogether useless in science as well as in the actual working of society. I am stressing this point because it seems to me that criticism like mine might support certain scientists in their striking an irrationalist stance, having long been the servants of one-sided rationality. We are just beginning to understand the dialectics of progress in the field of information technology. We should avoid finding ready answers in a couple of fragments of self-taught irrationalist philosophy. Much detail work of a multidisciplinary kind is still before us and the present meeting would be very useful if it could foster some of the cooperation needed for it.

EFFECTS UPON THE BALANCE OF SOCIAL FORCES

Ithiel de Sola Pool

May I start with some science fiction. In the 15th Century, so Paul Lazarsfeld tells us, 25 years after Gutenberg invented printing, UNESCO commissioned a study of the social impact of this new technology. Two years later there emerged a 300 page report by a panel of technology assessment experts, concluding that printing had had far fewer effects than anticipated. In the first place, the needs of the very small population of literates had already been quite adequately met by the skilled scribes. Furthermore, the books that the printers now published were the same old classics that had already circulated widely in manuscript, most notably the Bible.

By the 17th Century, UNESCO decided once more to review the impact of printing. A new panel of experts rejected the conclusions of the first report as too short-run a view. New technologies, they observed, tend to be used initially in ways that mimic the technologies that they replace. With the passage of time, however, printing had come to be used in new ways that greatly changed society. Printing, they claimed, was responsible for an explosion of popular religious participation. Tracts, sermons, and home Bibles, coupled with growing literacy, enabled the Reformation to create a new kind of mass congregational religiosity.

By the 19th Century, UNESCO decided once more to have a new expert review. That last panel of technology assessors were very critical of their forebears. Printing, they declared, far from difusing religiosity, had been the source of scepticism. The secular culture of novels, essays, and science, had been largely disseminated by the printed word. For better or worse, they concluded, religious faith had been severely challenged by the growth of printing.

This parable that I have told you has implications for our discussion of automated information processing. We live in the infancy of the computer. It is misleading to assume that the ways in which our clumsy, expensive, bug-ridden computer systems of today are used as predictive of how they will be used in the 21st Century. As Professor Lenk points out, at this stage they have been used to centralize management in large organizations. That, however, is no basis for prediction. We must examine the nature of the instrument to surmise whether efficient, powerful, reliable, and cheap computers of the future will centralize or decentralize power.

Our parable bears on the issue of whether computers are simply "a tool in our hands", as Prof. Zemanek suggests, to be used as we wish, or whether they are (in Prof. Lenk's phrase) "an autonomous force." The right balance, I suggest, is struck in the title of Harold Innis' book "The Bias of Communications". While the printing press was used in different eras by different forces for different purposes, no one would argue that it had no impact on the nature of the outcome. The mass intellectual revolutions of neither the 17th or 19th Centuries would have been the same without a cheap method of reproducing texts. There was a bias toward ideas originating outside of a narrow clerical establishment. So too with computers, the question is not whether they can and will be used to centralize authority, to decentralize it, to violate privacy, to secure it, to record votes, or to displace them. Just as with printing, computers can and will be used in all these ways. The key question is whether there is a bias in automated information processing that will gently shove the balance of social forces one way or another. I believe there is, and in many respects the bias is diametrically opposite for the long run from what appears today. Let me give you four examples.

Consider first the common fear or hope that computer networks will be used for push button plebiscites. We have all heard a futurist scenarie that the public will be polled nightly over interactive TV sets. Political scientists have viewed that prediction as nonsense because political deliberation does not generally consist of binary votes. The process starts with iterative formulation of a question. All the while, people choose which issues they care intensely about, to which they attach a passing glance, and which they will bypass. When initial decisions are made they must be tried out, revised, and redefined. Even in an ideal democracy, the question, for example, of whether, when, and how much to devalue a currency is one on which some people would choose to state a view, others only to help choose the decision maker, and others to leave it to experts who would be punished or fired only if the results were bad.

Automated information processing can help such democratic decision processes by giving these various kinds of people the various kinds of data bases and communications facilities that they need for their different roles in the process. That is a very different concept from forcing everyone into a rigid mold of plebiscitarian voting. Dr. Michaelson has told us that the US Navy spent 7-8000 man years in developing its payroll programs. An automated information system to serve democratic decision making would be at least one order of magnitude more complex. If, in the present state of the art, 70-80.000 programming hours are necessary to do this job, it is clear that all that will happen soon in computer aided democratized decision making will be partial and incremental experiments.

Consider second the common expectation that computer models will strengthen power wielders by enabling them to predict the future better. It is not necessarily so; automated information processing may not improve prediction. It should do so in situations where the tools are available to one side only. But in strategic conflicts in which both sides plan with the aid of forecasting models, neither side may be any better off than if neither side had them. They cancel each other out.

For the 1960 Kennedy presidential campaign I developed the first operational election computer model. It was widely attacked at the time as a potential tool of manipulation. Since then, the techniques that we used have become commonplace for election researchers. Nobody has gained any manipulative power, though everyone's interpretation of poll data is more intelligent than it used to be.

Consider third the common assertion that computers represent a threat to privacy. On the contrary, in the long run they are more of a threat to publicness. True, in the first decades of computers one of their main uses has been to facilitate rapid search of large data bases. In that application there does lie a threat of invasions of privacy. Other applications such as use of computers for encryption and protection of privacy were viewed as expensive overhead when the main purpose was file search. Looking to the future, however, we can see one-way codes and other forms of advanced encryption being implemented on trivially cheap chips. Computer files will be the most private files that mankind has ever enjoyed. There is a threat to publicness if retrieval of such individualized information, instead of pulicly edited mass media, becomes the main mode of obtaining news. There could be some erosion of the common stock of knowledge shared by all.

Fourth, and finally, we are told that automated information processing has a centralizing effect on power. In the recent era of large CPUs that was true. Powerful establishment centers were the units that could afford computers. But with the emergence of microprocessors and distributed computing, decentralization once more becomes economical.
The technology of automated information processing will, of course, be used for whatever purposes people choose to pursue, but the bias of the technology seems to be towards distributed autonomy.

SYSTEMATIC APPROACHES TO THE PROBLEMS OF INTERNATIONAL RELATIONS

Shuhei Aida

The development of modern techniques and particularly the practical utilization of communication satellites has exerted a powerful influence on international politics and has become a major factor in bringing about detente (a relaxation of strained relations or tensions) between the two super powers, i.e. the USA and USSR. When classifying computer oriented techniques from such a point of view, they fall into the following two divisions.

(i) Systematization of control, command and communication techniques.

(ii) Software technology aiming for information processing and intelligence.

The communication satellite and the natural resources surveying satellite have further heightened the effect of computer communication system techniques, established information processing on a global basis and introduced the concept of "Information Sovereignity" into international politics. As a result, information processing by computers has also adopted the graphical methods of expression which appeal to human perception in place of the conventional expression method relying only on numbers, therefore, we have developed the Faces Method as the techniques for expressing the data collected and processed by machines.

The concepts of Faces Method explained here is a method originally developed by H. Chernoff 1) and is used today for data expression in various fields such as graphical expression of multi-dimensional data. In the United States, for example, the Faces Method is applied 2) in the analysis and evaluation of the systems such as international relations and local community data necessary for political science studies, and symptomatic data necessary for the study of psychoses, and its effectiveness has been confirmed. Since the Faces Method draws up the facial expression as a lineal drawing by the computer with various data of objective fields as inputs and classification is made by human sensually upon observing the faces, it is a method which identifies the correlative characteristics of original data. Therefore, it is important in the Faces Method process to grasp the perceptive judgement characteristics of human on the face of the lineal drawing drawn by the computer. However, since this analytical study depends upon human fuzzy judgement, it involves, to a certain extent, the field of psychology. All of these results, however, have made the actual face photo as the object and it is difficult to say that they will always agree with the face expression simplified by the lineal drawing used in the Faces Method.

Special features of the Faces Method which should be mentioned here are that a face pattern closely resembling a human face has been developed as shown in Fig. 1, it possesses variable elements of 7 digits as shown in the drawing and each element changes in 9 ranks as shown in Table 1. Attention has been paid to the following points in preparing the face pattern.

(i) More closely resembles an actual human face compared to the conventional Face Method and uses only the expressions found in human faces.

(ii) Only the expressions of feeling were adopted in the face pattern while the diagrammatical facial feature changes of the face have not been made.

(iii) Expression elements have been set so that the facial expression changes emotionally from normal to anger along the displeased axis in proportion to changes from all 1 to all 9.

(iv) Expression change elements have been limited to 7 as shown in Table 3 and the pretentious complication of the facial pattern has been avoided.

Among back data on international politics, there are many quantitated as for economics and national armaments, etc. However, the development of a method which also involves extremely fuzzy factors becomes necessary for expressing the national power and strength incidental to international relations by computers accumulated on these back data.

From such a standpoint, the Faces Method should be introduced into the study in this aspect, in the future, as a method of also making expression and evaluation possible of fuzzy system of human activities by computers based on quantitative data.

Fig. 3 shows the classification of various basic facial patterns by hypothetical data and based on the interdependence between Fig. 3 (Classification of human facial expressions by Scholosberg 5), we shall discuss the meaning, etc., of introducing the Faces Method in the status quo understanding of international relations.

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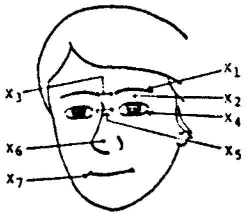

Fig.1 Original face and facial features.

Table 1 Change of Eacn Facial Feature

Variaoles	Facial Features	Rank 1 2 3 4 5 6 7 8 9
X_1	1. Shape of eyebrows	down ⟷ up
X_2	2. Distance between eyebrow and eye	wide ⟷ narrow
X_3	3. Distance between eyebrows	wide ⟷ narrow
X_4	4. Shape of eyes	narrow and drooping ⟷ open and slanting
X_5	5. Distance between eyes	wide ⟷ narrow
X_6	6. Shape of nose	upward ⟷ downward
X_7	7. Shape of mouth	open (lower lip) ← closed → open (upper lip)

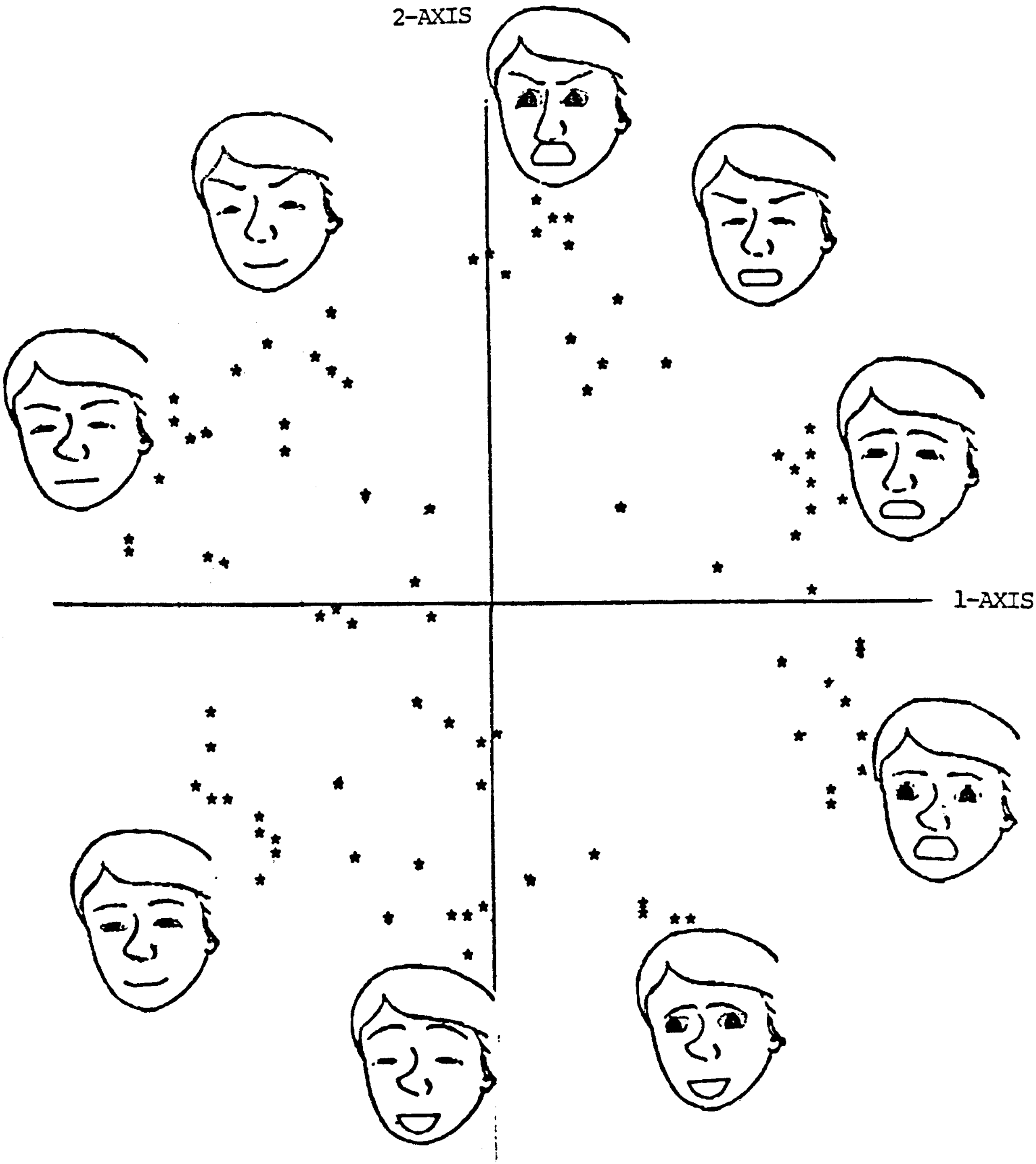

Fig.2 Result of 2-Dimensional Space Analyzed by M-D-SCAL (Facial Expression)

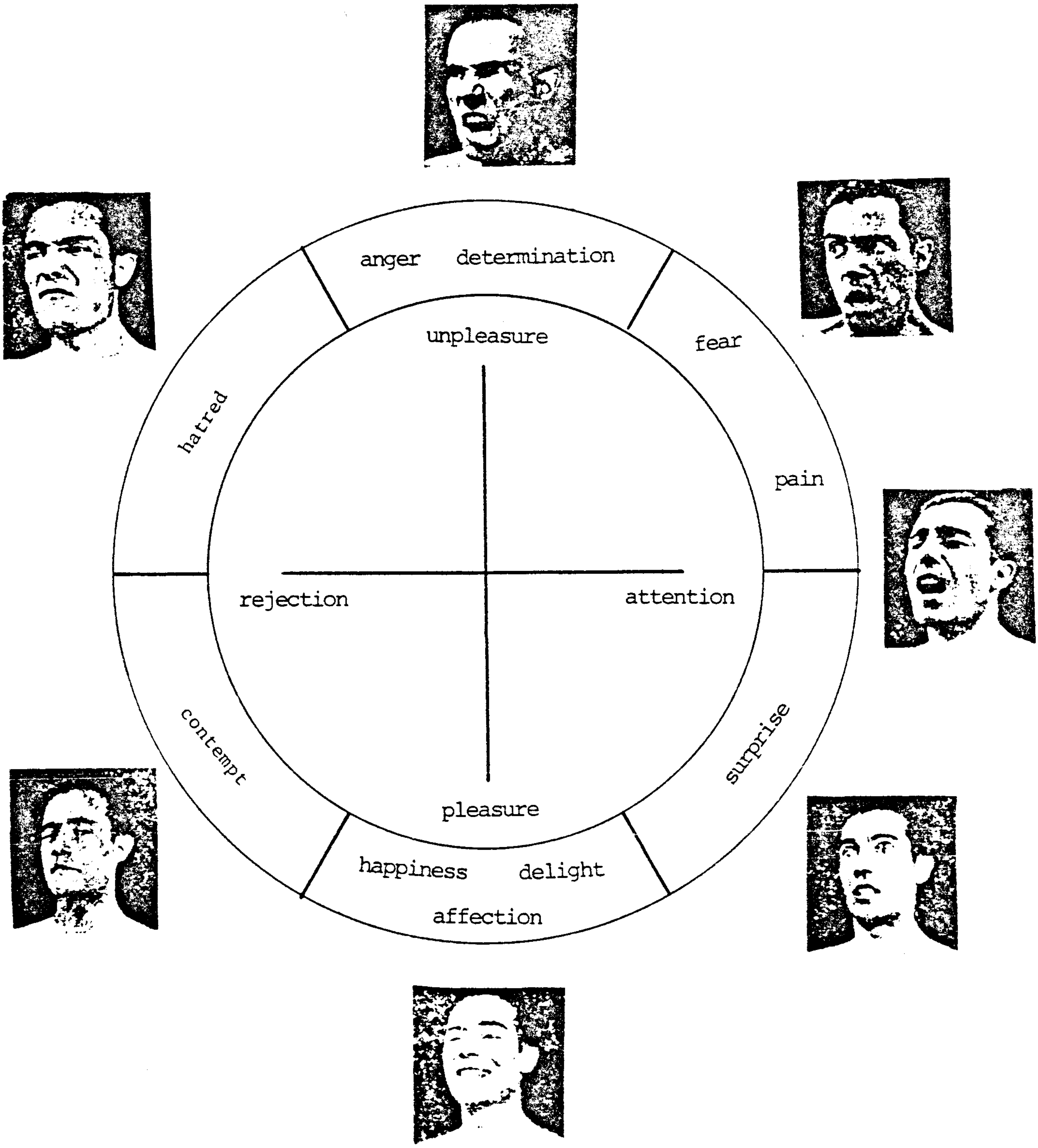

Fig. 3 Classification by H. Scholosberg

THE COMPUTERS VERSUS THE STATE

Thierry de Beaucè

After such a number of brilliant exposes on the technical and social components of the problem of informatics I feel like having nothing to say or too many things to comment. That is the normal result of an enriching dialogue. So I will stick to some limited thoughts on what I could entitle "The Computer versus the State".

First I should like to make two preliminary remarks:

1. We know the influence of technology over the structure of States. Military technology, industrial technology and communication technology inspire a different form of means and objects for the government:

- Fire power and governmental concentration - Steam engine and imperial domination - Printing and ideological totalitarianism (or its contrary of individualism)

So what about computers?

2. Industrial society has been contemporary with Affluent Society. In the western world, communication society appears in a parallel way to the new society of scarcity (energy crisis, pessimistic analysis of the Club of Rome).

It is no longer possible to waste our resources and postpone their better use.

Within wealthy societies, freedom was often considered as an anticipation. Improvement of communication can favour a society which is more intense, more conscious, more efficient and rationalized.

So what about informatics?

Sticking to this theme of "the Computers versus the State" I would like to point out two problems which have already been formulated in one way of another by most of the participants.

1 Informatics and Individual Freedom

We are all of us convinced that the State- let us say administration - can be made more efficient by informatics (in its double function of clarification and interrelationship).

a) Such a Scientific Policy realizes the old dream of Saint Simon, the one of absolute rationalism and administrative triumph. Informatics will contribute to destroy hierarchical obscurity (this cult of secrecy which is often the main force of bureaucracy). We know - through political philosophers - that Democracy is essentially this claim for more light and thus more control...

b) The Computerized State is more attuned to totalitarianism. It is the prize for efficiency. With informatics everything will be known, evident: No more swindle, secrecy, private life, grey areas where nearly anything can be done. This permanent light of a continuous day - can worry our latin societies, where citizens conduct a perpetual struggle against the State and demand the rights of escaping, hiding, if not directly swindling.

But history is here to tell the exact opposite. Neither Hitler, nor Stalin, ever had the need for informatics. Their terror was accomplished by using rumours of darkness, phantasms and irrational appeals. The Goulag bureaucracy is a bureaucracy of "small time bosses" of cheap romantics and not of informaticians. According to Voltaire, the Great Turk, the model of a despot, wanted each book to be destroyed and so his people plunged into ignorance. Today's despotism - whereever it exists - keeps up the same style. On the contrary, the most computerized industrial society - I could quote the United States and Japan - are among the most liberal societies. Tyranny acts over unconsciousness, never over a clear consiousness.

c) As a matter of fact, in front of the challenge of computers, there is a new libertarian answer of Society against the State. With better instruments in their hands, the two protagonists raise the level of resistance. The micro-computers boom, the decentralization of Data and of capacities of analysis and calculation to the benefit of many decision-centers give a stronger resistence capacity to various communities: Trade unions, local governments, associations, companies.

d) Democracy learns how to deal with new technology. In a first approach, the governing agencies, the parliaments have tried to adapt their control with new rules and new institutions. That is not enough. It is necessary for Democracy to be able to oppose different logical systems, data and means of calculation to the data and means of calculation provided by the State (if not a new unidimensional international society). The 21st century must find a new balance of power, a computerized version of the counter-organisations defined by Montesquieu in the 18th century.

2 Informatics and the New Dimension of Politics

With informatics, the dimensions of politics have to change. The State gets a new meaning within the new size of the political environment. We are living in a time where we can find as well the boom of private TV-networks, private radios (2 000 free radios in Italy), and, on the contrary, the concentration of international information through the statellites.

a) So, from one side, informatics imposes a miniaturization of politics. At each level a more fluid dialogue can exist. The social microscopy can find a political expression. Thus, the political fight is no longer limited to the conquest of power through the State Machinery. The themes of self-government, of minority rights, of minimal sociology belong to today's political research.

Once Dostoiewsky remarked that the grains of sand were what were most able to jam up the wheels of power.

b) On the other hand - the State - the old nation State of our European societies - is overwhelmed by a reinforced internationalization.

Some figures in the field of information: One billion men have seen the first man reaching the moon. And , in a maybe more significant way, one third of the world's countries get the educational programs of Sesame Street produced by the United States. This means a necessary influence over the concerned communities, even if not over their political choices and state structures.

International communication can be a good thing but it leads to a double ambiguity.

- Either it actualizes the domination of one system of thought

- or it elaborates an abstract common language without roots, connotations, cultural identity.

Even more: From the technological point of view, one multinational company, IBM, has the monopoly of 70% of the international market for computers. To preserve their independence, some countries have attempted various strategies, ranging from adaption to the creation of a national industry. I could mention European efforts, the start of a French policy in those fields, and the new success of Japan who already controls 66% of its naational market. Nevertheless, the gap is still there, if not increasing. I quote the recent ITM declaration: Informatics for the Third Worlds elaborated by representatives from 43 countries:

"The countries of the Third World which represent seventy per cent of the globe do not account for more than five per cent of the total number of computers in service and less than four per cent of their memory capacity. More alarming is the fact that these 117 countries carry out less than two per cent of the research in this vital field. This is happening at a time when the advancement of knowledge and the explosion of information are taking place at a rate of geometric progression". At the end of my comments, I would like to show a little more pessimism than most of my collegues. I think that informatics bring a greater danger of intellectual sclerosis than it does of totalitarism.

Informatics is not inherently committed to any specific ideology but always ends in dealing with already acquired notions. This intellectual processing may impart a new value to the bureaucratic way of thinking. The unpublished learning report to the Club of Rome insists on the impact of informatics on the process of knowledge. I quote:

- "Thus after an initial stage of imitating simple forms of human learning, now computers are returning as instructors, either in the form of computer assisted instruction or of metaphoric models that explain the brain as an neurophysiological information processor. The overall penetration of computers in the next decades compels us to look further for hidden differences, concealed beneath the conspicuous similarities with human intelligence so as to avoid the superficial comparison that could distort our conceptions of learning".

Knowledge and intelligence should be detached from memory and given back to their pure function of critics, speculation and inter-relationship. Andre Malraux used to say "Intelligence means destruction of comedy plus exploratory mind"! If we neglect using our intelligence, then we will be dominated by the integrated logic of the computer-system. Bureaucracies function that way, with an absurd logic which at the end hides reality.

It is this kind of mental Goulag that frightens me for the future.

INFORMATION PROCESSING IN THE PUBLIC SECTOR

Ingar Palmlund

I would like to start with two value statements.

1) I belong to those who look upon computers as neutral tools. The important question is: Who uses the tool and for what purpose. The user and the purpose will determine whether the tool contributes to good or evil in the world. The nature of the question is political, not technical.

2) To me governmental administration is not an evil force in society. I regard the organizations and agencies in the public sector as mechanisms to implement the decisions of government. In democratic countries this means that the way they work and function is subject to political control. As all organizations where human beings interact, they are not 100 % perfect. Nor do they always work in a way which is applauded by every single citizen. However, not even in our days is it the availability of new technologies that changes how the public sector functions, it is decisions taken by persons or groups of persons who have political power.

Innovations may be dangerous but they also widen our perspectives and provide us with new oportunities for development. This could have been stated by the first man who decided to walk upright instead of crouched. It is also a way of describing the impact which the introduction of automated information processing has had on society. And it can be a suitable point of departure for a discussion of the automation of information processing in the public sector. I will here briefly show how automatic data processing is used in the public sector in a developed country - Sweden - and point at the challenges which we have to face. What I say may to some extent reflect our new fear of where technological development might lead us. This has been one of the under-currents in the public debate in this country during the last years.

The administration of the public sector influences society in many ways. One, which is not often in the limelight, is the example which the public sector sets for managing big bureaucracies. It may not always and everywhere be a good example but it is contagious. This was highlighetd in a report a year ago to the French President on the importance of the information sector in society where the authors said: "Through the use that the state chooses to make or not to make of computerization in order to loosen the traditional hierarchies it creates the framework within which the great bureaucracis of the future will be lead".

In Sweden, conscious efforts have been made to utilize computer technology for information processing in the public sector. The incentives for introduction of the new technology were strong in the 60's when lack of manpower seemed to be a restraint for development both in the public and in the private sector. Now, however, we face a different problem, namely how to provide productive and suitable employment for everybody. The expansion of the public sector and its personnel-intensive services is looked upon as one of the solutions. Perhaps, in the coming years, we will often find ourselves in the classical conflict between automation and job opportunities.

In which respect can the public sector in Sweden be characterized as heavily dependent on computer technology? Computerization has in many cases been introduced as a tool to manage a social reform or to facititate a social service function and render it more efficient. An enumeration of activities may be sufficient. Computerized information processing plays an important part in

- administration of social benefits like family allowances, pensions, health insurance and social assistance,
- tax administration,
- maintenance of law and order,
- defence,
- hospital services,
- research and development,
- economic and personnel administration within the public administration.

In all these branches of the public sector a reversal to the manual information processing which we lived with only 20 years ago would probably be judged impossible by most parties involved. It would at least lead to serious loss of productivity, security and levels of service. Thus, in developed countries like Sweden with a high degree of automated information processing in the public sector we have to accept the fact that technology is there to stay. It has become part of the infra-structure of society. This is important for developing countries to consider when they move in the same direction.

Which, then, are the challenges of the utilization of automated information processing in the public sector? We have already touched upon some of them in our previous discussions. There are groups who feel that further computerization is a threat to their personal integrity. Others argue that a person who has nothing to hide cannot suffer from being registered in a computer file in a governmental agency. Some are concerned by the effects of computerization on employment and labor safety and health. Others claim that it is the efficiency of the public sector rather than its capability to offer job opportunities that should be the important criterion used in decisions regarding computerization. I will mention four others.

1) We cannot any longer regard automated information processing as something inherently different in nature from other factors in the public administration and managed by technicians only. In a recent forecast of the impact of microelectronics made at the request of the Department of Industry in the U.K., one of the major conclusions was that it will be social and economic factors rather than technological factors which will mainly determine the future of information technology. This is true for the utilization of information technology in the public sector as well in society at large. As for the public sector, this means that decision-makers both in the political decision-making bodies and in the public administration will have to consider, perhaps more consciously than before, how computer technology is and can be used in the public sector. In some countries, e.g. Sweden, it has even been judged desirable to create a special organism attached to the government, charged with following how the automation of information processing in the public sector develops. It should also devote attention to the development as regards information technology in society at large.

2) A small country without an advanced electronic industry and with a high degree of automated information processing in its public sector - and in other important sectors of its economy - is very dependant on foreign commercial and political powers. In times of peace and stability this is generally not considered a major problem. However, it increases the vulnerability of the country and may be a serious threat in times of conflict on the world's political arena.

3) The public sector is an interesting market for the producers of information technology. For governments, on the other hand, it is important to exercise the rights of the big customer so that public funds are utilized in a sound manner. In several countries - among them Sweden - this has led to central purchasing of computer equipment for the public sector. It has also spurred the central computer agencies in the public sector in several countries to work for the establishment of norms and standards as regards both hardware and software. Action in these fields may become even more important in the coming years to meet the surge of microelectronics in information handling which we foresee.

4) Finally, in countries where automated information processing is part of the infra-structure of society it is important that people - be they politicians, senior administrators, ordinary citizens or government employees - know enough about information technology to be able to judge its merits and disadvantages and to make prudent decisions about utilization of information technology. This increase the need for education at all levels. Education may in the long run be one of the best investments governments can make in order to ensure that automated information processing in the public sector develops in a way that is beneficial to society as a whole.

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TECHNOLOGY OF EDP SYSTEMS AND THE FORMALIZED ORGANIZATION OF SOCIETY

Umberto Pellegrini

1 The technology of centralized systems in the 60's

Data processing systems, designed in a centralized configuration around the big computer, basically originated the development of informatics in the 60's. Their organization and management were intended to offer services to many users for various applications. Optimizing the efficiency of centralized systems for a wide range of applications diminished the importance of the user as an integral part of the system. As a result, the user was forced to adapt himself to the system, instead of vice-versa which is desirable.

The trend towards bigger and bigger centralized systems was however supported by the so-called "Grosh's Law" which states that computing power "P" of a system was proportional (following a constant "K") to the square of the cost "C" of the system itself:

$$P = K C^2$$

Therefore, for twice the computing power it was not advantageous to use two like systems, but a larger one which, although as expensive as two smaller systems, would give four times the computing power of each of the smaller systems.

This law had also become the basis of another trend which was dominant in the informatic industry during the 60's. It was believed that only a few, large companies had the possibility to expand in this field. Only by reaching a suitable size would it have been possible to invest in new developments which would allow the building of bigger systems, and therefore, according to Grosh, cheaper systems. As an immediate consequence, the opinion was confirmed that only the largest firm in the field could prevail and survive.

In the 60's this "law" was justified by the type of technology available for electronic components at that time. It is valid therefore with reference to discrete components and to methodologies of assembling these components.

During the 70's the new developments of LSI - Large Scale Integrated - components have greatly modified the organization and the applications of EDP systems, so much that Grosh himself agrees with the fact that nowadays his "law" may no longer be applicable.

2 The consequence of EDP centralization in the 70's

Centralized EDP systems have found powerful allies outside the technical world. On one side bureaucrats thought that these systems could satisfy the need for a perfect administration through a centralized information system; on the other side, a stronger decision-making power, which is correlated to all centralized information systems, was backing the expectations of "top management".

This trend towards EDP centralization has not always given satisfactory results. And generally, these results vary greatly if one considers separately the public and the private sector.

For instance, as far as banks are concerned, the classical EDP centralized systems with local time-sharing terminals have impressively increased the productivity of bank services. A further optimization nowadays may be obtained by means of distributed systems, thanks to which we also speak about the "cash-less society". In addition to the centralized or distributed system, the adaptation of technology to better serve both the bank customer and the bank itself was successful. In Italy, this success led some experts to attach a political connotation to the development of EDP, above all intended as depending on and subject to "capital" interests. (*)

On the contrary, several big systems conceived in the 60's for public administration did not keep their original promises and often proved to be a deception.

The most typical example in Italy, which later became a national "case", was the ATENA project for decentralized application and assessment of income tax. The original system foresaw local terminals located throughout the country, allowing the collection of various data and then conveying them to a central system for elaboration and control. In practice, the ATENA system proved to be impossible to manage and its project an unreachable aspiration.

In more limited measure, the same remark may be valid for other public projects such as the central EDP system of the Ministry of Education for managing all the administrative activities regarding more than 900.000 teachers in the country (salaries, transfers, careers, etc.). The increasing number of strikes by teaching employees was reduced only when information management for local measures was decentralized again in regional districts.

When the size and complexity of large centralized EDP systems exceed a critical threshold, it is no longer true that computing capabilities increase faster than the cost (Grosh's law), while the efficiency of the operating system and the reliability and security of the EDP system decrease. Situations are known in which 95% of the CPU's time is spent for the operating system, that is for managing and monitoring the hardware and software resources of the system. This means that only 5% of the machine time is left for the specific computations required by the user.

The situation previously described can be summarized by saying that Parkinson's law for large centralized organizations is also valid for EDP systems: beyond some critical dimensions of the system, more and more resources are required just to manage the operation of the system itself; consequently, software operating systems become less and less efficient.

(*) Paolo Manacorda - "The computer of the capital: a marxist analysis of informatics" - Feltrinelli Editore - Milano 1976.

On the other hand, if we ask ourselves why the past of EDP technology did not succeed as well in the public sector as in the private sector (i.e. Banks), a possible answer could be that in the public sector there are service monopolies while in private sector there is a competitive use for technology for the benefit of the customer and the user.

3 The technology of distributed systems in the 70's

Today, LSI technology is forcing a true revolution, both in the design conception of computers and in the linking together of systems which offer diversified performances. Local EDP units can be placed at the user's location and equipped with data communication capabilities which allow them to exchange data with other units connected in a distributed systems network.

The properties which characterize computing units of a distributed systems network are the following:

1. each unit is located on the user's premises and is directly operated by himself;

2. each unit is dedicated to a single application or to a group of similar applications;

3. each unit can exchange information with any of the other units through data communication channels.

Distributed systems, which are based on local processing capabilities and linked through data communication networks, optimize the global cost due to the fact that only the most significant data is transmitted as a result of prior local processing. Although the local units in distributed systems have lower computing speeds compared with those of large centralized systems, the processing efficiency can be the same or even higher because the local unit structure is tailored to the local dedicated application. Since the unit is dedicated to the solution of specific problems, the programming languages can be codified in conversational mode, thus resulting in easier man-machine interaction and improved programming productivity.

4 Possible consequence of decentralized organization in the 80's

In our century, the objective of scale economies has created giant and centralized industrial and service structures. Large industrial complexes were justified because dimension was synonymous with higher productivity. All the negative effects that this type of organization could have on individuals and environment were accepted as a toll for economic effectiveness.

Today, this approach is debated also on economic grounds because the new technologies of materials, transportation and multipurpose automation instruments allow decentralization of manufacturing facilities. Therefore, these up-dated technologies are overturning a secular trend in production of material goods.

Nevertheless, the decentralization of management cannot travel together with the decentralization of manufacturing facilities as long as the key resource of organization - information - remains centralized.

Microelectronics and EDP distributed systems appear today as the technologies suitable to induce decentralization in management and in service activities according to the same criteria already followed in manufacturing activities.

Now a system structure, consisting of many units with local autonomy in operation but coordinated towards a common mission, is technically feasible. As a result, the computing and memory power of microelectronics and the real-time response of data-communication networks allow the single unit to share information resources world-wide and to be a partner in the decision making. Therefore it should be possible, not only for a social or political desirability but even for economic benefit, to adapt modern technology following the needs of the single unit, rather than to structure the single unit following the constraints of a past rigid and heavy technology.

5 Concluding remarks

From previous considerations, one could argue that both of the contrasting views regarding technology applications already mentioned by professor Klaus Lenk could be supported: technology as a tool or technology as an autonomous force.

There is no doubt that during the 60's the technology of discrete or small scale integrated circuits had an inherent impetus toward centralization; but at the same time, system engineers were well aware that, at the loss of sofistication and economics and at the profit of social and political values, it would have been possible to adapt the same technology in a partaker configuration for all the interested partners.

Now, the technology of LSI and of distributed informatics is making the process of decentralization easier. But, again we must face the power structures in our society. Governments, bureaucracy, military circles, police etc., are tempted by their nature to support centralized solutions for new systems. And distributed EDP systems could be fitted indeed with an increased effectiveness for these solutions.

The various EDP technologies could be seen as a force that makes a structural solution easier in respect to others; but technology in itself is a tool, or better, a gadget, while formalized organization of a community is a management problem, or better, a political question.

For instance if we agree that the competitive use of technologies improves managerial capabilities on how to use them, we can explain why the same centralized systems of the 60's have shown a different average effectiveness when applied to private or public sector.

Now distributed systems could have more complex configuration. Yet, if applied with decentralized structures and partecipative procedure they can offer once again individual and local autonomy to our overformalized society, combined with coordination for a global objective. A socio-political transformation by many desired, often tried, but never completely attained, is becoming possible. In conclusion, it is my opinion that EDP technology must be seen as a tool for good or for evil, depending on how we use it and for what values.

Therefore, the biggest problem of our age, as Mr. Frank Barnaby states (*), is that "man, who shows an exceptional cleverness to exploit modern technologies, on the contrary is not able to develop socio-political institutions to control the use of these technologies".

(*) Frank Barnaby (Stockholm International Peace Research Institute). "The real drama of our age is that the Man, who shows an exceptional cleverness to exploit modern technologies, on the contrary is not able to develop socio-political institutions to control the use of these technologies". Da i "Problemi di Ulisse" - pag. 75 - Sansoni Editore - Firenze - Maggio '79.

The challenge in industrialized countries is no longer the control of the physical world for a quantitative growth, but the control of that extension that man has given himself with modern machines, i.e. the control of ourselves for a qualitative growth.

THE IMPROVEMENT OF THE POLICY FORMATION FUNCTION AND RELATED ORGANIZATIONAL PROBLEMS

Toru Yoshimura

1 Stages of Development of the Administrative Information System

*From the routinized large-scale data processing to its advanced utilization in policy-making.

The movement to computerize public administration can be divided into the following stages. The first stage consists of administrative information processing by means of "mechanized operation system" or "massive repetitive data processing system." This is where most government departments and agencies stand at present.

Then comes the stage of information processing through the "individual administrative information system." This system is utilized by an integral administrative unit with a distinct task to systematize its work and judgemental process; it is an unified information processing system that brings together information and administrative procedure into a single whole for a given task. It is capable of vigorous interaction with administrative decision making, and as such it should be highly effective in assisting the line officer in making judgement and decisions. There are many government departments, local governments and public bodies that have built up their own systems that approximate it in order to process information in taxation, payroll, personnel managemet, and accounting. Nevertheless, there are as yet only a handful of organizations that have perfected an individual administrative information system. Those that are yet to do so can acquire the system by systematically integrating their mechanized operations system and massive repetitive information processing systems around specific administrative tasks.

The third stage is reached when information is processed through a "policy formation information system." Generally speaking, this is an all-purpose system utilized by government in getting administrative intelligence for overall policy formation process or for planning for a specific task within a larger whole. This system is strongly interactive with administrative decision making; it is a dynamic system that collects and organizes information needed for policy formulation with dispatch and accuracy. It should be accompanied by information analysis technique as a subordinate but immediate means of policy formation, planning and prediction. Basically, the policy formation information system (in the case of local government) can be divided according to uses into: community information system which stores information relating to the status, traits, and conditions of inhabitants in a local community; the local information system that treats comprehensively and systematically, the physical conditions and utilization of land, buildings, structures, and public facilities within an area; statistical information system that compiles various statistical data yielded by the society; the internal management information system that systematically deals with finance, personnel, and physical plants of an administrative unit; and the like. Systems such as these can be maintained by means of data base systems or information exchange systems. Generally speaking, the data base system subdivides into single purpose systems and multi-purpose systems. In either case the data base system as a rule stores in one location all information available for internal use. It is accompanied by an information retrieval system. The information exchange system leaves information storage in the hands of several administrative departments while providing for a central control of all information in storage. The policy formation system calls for the introduction of computer analysis techniques as means of policy formation and prediction such as mathematical analysis, statistical method, mathematical planning method, simulation, and the like. Such techniques are coming into practical use with the development of computer technology. Strictly speaking, local governments are yet to attain the stage of utilizing the policy formation information system for processing administrative information. On the other hand, the system has already made its appearance in the long-range comprehensive planning. As the research and development of the system goes forward, it is expected to be put to wider uses.

The fourth stage is reached when administrative information is procecced through "comprehensive administrative information system." This system becomes applicable at a stage where administrative information processing has progressed all round. In order to systematize and improve the efficiency of overall administration and management in local governments, the system provides information for all administrative functions in the matrix. It freely combines and builds on the information systems of the second and third stages to constitute a dynamic integrated whole. In view of the complexity and extensiveness of local government administration, it may be difficult to realize this goal any time soon, but ought to aim in this direction ultimately.

The forgoing is a prospective view of the development of administrative information systems. To promote such development, it becomes indispensable to introduce into practical uses such computer application techniques as mathematical analysis, statistical method, mathematical planning method, simulation, and the like. They would be extremely important in realizing the goal of computerizing local government administration.

2 Changes in Environmental Conditions Surrounding Public Administration and the Active Administration

*Shift from the passive to the active administration
*Emergence of a series of societal complex problems and expectation for the problem-solving capabilities
*Establishment of the anticipatory policy system based on the scientific knowledge and information processing
*Strategy for the improvement of the policy-formation process

(A) Shift toward Active Administration and Hopes for Adjustment Functions

Major characteristics of contemporary society--resting on the stunning innovation of science and technology, particularly information techniques and systems science and related industrial technological system--are increasingly accelerated and constantly expanding change, on the one hand, and mutual dependence between social sub-systems. Social and cultural changes up to a certain stage of industrial society are rather natural, static, and pastoral. In contrast the changes of contemporary society are unnatural, artificial, and technical. In the former it took a long time for a technological system to have structural impact on the industrial society; and such an impact, its secondary effect, and the causal relationship between its social impact could be grasped by means of a simple structural model. The same thing can be said of politics, with respect to the impact of policy program. In contrast in contemporary non-pastoral society the innovations in technological systems, policical activities, policy programs development, and social transmission and the like unfold within an extremely limited time span. Furthermore, innumerable social consequences of such change are inter-related among themselves. And it is very difficult to understand the structure of such changes. But as a consequences of mutual interaction between the development of social management techniques and intellectual technologies, the innovations in science and technology immediately affects various social subsystems through the first-order, second-order, and third-order impact. Thus societal problems such as environmental, urban, educational, medical ones that have arisen of late, are typical examples. Traditional conceptual formulation, politics, economic policies, and routinized administration of the time past are no longer able to cope with the complex changes.

In the contemporary social setting in which changes have become constant, interdependence hightened, and structure more complex and enlarged in size, politics and administration take on the function of governing the management of complex social systems. They assume the role of activist politics and activist administration. This is in contrast to the passive, order-maintaining, and licensing character of traditional politics and administration. There are expectations that administrations will shift from post-hoc administration to anticipatory policy systemic types. It follows from the forgoing that policy programs frequently transcend traditional administrative divisions to become inter-departemental in character. Thus the functions of coordination assumes the key role in the administrative processes.

(B) Phases in Policy-Formation Process

(I) Identifying the policy problems and their formulation.
I-1 The process of opinion formation through mass media; extension of mass political education.
I-2 Political activities of political parties. E. Barker has once observed of the functions of political parties: "Political parties are a reservoir of public opinion, and serve as a channel for transmitting public opinion into the government." Or as a political scientist has said, "Political parties are chains that links public opinion with the government." Today, as ever, one of the major functions of political parties and political activities is to provide an input channel for public opinion so as to identify political issues.
I-3 However, in contemporary times when policy needs have multiplied, the channel provided by political parties alone is inadequate. The government itself must provide an improved policy identification mechanism through research organisation, and collection and analysis of statistics.
I-4 Once a policy task is identified, the next stage is to formulate the policy-problem, and this is primarily the role of policy makers. Political parties, especially the policy research bureaus of the governing party, is expected to perform this role.

(II) Policy formation (in the narrow sense).
II-1 Proposing a series of policy alternatives for problem solution, and readying a series of action plans. Their evaluation, deciding on the most appropriate solution, and consultation with fiscal authorities.
II-2 When the policy task is large and calls for the establishment of the policy system, check the consistency of the policy system including megapolicy, policy, policy strategy, and tactics. Check also the coordination and cooperation of administrative agents (ministries).

II-3 Adjustments with the legislature, especially the policy research bureau of the party in power.

(III) Policy decision.
III-1 Confirming the legality of the project by the authority, and enacting the statute.
III-2 Acceptance by the legislature, and accompanying enactment.

(IV) Implementing the policy.
IV-1 Administrative action.
IV-2 Public relations work with the society, peripheral policy concerning the timing of the action proposed.

(V) Policy assessment.
V-1 Identifying the reaction and response to policy.
V-2 Assessing the effect of policy.
V-3 Identifying the feedback to policy adjustment that takes account of public support for the policy and policy impact. Identifying new problems complex.

Efficiency in politics and administration refers to the sensitivity and refinement of each phase of these policy formation functions in the broader sense.

As for items I through III, development in information science and information technology should make large contributions.

Phase II consists mainly of internal administrative activities, and analyzing the mode and mechanism of these activities one must depend extensively on policy science and policy process studies. To improve internal administrative processes, it is desirable to introduce systems analysis, normative policy analysis, and a policy science approach based on the integration of behavioral sciences knowledges. Above all, in eliminating the time-lag resulting from internal coordination of government departments, creation of new administrative customs should be the subject of research.

The time-lag between the time of policy implementation and the identification of policy impact in phase IV results from the time element in the working out of social science approach directed at specific policy objective should be promoted further.

3 The Policy Analysts as Government Staff Officers and the Improvement of the Staff Function within the Administration

*The high priority on GENERALIST within the Japanese administration and its personnel promotion custom.
*The Japanese cabinet system and the weakness of the staff function (comparison with the Presidential system).
*The strong tradition of legislationism (legal perfectionalism, incompatibility with technological progress and maladjustment to uncertainty).

It is the demand of the times that public administration be energized and made more efficient. In response, efforts to increase policy formation capability is already underway in bureaucracies. In this context we are looking forward to the development of: and intensive utilization of administrative information system; the rise of policy analysis professionals with qualifications and competence to analyze processed information, formulate policy problems, and propose policy alternatives; the creation of departments or agencies with planning or coordinating functions within existing bureaucratic system; and a host of other organizational innovations.

It is already possible to launch an administrative information system itself today, but there are several large organizational obstacles in the way of introducing them into government.

We must promote public policy studies and administrative information system, increase their utilization in government, and strengthen the role of policy formation functions. In doing so we are well advised to take into account of the peculiar traits of our government and civil service, their time-honored customs, and climate.

(A) In order to improve the capability of government bureaucracies for policy formulation, it is particularly desirable to recruit administrators with policy analysis ability. For a long time past personnel management practice in our government has been to prefer so-called GENERALISTS to specialists. Ii is our opinion, however, that in view of the changes surrounding public adminisstration we should shift toward recruitment of something that combines the best of both specialist and generalist.

It should be stressed at the outset, however, that we are not in favour of promoting the so-called "specialist" rated job categories in the existing bureaucracies. These job categories are not for policy analysts as such but for those who are "in the know" about specialized division of work in a field of administration. We do not suggest that their importance will diminish in the future. Still it must be pointed out that while they serve advisory and contributory roles, they cannot assume the initiative in policy formation. The particular roles, of specialists we have in mind here-- the policy analysis specialist--must not only possess intimate knowledge of the subject of his concentration but also the capacity for formulating and structuring a policy problem, formulating policy alternatives, and policy assessment.

In connection with such recruitment changes, there arises the need to promote in-service, mid-career training or retooking of talented cadres. It seems most optimal that such training programs take place in conjunction with institutions offering graduate school education.

It is also desirable to assign candidates for policy analysis functions to research institutions that are conducting research projects having to do with scientific and technological policies. The candidates will be expected to acquire on-the-job training in administering a research project over a given period of time. (B) The next more important by far among these are: the parliamentary cabinet system in Japan; the so-called "vertical jurisdictional division" and "departmentalism"; the role and status of planning and coordinating agencies that were later grafted on the existing structure.

By tradition and in origin, our system of government administration differs from the presidential system in the United States. In the presidential system of government, all administrative powers are ultimately subordinated to the president as the chief executive officer; in recent years, the expansion of government functions has led to the enlargment of the presidental staff as a super-bureaucracy, whose supervisory role revolves around budget review. In the absence of such a system, our government has had to devise different means to deal with the problem of inter-departemental relationship, assignment of status, power, and roles within government hierarchy, and the like.

Owing 1) to the institutional origin as a parliamentary cabinet system, and 2) to the time-honored recruitment system that preferred generalist, the staff organization and function found a rather indifferent environment in our country.

For instance, this fact is necessarily reflected in the role and characteristics of advisory organs such as the "Council for Science and Technology". The Council is an advisory organ created by the Prime Minister's office to be sure; but in our system that lacks the counterpart of the special presidential assistant on science and technology policy, the Prime Minister himself has to act as the chairman under whom related ministers involved enjoy equal participations; thus reproducing the "business-as-usual" group-think. The Council is therefore unable to act as a mobile task force that its counterpart, the Presidential Science Advisory Committee can.

On the surface and in terms of organizational tables, it may appear that we have established various planning offices, bureaus, commissions, and councils that correspond to those under the presidential system. But in terms of their roles and behavior patterns, they are quite far apart from one another. The reasons for this state of affairs is as explained above.

We submit that we are in serious need of persuasive and vigorous coordinating staff based on expertise and ability. Should such staff functions be made available to the Prime Minister, he should be able to enhance his political leadership role significantly. In our public administration system heretofore, there was a painful lack of expertise-based indirect control to augment and coordinate the legally bound powers and jurisdictions of line functions. Such practices have simply remained an unexplored territory. Looking ahead to the future in which administrative tasks will multiply and expand, and environmental conditions change ever more rapidly, would it not be of incalculable benefit to foster and nourish new administrative practices as we have outlined here?

We propose that coordinating conferences of officers in charge of research and development be reinforced in every ministry concerned; that a network of policy analysis staff that cut across existing bureaucratic jurisdictions be established; and that the administration of research and development by central ministries be closely coupled with their counterparts in local governments and agencies.

4 The Decentralization of Political Power through Pluralistic Planning and Adequate Coordination

*Pluralistic planning through advanced utilization of the administrative information system.
*Competition and cooperation through pluralistic social experiments.
*Revitalization of administrative activities within local governments.

We have been promoting modernization and industrialization since the Meiji Restoration by relying consistently on highly centralized political and administrative systems. This tendency was in substance enhanced after World War II. The centralized system turned out to be highly effective in enabling us to catch up with the social development patterns of advanced western countries. But it is no longer adequate or necessary today when we have already "caught up" with the west and hence we must seek a balanced growth on our own. In the new era that is opening before us, there will be a need for fostering social progress through healthy competition among various entities and through trial and error. In an age characterized by the move "homeward to the countryside", as the saying goes, the engines of social development in the future might be innovative social experiments at the grass roots centering around local governments. If the achievements and news of successful experiments are freely transmitted among local public bodies of all areas, that may act as a stimulant to further and selfsustaining social innovation.

Surely this should provide a new foundation for liberalism and democracy in our country. In this context, the development of a administrative information system by local governments should make an important contribution toward decentralization of political power and promotion of "politics of participation".

5 The Elimination of Intelligence Gap between Public Administration and the Citizen through the Diffusion of Scientifically Processed Social Information

One can lay down the general rule that a large intelligence gap tends to develop between the client public and the policy maker in public administration as the problems handled by the latter becomes more complicated and the administrative means of solving them become sophisticated. If left uncorrected, the gap may grow into political apathy or, contrariwise, anti-establishment sentiment. In fact many a critic projects the rise of information society into the future and warn against the rise of the so-called "managed society". But this anxiety will turn out to be unfounded if the policy-maker were to constantly moniter social informations picked up by the "administrative information system", process that information in a way that is most comprehensible to the people, and offer it to them, we can help elevate from the state where they simply respond with emotional "likes" and "dislikes" to government actions to the state where they themselves partake of policy choices through rational reasoning. Again, if in the process of implementing policy programs, government can present an honest assessment of achievements to the people, it may be possible to generate a bedrock of consensus in the society at large.

THE IMPACT OF COMPUTERIZATION ON THE LABOUR MARKET

Fred Margulies

Talking about "Computers and Society" we have to ask ourselves not only what kind of computers we are talking about, as has been suggested yesterday, but also what parts of society we are concerned with. Society is not an entity. We know of the distinction between East and West, we know of the similar split between North and South, there is the well-known division between Rich and Poor (the modern subset being the "Information-rich" and the "Information-poor"), we have to distinguish between Employers and Employees, or - to use a more political term - between Exploiters and Exploited.

Conferences like ours suggest yet another division: between people, who are very concerned about their present situation and about to-morrow, and people, whose main concern seems to be the world after the year 2 000, frequently thinking in terms almost of science-fiction.

Interesting and fascinating as most of the contributions we have listened to were, I have so far identified very few indications of today's actions suited to solve tomorrow's problems. We tend to predict and interpret future scenarios as prescribed by prevailing conditions, while I see our task in prescribing our own scenario and in taking the necessary actions to accomplish it.

We speculate as to what the computer might do _to_ us, while we should rather think about what the computer (our computer!) could do _for_ us. Whether the computer will be a tool in our hands, or whether it will become an autonomous force simply depends on whether, like any other tool, it is going to be harnessed, planned and controlled, or whether it is left unattended, until it becomes harmful just like unattended water, fire or explosives.

The Austrian Trade Union Federation dealt with these problems in detail as early as 1959, at its fourth National Congress. At this congress, Prof. Fritz Sternberg from the United States gave a lecture on "The Second Industrial Revolution", at the end of which he said:

> "It will be of utmost importance to make workers and employees conscious of their own part in society. They must not ask the question: What will be the results of automation? - They've got to ask: What can we do about it? What would be the results, if things were allowed to drift along? - Workers must be made to outgrow their role as spectators and to become actors in changing technology and society". (1)

Looking at the problems on the labour market from this angle, it seems to be futile to argue about whether the computer, or the microprocessor, is a "job-killer" or not. I think, we all agree with Prof. Zemanek's statement: Technology can be made to do both: it can kill jobs as well as create new ones. The crucial question is that of the relationship between time and quantities, and this is, essentially, an economic question.

Things would equal out perfectly, if the inventors of new technology were identical with those, who apply it. This was the rule in the simple and primitive economies of former times, but it has become a rare exception in our days.

But things have also worked out fine, when for example in the sixties, tremendous advances in technology met with an equally tremendous growth in production and economy in general. A long period of full employment, rising incomes, and increased consumption was the result, which was reflected in election-slogans such as "you never had it so good before".

Today we are confronted with entirely different facts: eighteen million unemployed in the OECD area alone, while a slowdown in economic growth (caused by reduced demands, reduced income, shortage of energy and raw-materials) coincides with an increased productivity and the advent of new, cheaper and more efficient technology (microprocessors), which, in turn, leads to rationalisation and intensification of work. The result of this development is, that fewer workers are able to produce even more commodities within the same time.

Whether we are social scientists, computer-experts, economists, politicians or just simple trade union officials - we must not become Marie Antoinettes of our time: If they have no work, let them enjoy leisure time, or get prepared for the Garden of Eden.

We cannot comfort ourselves by hoping, that, in the long run, things will re-adjust themselves, since - as somebody already quoted in this connection - in the long run, we shall all be dead. If we cannot find alternatives to unemployment now, we must not be surprised, if - in spite of and contrary to - trade union policy, people take against technology and start some new sort of Luddyism, just like the desperate textile workers 150 years ago.

We are all in favour of killing inhumane jobs - jobs, that are harmful to our health and well-being, monotonous jobs, jobs, that constitute a waste of the most precious resource of our economy and society: the human brain-power. But we have to make sure, that new and more humane jobs will be offered, by applying technology and productivity in such a way as to meet the real human needs.

Nobody will deny, that such needs do exist. Even in our developed industrial societies there are still needs for better housing, better transport, better education, better health-care, better social services and, last but not least, better (i.e. humanized) work places.

Nobody will deny, that resources to meet these needs also do exist. All we have to do is, to direct these resources to where they are needed most, instead of wasting them on armaments, on economical or physical warfare.

- Do we really need a superbrain to be able to solve these problems?
- Is this too big a task for our computers and our programmers?

We do need modern technology, not to displace man, but to reactivate man's human capacities to think and to act consciously and creatively.

On the other hand, technology must not become an end in itself, but has to be seen in connection with man. In our new trade union programme for action, adopted last year, we state (2):

> "It is one of the most regrettable features of our time, that the achievements of human brains and human skills, that the accomplishments of science and technology have met with fear and resentment in so many people. We do not deny, that, in fact, severe damage might be imposed upon the individual as well as on society, as a result of unplanned and uncontrolled application of science and technology. This is why we want to make sure by planning, control and participation, that technological progress shall also become human and societal progress".

New means of production, however, call for new methods of human cooperation, i.e. new kinds of relationships within the production process. Together with the development of technology we shall have to develop complementary organizational and societal structures, which means to do away with the old-established hierarchies and privileges. A development like this never has taken place in a smooth and peaceful way, it has always met with the resistance of old societal and organizational structures, and if the change was accomplished, it was with considerable delay. This time lag has always brought about serious desproportions and those grave consequences for the individual as well as for society, that we had to experience in the past, and might experience again in the future, if we still have not learned our lesson.

If things go wrong, we must not blame the computer, we have to blame society, which is still unable to make a human use of human achievements; and we should not hesitate to change our society so as to fit our new means of production. This means, that we shall have to extend democracy to all fields of our every-day-life. We shall have to develop industrial democracy, i.e. to enable workers and employees to have an influence on, and to participate in all decisions concerning organization of work, investments, technology, etc. Democracy, as I see it, essentially means to find new solutions not <u>for</u> the people, but <u>with</u> the people. Giving not only a chance, but a choice to the people might get us a long way further towards the solution of the problems we are confronted with today.

It very well fits into this pattern, that IFIP, the International Federation for Information Processing, has established a Technical Committee, (TC9), which is to deal with the problems of "Computers and Society", and that this committee has sponsored two international conferences under the title of Human Choice and Computers.

In his opening speech at the second of these conferences, which took place in Austria in June 1979, Prof. Zemanek made the following suggestions (3):

> "Sometimes, development from now on will have to go a less rational or less economic path because a human choice requires it so. And the overall result will be better, not only for the quality of life, but also for the total system's economy, which is not anymore independent of human aspects. ...The logical yes-no-decision has a no less counterpart in the human choice. It is not an exaggeration to formulate this as a philosophy. Each bit in the hardware and in the software of our systems, each bit in the programs and data of our applications should, in principle, be complemented by a bit of human nature - and I should ... say, a little bit of human nature. Think of the power of such a little bit of human nature, if attached to every one of our logical bits. ... a similar mass of logical processing bits and human little bits in our profession and in all applications. - Such a starting point of a philosophy you may call naive, and I would agree to that. But are not the basic functions of switching algebra, negation, conjunction and disjunction, equally naive - and what were we able to

make up of them? A professional field and an industry of major importance!"

Maybe this philosophy also provides an answer to the problems of the labour market.

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A.I.P., AND THE LABOUR MARKET

Samuel Edward Finer

Mass-production of the micro-chip at a throw-away price will vastly accelerate the introduction of A.I.P. The break through is already being heralded as the Third Industrial Revolution. Its effects on the labour market have engendered a furious controversy. Some claim that it will throw a vast proportion of wage earners into enforced idleness; others argue that over time the net result will be cheaper products and increased living standards.

Analysis must proceed at three levels of decreasing generality. First come estimates of global loss of employmet. A.I.P. is not, however, applicable to all sectors or processes. The second level of analysis therefore identifies those which are likely to suffer most. But even this exercise is too general because it discounts the difference between the reaction-rates of the various national economies, and even when this is estimated, it ignores the reactions of the various Labour unions concerned. In particular it fails to distinguish between the likely reactions in the public as contrasted with the private sector.

1 Global Effects of A.I.P. on Employment

Many analysts start their speculation about this by building on the current levels of unemployment in the industrialized countries which, they anticipate, are bound to become worse, irrespective of A.I.P. The method chosen is a favourite one, which assumes a ratio between Gross Domestic Product and employment (the so-called "GDP-employment elasticity"), and associates this with two other factors namely, an assumed growth of productivity per capita, and an assumed rate of growth. Projections based on such exercises have forecast a job loss of 16% in the UK by the year 2003: in other words, 4 million unemployed at the end of the century. However, as Beenstock points out (London Business School Economic Outlook, July, 1979), such projections depend on the figures inserted into the formula. On one set of figures, the forecast will be of neverending unemployment. With different figures the result would be a never-ending labour shortage. In fact, as Beenstock states, real wages do move up and down so as to balance the supply and demand of labour.

However, unemployment due to A.I.P. is also estimated independently of such global forecasts. The Nora report (L'information et la societe) certainly rejected the optimistic notion that the French economy could find room for another 1 1/2 million employed. The SPR Unit at Sussex Univerity forecast a loss of 16% in jobs by the end of the century, and this is not very different from the projections of the Siemens report, in Germany.

The vital question is whether these losses are net irrecoverable losses, generating permanent unemployment. Such is the view taken by such observers as, for instance, Jenkins and Sherman, (The Collapse of Work, London, 1979). But this seems very naive. It adopts the "lump of work" fallacy: i.e. that there is a fixed amount of work to be done and therefore any improvements in productivity will end up in enforced unemployment. This is not the lesson of past industrial history. Indeed, the reverse is the case. The counter argument is as follows. Assume that 16% of the labour force is indeed affected by micro-processing. This will reduce the cost of the products or enable new ones to be made. This will increase purchasing power to spend either on the new products or on other ones. On this basis Beenstock has calculated that if this displacement of labour took place over the next 16 years, and even assuming a two years unemployment-stop before the offsetting labour creation effects worked through, the maximum extra unemployment of the labour force would initially be 2%. After the initial unemployment, labour demand and employment would both slowly rise; and Beenstock predicts that at the end of the 16 years, real wages would be 4% higher and employment 0.5% higher.

2 Differential Losses in Employment Due to A.I.P.

A.I.P. affects those processes which fall into a determinable and hence programmable range, and also affects some products. It does this by reducing the number of components (e.g. electronic ignition systems, in cars) and correspondingly reduces the number of sub-assembly systems, the final assembly system and the supervisory processes along this line. It also produces important spin-off effects in the number of components that have to be stocked, stored, and catalogued. (To give one example: the all-electronic System X telephone system will, it is estimated, require only 4 workers to produce, for every 40 used in the TXE4 semi-electronic system, and the 100 required by the current Crossbar/Strowger system.)

Consequently forecasts as to which type of jobs are likely to be lost, and in what proportions are more firmly founded than the global ones.

(a) Unaffected

Agricultural labour, general unskilled labouring, and - at the other extreme, top management - will not be affected. These categories amount to 4.4% of the British workforce.

(b) Minimally affected

The senior professions; the security and protection services; many personal services such as hairdressing, and the public-service personal services like education, welfare, health services, will hardly be affected aat all. These form as many as 28.4% of the British labour force.

In addition certain basic industries will also be almost unaffected. The two most important are construction-work, and mining. The workers in these form 3.6% of the labour force.

Transportation, the handling of materials and related jobs are also unlikely to be much affected either. The workers in these fields amount to another 8.4% of the labour force in Britain.

(c) High risk

These occupations fall into two classes. (1) certain classes of actual makers:

manufacturing and repairing (5.2% of the Labour force) managing (5.0%) textile and food processing work (3.2%). The second class (2) consists of supervisors in processing, making and repairing - mostly in the iron, steel, shipbuilding and automobile industries.

On the basis of the Siemens report, one might expect a 10% reduction in the sectors mentioned above.

(d) Very highly affected

The clerical and related occupations will, on the basis of the Siemens report, suffer a loss of some 40% by the mid-eighties. These occupations make up about 14.4% of the British labour force.

Another way of analysing these results is (following Siemens) to divide jobs into the "information" and "non information" sector. In the former that report anticipated 30% loss; in the latter, some 10%. Across the board this would add up to about 16% for Britain.

(Similar exercises can be performed for individual countries, by replacing the British-labour force coefficients with those for each individual country.)

3 Qualifications

A. Responses of individual economies

Some economies will adopt microprocessing more readily and in more sectors than others. It is argued that British management, for instance, shows little awareness or interest in its possibilities. In such a country microprocessing may well have a very disastrous effect on employment since, being subject to international competition, entire industries may collapse.

B. Inside individual economies: responses of the labour force itself

This may be exemplified by the following contrast: both VW and Fiat use robotics on their assembly lines, but that in the latter case, the Unions have insisted on a "no job loss" manning level. Again: in Britain the Times has been shut down for over eight months because the Unions will not accept the job-loss entailed by the "new technology" (which itself is a direct outcome of microprocessing). In general: countries whose unions collaborate with management (e.g. Germany, Sweden, Japan, USA) or alternatively, those where the unions are too weak to stand up to management (e.g. France) will fare much better than countries such as Britain where unions put full employment at the very top of their agenda and are hostile to new technology where this means job losses.

C. Private vs Public sector

A better dividing-line is between those sectors, whether public or private, that have to make a money profit, and those which do not. Thus, publicly-owned industries fall on one side of the line while administrative and service staff in the public sector fall on the other.

In the market-sectors (public or private) the introduction of microprocessing and job-shedding will ultimately be governed by international competition. We have already dealt with this.

But this will not apply to public sector service and administrative agencies. And here the following points should be noted.""

> 1. Since 1960 there has been a vast shift from industry into these sectors: equivalent in Britain to a 33% switch over, and about half that in the rest of the industrialized world. 2. In Britain certainly, but also across the rest of Europe generally, this sector is the most highly unionized in the economy. 3. As the sector is non-market, there is no yardstick by which its efficiency can be measured; will doubling the number of teachers "double" the quality of education? Will twice as much spent on the health services generate twice as much health? 4. While it would be cynical to suggest that the administrator inflates his self-importance by "empire-building" he does not have a great incentive to argue that his bureau is useless and ought to be abolished. 5. The unions rationalize their resistence to losing their jobs, on the grounds that their work is morally superior to that of their comrades in industry. The latter merely work to generate profits; they themselves generate public goods like education, health and welfare.

Yet microprocessing can make far larger job economies in this sector than in any other.

Since 1973 every government in the industrial world has contemplated economies in the public sector. Since they have failed to make significant ones, it is unsurprising that the late 1970's should have seen a number of tax revolts. The rise of the progressive party in Denmark, Proposition 13 in California and the 1979 general election in Britain foretoken this world wide trend.

At last however governments have a novel opportunity to make big reductions in this sector, since microprocessing can permit substantial job-shedding - perhaps by 30% - without reducing the quality of service. Governments would have to introduce the necessary systems, and then fail to make good wastage of the labour-force. It is quite obvious however - in Britain at any rate - that this is something that the public sector unions are prepared to resist. The reduced public expenditure would generate the capacity for substantial industrial investment, together with enhanced purchasing power. It is in this area, it seems to us, that the critical industrial battle will be fought.

COMBINATION OF MAN AND AUTOMATIC INFORMATION PROCESSING SYSTEM

Toshiro Terano

1 Long-range Outlook

In observing the process of evolution of creatures on earth (1), we find that the volume of inherited information contained in chromosomes steadily increased during the first 3 billion years after the beginning of life on earth but the growth levelled off thereafter. Contrary to this, the number of brain cells of individuals kept on increasing and after the dinosaur age, the information volume stored within the brain came to exceed the inherited information volume and it is known that the speed of evolution of creatures rapidly increased together with this.

It is said that the information volume stored in one person's brain today is equivalent to about 4000 volumes of 500 page books. Since hundred thousands kinds of books are published every year by advanced nations, the entire information volume of these books is enormous. Of course, such information no matter how abundant is worthless unless it can be freely exchanged among individuals and recalled whenever necessary. The development of the information retrieval system has made this possible. Through this means, man will come to possess a new function, which may be called the ectosomatic brain, besides his individual brain. It is predicted that the effect will be immeasurably great.

2 Systemization of Information and Systemization of Social Community

Various discussions are being made on the influence exerted by the information processing technique on the social community. Among these influences, there is the problem of "Systemization of Social Community" (2). When the prompt processing of an enormous volume of information becomes technically possible, minute inconsistencies which were hitherto overlooked in large-scale systems can be processed and delicate, microscopic and yet comprehensive management becomes possible. This is called systemization.

It goes without saying that the promotion of such a systemization is also one way for efficiently managing the human social group or social community. This is also a pursuit of an objective rationality on a group. On the other hand, there is also the thinking that a social community is a gathering of individuals and its purpose of existence is only for protecting the interests of the individuals.

In many cases, the subjective value of individuals does not accord with the above-mentioned objective value. Both are mutually related by the feedback loop called the social community environment, but, their natures are essentially contrary to each other and when the systemization of the social community is advanced, the degree of personal liberty is reduced and when personal liberty is approved, the irrationality of the social community increases. Yet, both are demands of human beings. After all, the solution to the problem lies in finding a compromise between the two upon comprehending the above-mentioned feedback structure. Democracy is also one example of these solutions.

The purpose of systemization of information is to arrange man's confused konwledge to facilitate its usage and the development of an automatic information processing system for this purpose is purely a problem of "machine". However, there are two types of relations of man with this system. One is the relation as the user of the system and the other is the relation of man as one of the data stored in the information system. Contrary to the former being a beneficiary of the information processing system, there also lies a fear that the latter will have his privacy infringed and become a victim. There are those who draw a hasty conclusion that "Information Systemization equals systemization of the social community". However, these two are entirely heterogeneous. Irrespective of the existance of the information processing system, the problem of systemization of the social community --- problem of public and private opposition --- will always exist and this is entirely a problem of "man system".

Two thousand years ago, a tyrant in China burned books and killed scholars fearing the diffusion of knowledge. However, in today's society, the progress of the information processing system cannot be stopped. If a knife falls into the hands of a killer, it will become a dangerous weapon but when a surgeon handles a knife, it is a operation knife for saving lives. It is not so difficult technically or legally to ensure that a machine is not abused by man. Preferably the deciding of the point of compromise in regard to the aforementioned public and private opposition is considered most important.

3 Information Processing System as Supplementary Brain

In observing man and machine as a whole system, we find many examples where deficiencies of machines, which should originally serve man, are conversely supplemented by man. There lies a possibility of the automatic information processing falling into a condition where man is merely involved in a flood of information and no contributions whatsoever are made on the improvement of actual living.

The outstanding merits of the automatic information processing system lie in its massive memory capacity and its accurate and prompt action of logical calculation. This is uparalleled by man. However, as H. A. Linstone has pointed out, man has a function which govers emotion and sensation on the right cerebral hemisphere and this is a source which exhibits humanity more than logic and language. Particularly, imagination, synthetic judgement, intuition, etc., possessed by man cannot possibly be expected of computers.

When observing the automatic information processing system as a "man-machine system", it would be preferable to cease copying the various functions which man alone possesses and to help the above-mentioned human functions. In other words, a hierarchy system which places man above the automatic information processing system should be developed.

The fact that automatic information processing is not completely automatic is also a problem. For example, all input data are collected, arranged, and formalized by man. This work includes the selection, and transforming of information and necessitates relying on the subjective judgement of the operators. Even though information processing is automatically performed, its program is characterized by the intention of the programmer and it is not complete. Also in the stage of using the processed information, outputs are variously interpreted and either amplified or condensed by the subjective point of view of either the user himself or the mediator. As seen here, information processing contains many processes which cannot be simply described as logical or objective, so it is necessary for users to make the final decision.

In the man-machine system, it is preferable that the output of the machine adopts the form of promoting the creative ability, judgement, intentive power, etc., as aforementioned. It may be said that evocative patterns and sentences would be more effective than numerical figures and words. This is because the interpretation of these is free and therein lies the margin for the user's intuition and imagination to work.

The automatic information processing system which possesses such "fuzzy outputs" is presently studied in many ways. The users, by engaging in a dialog with the computer, have been spurred on to a new conception and contemplative contents are also gradually being consolidated. The following can be listed as examples of this.

Computer assisted designing of machines and plants
Computer assisted instruction
Automatic scheduling
Automatic diagnosis
Science information retrieval
Word processor
Interpretive structural model

Among those listed above, there are some which possess the function of "fuzzy reasoning" and are also of great interest as a model of the communication process in which man promotes a better mutual understanding. The above-mentioned examples are man-machine system by a singular user, however, it is considered that communication involving plural persons will be performed in the near future through the mediation of the automatic information processing system and it is also anticipated that agreement forming, conflict settlement, policy evaluation, etc., will become smoother.

In the man-machine system, it is necessary that the machine always works as the competent subordinate of man and is also unobstructive. The machine should not be an artificial intelligence which aims at substituting man and must exhaustively fulfill the supplementary brain role of promoting the functions of man.

4 Conclusion

We have commented here on the relations between man and information as a combination system of man and machine. The present society is a multi-objective and multi-value society and the idea of promoting an objective rationality, that is, performing systemization for betterment of the society, is not accepted. There lies a possibility of various conflicts arising. Man must avoid this possibility by drawing on his wisdom.

If the automatic information processing system is skillfully utilized, it is considered that it will serve for such measures as forestalling opposition based on lack of knowledge, enabling avoidance of unnecessary confusion by adjusting the thinking of persons concerned, performing concrete suggestion of rebounding effects to oneself as a result of adopting a certain policy, etc.

For accomplishing an automatic information processing system which acts as such a clever subordinate, it is necessary to study in greater depth man's role in the man-machine system. For example, data must be steadily compiled on matters such as "In what cases is the creative power of man stimulated?", "What amount of information can be accepted by man?", "What condition does the mutual understanding of man indicate?", "What is the effect of mass-communications?", "In what condition does man obey or resist group decisions?", etc. This is the approach for pursuing a new harmony between man and machines.

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CHAPTER 7

THE CASE STUDY

CASE STUDY INTRODUCTION

Sixten Abrahamsson

Automated information processing has been introduced into the health care field in many areas and this will no doubt increase considerably during the 1980's. It seems appropriate, therefore, to devote sessions at this Symposium to the application of computers in health care as both Man and Society will be highly influenced by this development. The same is, of course, true for other fields but in the medical environment some special features are encountered.

There are many interesting aspects of the use of computers in health care but only a few can be mentioned here. In the following case studies we will try to illustrate how the individual can benefit from automated information processing and how the health care authorities now have an effective tool to improve and control the health care delivery system. This introduction will provide some background information where also some of the initial and current problems are taken up.

The use of computers in medicine began some 20 years ago. The expectations were great. Grand systems were drawn up on paper. Fig. 1 shows an example from about 1965 where the computer system covers all hospital functions from the delivery room to the morgue. No such system have ever become operational though costly attempts have been made.

If one look at the individual applications one finds most of them today computerized but divided on different computers and in several geographical locations.

Work was not only initiated on such large total information systems but also areas like automated diagnosis and education of medical students were tried at too early a stage leading to a negative attitude towards computers by those involved in medical care. Whereas - mainly in the USA - the business function of a hospital could be easily automated - like mainly other economic-administrative systems - understanding of the problems involved in medical systems was difficult. The transition from an idea to a working system often offered unpleasant surprises and perhaps even more so the move from a demonstration activity to a fully working system as an integral part of the routine health care operations. Many projects performed in a protected and friendly environment such as a specially selected clinic faced disaster when they were spread into other hospital units.

In addition to these problems the development was hampered by a computer technology that was not powerful enough to handle all the tasks suggested by the enthusiasts. Many projects were therefore discontinued. Even projects still alive have taken longer time than expected originally. I shall come back to that later.

A large medical information system should be made modular but the various subsystems are so intimately connected that all users come into contact with most of them. This is perhaps the major cause of difficulties as virtually one system has to serve different user categories. When designing a system its effect on the working environment and working conditions of all users should be considered (according to Swedish legislation such a procedure is now mandatory). In large organizations every user cannot be consulted so that in practice design questions have to be discussed between various selected groups. This is an inherent weakness as new persons being employed in health care are faced with an information processing system the design of which they have not had a chance to influence.

The various user categories can have widely different views about system function and information content. The physicians might want data that aids him in his diagnostic and treatment procedures whereas the politicians and administrators - who often put up the money for the information system - need information on all activities in health care and the associated resource consumption both for long-term and short-term planning. The data on the otherhand is fed into the system mostly by nurses and medical secretaries who might feel that they hereby get an extra workload rather than a relief in their normal daily duties.

The patient's situation is unsatisfactory in that he can influence system design rather little. His interests, though, seem to be taken care of by the other user groups and most medical systems contain functions to make faster and better care possible. They fear on the other hand that the patient's privacy is threatened by the storage of personal data in information systems. These also usually contain rigorous security systems to prevent access to files by unauthorized persons. Sweden has as the first country in the world adopted a data privace act. According to that every patient may once a year free of charge request a copy of his medical data. This right is used surprisingly little which might indicate that the patient is less worried than the other user groups about his data being present in medical data banks. After all this could be of help to him in contrast to the information on him in many other computer systems in Society which is of pure control nature.

The demand for health care is constantly increasing. It is a labour intensive industry - in 1990 every tenth employment opportunity in Sweden will be found in health care. The costs are also taking an unproportionally high share of the total economical resources in developed countries. If the problems of the developing countries are to be handled the requirements on health care operations will be tremendous with direct effects on the developed countries. It is difficult to see how the decision "health for all by the year 2000" - at a recent world conference can be fulfilled without the use of advanced support systems including computers.

No one appears to believe that the demand for health care can be saturated. It therefore is essential to try to arrive at a better utilization of existing resources and at an optimal planning of future facilities and care. Some pessimistic politicians claim that this is impossible - health care grows uncontrollably. This is, of course, not true in times of shortage of funds and personnel. A selfregulation takes place in the sense that care units are closed down and the remaining ones get more crowded. Investment in new technical equipment which would help both patients and staff becomes low. Such a state of affairs is not compatible with the wish to provide better health care to more people. Work on a more effective health care delivery system must therefore be pursued. In this context it is important to investigate the interplay between demand and resources. Professor Atsumi will during this case study show how computer simulation can be used how to forecast allocation of medical resources. This is a very effective technique with which many alternatives can be tested without having to make costly changes to the current organization.

Resource scheduling can serve as an illustration to my discussion earlier of the combined difficulties when designing medical computer systems. Booking of flights and seats on trains has worked well for a number of years. Bed scheduling in hospitals is more difficult as you have to take into account that the larger number of reserve beds you allow the lower you utilize your resources. The real problems show up in medical service units such as the clinical physiology laboratories where both staff and apparatus during one patient's visit are simultaneously used for other patients. In order to make a workable resource list staff and apparatus have to be "divided" into part resources. An algorithm to use these part resources efficiently is extremely difficult to construct. The alternative is to book a number of patients to the same time and allow a somewhat less efficient use of these resources.

The requirement of an efficient use of all resources can be one cause of the user conflicts which I earlier referred to. A resource scheduling system is a very efficient control tool in hands of the administrators. They can exactly follow the number of patients a physician sees per day and the load on the medical service units. An ambition to increase the resource utilization which from what I said before is desirable might lead to an intolerable working situation for all or part of those involved in medical care.

The two case studies on Wednesday and Thursday will deal with the comprehensive medical information system of Stockholm County. Dr. Peterson will take up two aspects: care programs in oncology and the total registration of patient visits and its implication on the planning function.

Stockholm County is one of the medical regions in Sweden (Fig. 2) responsible for the health care of its about 1.5 million inhabitants. The system covers the entire region and represents a major development in automated information processing in health care. It has been in operation for many years and it is now possible to perform studies of its effect on medical care and planning.

The County system is unique in being centered round a population file with basic information on all inhabitants. It is updated with medical data at every patient visit. The information is instantly available via terminals to all authorized users.

The file is extremely valuable for total system operation as it acts as a co-ordinator for the activities in all hospitals. The usually tedious input from terminals is greatly facilitated as all the basic information such as name and address can be automatically fetched from the population file. The patient can get faster treatment as he does not need to inform the terminal operator on registration when and where he has been treated earlier. This is stored in the file so at a scheduled visit all necessary records can be ordered in advance from the hospitals where he has been treated earlier.

The file has been in operation for many years and contains a wealth of information for research, follow-up and planning. The real consumption of health care resources can now be studied in relation to the expected one based on the prognosed morbidity for the population in various regions of the County (Figs. 3 and 4). The overconsumption in certain areas can be explained by socio-economic factors whereas in others it is more difficult to understand. The health care administrators now have a total picture of the resource overconsumption and should initiate work together with other involved authorities to correct the situation.

The total population file offers in addition possibilities to detect changes in the panorama of diseases. By means of long-term storage of data harmful effects of drugs or the environment on the individual can be traced at the earliest possible time.

Total population files have been discussed in other countries but various reasons such as privacy and patient identification problems have been raised against the establishment of such files. High cost has also been mentioned in this connection. I should point out though that the population file represents less than 10 per cent of the total computer expenditure of Stockholm County.

Swedish long-term studies using the total population file might in some cases be of international value. National conditions, however, often determine the incidence of diseases and then similar research would be difficult without national population files.

Dr. Peterson will elaborate further on how the County system have been used in these respects. Still only part of the information has been used for analyses relevant to health care functions. The reason for this is partly lack of personnel to perform this work partly deficiencies in human communications. An increased education is necessary before the non-technical potential user can appreciate the full value of the system.

So far I have been talking about the past and mentioned several problems including the limitations of earlier computers. What can we now expect in the near future in light of the dramatic technical advances during the last years? The cost of computer mainframes is decreasing rapidly and peripheral devices and communications are steadily improved. It therefore appears that the cost of automated information processing in health care would go down and make it feasible for an increased number of authorities to introduce the technique. However, we still need personnel for system design, programming and system operation. As salaries are steadily increasing the reduction of the total cost for an information system is comparatively small. Admittedly the computer manufacturers now provide us with basic software as such data base and communication systems allowing projects to concentrate on the application part. This removes some of the costs but what is really needed is more effective system design and programming aids on the market which would allow a radical reduction in the time to construct an information processing system.

Costs might be shared if a system could be transferred from one health care authority to another. Here we meet two types of difficulties. One is technical. A program is usually not directly transferable between computers from different manufacturers and often not even between different computers of the same manufacturer. A shift to modern hardware thus often requires costly reprogramming. It is amazing why computer users cannot exert a stronger pressure on manufacturers to make application software portable.

The other difficulty concerns systems function. I can fully understand that both language problems and differences in national health care organizations make transfers of systems between countries less feasible. Some successful attempts, though, have been made to transfer basic functions such as file structure and terminal handling. What then about transfer of systems to other medical regions in Sweden? It is sad to note that though we have had co-ordinating bodies for many years practically no working system has been adopted by another health care authority. Differencies in size and organization of the Counties are emphasized but I find that less convincing in a country with a rather homogenous health care structure. I think myself that the technical development is to blame.

All computer manufacturers thought that the health care field would become a good source of income and made great efforts to sell computers to the Counties. From what I just said about technical portability the mere fact that Counties had different computers prevented exchange of programs. The technical question if the systems should be real time or batch oriented was also of hindrance to co-operation. With this background in mind I have some fears for the rapid technical development nowadays.

Advances in communications make it feasible to use a number of smaller computers instead of a central large one. Distributed computing has become a concept of fashion and the technical term has now almost a working condition value attached to it. An own computer in the clinic appears to the staff more satisfactory than a remote central computer though they never see more than the terminals! I think personally that distributed computing will increase as intercomputer communications software improves. A number of linked smaller computers have an advantage in being less vulnerable than one central computer with the same total capacity. On the other hand they represent a more complex structure in a large information system with communication between files on different computers. The operational facilities and staff are also more expensive and difficult to co-ordinate.

Discussions of this sort will no doubt be vigorous during the next few years and might cause confusion among the decision makers in health care. It would be highly undesirable if this would happen as it would draw attention to technical questions rather than to the real information processing problems in health care. Already now hesitation concerning which way to go has delayed several projects. For a large system like that of Stockholm County it is clear to me that both central and local computing power is needed in the future.

The smaller computers - micro- or minicomputers will be in a different situation compared to the large systems. They will be found in special, stand-alone equipment where they require no or little attention by computer specialists. Examples are found in the service units - clinical chemistry and physiology - where they perform data collection from instruments analyze the data and present it in a form requested by the physicians. Such computer applications easily become cost-effective and will increase rapidly in the future.

Very small computers can also be used with advantage for "non-instrumental" medical applications which require no direct connection with the main information system. In UK a system has been developed for computer assisted diagnosis. (The term automated diagnosis is today largely avoided). It was tested on patients with acute abdominal pain. Junior physicians had before the installation of the system a rather low percentage of correct diagnoses compared to a specialist. With the computer system reminding the young doctors during the diagnosis and suggesting actions their ability soon improved to that of the specialist. In order to test if this was a normal learning procedure instead of an effect of the system the computer was removed and it was indeed found that the young doctors' percentage of correct diagnoses went down to their original values.

This low-cost system is thus of value both to the patient and the hospital for instance by increasing the number of correct diagnoses thereby reducing the number of unnecessary costly surgical operations. The system was considered so important that it has been transferred to another country. Here a different portability problem appeared. Apart from having to change the language the symptom list had to be reworked strangely enough to give correct diagnoses.

One final comment about the technical development. Though the terminals can perform more functions than before by the introduction of microcomputers they look largely as before and are not designed with the operator in mind. Whereas a secretary can work for several hours at a typewriter she need to pause after a short time's session at a terminal. The terminal is also usually made very general so that it can be utilized in all possible applications. This makes them expensive to use when only a few functions are needed. The manufacturers are, however, also in this case rather indifferent in meeting the users needs. Dr. Peterson will describe how all outpatient visits in the County will be recorded and stored in the population file. As they approach 4 million per year the data collection would be formidable - if not impossible - on a conventional terminal. After many approaches to manufacturers the production of a special terminal is now finally in progress.

In summary: Most functions in health care can be automated with the technology of today. In the future microcomputers will make stand-alone systems for various applications very common in health care. In order to reach a better resource utilization, better planning, improved care and improved protection from harmful effects from the environment an interplay between various subsystems is necessary. Such an integrated information processing system will consist on a hierarchy of computers. Though considerable experience have accumulated concerning the special human problems in designing medical information systems much remains to be done before we can arrive at systems that can help us approach the WHO goal for health care: complete wellbeing.

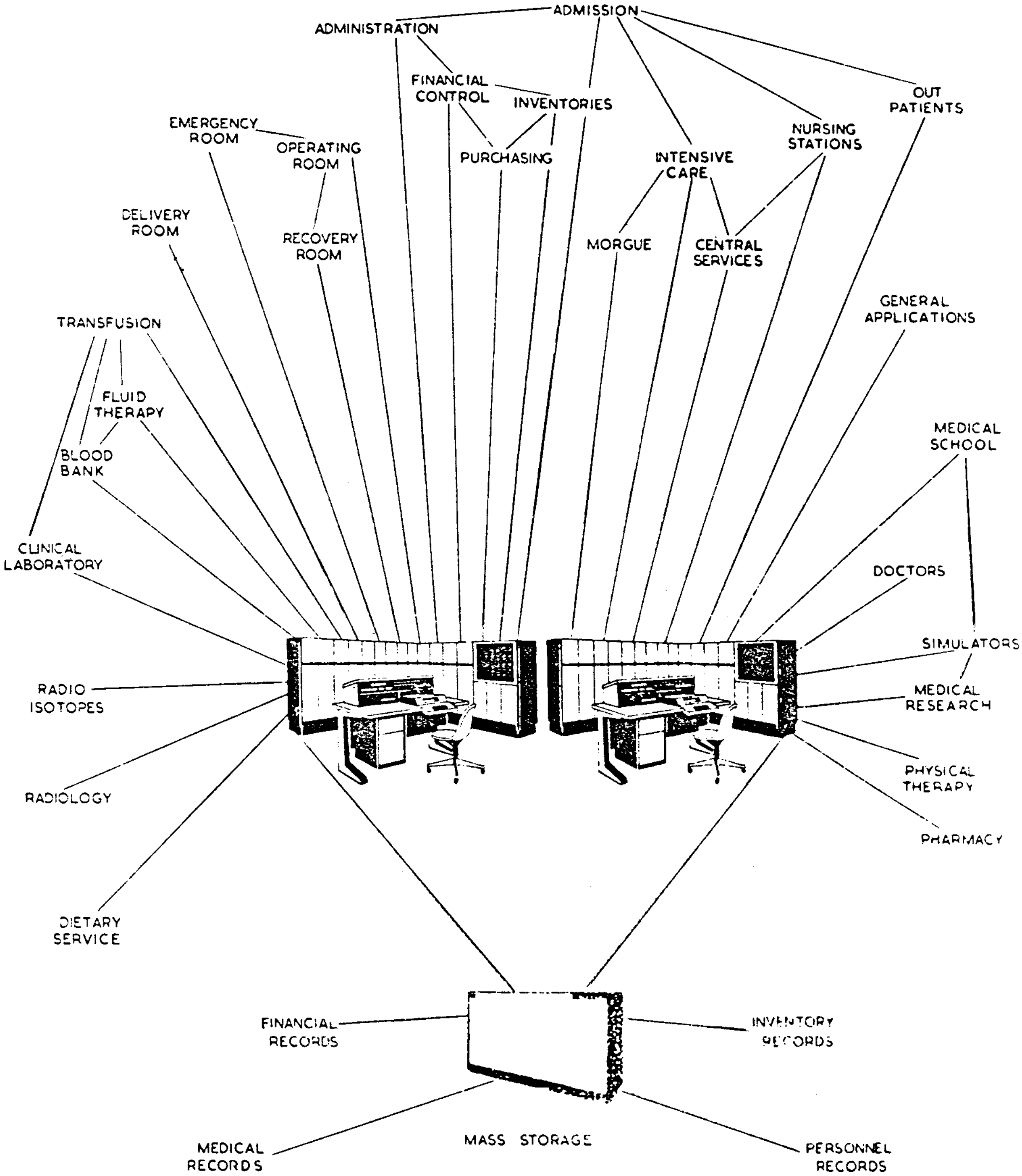
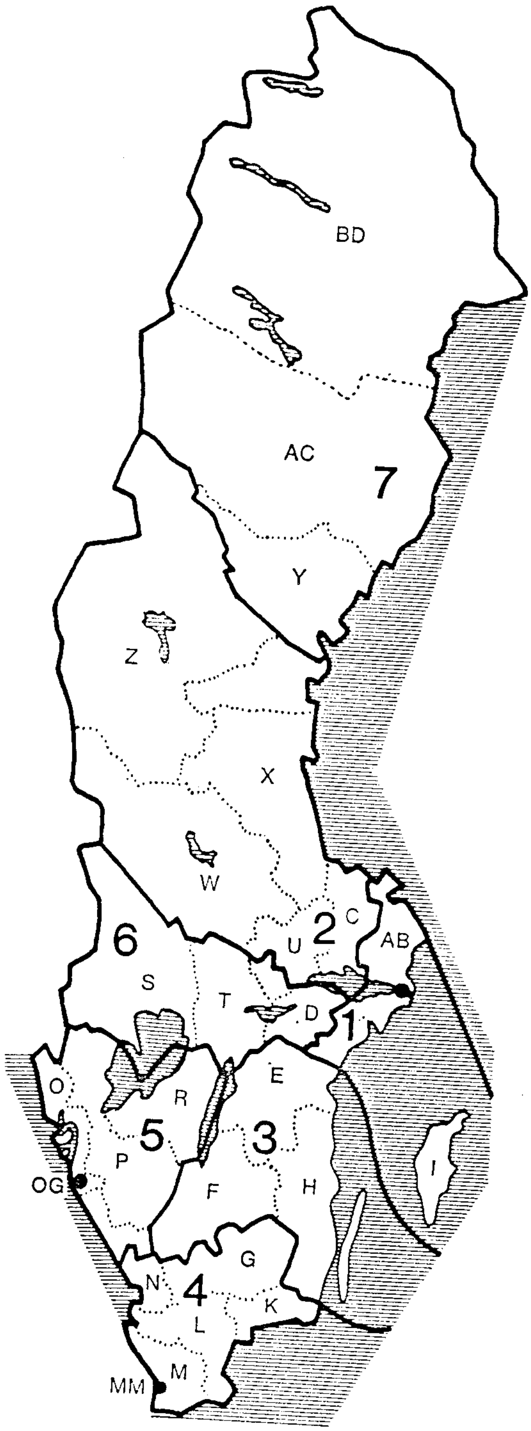


Fig. 1.

Sketch of a total integrated hospital information system from about 1965. Only few of the possible interlinks are drawn.



DISTRICTS AND REGIONS FOR HEALTH AND MEDICAL CARE

HEALTH AND MEDICAL CARE DISTRICTS:

County Councils districts:

AB = Stockholm
C = Uppsala
D = Södermanland
E = Östergötland
F = Jönköping
G = Kronoberg
H = Kalmar
K = Blekinge
L = Kristianstad
M = Malmöhus
N = Halland
O = Göteborgs & Bohus
P = Älvsborg
R = Skaraborg
S = Värmland
T = Örebro
U = Västmanland
W = Kopparberg
X = Gävleborg
Y = Västernorrland
Z = Jämtland
AC = Västerbotten
BD = Norrbotten

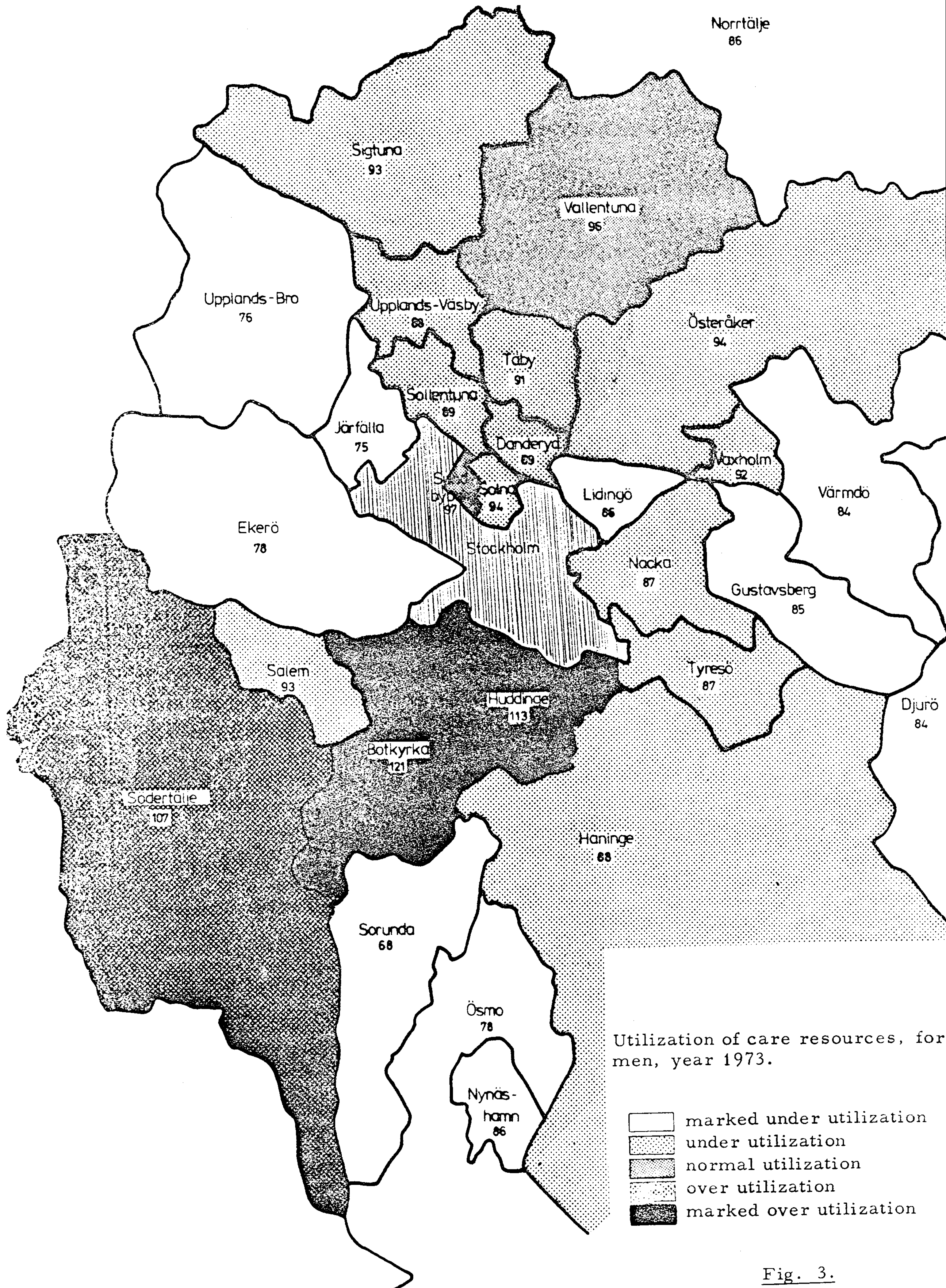
Municipalities outside the county councils:

I = Gotland
MM = Malmö
OG = Göteborg

POPULATION 1/1 1971 IN THE HEALTH AND MEDICAL CARE REGIONS OF:

1.	Stockholm	1 605 596
2.	Uppsala	1 247 440
3.	Linköping	931 027
4.	Lund-Malmö	1 432 731
5.	Göteborg	1 446 834
6.	Örebro	788 977
7.	Umeå	639 177
		8 091 782

Fig. 2.



Utilization of care resources, for men, year 1973.

Fig. 3.

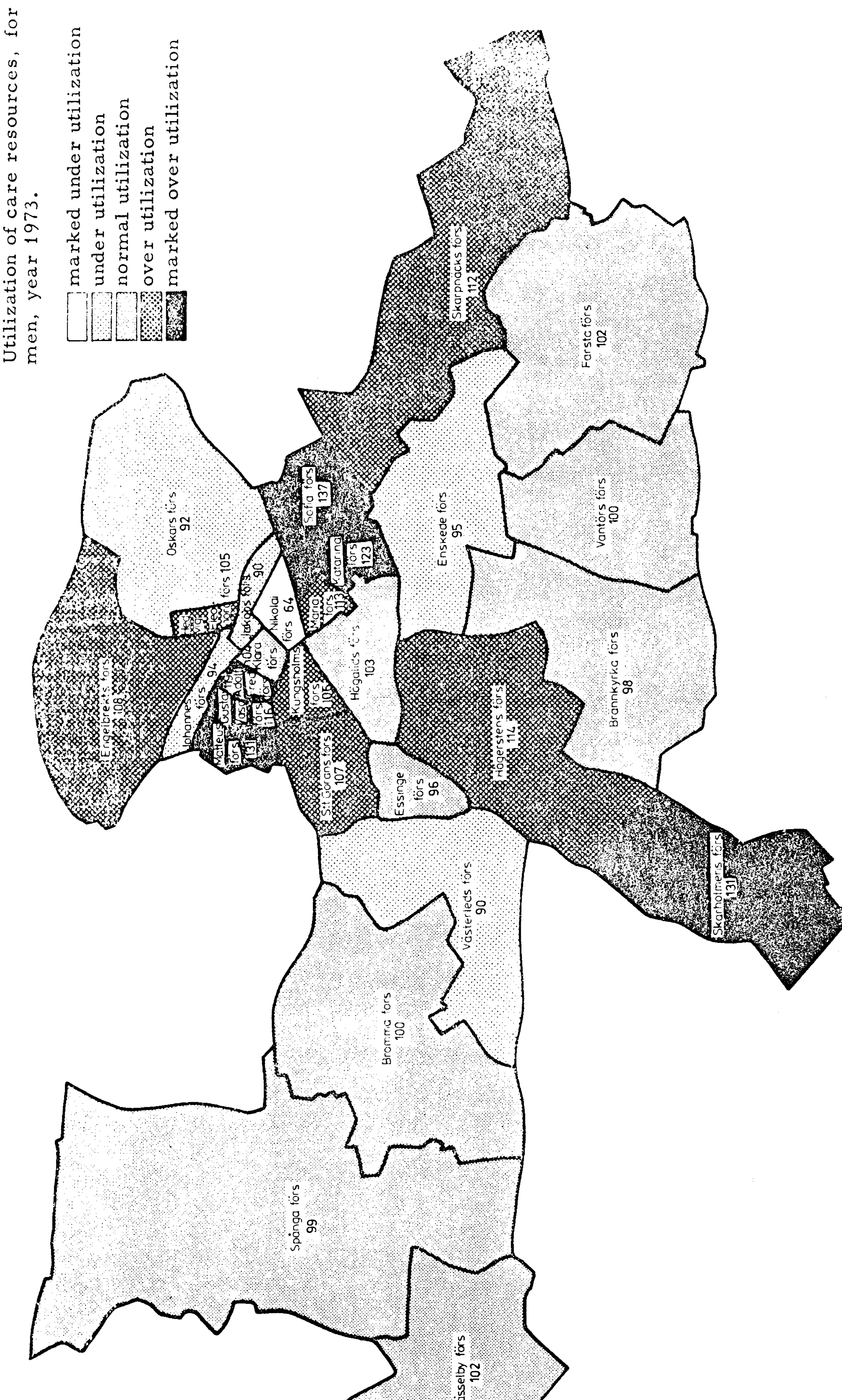

Utilization of care resources, for men, year 1973.
marked under utilization
under utilization
normal utilization
over utilization
marked over utilization
Oskars förs 92
Engelbrekts förs 108
Johannes förs 94
Jakobs förs 90
Nikolai förs 64
Klara förs
Kungsholms förs 105
Matteus förs 131
St Görans förs 107
Essinge förs 96
Sofia förs 137
Katarina förs 123
Högalids förs 103
Enskede förs 95
Skarpnäcks förs 112
Farsta förs 102
Vantörs förs 100
Brännkyrka förs 98
Hägerstens förs 114
Skarholmens förs 131
Västerleds förs 90
Bromma förs 100
Spånga förs 99
102

Fig. 4.

FORECASTING ON MEDICAL RESOURCES AND THEIR ALLOCATION BY THE METHOD OF A SIMULATION MODEL

Kazuhiko Atsumi

Preface

The medical demands have been increasing year by year in developed countries as well as in developing countries, however the medical resources are limited. Therefore, the medical resource allocation is considered as the important problem throughout the world. For this solution, modeling methods has been studied and applied in the field of estimation on medical demand.

Submodels of Health Care

The health care system is a complicated system related to various social and economic factors. The building of a model that includes all these factors may be too complicated; hence it is necessary to divide the health care system into several submodels. We therefore divided the health care system into five models as follows. (Fig. (1), (2) Table (1)).

Demand Model, The demand submodel compirses three models. The first, the population model, estimates the number of persons classified by age and sex in the projection of future years. This type of population model has been fully investigated by researches of population phenomena.

The second, the morbidity model, analyzes the factors related to the incidence of dieases. Since these are not single, the factors must be analyzed and a model built according to different types of diseases. In the study, the diseases were classified into four groups.

In the demand-supply model, the process related to transferring latent sick to registered patients is analyzed. In some diseases, the factors related to awareness rate must be analyzed. Most of these factors are social or economic. Medical supply is another important factor related to this process.

Resource Model: Health care resources will be analyzed in relation to various other social or economic factors. The main variables are the number of health care personnel and hospital beds.

Resource Allocation Model: At this level of model development, the problem of HCS resouce distribution will be analyzed according to population composition and geographic and perhaps other peculiarities, taking into account different objectives of health care management.

All these submodels are necessary as components of the health care system. As the first step toward building such models, we describe the modelling of the morbidity of degenerative diseases.

MORBIDITY MODEL OF DEGENERATIVE DISEASES

Classification of Diseases

There are various kinds of diseases whose origins have different characteristics. In the morbidity model, diseases must be classified according to the nature of their causes.

Degenerative diseases are inherent to human beings, as they are due to the aging process. In these diseases, the morbidity rate usually increases with age. In this study, three groups of diseases are defined as degenerative:

- Cardiovascular diseases (ICD A80-A88);
- Malignant neoplasms (ICD A45-A60);
- Senile deaths and deaths from unknown causes (ICD A136-A137).

We included senile deaths and deaths from unknown causes because in some countries, especially in developing countries, death in old age is classified as a senile death when the cause is unknown.

The second type of disease is infectious disease. They are of external origin, and can therefore be prevented by removing the cause. It is also possible to recover completely from such diseases. The morbidity and recovery rates are generally influenced by the level of preventive and therapeutic medicine. There are two types of infectious diseases - gastrointestinal and respiratory. In the model, these two will be treated separately.

The third type of disease is also of external origin, but the cause is the progress of civilization. Since technology cannot be compared to microorganisms, this type of disease must be differentiated from infectious disease. Diseases due to labor accidents, to pollutants, to urbanization are examples. These diseases will increase with the progress of civilization unless countermeasures are taken.

Malnutrition is the cause of the fourth type of disease, which is often related to infant deaths. Since infant mortality relfects different factors than adult diseases, this will be analyzed in this category in the study.

Assumptions in the Degenerative Disease Model

In the morbidity model of degenerative diseases, the following assumptions were introduced about the nature of degenerative diseases.

- The morbidity rate, MR(i), of the degenerative disease depends only upon the age (i).

- Sick people suffering from degenerative diseases never recover; this means that the recovery rate, RECOV (i), of degenerative diseases is equal to zero.

- Persons who became ill will die after a certain definite time.

The mean of the time, defined as duration of illness (T), is dependent only on the type of disease.

The duration times used in the calculation are 2 years for malignant diseases and 15 years for cardiovascular diseases.

Structure of the Degenerative Disease Model

The structure of the morbidity model to degenerative diseases is illustrated in Figure (3). The population of each age group is divided into two groups: healthy persons, HP(i), and sick persons TS(i). The sick include latent patients. The transfer rate from the healthy to the sick stage is defined as the morbidity rate, MR(i), and that from the sick stage to death as the death rate, DR(i). The death rate per total population, in the age group is referred to as DRPN(i). The recovery rate, RECOV(i), is 0 according to the assumption, and the morbidity rates are given in each age group. We also assumed that the persons who become ill will die after a certain time. With this structure, the only input required for the model is the number of population in each age group; if that is given, all other variables can be calculated from equations (1) to (3):

$$TS(i) = \sum_{j=i-T}^{j=i-1} HP(j)\,MR(j), \qquad (1)$$

$$HP(i) = PN(i) - TS(i), \qquad (2)$$

$$DRPN(i) = \frac{HP(i-T)\,MR(i-T)}{PN(i)} \qquad (3)$$

In the first several age groups, since the morbidity rate is 0, HP(i) is given by equation (4):

$$HP(i) = PN(i). \qquad (4)$$

Accordingly, equations (1) to (3) can be calculated successively from the younger to the older age groups only if the population structures are given.

Estimation of Morbidity Rate and Duration of Sickness

If death rates per population DRPN(i) are given, the morbidity rates can be obtained from equation (5) by procedures similar to those described in the previous section:

$$MR(i) = \frac{DRPN(i+T)\,PN(i+T)}{HP(i)} \qquad (5)$$

Here it is necessary to assume that the population structure is stable for the duration of the sickness. In developed countries, fairly reliable statistics of death rates, DRPN(i), can be obtained. (Fig. (4), (5)). Accordingly, if the duration of sickness (T) is determined, these morbidity rates can be calculated. (Table (2), Fig. (6)).

The morbidity rates and duration of sickness used in this model are based mainly on the data of Austria. We chose Austria because the population structure is stable and the number of senile deaths or deaths of unknown causes is very small. Thus the statistics were considered reliable.

Results of Calculations

To test the validity of the model, we applied it to various countries, using the data of the Philippines, Mexico, Japan, England and Sweden. In the calculation, a population structure of five-year intervals was used as initial data. It was then further divided into one-year intervals, and the viriables for outputs were calculated separately for cardiovascular and malignant diseases. The results for the two diseases were then combined to obtain an estimation of prevalence for the degenerative diseases. The death rates thus obtained were compared with the figures from WHO statistics. Figure (7) gives a comparison of total death rates in the countries tested, and Figure (8) shows the death rates in each age group. We believe that the agreement is in a reasonable range.

Application of the Morbidity Model of Degenerative Diseases

The first application area will be an international or regional comparison of the death rates for, or number of patients with, degenerative diseases. (Fig. (9), (10), (11)). In addition to the death rates estimated the model also gives the total number of sick persons with degenerative diseases. If statistics for patients with degenerative diseases are available, it is of interest to compare them with the results obtained from the model. A difference between the two figures would imply the presence of latent patients who have the possibility of seeking medical care. Analysis of the factors causing this difference will be important; and this will be the subject of the next study, namely the resource utilization model.

The second application of the model is the projection to the future of trends in the degenerative diseases. Various methods have been developed to estimate the future population structure. If the population and morbidity models are combined, the future trends in degenerative diseases are easily calculated, since the morbidity model is dependent only on the age structure of the population.

Figures (12, 13, 14, 15, 16, 17) are examples of the calculations. The aging index used in the figure is defined as follows:

$$\text{aging index} = \frac{\text{number of people older than 65 years}}{\text{number of people younger than 15 years}} \quad . \qquad (6)$$

For these examples, two representative countries were taken. As is easily seen in the figures (12, 13, 14), the prevalence of degenerative diseases in England decreases gradually, while that of Japan (Fig. (15), (16), (17)) sharply increases toward the year 2000.

The third application of the model may be the evaluation of treatments for degenerative diseases. At present, there is no effective treatment that prolongs the life of these patients. However, if such treatments are developed, the model will be useful for assessing the decrease of death rate or the increase of the number of patients before the treatments are actually introduced.

Medical demand model to estimate medical care cost

1 Introduction

Medical demand is basically defined by the number of patients including latent patients.

The number of patients segregated by each disease can be estimated bu utilizing morbidity models.

In the present status, most patients have degenerative diseases and infectious and acute diseases, as shown in Figure (18) and (19). Therefore, most of the medical care expenditure is mainly occupied by the costs involved in caring for patients with these two diseases.

Therefore, if the estimated number of patients with biologically generated diseases is the universal morbidity model the maximum national medical care cost can be estimated. Afterward, international comparison on medical care costs will be possible.

2 Estimation on Annual Inpatient Care Cost per Capita

In this paper, the various diseases were classified into eighteen groups. (Table (3)). The population strata of developed countries are calculated from WHO's statistics.

From data on population and the prevalence rate of diseases (Table (4), (5)), the number of sick people by category and the total number of sick people per day are calculated (Table (6)).

General flow chart of the demand model to estimate medical care cost is shown in figure (20).

These patients are divided into two numbers of inpatients and outpatients visits per day, based on the ratio of inpatients and outpatients. (Table (7)).

The standardized number of annual bed days per capita for inpatients is calculated by multiplying by 365 days and dividing by the population in each age stratum. (Fig. (21), Table (8)). From the data multiplying the number by hospital care cost rate, which is also sampling values from a Japanese inpatient cost survey, the annual inpatient care cost per capita for a target country can be calculated on a standardized country basis. (Table (9)).

3 Estimation on Bed Utility Ration and Cost Ration

It is possible to estimate the annual inpatient and outpatient care cost for each target country through a real medical care cost survey.

However, the length of stay in hospitals differs in each country. Therefore, if it is desired to compare the real cost and the estimated cost of the other countries by Japan's standard, the same indices should be introduced. (Fig. (22)). The standard bed days should be corrected by the ratio of the domestic length of stay and the standard length of stay. From this ratio and the annual number of bed days per capita for the patients, the weighted inpatient number is calculated. The weighted inpatient number means how many patients can be handled in the standard country data for the same length of stay on the target country.

Then, from the weighted inpatient number and the domestic inpatient number, that are easily attainable from the national statistics, the bed utility ratio is calculated, which means the efficiency rate of inpatient care.

$$\text{Bed utility ratio} = \frac{\text{domestic inpatient number}}{\text{weighted inpatient number}}$$

Therefore, utilizing these data, the cost ratio is calculated which means the cost ratio per one inpatient.

$$\text{Cost ratio} = \frac{1}{\text{bed utility ratio}} \times \frac{\text{domestic annual inpatient care cost}}{\text{(estimated) total annual inpatient care cost}}$$

4. RESULT

Medical care cost for inpatient and outpatient, bed utility ratio and cost ratio were estimated in Japan, in the U.S.A. and in England and Wales. (Table (10)).

a) Population

Population data, computed from the population model in Japan, the U.S.A. and England in 1974, are 110, 211.4 and 49.2 (millions). Actual statistics in 1975 in each contry are 103.5, 204.9 and 46.5 (millions), respectively.

b) Demand

Bed days for inpatient per 1,000 people, per year in Japan, the U.S.A. and England are 2,500, 1,400 and 2,130, respectively, based on statistics from these countries.

The bed days for inpatient, calculated from the model utilizing Japanese standard data, are 2,540 in Japan, 2,820 in the U.S.A. and 3,040 in England. However, average length of stay is 44.5 days in Japan, 9.5 days in the U.S.A. and 20.1 days in England.

Therefore, calculated bed utility ratios in each country are 1.00 in Japan, 2.39 in the U.S.A. and 1.55 in England.

c) Expenditure

Finally, calculated cost ratios are 0.62 in the U.S.A. and 0.73 in England, compared with the 1.12 value for Japan.

In comparison with the value of this cost ratio, the result shows that the U.S.A. (0.62) and England and Wales (0.73) are more efficient in cost/performance in medical care, compared with Japan (1.12).

RESOURCE ALLOCATION MODEL

From the population and morbidity model, the medical demand can be calculated. (Fig. (23)).

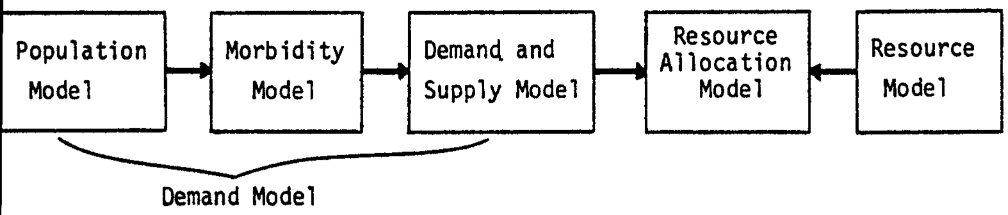
Furthermore, if the ideal standards are estimated and the policies of treatment and prevention are determined, the resource needs can be estimated.

However, this estimation means an unconstrained stage of planning.

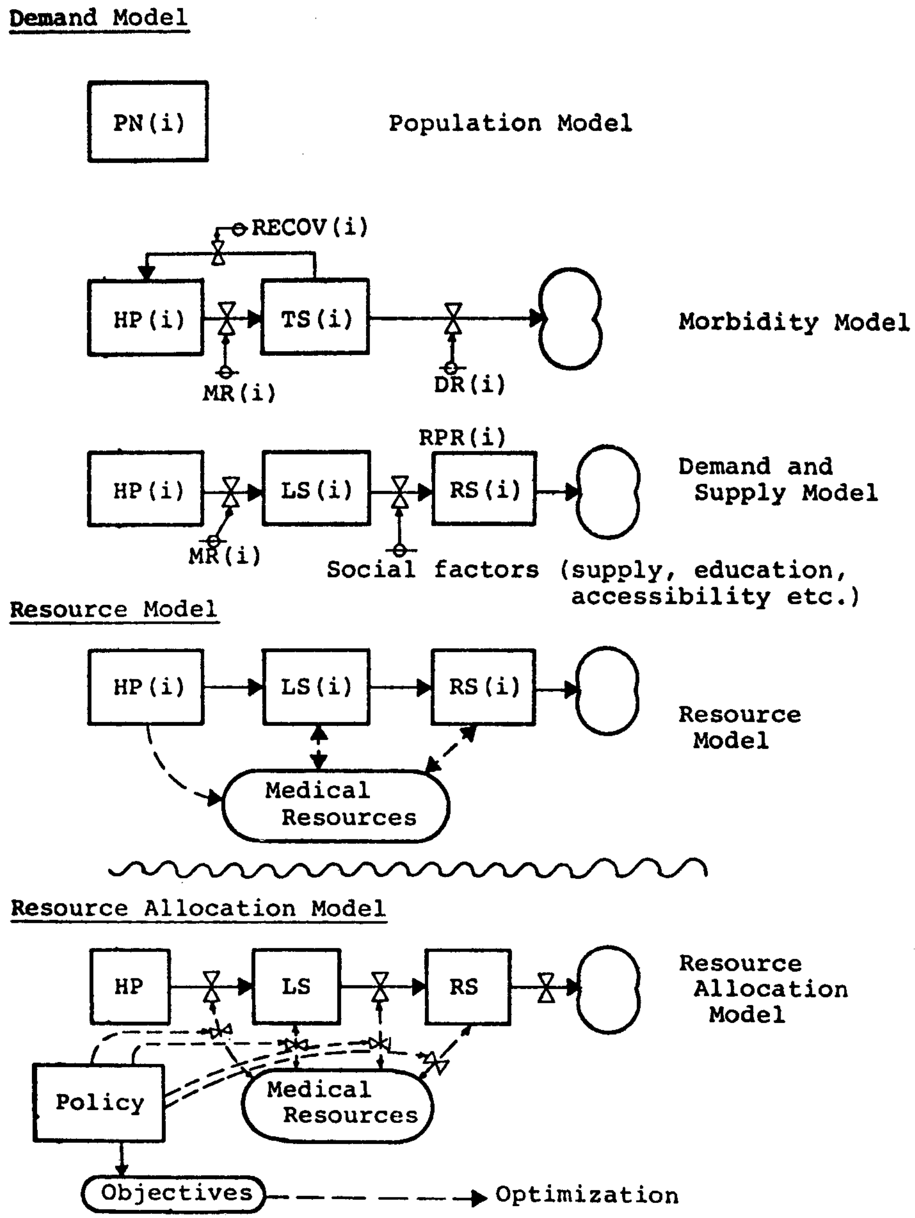
In actual circumstances of health care, medical resources ---- man power, facilities, economy etc. ---- are limited.

Therefore, in order to allocate the limited resources for medical needs effectively, appropriate options on policies and standards should be decided by the decision maker.

Furthermore, if the prognosis model and feedback loops to population model are considered, the whole model will approach to more complete stage. (Fig. (24)).



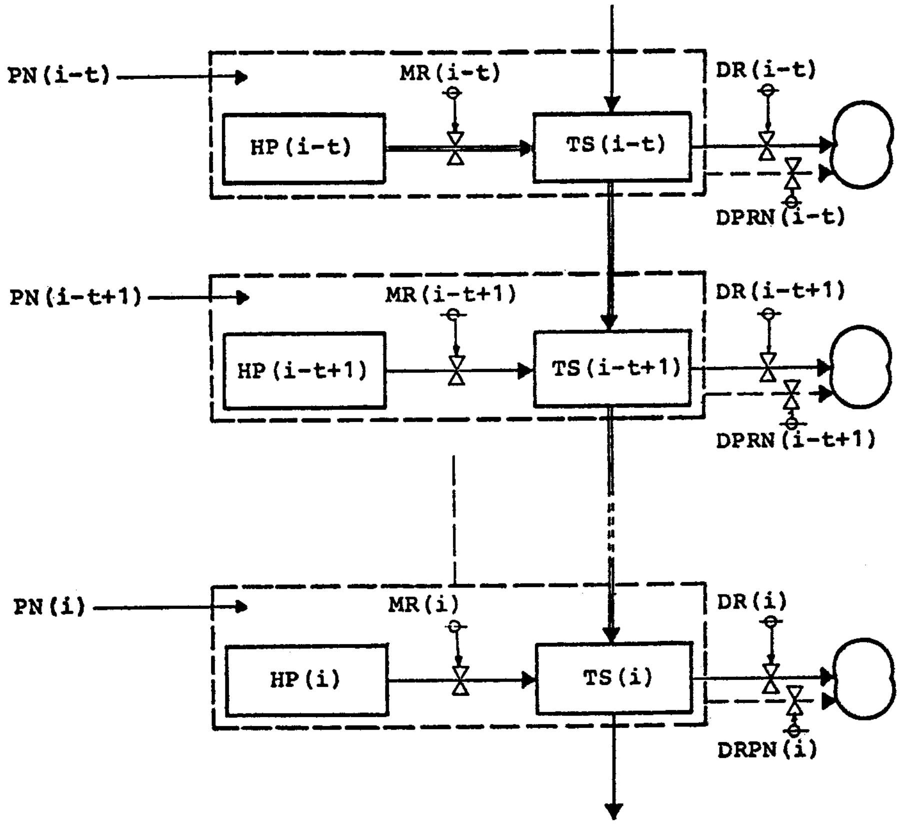
Figure(1) Submodels of Health Care



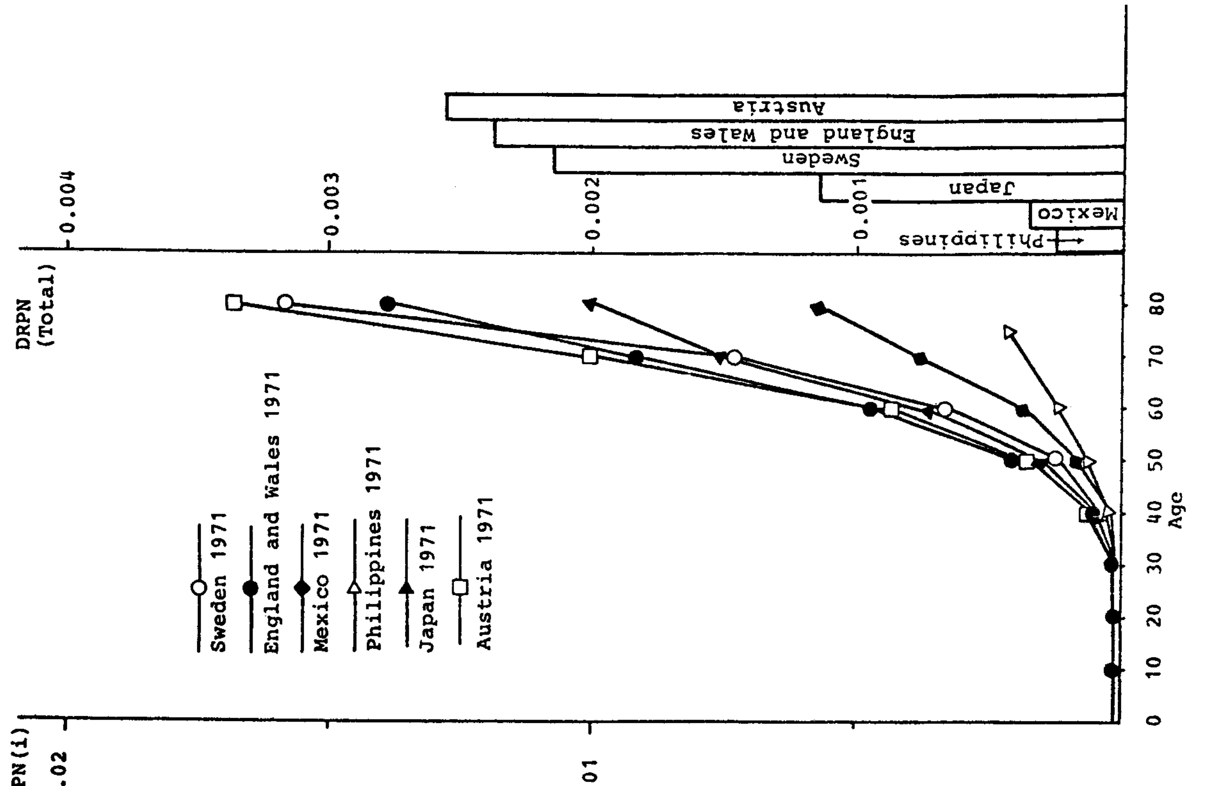
Figure(2). Submodels of health care.

Table(1) VARIABLES

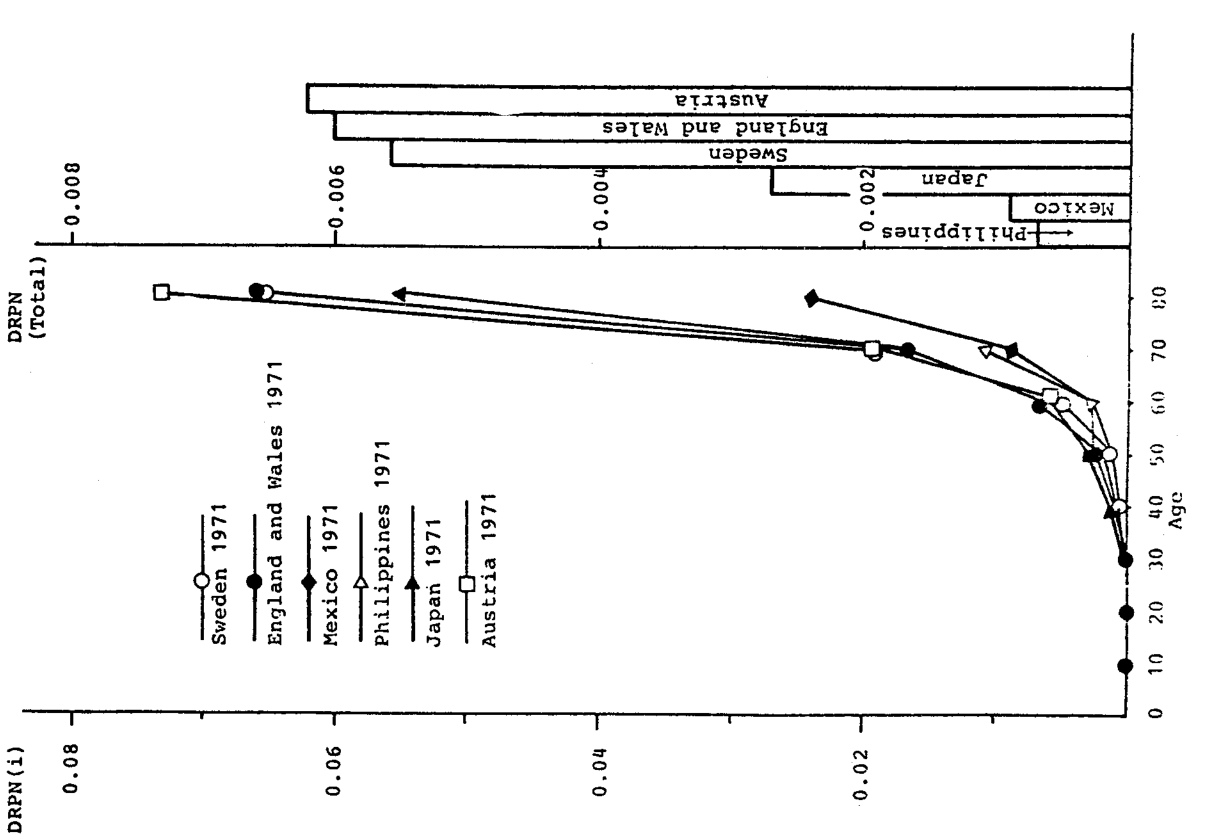
I	- number of sex-age group.
PN(i)	- population, or number of persons.
HP(i)	- healthy or non-sick persons.
TS(i)	- total sick persons.
LS(i)	- latent or non-registered sick in total sick.
RS(i)	- registered sick in total sick.
UAS(i)	- unaware sick in latent sick.
AS(i)	- aware sick in latent sick.
MR(i)	- morbidity rate, or number of persons who transfer from HP to TS per unit of time.
DR(i)	- death rate, or mortality rate from TS.
AR(i)	- awareness rate.
RECOV(i)	- recovery rate.
RPR(i)	- patient registration rate.
DRPN(i)	- death rate per population.
T	- duration of sickness.



Figure(3) Structure of the degenerative disease model.



Figure(5) The death rate, DRPN(i), of malignant neoplasms.



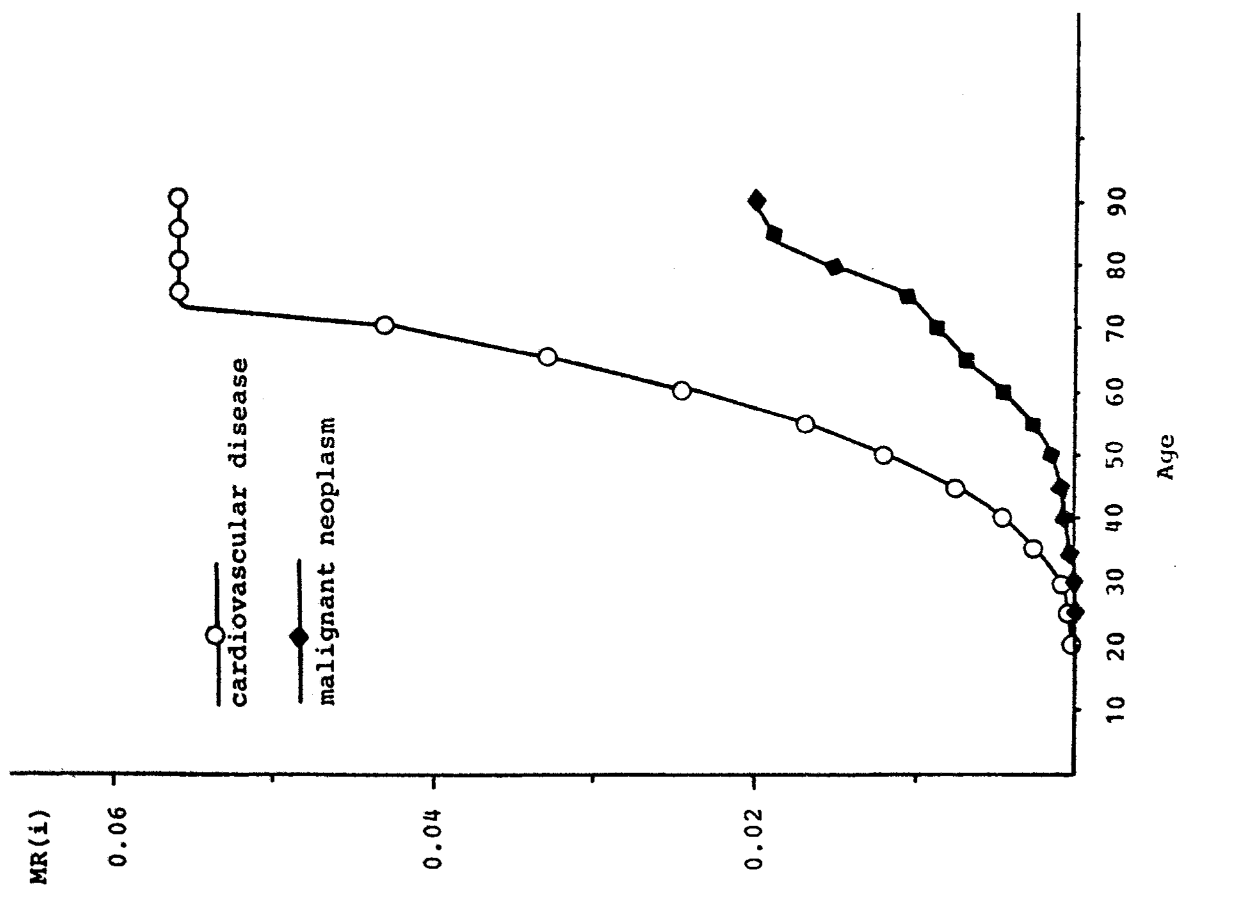
Figure(4) The death rate, DRPN(i), of cardiovascular disease.

Table(2) Examples of Output

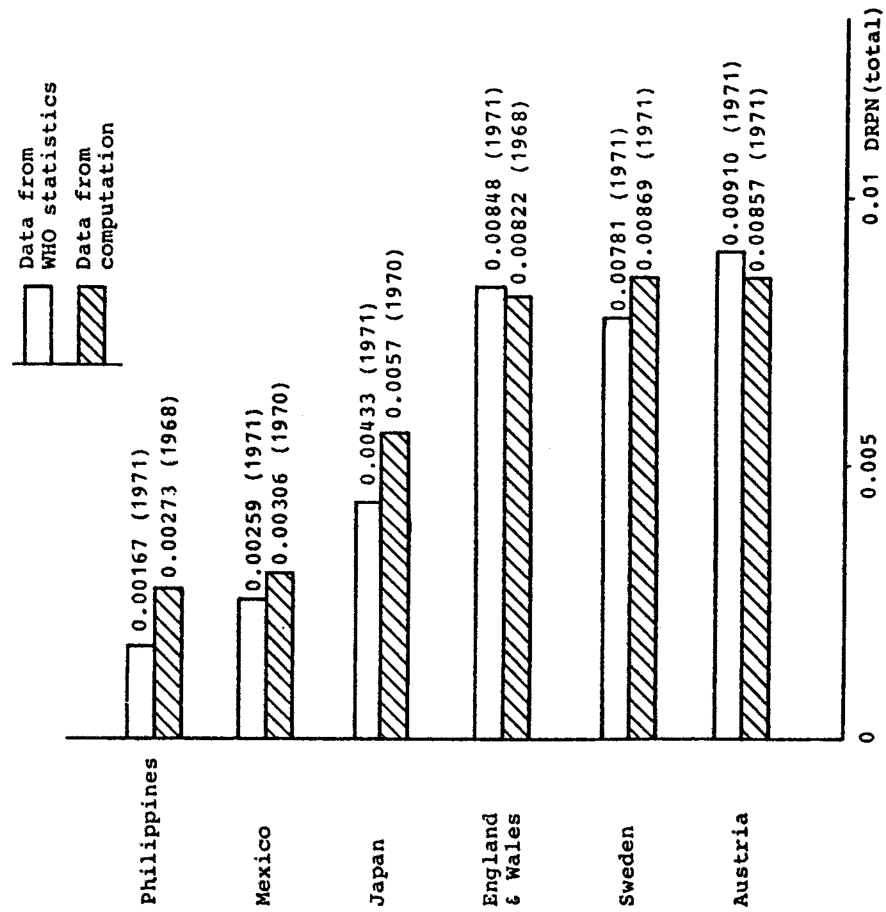
JAPAN 1960 AGING INDEX= 19.40

TOTAL = CARDIOVASCULAR + MALIGNANCY

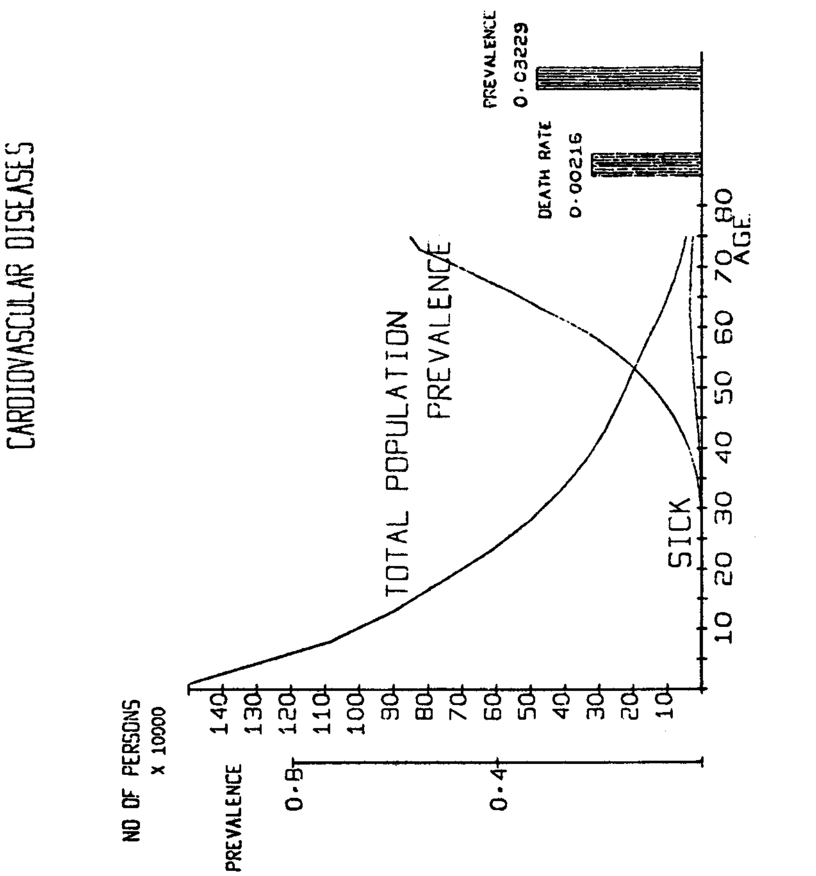
AGE	POPULATION (PN)	HEALTHY (HP)	TOTAL SICK (TS)	PREVALENCE (TS/PN)	MORBIDITY (MR)	DEATH RATES (DR)	DEATH RATES (DRPN)
0	1460072.	1460072.	0.	0.00	0.000000	0.0000	0.0000
1	1514480.	1514480.	0.	0.00	0.000000	0.0000	0.0000
2	1568887.	1568887.	0.	0.00	0.000000	0.0000	0.0000
3	1623295.	1623295.	0.	0.00	0.000000	0.0000	0.0000
4	1677703.	1677703.	0.	0.00	0.000000	0.0000	0.0000
5	1732111.	1732111.	0.	0.00	0.000000	0.0000	0.0000
6	1786519.	1786519.	0.	0.00	0.000000	0.0000	0.0000
7	1840927.	1840927.	0.	0.00	0.000000	0.0000	0.0000
8	1913444.	1913444.	0.	0.00	0.000000	0.0000	0.0000
9	1985960.	1985960.	0.	0.00	0.000000	0.0000	0.0000
10	2058476.	2058476.	0.	0.00	0.000000	0.0000	0.0000
11	2130992.	2130992.	0.	0.00	0.000000	0.0000	0.0000
12	2203508.	2203508.	0.	0.00	0.000000	0.0000	0.0000
13	2135148.	2135148.	0.	0.00	0.000000	0.0000	0.0000
14	2066788.	2066788.	0.	0.00	0.000000	0.0000	0.0000
15	1998428.	1998428.	0.	0.00	0.000000	0.0000	0.0000
16	1930068.	1930068.	0.	0.00	0.000000	0.0000	0.0000
17	1861708.	1861708.	0.	0.00	0.000000	0.0000	0.0000
18	1822105.	1822105.	0.	0.00	0.000000	0.0000	0.0000
19	1782501.	1782501.	0.	0.00	0.000000	0.0000	0.0000
20	1742898.	1742898.	0.	0.00	0.000000	0.0000	0.0000
21	1703294.	1703294.	0.	0.00	0.000000	0.0000	0.0000
22	1663690.	1663690.	0.	0.00	0.000020	0.0000	0.0000
23	1659327.	1659294.	33.	0.00	0.000150	0.0000	0.0000
24	1654963.	1654681.	282.	0.00	0.000260	0.0000	0.0000
25	1650600.	1649887.	712.	0.00	0.000380	0.0000	0.0000
26	1646236.	1644897.	1339.	0.00	0.000530	0.0248	0.0000
27	1641872.	1639694.	2178.	0.00	0.000659	0.0305	0.0000
28	1614210.	1611016.	3195.	0.00	0.000779	0.0311	0.0001
29	1586548.	1582195.	4353.	0.00	0.000958	0.0303	0.0001
30	1558886.	1553145.	5741.	0.00	0.001177	0.0287	0.0001
31	1531224.	1523813.	7410.	0.00	0.001395	0.0266	0.0001
32	1503561.	1494212.	9349.	0.01	0.001730	0.0242	0.0002
33	1444370.	1432646.	11724.	0.01	0.001965	0.0216	0.0002
34	1385179.	1370871.	14309.	0.01	0.002299	0.0196	0.0002
35	1325988.	1308776.	17213.	0.01	0.002630	0.0178	0.0002
36	1266797.	1246403.	20395.	0.02	0.003057	0.0175	0.0003
37	1207607.	1183697.	23909.	0.02	0.003402	0.0168	0.0003
38	1166850.	1139234.	27617.	0.02	0.003940	0.0225	0.0005
39	1126094.	1094503.	31592.	0.03	0.004472	0.0255	0.0007
40	1085338.	1049516.	35823.	0.03	0.004901	0.0278	0.0009
41	1044582.	1004438.	40145.	0.04	0.005516	0.0314	0.0012
42	1003826.	959180.	44647.	0.04	0.006257	0.0334	0.0015
43	995724.	946285.	49438.	0.05	0.006960	0.0340	0.0017
44	987621.	932993.	54627.	0.06	0.007629	0.0358	0.0020
45	979518.	919314.	60204.	0.06	0.008347	0.0379	0.0023
46	971415.	905316.	66099.	0.07	0.009147	0.0398	0.0027
47	963312.	890956.	72356.	0.08	0.010078	0.0433	0.0033
48	958706.	859774.	78931.	0.08	0.011169	0.0433	0.0036
49	914099.	828102.	85997.	0.09	0.012139	0.0444	0.0042
50	889492.	796214.	93278.	0.10	0.012631	0.0447	0.0047
51	864885.	761544.	103341.	0.12	0.013554	0.0465	0.0054



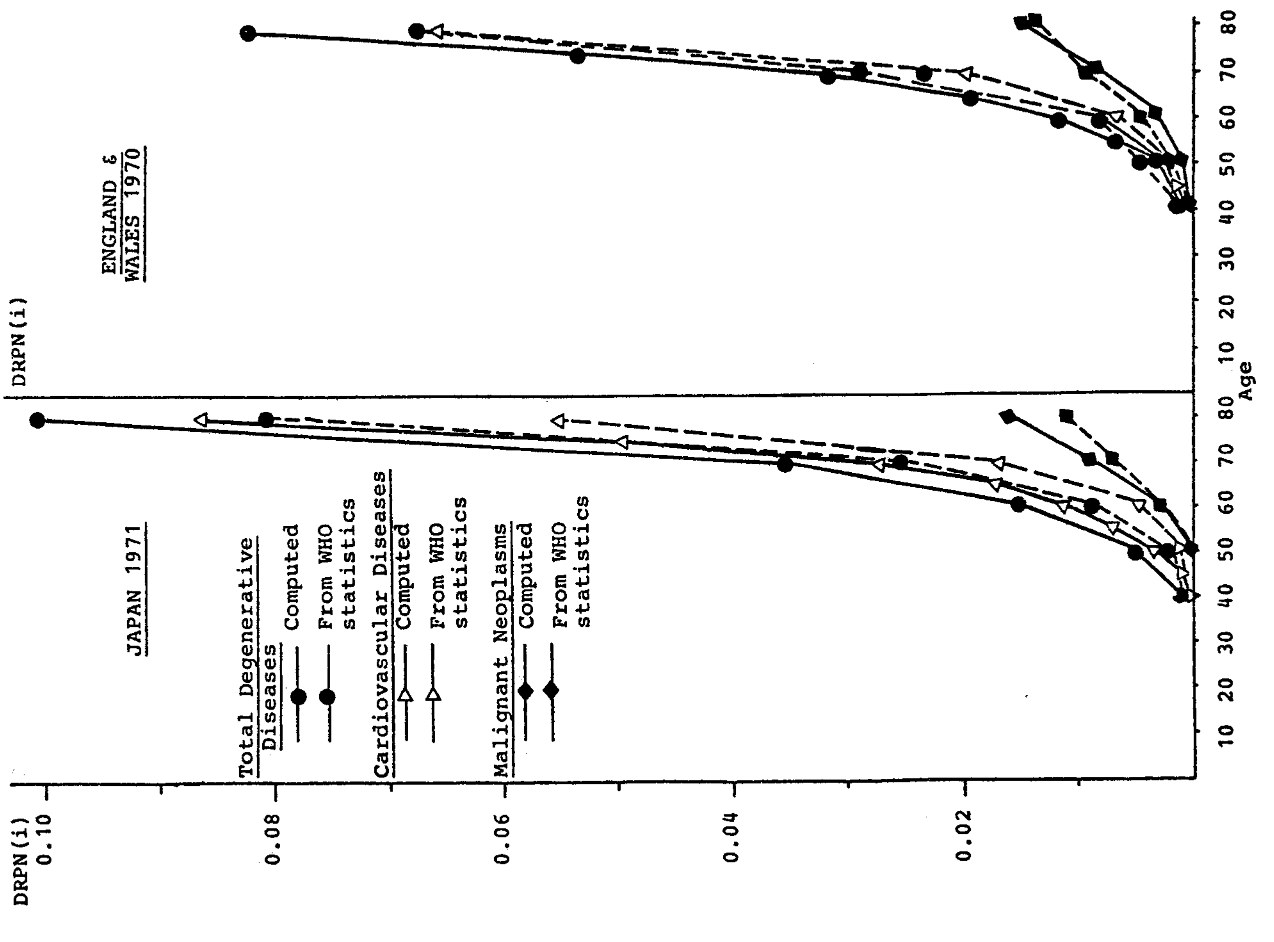
Figure(6) Morbidity rate specified for age and sex.



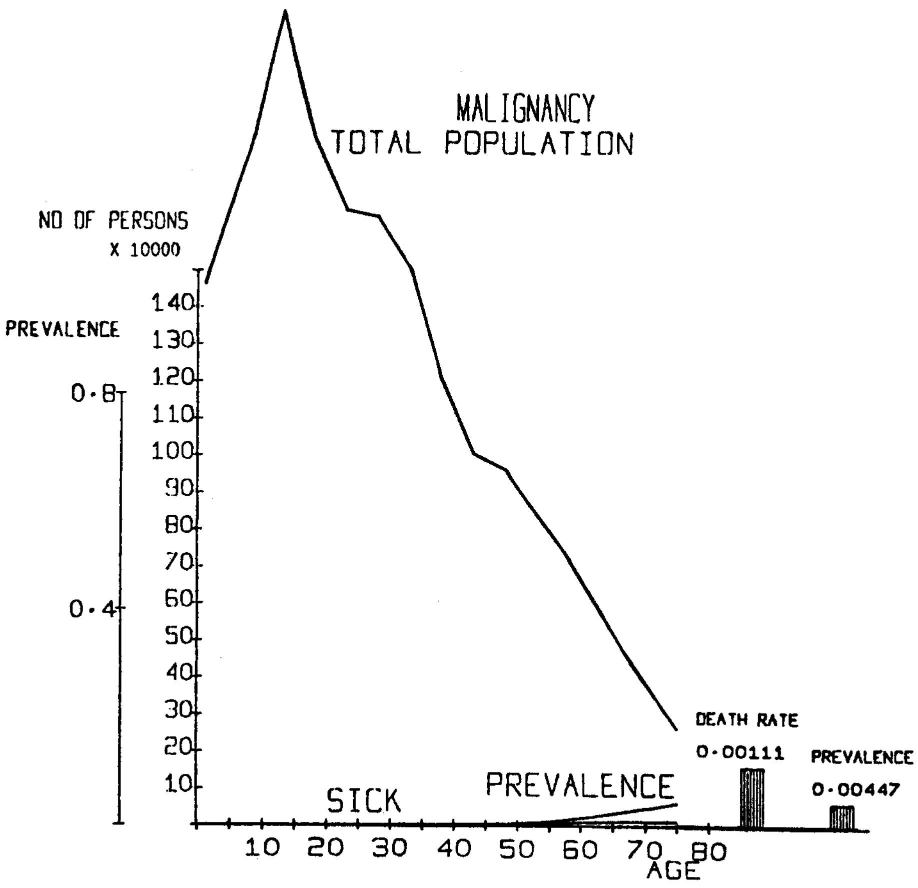
Figure(7) Comparison of death rates, DRPN(total), from WHO statistics and from computations.



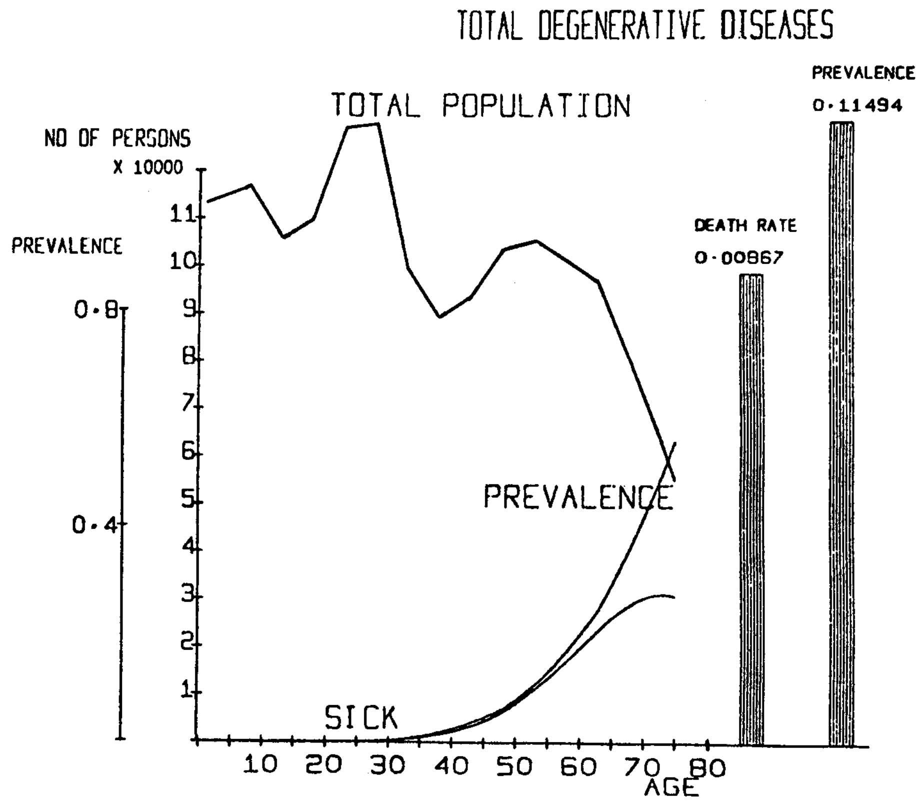
Figure(9) Number of sick, prevalence and death rates of degenerative diseases (Philippines, 1968): result of Calculation 1.



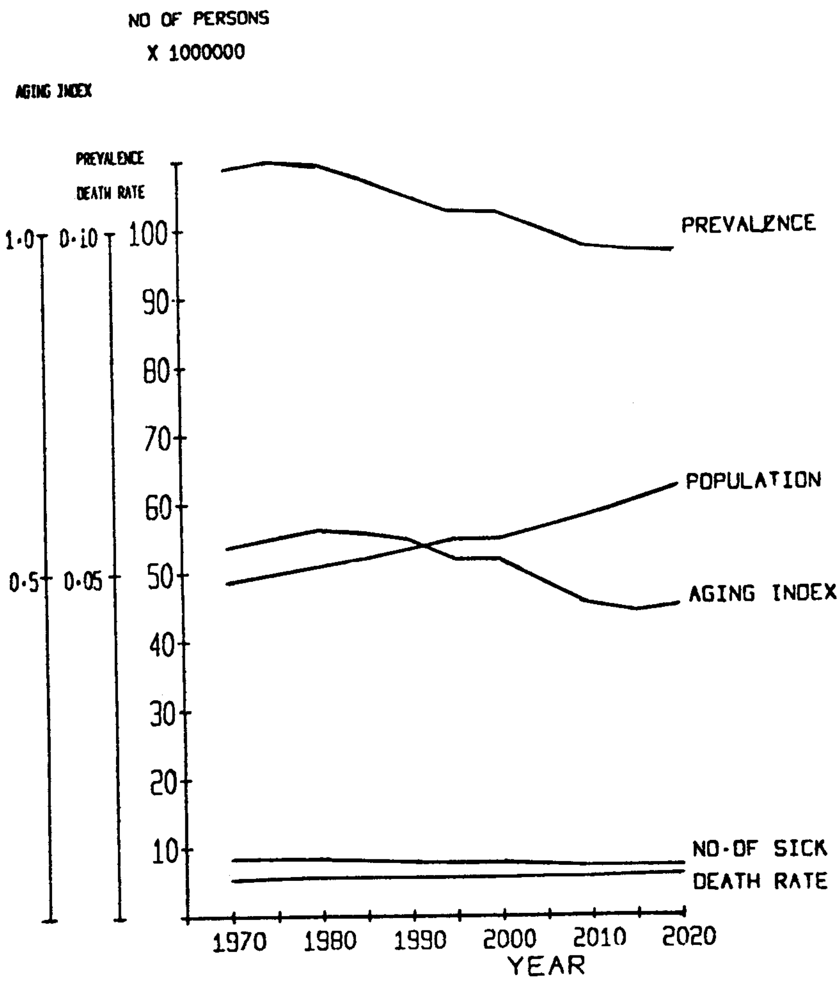
Figure(8) Comparison of WHO statistics and results of computations.



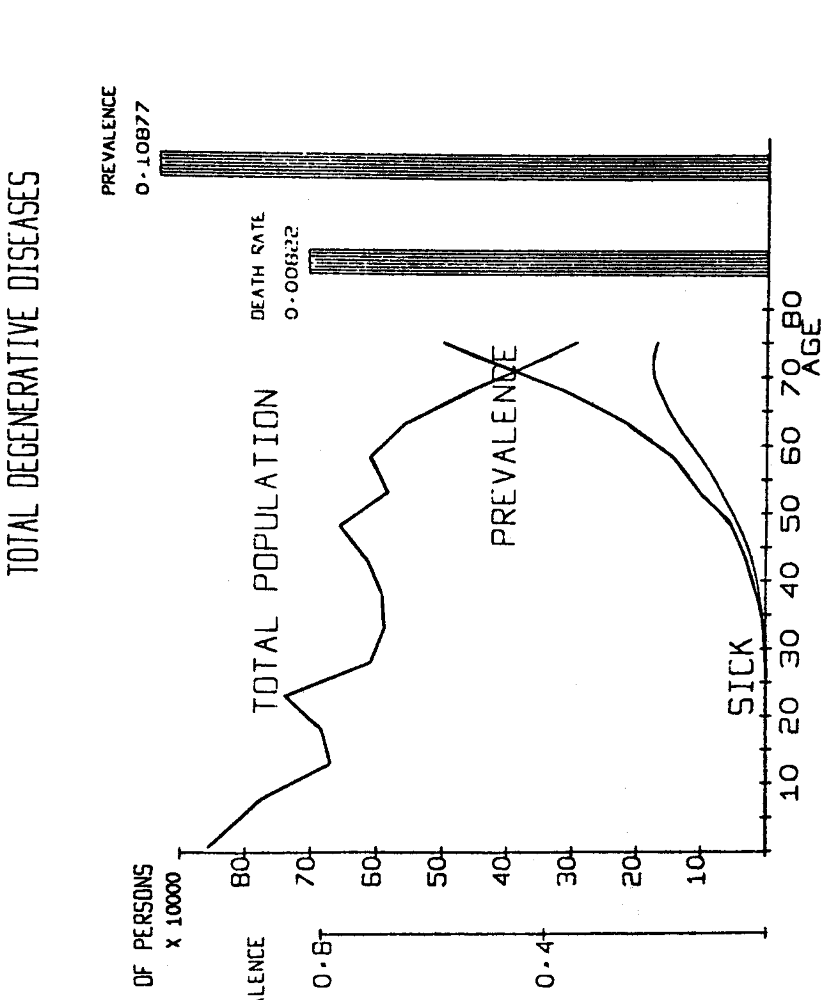
Figure(10) Number of sick, prevalence and death rates of degenerative diseases (Japan, 1960): result of Calculation 3.



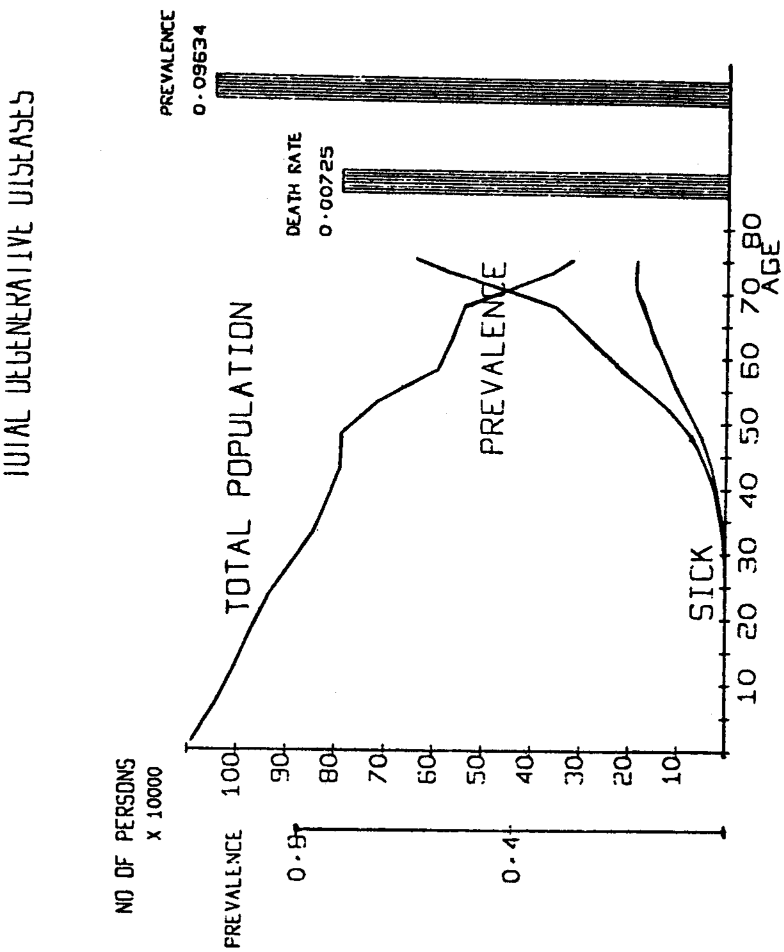
Figure(11) Total degenerative diseases: Sweden, 1971.



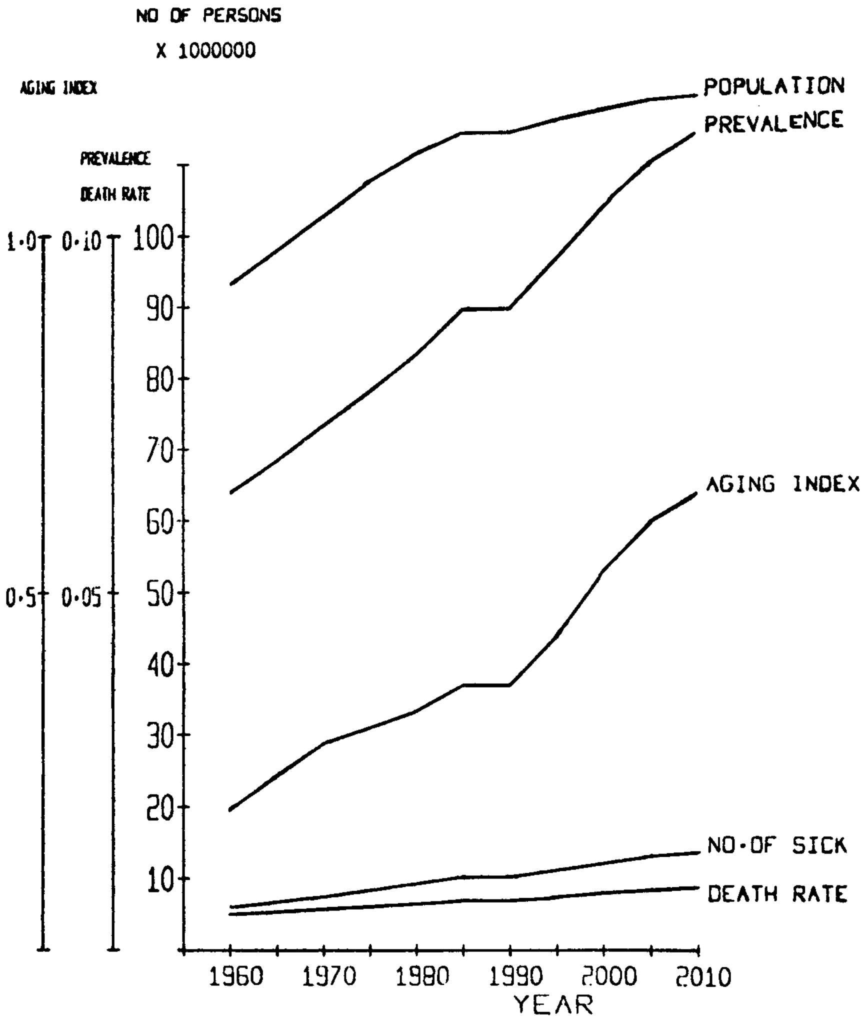
Figure(12) Estimation of future trend in total degenerative diseases: England and Wales.



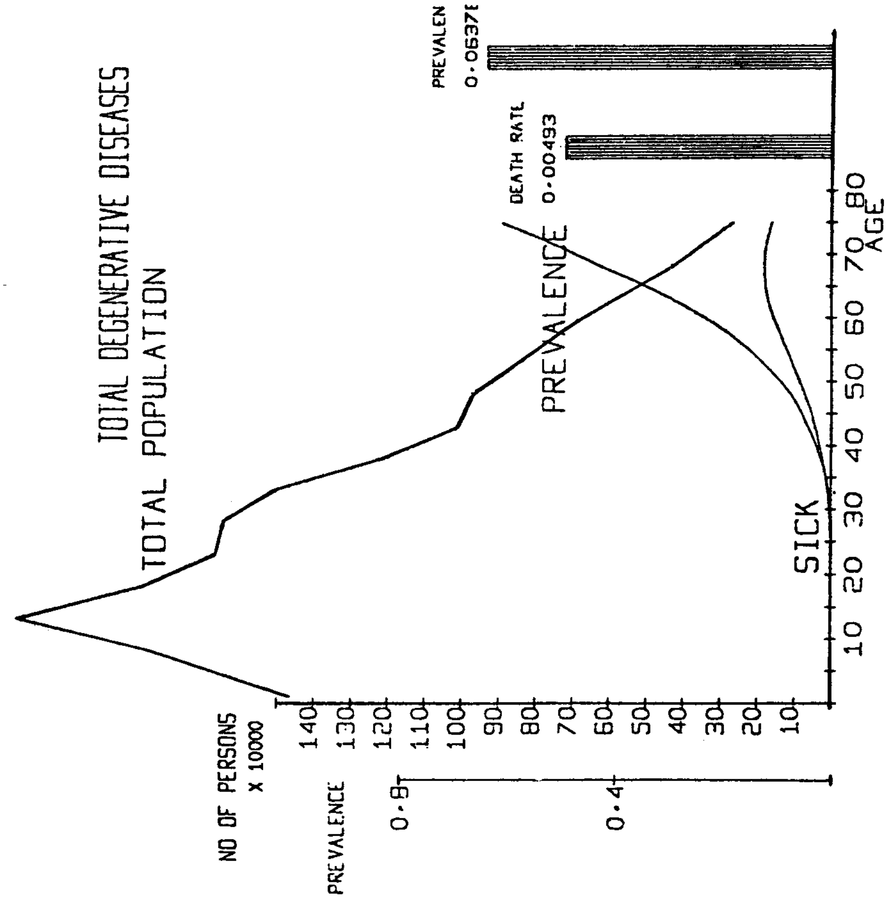
Figure(13) Estimation of future trend in total degenerative diseases: England and Wales.



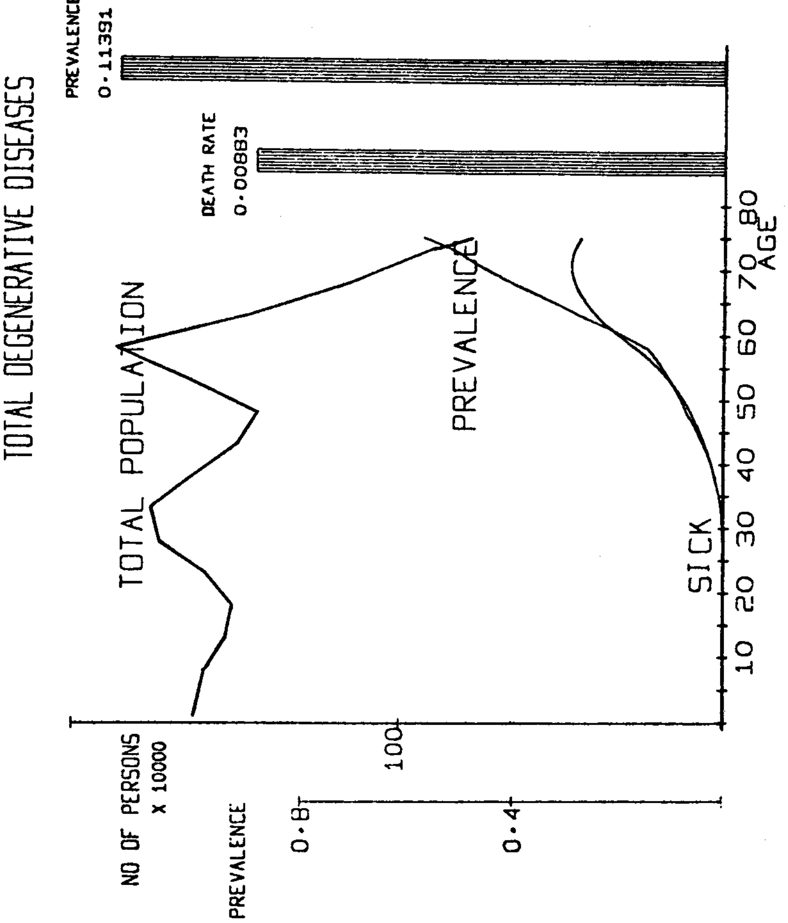
Figure(14) Estimation of future trend in total degenerative diseases: England and Wales.



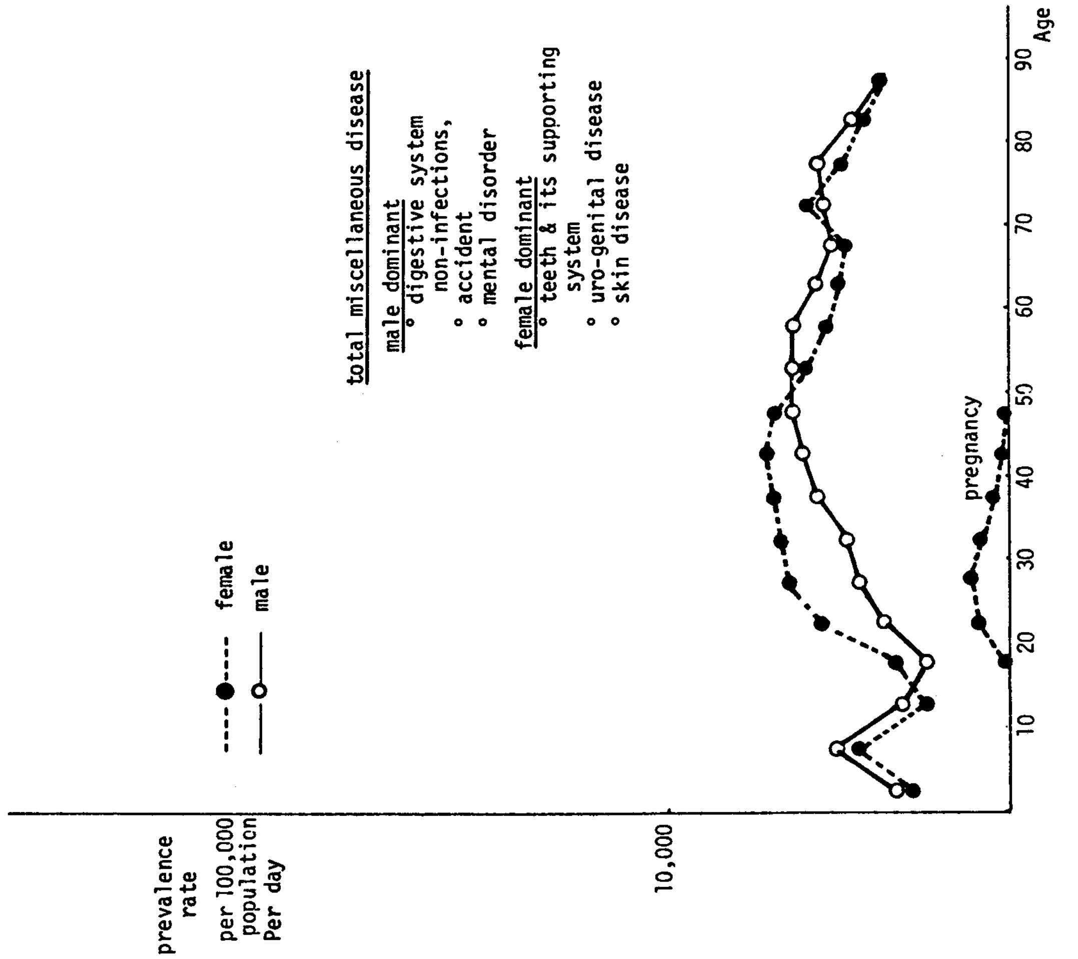
Figure(15) Estimation of future trend in degenerative diseases: Japan.



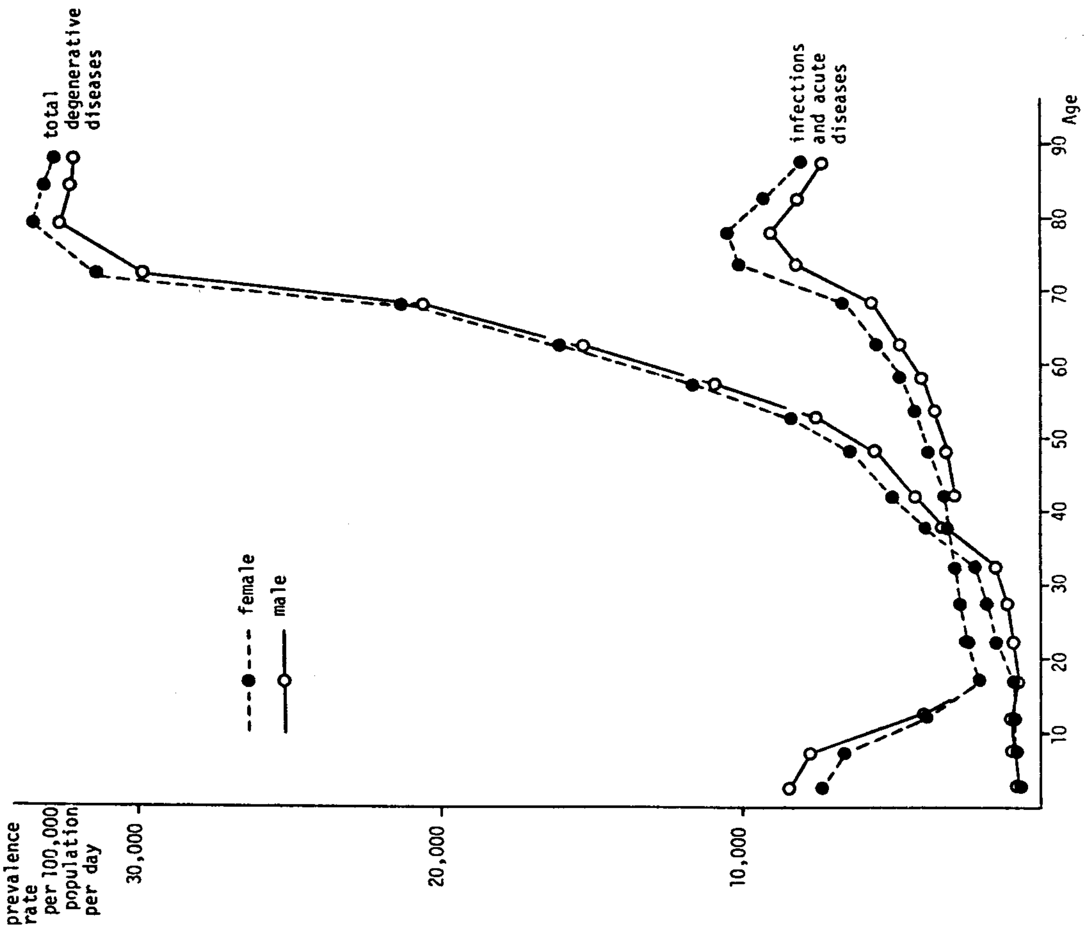
Figure(16) Estimation of future trend in degenerative diseases: Japan.



Figure(17) Estimation of future trend in degenerative diseases: Japan.



Figure(19) Prevalence Rates of Non-degenerative Non-infections Diseases



Figure(18) Prevalence Rates of Degenerative Disease and Infections Disease

Table(3) Groups of Conditions of Diseases

Conditions of diseases	WHO 150 classes	WHO 50 classes	classification of England
A. degenerative diseases			
1. neoplasms	a 45 - 61	b19, 20	II
2. cardio-cerebro vascular d.	a 80 - 85	b25-30, 46c	VII
3. other systemic d.	a 62 - 68	b23, 24	III + IV
4. nephritis and nephrose	a105 - 108	b38a	X
5. urogenital system d.	a109 - 111	b38b, 39	X
6. ill-defined conditions	a136 - 137	b45a, b, 46c	XVI
7. musdoskeletal and connective tissue d.	a121 - 125		XIII
8. asthma and chronic brondritis	a 93	b33b, c	VIII
B. acute or sub-acute curable diseases			
9. infective and paracitic d.	a1-44,72,89-92, 94-96,99	b1-18,24,31-33a 46e,d	I, VIII, IX
10. neuro-sensory d.	a 73 - 79		VI
11. peripheral circulatory d.	a 86 - 88		VII
12. digestive systemic d.	a98, 100-104	b 34 - 37	IX
13. skin and subcutaneous d.	a119, 120		XII
14. teeth and its supporting system d.	a 97		IX
15. mental disorders	a 69 - 71	b46a	V
16. injuries and disorders of outer causes	ae138 - 150 an138 - 150	be47 - 50	XVII
17. pregnancy, child birth and puerperium	a112 - 118	b40, 41	
C. congenital abnormality			
18. congenital abnormality and perinatal morbidity.	a120 - 135	b42 - 44	XIV, XV

Table(4) PREVALENCE RATE MATRIX (age groups, groups of disease conditions)
calculated from Patient Survey Statistics of Japan 1975

per 100,000 population

male	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0-4	20.	0.	100.	100.	50.	120.	40.	200.	6450.	2000.	0.	200.	1300.	1250.	0.	825.	0.	350.
5-9	15.	15.	100.	100.	50.	120.	50.	275.	5250.	2400.	0.	200.	700.	3250.	10.	825.	0.	90.
10-14	15.	15.	100.	100.	30.	80.	100.	200.	2000.	1600.	15.	200.	500.	1900.	30.	700.	0.	90.
15-19	15.	30.	100.	70.	50.	60.	200.	40.	1000.	800.	30.	250.	400.	1500.	110.	700.	0.	90.
20-24	15.	70.	100.	70.	100.	60.	350.	40.	1200.	800.	50.	500.	450.	1750.	430.	700.	0.	90.
25-29	25.	100.	160.	70.	100.	60.	450.	55.	1350.	800.	70.	800.	475.	1750.	560.	700.	0.	90.
30-34	40.	430.	200.	70.	110.	80.	600.	95.	1450.	900.	100.	1200.	500.	1775.	710.	700.	0.	90.
35-39	55.	1000.	400.	70.	120.	100.	700.	125.	1550.	1000.	150.	1600.	525.	1875.	860.	800.	0.	90.
40-44	80.	1800.	570.	70.	130.	130.	900.	165.	1700.	1100.	180.	1800.	550.	2000.	860.	850.	0.	90.
45-49	120.	2900.	730.	75.	140.	150.	1200.	200.	1850.	1200.	230.	2000.	575.	2125.	750.	870.	0.	90.
50-54	200.	4700.	975.	80.	150.	160.	1500.	275.	2100.	1500.	300.	2000.	600.	2200.	640.	900.	0.	90.
55-59	290.	6800.	1200.	85.	160.	170.	1800.	370.	2250.	1800.	370.	2000.	650.	2125.	560.	915.	0.	90.
60-64	390.	9700.	1450.	90.	220.	180.	2100.	550.	2550.	2200.	550.	2000.	700.	1750.	525.	885.	0.	90.
65-69	470.	13300.	1950.	120.	350.	190.	2400.	1000.	3000.	2600.	800.	2000.	800.	1310.	490.	800.	0.	90.
70-74	680.	21240.	1950.	140.	560.	200.	3700.	1000.	3750.	4100.	1130.	2000.	1000.	1250.	460.	800.	0.	90.
75-79	630.	23400.	1550.	200.	850.	210.	4000.	1375.	3700.	4800.	1430.	1900.	1100.	1225.	430.	855.	0.	60.
80-84	560.	23400.	1100.	200.	1000.	210.	4000.	1375.	3650.	4000.	1600.	1600.	1100.	.810.	410.	800.	0.	30.
85-	490.	23400.	800.	200.	1000.	210.	4000.	1375.	3600.	3200.	1750.	1200.	1100.	500.	410.	700.	0.	0.

female	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0-4	20.	0.	100.	100.	50.	120.	40.	200.	6000.	1600.	0.	200.	1300.	1250.	0.	600.	0.	350.
5-9	15.	15.	100.	100.	50.	120.	50.	275.	4200.	2400.	0.	200.	750.	3250.	10.	400.	0.	90.
10-14	15.	15.	100.	100.	30.	80.	100.	200.	2000.	1600.	15.	200.	500.	1900.	30.	285.	0.	90.
15-19	15.	30.	230.	70.	130.	60.	200.	40.	1000.	800.	30.	250.	550.	2250.	40.	285.	30.	90.
20-24	35.	70.	550.	70.	600.	60.	350.	40.	1200.	800.	100.	350.	800.	3250.	260.	285.	780.	90.
25-29	60.	100.	570.	70.	900.	60.	450.	55.	1350.	800.	140.	400.	800.	3580.	340.	285.	860.	90.
30-34	100.	430.	600.	70.	900.	80.	600.	95.	1450.	900.	190.	500.	800.	3580.	450.	285.	720.	90.
35-39	160.	1000.	550.	70.	900.	100.	800.	125.	1550.	1000.	240.	600.	800.	3580.	540.	360.	300.	90.
40-44	210.	1600.	760.	70.	900.	130.	1200.	165.	1700.	1300.	270.	700.	800.	3580.	590.	420.	90.	90.
45-49	250.	2900.	930.	75.	900.	150.	1600.	200.	1650.	1600.	280.	800.	800.	3060.	590.	450.	30.	90.
50-54	265.	4700.	1050.	80.	780.	160.	2000.	275.	1900.	2100.	300.	900.	800.	2690.	590.	495.	0.	90.
55-59	275.	6400.	1200.	85.	600.	170.	2400.	330.	1950.	2600.	370.	1000.	700.	2275.	560.	525.	0.	90.
60-64	300.	9700.	1450.	90.	400.	180.	3000.	360.	2000.	3300.	550.	1200.	700.	1875.	525.	570.	0.	90.
65-69	380.	13300.	1950.	120.	300.	190.	3600.	500.	2150.	4100.	800.	1500.	800.	1500.	490.	645.	0.	90.
70-74	520.	21240.	1950.	140.	300.	200.	5700.	680.	3000.	7000.	1750.	2000.	1000.	1325.	460.	800.	0.	90.
75-79	410.	23400.	1500.	200.	300.	210.	6000.	850.	2900.	7200.	1850.	1900.	1100.	525.	430.	855.	0.	60.
80-84	320.	23400.	1100.	200.	300.	210.	6000.	1000.	2400.	6200.	1850.	1600.	1100.	400.	410.	800.	0.	30.
85-	250.	23400.	800.	200.	300.	210.	6000.	1100.	2100.	5200.	1850.	1200.	1100.	250.	410.	700.	0.	0.

Table(5) Prevalence Rate Matrix

per 100,000 population, per day

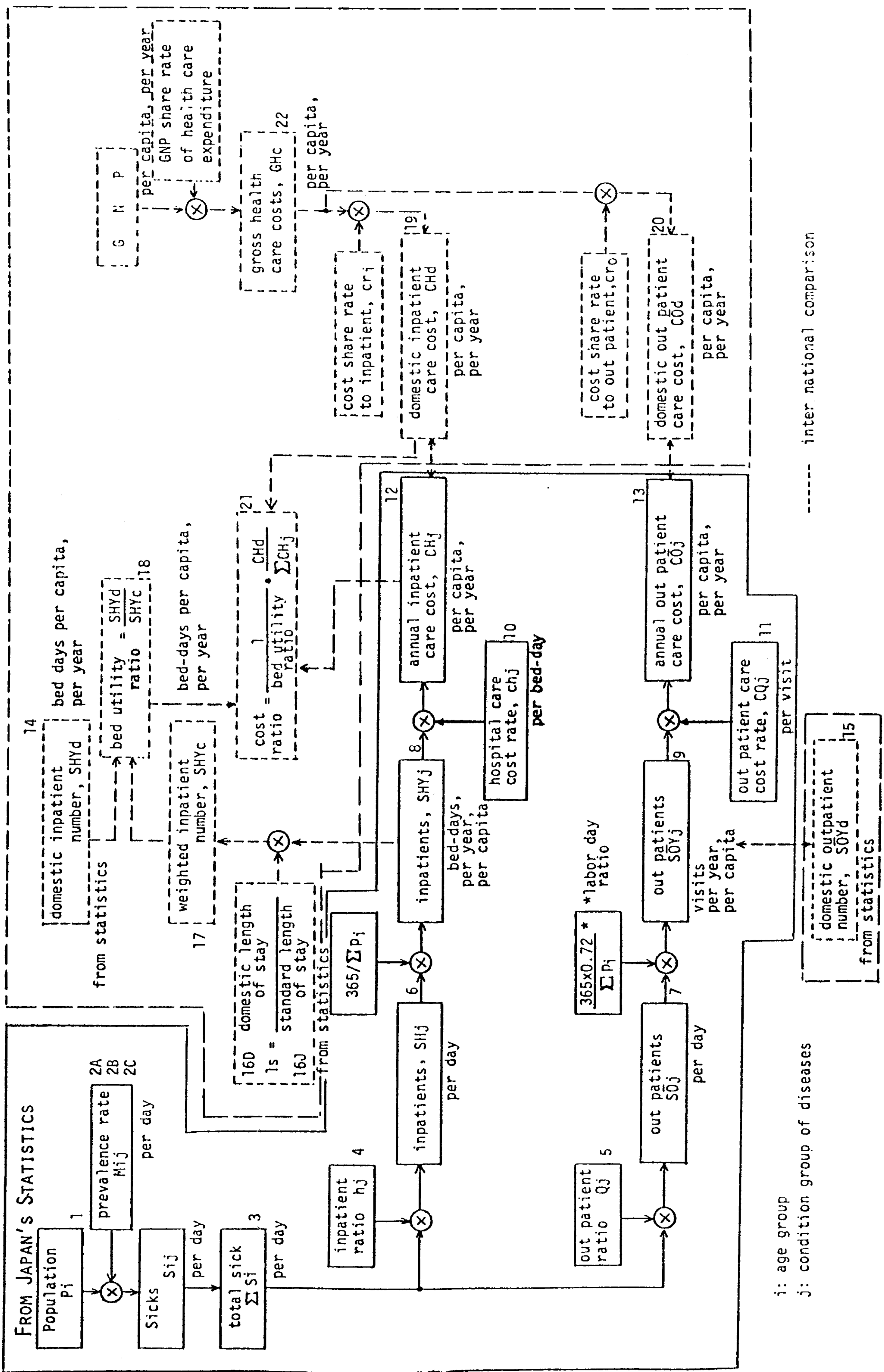
Groups of disease condition(j) \ Age groups (i)	0 - 14	15 - 34	35 - 64	65 -	type of disease	name of disease condition
1	17	38	216	400	degenerative	neoplasma
2	10	150	3,000	20,000	"	cardio-cerebro-vascular d.
3	100	300	950	1,500	"	other systemic d.
4	100	70	78	140	"	renal d.
5	43	360	450	550	m:degenerative f:miscellaneous	urogenital d.
6	105	65	150	200	degenerative	ill-defined conditions
7	63	400	1,600	5,000	"	muscloskeletal d.
8	225	60	260	800	"	asthma and chr. bronchitis
9	4,300	1,250	1,970	3,000	acute infections	infections d.
10	1,930	825	1,725	4,500	"	neuro-sensory d.
11	5	90	315	1,200	degenerative	peripheral circulatory d.
12	200	530	1,380	1,800	miscellaneous	digestive system d.
13	840	600	680	1,000	"	skin & subcutaneous d.
14	2,130	2,430	2,430	1,200	"	teeth & its supporting system d.
15	13	360	630	450	"	mental disorders
16	605	490	670	800	"	injuries
17	0	300	35	0	pregnancy	pregnancy
18	175	90	90	50	congenital	congenital abnormality
total(ΣM_j)	10,867	8,408	16,569	42,590		

calculated from Patient Survey Statistics of Japan 1975

Table(6) Computed Total Patient Numbers (S_j)

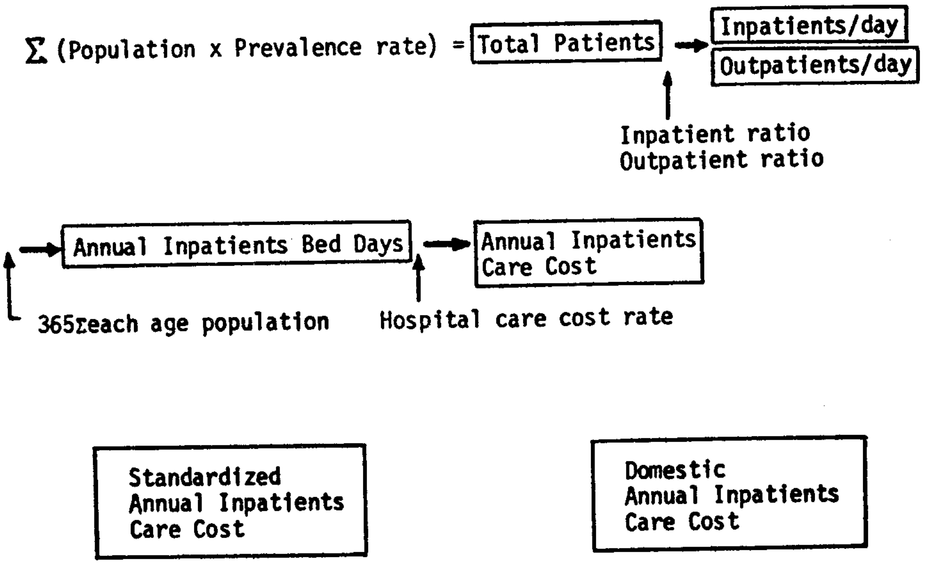
(000s per day)

group(j)	J A P A N	U. S. A.	England and Wales
1	134.0	265.5	72.2
2	2,882.1	6,454.9	1,931.4
3	623.2	1,216.3	320.4
4	94.0	184.9	44.1
5	361.1	688.8	170.0
6	125.8	244.9	60.6
7	738.9	1,665.3	685.6
8	248.4	510.6	134.2
9	2,591.6	5,126.3	1,197.0
10	1,855.1	3,744.1	942.4
11	255.0	534.7	150.7
12	922.8	1,778.9	458.1
13	788.8	1,539.6	364.3
14	2,489.6	4,704.8	1,076.5
15	412.5	769.5	190.5
16	664.3	1,285.2	306.8
17	124.2	437.9	47.2
18	118.5	228.0	51.2
total(ΣS_j)	15,429.9	31,380.2	8,203.2



Figure(20) Flow chart of Demand Model to Estimate Medical Care Cost

Figure(21) **Calculation Process in Model**



Table(7) **Inpatients and outpatients per 100,000 population per day, classified 18 groups of disease conditions and their costs per day**

Group (j)	① hospitalize *	② old out patient *	③ new out patient *	④ total out patient *	⑤ hospitalize ratio (hj) %	⑥ out patient** visit *	⑦ out patient ratio %	⑧*** out patient visit ratio (Qj) %	⑪ in patient price (JP) '75 (Chj) ¥/d	⑫ out patient price (JP) '75 (CQj)¥/visit
1	57	63	5	68	0.456	38	0.544	0.304	12,000	3,600
2	119	2,654	27	2,681	0.043	659	0.957	0.235	7,000	2,400
3	25	520	15	535	0.045	145	0.955	0.259	7,500	2,050
4	16	65	3	68	0.190	45	0.810	0.536	14,300	8,000
5	17	173	38	211	0.075	113	0.925	0.495	8,000	2,700
6	8	81	13	94	0.078	50	0.922	0.490	10,600	1,850
7	38	871	45	916	0.040	441	0.960	0.462	6,500	1,650
8	11	195	6	201	0.052	67	0.948	0.316	8,000	1,700
9	114	2,328	418	2,746	0.040	1,476	0.960	0.516	5,500	1,800
10	51	1,543	103	1,646	0.030	774	0.970	0.456	6,200	1,450
11	11	416	8	424	0.025	107	0.975	0.246	6,500	1,800
12	96	630	34	664	0.126	308	0.874	0.405	7,400	2,300
13	4	612	86	698	0.006	352	0.994	0.501	6,500	1,650
14	0	2,328	165	2,493	0.000	916	1.000	0.367	——	2,300
15	222	160	6	166	0.572	47	0.428	0.121	4,300	2,700
16	81	343	69	412	0.164	314	0.836	0.637	6,000	1,800
17	43	75	6	81	0.347	36	0.653	0.290	6,500	1,700
18	13	36	4	40	0.245	24	0.755	0.453	7,300	1,600

from Patient Survey Statistics of Japan 1975 and Hospital Survey Statistics of Japan 1975

* per 100,000
** ⑥ = (② / meanvisit interval) + ③
*** ⑧ = ⑦ x ⑥ / ④

Table(8) Inpatients (SH_j)

group(j)	JAPAN	U. S. A.	England and Wales
			000s (per day)
1	61.1	121.0	32.9
2	124.0	277.6	83.1
3	20.1	54.7	14.4
4	18.9	35.1	8.4
5	27.1	51.7	12.7
6	9.9	19.1	4.7
7	30.0	66.6	27.4
8	13.0	26.6	7.0
9	103.7	205.1	47.9
10	55.7	112.3	28.3
11	6.4	13.4	3.8
12	116.3	224.1	57.7
13	4.7	9.2	2.2
14	0	0	0
15	235.9	440.2	109.0
16	108.9	210.8	50.3
17	43.1	152.0	16.4
18	29.0	55.9	12.5
total	1,007.8	2,075.4	518.7

Table(9) Inpatient care cost (CH_j)

group(j)	JAPAN	U. S. A.	England and Wales
			(000,000 yen per day)
1	733.1	1,452.6	394.8
2	867.5	1,942.9	581.3
3	156.3	410.5	108.1
4	255.5	502.4	119.9
5	216.7	413.3	102.0
6	104.0	202.5	50.1
7	192.1	433.0	178.2.
8	103.3	212.4	55.8
9	570.1	1,127.8	263.3
10	345.0	696.4	175.3
11	41.4	86.9	24.5
12	860.4	1,658.6	427.1
13	30.8	60.0	14.2
14			
15	1,014.6	1,892.7	468.6
16	653.6	1,264.7	301.9
17	280.2	987.7	106.4
18	211.9	407.7	91.5
total	6,636.5	13,752.1	3,463.0

Figure(22) Variable Ratios used in the Model

$$\text{Annual Bed Days of Inpatients (per capita, per year)} = \frac{\text{Inpatients(per day)} \times 365}{\Sigma\ \text{Population}}$$

$$\text{Weighted Inpatient Number} = \text{Inpatient Number} \times \frac{\text{Domestic Length of Stay}}{\text{Standard(Japanese) Length of Stay}}$$

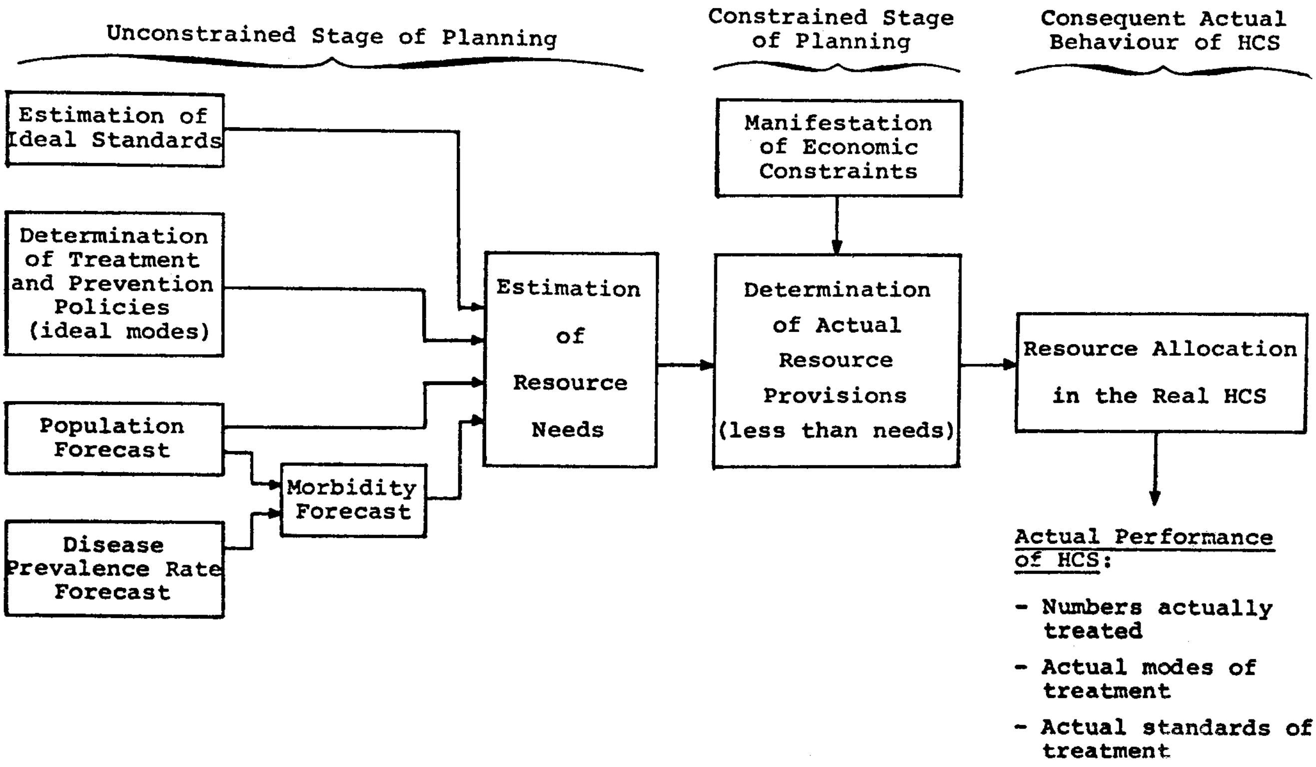
$$\text{Bed Utility Ratio} = \frac{\text{Domestic Inpatient Number}}{\text{Weighted Inpatient Number}}$$

$$\text{Cost Ratio} = \frac{1}{\text{Bed Utility Ratio}} \times \frac{\text{Domestic Annual Inpatient Care Cost}}{\text{(Estimated) Total Annual Inpatient Care Cost}}$$

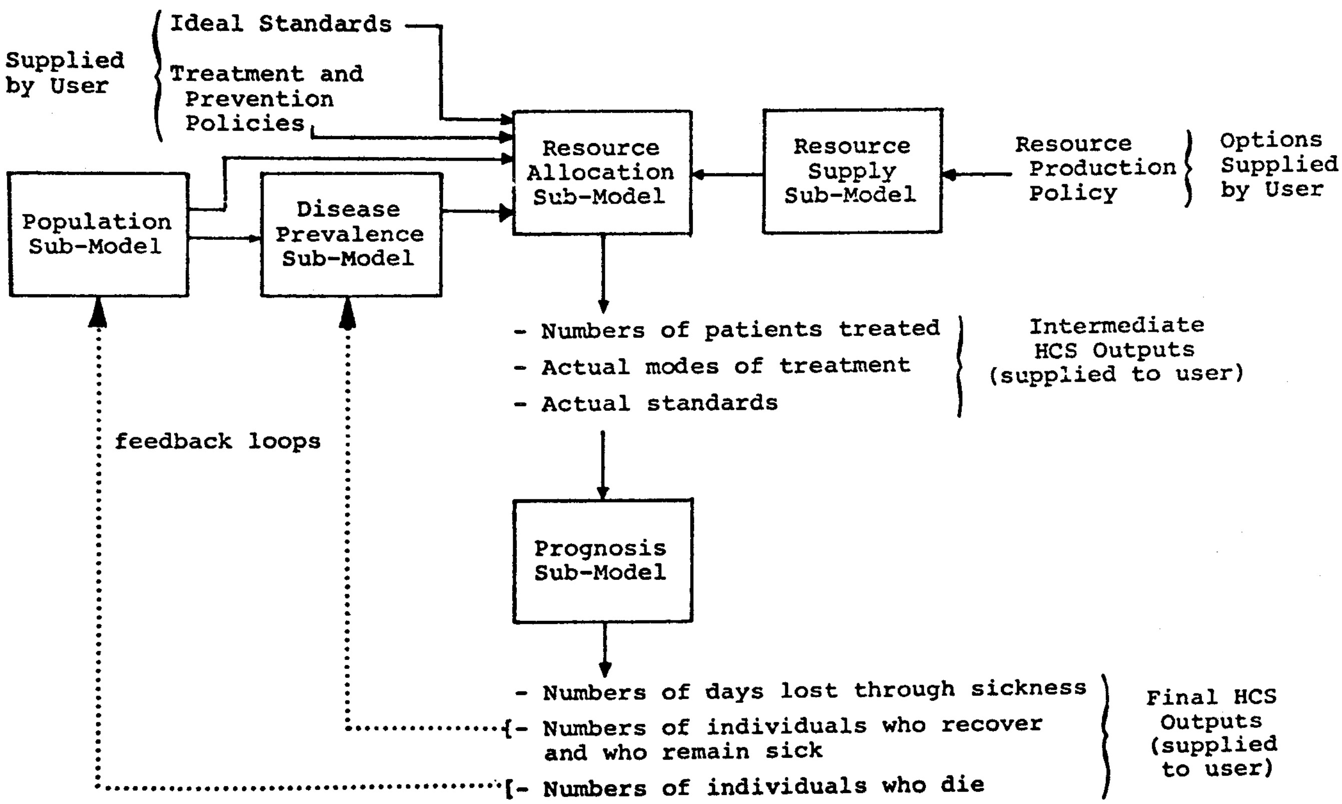
Table(10) Comparative Study of National Health Care Demand and Expenditure

			JAPAN computed 1974	JAPAN statistics 1975	U. S. A. computed 1974	U. S. A. statistics 1975	ENGLAND computed 1974	ENGLAND statistics 1975
population (000,000s)			110.0	103.5	211.4	204.9	49.2	46.5
demand (per 1000 peoples, per year)								
in patient (bed days)	general & special		2,540 (*2,500)	2,500 (**1.00)	2,820 (*602)	1,440 (**2.39)	3,040 (*1,373)	2,130 (**1.55)
in patient (bed days)	mental		780	880	760 (*590)	860 (**1.46)	800	1,470
average length of stay	general			44.5		9.5		20.1
average length of stay	mental			336.2		261.2		—
out patient (visit days)	general & special		13,900	13,500	17,500	—	14,800	2,100
out patient (visit days)	teeth & support system		2,400	2,700	2,100	—	1,060	—
expenditure (per capita, per year)								
inpatient	domestic currency		21,900 ¥	24,520 ¥			39.4 £	44.3 £
inpatient	$		78.2	87.6 (***1.12)	84.7	125.4 (***0.62)	92.5	104.0 (***0.73)
out patient	general	domestic	32,217 ¥	32,473 ¥			51.8 £	9.7 £
out patient	general	$	115.1	116.0	182.6	135.0	121.7	22.8
out patient	teeth & support system	domestic	4,997 ¥	5,474 ¥				
out patient	teeth & support system	$	17.8	19.6	17.7	21.6		
total health care expenditure	domestic			6,478 bil. ¥				2,788 mil. £
total health care expenditure	$	t		23.14 bil. $		71.57 bil. $		6.55 bil. $
total health care expenditure	$	per cap.		223.5 $		349.1 $		117.0 $
total health care expenditure	% GNP			4.3 %		7.1 %		3.8 %
			exclude construction research and public health expenditure				exclude research expenditure	

* correction by average length of stay
** bed utility ratio (Japan'75 = 1.00)
*** cost ratio (Japan'74 = 1.00)



Figure(23) The context of the constrained stage in planning the provision of HCS resources.



Figure(24) Mark 2 IIASA model for the constrained stage of HCS planning.

HEALTH CARE PROGRAM

Hans Peterson

The Stockholm County has a population of about 1,5 million. The Stockholm County Council Medical Services Administration has under its jurisdiction 74 hospitals including 13 acute hospitals with a total of 20,700 beds. The total number of out-patient visits handled by the 1450 county employed physicians are about 3,7 million per year. Of these physicians 350 are employed as primary care physicians and 1100 at the different hospitals.

Person identification and population registration

Every Swedish national is assigned a permanent identification number. This number embeds the date of birth and some other information.

The number is used very widely for identification in official and non-governmental processes, and is used generally for patient identification purposes. The use of the identification number long preceded computers and is well accepted. Beyond this systematic numbering of its residents, and the mere registration of birth, marriages and deaths that is ubiquitous in the world, Sweden operates a thorough system of recording the residents in each locality.

Thus, in conceiving the envisaged medical information system as based on a central population register, the authorities had the advantage of a well-established scheme for identifying the population and for recording its changes.

The Regional Information System

To help handle the flow of information between individual physicians, medical departments and hospitals, a regional information system has been developed.

At present, the on-line systems serve more than 20 hospitals where a total of 420 terminals are installed.

One of the basic functions of the information system is that relevant basic data on all presumptive patients, that means all inhabitants of the county are stored in an on-line file, the Master Index. The file is updated every week by means of magnetic tapes from the Central Population File. In this way, the Master Index is always kept up to date with respect to those people who actually live within the region. (Fig. 1)

The file contains:

(1) Census information (official personal data, address etc.. The file is updated every week by means of magnetic tapes from the Central Population File) (2) Vital medical information (3) Information on previous in- and out-patient care (4) Information on previous examinations and tests (Table 1)

The information in (2) - (4) above is built up from a number of modules, each containing information on the treatment of the patient, making it possible to follow the patient from the initial contact with the hospital to the end of the treatment - in out-patient as well as in-patient care. The index information on previous in-patient care and X-ray examinations is available from 1969 and onwards.

For current patients, a special PATIENT FILE for each hospital or a group of hospitals has been created. This file is on direct access memory, but information is only stored during the time that the person is actually a patient. After that period, the information is partly transferred to the Master Index and partly to the MEDICAL STATISTICAL FILE and stored on magnetic tape.

As the Master Index contains vital statistical data for the entire population of the County together with the medical data, a lot of different statistics can be produced.

There is now the unique possibility to follow the morbidity in a population of 1,5 million inhabitants on an individual basis.

Treatment Programs

In Sweden the treatment of patients with cancer diseases is centralized. In the Stockholm area, the specialized treatment and registration of all patients with cancer diseases started in 1918. At that time, the Carolinian Institute was the center for treatment of that disease not only for Stockholm, but for the whole country. All patients treated at that centre were followed up during their life time. This unique material is still active and at disposal for research workers.

Since 1931 a part of the Carolinian Hospital was allocated for treatment of patients with cancer diseases. As more hospitals started to treat cancer diseases, there was a need for a national registry of all incidents of cancer diseases. In 1958, the Cancer Registry of the National Board of Health and Welfare was created. The notifications to this registry was made mandatory both for the physicians and for the pathologists. In this way, there should be two notifications on each patient. This means that a number of not registered incidents is very low, about 2%. The number of cancer patients was at that time about 20,000 a year. In 1971 the number had increased to 40,000 a year. The notifications to the Cancer Registry were done by forms filled in at the medical department treating the patient, and the pathology department examining the tissue. Before this information was entered into a computer system it was very carefully checked, which means that the quality of the information in this registry is very high.

In 1976, seven oncologic regions were formed and these regions were given the responsibility to create a Cancer Registry for their catchment areas. In Stockholm where all diagnoses are registered from 1969 and onwards, together with a population file, it was natural to connect these two registries.

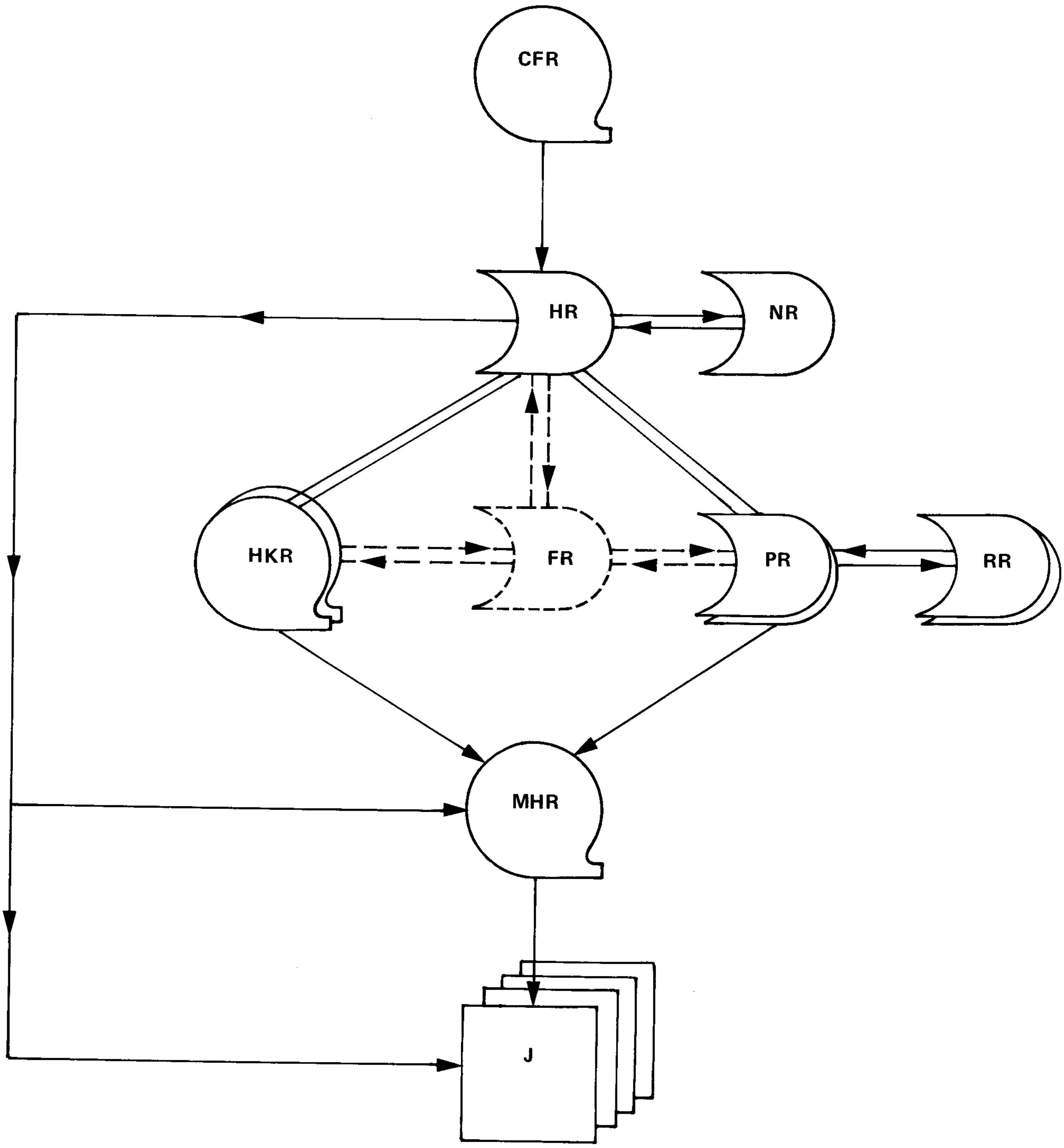
There was also a need to register more information about each patient and to follow up not only individual patients but also different treatment matters. This could be done only by using treatment programs, which means that all the physicians treating a specific type of cancer disease in the region agreed upon, not only the way of treatment on these patients, but also on all information that should be stored on each case. In this way, the number of patients treated in the same way is larger and therefore the follow up could be done earlier. There was also a possibility to divide the patients in different treatment groups and compare the results of the treatments. For each case a number of forms has to be filled in and this information is entered by terminals to a computer system. The information is stored in a modern designed data base which makes it easy to retrieve the information for statistical purposes and to add and correct information.

The first four treatment programs in operation were Breast Cancer, Acute Leukaemia, Malignant Melanoma and Myeloma.

For Breast Cancer there are five different forms to be filled in. The first form (Figure 2) covers the identity of the patient and the hospital, the results from the physical examination, how the diagnosis was set and how the treatment should be done. The next form (Figure 3) covers the surgery and the result from the histopathological examination. The third form (Figure 4) is for radiation therapy, the fourth (Figure 5) for follow up information and the fifth form (Figure 6) for chemotherapy. The information is checked and entered by the terminal at the Oncologic Center.

A summary of the case can be displayed on the VDM and is shown in Figure 7-9.

Figure 1 DATABASE



CFR	=	CENTRAL POPULATION FILE
HR	=	MASTER INDEX
NR	=	NAME FILE
HKR	=	HEALTH CONTROL FILES
FR	=	INSURANCE FILE
PR	=	PATIENT FILES
RR	=	RESOURCE FILES
MHR	=	STATISTICS FILE
J	=	MEDICAL RECORDS

MASTER INDEX

Census Information

Identity number
Name
Address
Postal Address code
Citizenship
Civil status
Date of latest change of civil status
Identity number of husband/wife/parents
Codes for county, district, parish

Previous Inpatient Stays

Hospital
Clinical department
Date of admission
Terms of admission
Date of discharge
Terms of discharge
Diagnosis code(s)
Date(s) of operation
Operation code(s)
Anesthesia code(s)

Previous Outpatient visits

Vital Medical Data

Blood group
Critical illnesses
- Diabetes
- Blood coagulation disorders

Important medical findings
Treatment program

Previous X-ray Examinations

Hospital
Clinical department
Referring nursing unit
Date of examination
Classification codes:
- Organ (part of body)
- Method
- Findings

Previous Chemical and Hematological test results

Previous Histopathological Examinations

TABLE 1

TREATMENT PROGRAM SCREEN 2

DRUG THERAPY

DRUG ? 1111111

LEUKERAN

DRUG:1111111 DATE:790606 HOSPITAL:11001 DEPT:741 COMBINATION:01 STATUS:

1 DATE:790606 TREATMENT PERIOD NR:01 DOSAGE:001500 MODIFICATION

TREATMENT PROGRAM SCREEN 3

FOLLOW UPS

HOSPITAL:11001 DEPT:741 DATE:790606

PHYSICAL EXAM: O.R KARNOWSKY INDEX: TREATMENT:

NEXT HOSPITAL:11001 DEPT:741 DATE:791212 TYPE OF VISIT: NR:01

TREATMENT PROGRAM SCREEN 1

HOSPITAL DEPT:11001 301		TREATING HOSPITAL DEPT:11001 741	
PROFESSION	:X21	PROFESSION	:SÖMMERSKA
RECORD NR	:	DIAGNOSIS DATE	:790505 DEATH DATE:
ICD7	:1701	ICD81/82	.17402
EXAMINATION	:3	SNOMED CODE	:096
HISTOPAT DEPT:011		TYPE/NR OF SAMPLE	:3 0088879
AUTOPSY	:	CAUSE OF DEATH	

TREATMENT PROGRAM SCREEN 1

ID NUMBER: 91105079261 SEX: 2 TUMOR NR: 1 TREATMENT PROGRAM NR: 1740A

NAME :SVENSSON ELISABETH

ADDRESS :STORGATAN 25 111 11 SMÅSTAD

CIVIL STATUS :1 HOMETOWN:018601

VÅRDPROGRAM FÖR BRÖSTCANCER

1

Inrättning, klinik	Personnr
	Namn
Ifylles för samtliga nydiagnosticerade patienter. **Originalet insändes till Onkologiskt centrum, Radiumhemmet.**	
Datum	Läkare

PATIENTUPPGIFTER

Nuvarande el. fd yrke/sysselsättning

Tidigare sjukdomar av betydelse

☐ Tidigare bröstcancer år ☐ Annan cancer år Diagnos: ☐ Annan allvarlig åkomma diagnos:

Menstruationsstatus

☐ Premenopaus ☐ Gravid el. < 6 mån efter d:o ☐ 0–5 år postmenopaus ☐ >5 år postmenopaus M.P. år:

☐ Osäkert, t.ex. efter hysterektomi ☐ Övrigt

STATUS

Tumörstatus, palpatoriskt

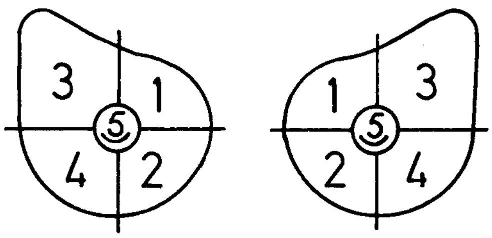
☐ Paget ☐ a fritt förskjutbar ☐ Höger ☐ Vänster

☐ T_0 ej palpabel tumör ☐ b fix. mot pectoralis

☐ T_1 Tumör < 2 cm ☐ T_{4a} fix. mot bröstkorgsvägg

☐ T_2 Tumör 2-5 cm ☐ T_{4b} hudengagement inkl. peau d'orange

☐ T_3 Tumör 5-10 cm ☐ inflammatoriskt ca.



☐ T_3 Tumör > 10 cm ☐ armödem ☐ multipla tum. ☐ bilateral (en blankett för varje bröst)

Lymfkörtelstatus — Palpabla körtlar axill — Dito fossa icl/scl — Fjärrmetastaser påvisade

☐ N_0 inga palp ☐ N_{1a} ej susp ☐ N_{1b} susp ☐ N_2 fix. ☐ N_3 ☐ M 1

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DIAGNOSTIK

Mammografi

☐ negativ ☐ tveksam ☐ positiv ☐ ej bedömbart ☐ ej utfört

Utförd vid (institution) Storlek: mm ☐ multipla ☐ bilaterala

Cytologi — Utförd vid (institution)

Datum

☐ negativ ☐ tveksam ☐ positiv ☐ ej bedömbart ☐ ej utfört

Öppen biopsi — Utförd vid (institution)

Datum

☐ negativ ☐ tveksam ☐ positiv ☐ ej bedömbart ☐ ej utfört

BEHANDLINGSUPPLÄGGNING

Operation

☐ Lokal excision + axill utrymning ☐ Mod radikal mastektomi ☐ Annan kirurgisk behandling

Primär inoperabilitet pga

☐ Lokal sjukdom ☐ fjärrmetastaser ☐ komplic. sjd. ☐ annan orsak

Patienten bedöms ej klara av

☐ Radioterapi ☐ Cytostatika

FORTSATT BEHANDLING/KONTROLL

Datum, alt. ungefärlig tidpunkt för återbesök	Inrättning/klinik

Ifylles vid OC

Inkom den .... Komplett .... Komplettering begärd .... Registrerad ....
sign.

Figure 3

2

VÅRDPROGRAM FÖR BRÖSTCANCER

Inrättning, klinik	Personnr Namn
Ifylles för samtliga nydiagnosticerade patienter. **Originalet insändes till Onkologiskt centrum, Radiumhemmet.**	
Datum	Läkare

KIRURGI

☐ Ej opererad	Orsak ☐ lokal inoperabilitet	☐ fjärrmetastaser	☐ komplic. sjd.	☐ annan orsak
Op. datum	Klinik			
Operationstyp ☐ Höger bröst:	☐ modifierad radikaloperation	☐ ablatio	☐ lokal excision m axillbiopsi	☐ annan
☐ Vänster bröst:	☐ bilateral (en blankett för varje bröst)			
Postop. komplikation ☐ Nej	☐ Ja			

PAD OCH RECEPTORBESTÄMNING

Datum	Institution		
Tumörstorlek Ø	mm (största diam. ofixerat)	Radikalitet ☐ tveksamt	☐ ej radikalt
Antal tumörer			
Antal undersökta lymfkörtlar:	varav med metast:		☐ periglandulär växt
Östrogenreceptor bestämning ☐ Ej utfört	☐ utfört	Resultat:	f mol/µg DNA

POSTOPERATIV BEDÖMNING

Datum			
Postoperativ behandling ☐ Ingen	☐ Radioterapi	☐ Cytostatika	☐ Nolvadex
☐ Annan	Vilken		

FORTSATT BEHANDLING/UPPFÖLJNING

Datum, alt. ungefärlig tidpunkt för återbesök	Inrättning/klinik

Ifylles vid OC

Inkom den .... Komplett .... Komplettering begärd .... Registrerad ....
sign.

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VÅRDPROGRAM FÖR BRÖSTCANCER

Figure 4

3

Inrättning, klinik	Personnr
	Namn
Ifylles efter avslutad strålbehandling. Originalet insändes till Onkologiskt centrum, Radiumhemmet.	

Datum	Läkare

STRÅLBEHANDLING

☐ preop	☐ postop	Datum start	Datum slut

HÖGER	Axill	Supraclav	Parasternal	Bröst/ bröstkorgsvägg
Strålkvalitet				
Specifikationsdos, Gy				
Antal dygn				
Antal fraktioner				

VÄNSTER	Axill	Supraclav	Parasternal	Bröst/ bröstkorgsvägg
Strålkvalitet				
Specifikationsdos, Gy				
Antal dygn				
Antal fraktioner				

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FORTSATT BEHANDLING/UPPFÖLJNING

Datum, alt. ungefärlig tidpunkt för återbesök	Inrättning/klinik

Ifylles vid OC

Inkom den .... Komplett .... sign. Komplettering begärd .... Registrerad ....

VÅRDPROGRAM FÖR BRÖSTCANCER – UPPFÖLJNING

Figure 5

4

Inrättning, klinik	Personnr
	Namn
Ifylles vid varje återbesök el. vid utskrivning från sjukhus och insändes till Onkologiskt centrum, Radiumhemmet	

Datum	Läkare

Tumörstatus

☐ **Inga tecken till tumör**

☐ Misstänkt recidiv/metastaser

☐ Lokalt recidiv, lokalisation ....

☐ Fjärrmetastaser, lokalisation ....

☐ Annan primär tumör; lokalisation ....

☐ Primär tumör i andra bröstet (v g fyll även i blankett 1)

Behandling

☐ **Ingen behandling/behandling utanför vårdprogrammet**

☐ Adjuvant cytostatikabeh. enl. vårdprogrammet (v g fyll även i blankett 5)

Adjuvant Nolvadexbeh. enl. vårdprogrammet

☐ fullföljs ☐ Avslutad (komplett)

☐ Dosen reduceras p g a .... ☐ Avbryts p g a ....

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Nästa återbesök i öppen/sluten vård

Datum, alt. ungefärlig tidpunkt för återbesök	Inrättning/klinik

Ifylles vid OC

Inkom den .... Komplett .... sign. Komplettering begärd .... Registrerad ....

VÅRDPROGRAM FÖR BRÖSTCANCER/CYTOSTATIKABEHANDLING

5

Inrättning, klinik, avd/mottagning	Personnr Namn
Anvisningar **Ifylles vid varje behandlingstillfälle och insändes efter 3 behandlingar till Onkologiskt centrum, Radiumhemmet.**	

Patientdata

Längd cm	Vikt kg	Kroppsyta m^2

BIVERKNINGAR under/efter föregående kur (ange graden 1=saknas, 2=måttliga, 3=uttalade)

☐ Kräkningar ☐ Diarré ☐ Stomatit ☐ Konjunktivit ☐ Cystit ☐ Håravfall ☐ Andra biv. spec. ....

KUR NR

Datum	Hb	V	Trc	Preparat	Standard dos*	Dos, mg under denna kur	Ord av läkare Sign	Beh av sköterska Sign	Anmärkningar
				MTX i.v.	40 mg/m^2				
				5 - FU i.v.	600 mg/m^2				
				MTX i.v.	40 mg/m^2				
				5 - FU i.v.	600 mg/m^2				
Premenopausal, datum senaste mens				Sendoxan p.o.	100 g/m^2	/dag			

BIVERKNINGAR under/efter föregående kur (ange graden 1=saknas, 2=måttliga, 3=uttalade)

☐ Kräkningar ☐ Diarré ☐ Stomatit ☐ Konjunktivit ☐ Cystit ☐ Håravfall ☐ Andra biv. spec. ....

KUR NR

Datum	Hb	V	Trc	Preparat	Standard dos*	Dos, mg under denna kur	Ord av läkare Sign	Beh av sköterska Sign	Anmärkningar
				MTX i.v.	40 mg/m^2				
				5 - FU i.v.	600 mg/m^2				
				MTX i.v.	40 mg/m^2				
				5 - FU i.v.	600 mg/m^2				
Premenopausal, datum senaste mens				Sendoxan p.o.	100 g/m^2	/dag			

BIVERKNINGAR under/efter föregående kur (ange graden 1=saknas, 2=måttliga, 3=uttalade)

☐ Kräkningar ☐ Diarré ☐ Stomatit ☐ Konjunktivit ☐ Cystit ☐ Håravfall ☐ Andra biv. spec. ....

KUR NR

Datum	Hb	V	Trc	Preparat	Standard dos*	Dos, mg under denna kur	Ord av läkare Sign	Beh av sköterska Sign	Anmärkningar
				MTX i.v.	40 mg/m^2				
				5 - FU i.v.	600 mg/m^2				
				MTX i.v.	40 mg/m^2				
				5 - FU i.v.	600 mg/m^2				
Premenopausal, datum senaste mens				Sendoxan p.o.	100 g/m^2	/dag			

* För dosreduktion se behandlingsprogram omstående sida.

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CASE STUDY CONTINUATION: SOCIETY AND THE ALL COMPRISING MEDICAL INFORMATION SYSTEM

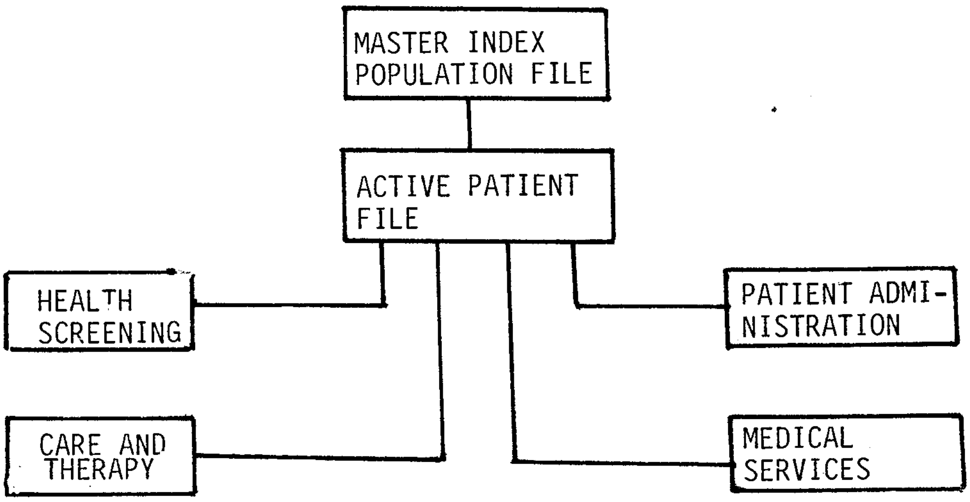
Hans Peterson

Sweden has an exceptionally high concentration of its medical care to large hospitals. A more decentralized system has however now become a strong political issue. The optimal balance between in-patient and out-patient care is by no means clear as the total health care activities in a certain geographical region are not known in any country.

Stockholm County offers a uniqe possibility to clarify these problems as it operates a medical information system covering a medical region. The system will shortly also be extended to include all out-patient visits thereby giving for the first time a total picture of the morbidity and resource utilization in a total population.

The philosophy for the system can be expressed as follows:

FIG. 1



The system structure can functionally be divided into the following levels:

Central function for a region including Master Index, Health Screening and Statistics

Local functions for each hospital or groups of hospitals, including Active Patient Files, Patient Administration and parts of Care and Therapy

Peripheral functions for specific laboratories and departments including Medical Services and parts of Care and Therapy

This philosophy and system structure is used in the centralized system and will not be changed in the distributed system under development. Computers linked together in a network will be used in each level of the structure to handle the functions mentioned.

Patient administration system

The information system is built up from a number of modules. Each of these contains information on the treatment of a patient, which makes it possible to follow the patient from the initial contact with the hospital to the end of the treatment, in out-patient as well as in-patient care. All information concerning active patients is compiled in a patient file (PR), which can be reached immediately by direct access (Figure 2).

The following system modules are now working on-line:

Out-patient routine
In-patient routine
Laboratory routine
(e.g. Chemical, Haematological, Histopathological and X-ray)
Waiting list routine
Booking routine

The three first named routines are mostly used for registration, e.g. the results of analyses, examinations, treatment and performed procedures are noted. The two last ones are used for planning.

The waiting list routine collects information which is used to form the base for the planning of both out-patient and in-patient care, as well as for examinations and tests at different laboratories. The booking routine coordinates and schedules the ordered examinations and tests with consideration given to medical needs and the patient's convenience.

Out-patient routine

For entry into the patient file, the patient must be registered either through out-patient or in-patient routines. At registration only the identification number is fed into the computer (e.g. 340510-1534), whereas other relevant personal data such as name, address, etc., are automatically transferred from the Master Index (HR) to the patient file. When using other routines, these personal data are transferred from the out-patient or in-patient routines to the routine in question.

The out-patient routine is divided into three parts:

Registration of consultation. Besides personal data other data, such as hospital department, type of consultation (first; renewed), emergency or not, diagnosis, if the patient is to return or not, are fed in

Registration of the medical data in connection with the consultation. Here are registered the name of the examining physician, the referring institution, where the patient is transferred (home, in-patient care, other department, etc), the examinations/treatments performed, vaccinations, drug sensitivity, reported ill or not.

The accounting routine. Two different routines available, one for payment by the post bank, the other for cash payment. A proposal concerning the transmission of information direct to the central insurance office is under consideration.

This routine produces operational statistics from part 1 and medical statistics from part

2.

The head physician of the department will get a list of patients whose treatment is finished, but for whom the diagnosis is not reported.

In-patient routine

On reservation or admission by the in-patient routine an entry is made in the patient file for the patient.

In principle this routine will function paper-free by using the terminal. Information on name, address, etc., is automatically transferred from the Master Index. Then certain obligatory data as hospital and department are fed in. Already prior to admission the examinations to be performed as well as the procedures planned after admission, such as an operation, will have been registered by the pre-admission transaction. In the future this will be handled automatically by transfer from the waiting list routine, while the appointments for laboratory tests, to be performed after admission, will be transferred to the laboratory routine.

There are special real time transactions to report the transfer of a patient from one department to another within the hospital as well as the discharge of a patient, whereby it is reported to which place he was transferred (home, to another hospital, etc.).

Through the in-patient routine, bed census reports are produced together with the monthly statistics and, if required, statistics on diagnosis and operations. By this routine, the computer automatically produce admission and discharge reports, which are sent to the central insurance office. Moreover, information for internal and external billing is produced.

The information stored is also available for other studies using special programs.

Medical Statistics

As the Master Index contains, besides medical data, vital statistical data for the entire population of the County a lot of different statistics can be produced.

The records of departed persons are transferred from the Master Index to a special file kept only for statistical reasons. On the same file are also stored all changes in the vital statistical data so it is possible to make studies on the population as it was at any previous time.

Certain statistical reports are produced regularly, in particular

operational, showing the number of patients and length of stay for all diagnoses or groups of diagnoses or any types of surgery for different departments, hospitals and the entire County. These reports are produced every 6 months, covering half a year and one year periods and divided by age and by sex.

operational, showing the breakdown of diagnoses for different parts of the County and divided by age and by sex. Produced only for requested diagnoses.

individual follow-up or selective clinical research to inlcude any part or parts of the information stored, and sorted in any desired way. These are produced on request on a day-to-day basis, mostly for individual physicians. This possibility is at the moment used approximately 50 times per month.

operational, showing the distribution of costs of tests and examinations to the referring unit using a point system.

Use of the information system for health care planning

The planning process in Stockholm County contains three levels

Development plan
Operational plan
1 - 5 year budget

The above mentioned medical statistics are used as a foundation for all three planning instruments. In addition to this a number of speciality studies are performed such as

The geographical distribution of care consumption
Estimates of consumption
Changing trends in the panorama of diseases
Measuring the demand for medical care

The Geographical Distribution of Care Consumption

In order to establish an acceptable allocation of resources and an even distribution of the work load at the institutions all these units/clinics have been assigned a geographical catchment area from which patients are recruited. The intention of this system is ultimately that all patients regardless of the nature of their ailment should have an equally good opportunity for obtaining health and medical care services.

Not many years ago a data based project was initiated in order to survey the geographic distribution of the consumption of medical care. This survey now gives annual information on the distribution of consumption of medical care.

In summary it can be said that this information is produced by simultaneous processing of the diagnostics data mentioned earlier, containing a record of 250,000 - 300,000 hospitalised cases annually and a population data file on every person resident in the county during the year. When compared with the manual bed-occupancy statistics, the shortfall in the diagnosed in-patient cases has throughout been less than 5%.

There are possibilities for obtaining a variety of data tables in accordance with the planning question to be dealt with. The material has been standardised for age groups so that varying age distribution in the 160 parishes of the county with its 23 municipal districts and 13 basic recruiting of catchment areas, does not affect the relative figures for care consumption that are obtained.

One table gives breakdown of the care consumed in Stockholm County in terms of 20 age groupings of five years each, and in terms of male and female. For each of these age group categories the actual medical care consumed can be read in terms of bed-days, number of patients and number of admissions. Furthermore the population in each age group is indicated. The quotients for relating care consumed to the number of inhabitants are also stated. This basic table is presented for three different diagnosis levels as well as in the form of several special data runs, for example, for somatic acute care and psychiatry.

Another table called comparative use or consumption indicates the actual, the expected and the age-standardised consumption of care for each parish and municipal district in the county. Bed-days, number of patients and admissions, constitute the basis of description here as well. The number of inhabitants per parish district and municipal district is also indicated together with certain quotients which enable direct comparisons to be made of the relative care consumption in different geographical areas. An expected use of consumption of 100 corresponds to the average for the county as a whole. Also here three levels of diagnoses are technically possible.

The third type of table presents the actual and expected use per age group and parish district. The factors described are in principle the same as before. Actually the only innovation is the age classification. Any group of diagnoses or any level of diagnoses is technically feasible.

A few of these basic tables are of special interest from the point of view of medical care planning.

With table two, on comparative use or consumption of medical care it is possible to compare the relative use of hospital care within various recruiting or catchment areas (or for some other geographical distribution).

Use of consumption is measured in terms of the number of patients. The index 100 indicates the "normal" use of medical care for the county as a whole. The material is indirectly standardised for age groupings and covers all admissions for in-patient care in the county.

Map diagrams indicate that there are considerable variations in the amount of hospitalisation consumed. These variations can be interpreted in at least two ways. The variations may reflect an actual difference in the need for medical care and/or a demand for medical care that is conditioned by socioeconomic factors. Another interpretation could be that differences in the organisational structure of medical facilities account for variations in use. Since in this case the material is derived from in-patient hospital care, it can be assumed that as a rule the variations reflect the first mentioned explanation even if it has not yet been proven statistically. The fact that variations arise within one and the same recruiting area also speaks in favour of that conclusion.

Estimates of Consumption

The data based information system is already being used in order to seek to equalize the patient burden at the various hospitals and also to dimension bed-capacity within the field of the basic disciplines. This is achieved by means of consumption-estimates for the basic recruiting areas. The starting point of the calculations is the number of bed-days per five year group, during a given year, within the county area as a whole. The series of figures obtained for 20 five year groups is applied to the population within the respective base recruiting area. Adding the figures for all the age groups produces a total figure - a consumption figure which can be determined for each individual basic recruiting area.

The method thus makes it possible to take age structure into consideration when distributing resources and thus not only the absolute size of the population.

Changing Trends in the Panorama of Diseases

The statistics on health and medical care which have been presented in the foregoing have been available in data bases form since 1971. These will constitute an excellent basis for studying various types of long term changes within and outside the medical care organisation.

The long term changes in the panorama of deseases constitute a decisive factor which must provide a foundation for all long term planning in health and medical care.

The individual-based diagnostic statistics form a good starting point for a description of how different diagnoses co-variate with age, sex and residential districts in the county area. In our county specialised knowledge of the significance of age in this connection has been of great value and has justified a major expansion of somatic long-term care, while taking account of the special pattern of diagnoses in that branch of care.

Current statistics also make it possible to study the effects of different types of preventive measures. An example of this is the decrease in some children's diseases which is verifiable and which is related to the expansion of the child health care programme.

It is most important, in the prevailing situation, to concentrate on following up those diagnosis groups whose development is related to certain aspects of society's development. This applies to injuries from alcohol, smoking and narcotics and the consequences of environmental pollution in its various forms. Various states of psychological stress should also be studied. This type of follow up is presented in the annual statistical reports which are published by the Health and Medical Services Board of the county council.

Measuring the Demand for Medical Care

A fundamental principle of medical care planning in Stockholm is to make clear distinctions between different forms of care so that a structure can be obtained that permits rational exploitation of resources.

The principle of distinct forms of care implies that the methods of analysis will be different for the different forms of care.

In the most recent long-term planning for that form of care a model has been applied which in the first instance is designed to select the categories of patients who could be cared for equally well in long-term care rather than acute somatic care. The criteria for what can be regarded as acute care has been set at a maximum of 30 days care. Empirical study has shown that the hypothesis of 30 days as a limiting value for adequately dimensioning acute care is reasonably generous. Actual conditions suggest that the limit probably could be set much lower.

The basic statistical material upon which the dimensioning of somatic acute care is founded consists of facts on all the patients that have been discharged during the course of one year. The patient statistics have been compiled for age groups of five year intervals in order to correspond to the comparable descriptions of the population prognoses.

The analysis of demand starts with the number of in-patients and then proceeds by comparing the patients in the different age groups with the population in the same age groups in the county area. A figure is thereby obtained for the proportion of care recipients as a percentage of the population. Assuming no change in the frequency of disease in the different age groups, the currently derived care percentages can be applied to the future population. By this the quantity or expected number of patients ten to fifteen years ahead can be predicted.

In order to further estimate the future number of beds, assumptions must be made about the average number of bed-days in the future and the bed occupancy rate.

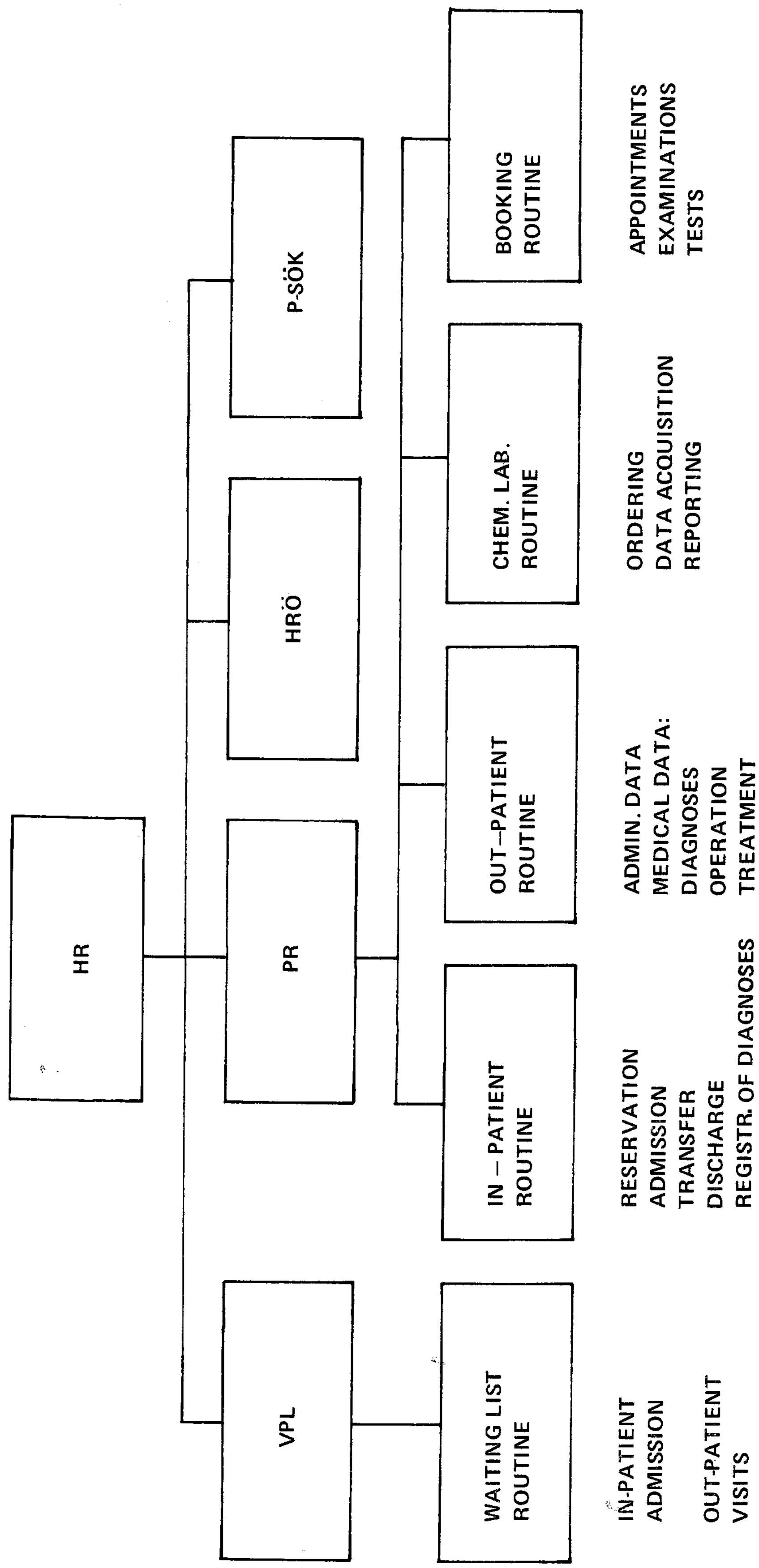
The information stored is also available for other studies using special programs.

There is now the unique possibility to follow the morbidity in a population of 1,5 million inhabitants on an individual basis.

The content of the Master Index will be increased to contain vital medical information from tests and examinations.

Together with this the statistical programs will be reworked so that trend analyses, covering many years, can be obtained. Integrated statistics and prognostications are under development, e.g. distribution and economic results on treatment of different diagnoses from in- and out-patient care and how this will affect, e.g. number of doctors and other resources to be employed at different treatment levels. The end result should of course be to aid the long range planning of the medical care in all aspects, e.g. buildings and personnel, hospital and home care, transportation and administration.

FIG. 2 PATIENT ADMINISTRATION SYSTEM



HR = MASTER INDEX PR = PATIENT FILE P–SÖK = IDENTITY NUMBER SEARCH

HRÖ = PATIENT IDENTITY INFORMATION