IMPACT OF INFORMATION TECHNOLOGY — SOME DIMENSIONS OF THE PROBLEM

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ABSTRACT

The paper comments on the difficulty of analyzing the impacts of Information Technology. Some areas in which unexpected but important impacts may occur are pointed out, and the possible nature of these impacts is discussed. Suggestions are made regarding ways in which these impacts may be studied in order to determine their magnitude and importance.

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INTRODUCTION

A major difficulty in attempting to analyze the Impact of Information Technology lies in determining the areas in which to examine these impacts. No human activity is exempt, for information technology defines the mechanism and philosophy which govern gathering, analysis and transmission of intelligence between individuals and, increasingly, between individuals and machines or between machines themselves. Taken in the broadest sense, it may be extended cover all communication and control functions. When we speak of Information Technology we are thus really addressing the brain and nervous system of society seen as an evolving organism, as a living system (Miller 1978:783, et seq.).

The difficulty in attempting, at the present time, to analyze the impact of this technology may perhaps be better appreciated by reference to the impact of the automobile. In the early 20th century, the possibility of widespread use of privately owned vehicles, powered by internal combustion engines and using the public highways, first became apparent. It would, however, have been virtually impossible to foresee all of the areas which were to be drastically affected by this development, let alone the nature and scope of the effect. Some areas were fairly obvious: town planning, for one. Increased personal mobility would obviously permit workers to live further from factories or offices. New types of industrial, commercial and residential sections would probably develop. And they did. Much less obvious were other areas which turned out to be vitally affected. In the political area; developed nations have become at least partially hostage to countries with large reserves of oil. In the

economic area; when the automobile industry falters whole national economies suffer. In the technical/industrial area; the underlying and steadily increasing market for gasoline permitted, and conditioned, development of the petrochemical, pharmaceutical, plastic and other industries as we know them today. In the social area; the automobile has contributed to disintegration of the extended, supportive, family. Sexual mores have been affected by use of the automobile as a "rolling bedroom." Even our attitudes towards the value of human life have conceivably been affected, for who would have known that by the middle of the century more people would be killed on the highways than in the as yet unimagined wars? This must result in a blunting of sensitivities.

The list of unexpected or surprising areas which were significantly affected by the automobile could be prolonged. The point is that a revolution in the manner of carrying out one of society's vital functions will have repercussions well beyond the area normally associated with that function. In the case of the automobile, the function was transportation. In the case of Information Technology the function is the even more vital one of dealing with knowledge. This paper represents an attempt to signal certain important, but possibly unappreciated, areas which may be affected by developments in information technology; to "run up a flag," as it were. Where this appears feasible, comments are also made on the nature or extent of the changes which may result. In certain cases, suggestions are made on the nature and timing of studies which may enable relevant decisions to be made in a timely and knowledgeable manner. An attempt is also made to point out the types of decisions which these impacts may force on society; decisions which may be made by default if they are not made consciously. It is not intended to be an exhaustive or definitive study of the question, but rather to provide indications of directions which I feel it would be profitable to pursue in further investigations.

PUBLIC PARTICIPATION IN THE DESIGN AND CONTENT OF INFORMATION SYSTEMS

Conventional cinema, television and, to some extent, publishing are largely insensitive to the requirements of individuals or small groups. They provide one-way transmission only, and their very nature almost precludes tailoring to meet specialized requirements. As representatives of todays mass media, they share another characteristic of mass; inertia. Reaction against this insensitivity is apparent in the growth of community interest newspapers, the "underground" press, and the drive for locally originated programs on Cable TV systems. Proliferation of small, independent film makers, frequently using the technology of Video recording, is another manifestation of this reaction.

The nature of the technology employed by the mass electronic information medium, however, makes it possible to provide effective feedback from the audience and thus modify the present sharp distinction between consumers and originators of information. The infosphere in which we exist can, by virtue of this technology, become richer, more responsive to individual needs, and more satisfying for society as a whole. It is not too early to look at the question of how the electronic information medium

can be structured so as to provide truly interactive features, with opportunities for creative participation by the public. Basic technology for such participation is available, and being constantly improved (see, *inter alia*, Maurer and Sebestyen 1982). The obstacles to achieving a participatory information medium will be mainly financial, legal and administrative. If these obstacles are not overcome, society will not realize the full potential of the new medium. As James H. McDonnell (1982) puts it:

> Unless the public can participate at different levels (national, regional and local) in the development of these media, control will remain vested in elite groups (broadcasters, information providers, media producers, government regulators, etc.) and the public will feel increasingly dissatisfied and powerless.

There have been a number of experimental information systems designed to provide user feedback on the structure, purpose and information content of the system itself. These include the HiOVIS and the TAMA Coaxial Cable Information System (TAMA CCIS) in Japan, the Warner Cable Corporation "Qube" system and the Reading (Pennsylvania) cable experiment in the USA. The Heinrich Hertz Institute of West Berlin has recently been asked by the government of the Federal Republic of Germany to develop an experimental two-way cable TV system serving 100,000 homes (InterMedia 1982). More such experiments are needed in order to determine, among other matters:

- Factors which affect the publics acceptance of such systems. (Is the technology frightening? How much training is required? How can the system best be publicized? How important are economic factors? etc.)
- Changes necessary in the legal or administrative framework in order to promote growth of participatory systems. (Licensing policies. Shall carriers have control over content? Should service be controlled by a single organization, agency or corporation, or shall it be provided from a multiplicity of sources?)
- Types of services most immediately in demand, and those most likely to develop. (Database access for personal or business use, telemessaging, leisure and amusement, information on local facilities available, access to computer assistance, etc.)
- Effect on personal life-styles. (Greater participation in local affairs? Reduction in isolation? Broader range of interests? Subjective reactions of participants, etc.)

It would be very useful to provide for continuing general analysis of the results of all such experiments, wherever carried out. This would help point out areas in which information is lacking or contradictory — and these are bound to be numerous! — as well as provide guidance both for those planning further experiments and for organizations building operational information systems.

It should, incidentally, be noted that the requirement for participatory information system configuration will not be met by providing "serendipity" features, as discussed elsewhere in this paper; see p. 7. What is called for here is public input, and to some extent public control,

of the structured environment of electronic information systems. In order to provide "serendipity" features, however, this structure must provide a "space in the cracks," where anything can happen; where anyone (or thing) may be encountered. The benefits flowing from provision of these features are completely different from those sought through public control of design and information content of the entire system.

SECURITY

Computers are not invulnerable. Databases can be accessed illegally and their contents manipulated, used, deleted or falsified. Transmission networks can be tapped, or jammed with varying degrees of facility. These conditions have given rise to widespread fear that societies increasing reliance on interlinked computers and data transmission will make it necessary to impose tight security regulations and institutional controls which will diminish individual personal freedom. [This type of concern has also been voiced in regard to atomic power, where the potential for harm to society through misuse or sabotage of the facility may justify — even require — increased societal control of the individual in order to prevent such misuse or sabotage.] But these are not new types of concerns; they are, rather, a reflection of the increasing complexity of society. As any system becomes more complex, it inevitably becomes more sensitive to irrational, perverse and unexpected acts by its individual components, and is forced to take steps to protect itself against such acts. Trade is a simple and easily understood example. When trade, and payment, was based on barter there was little problem. After all, who can counterfeit a cow? But the increasing complexity and geographical ambit of trade made it necessary to replace barter by other mechanisms, with safeguards against their misuse. Coinage used noble metals, easily checked by feel, weight and physical characteristics. Further safeguards were introduced in the form of complex stamping or engraving. When coinage proved inadequate, it was replaced by paper money. The increased level of protective sophistication this required was achieved through use of special inks, engraving, paper, etc., supported by legal sanctions against counterfeiting and an elaborate police mechanism for detecting, apprehending and punishing counterfeiters. Paper money is now slowly, almost imperceptibly, being replaced by bits in a computer memory. The resultant increasing complexity of protective systems is shown in use of techniques such as cryptography, audit trails, passwords, controlled access, and verification procedures. (These, it will be noted, are all aspects of information technology. And so, we are back to the original thesis of this paper, namely that Information Technology will impact every area of human activity!)

Our proper concern is thus not *whether* increased reliance on information technology will result in increased stringency of control of people and their actions. Given societies need to protect itself, this development is inevitable. Even King Canute learned the folly of standing against the inevitable. Our proper concern is rather on *how* these controls will be implemented. There are many ways in which information technology may enhance personal freedom; freedom of movement, of choice, of exchange, of access to knowledge. Our concern must be to ensure that the overall

result, the balance between beneficial and baneful results, is positive. Care must be taken to see that the necessary legislation, the unofficial — but generally binding — social customs, the administrative procedures, developed to protect society against accidental or planned misuse of computer power are neither over-stringently conceived nor over-zealously applied. This implies intelligent study of the need for such protection and the modalities by which it may be most efficiently and painlessly achieved. Such study will require collaboration between experts familiar with the technology, its capabilities and requirements, and social scientists who can evaluate the social implications of protective or restrictive practices. Nor should such a study be a "one-shot" affair. Technology, legislation and social systems are constantly evolving. Practices which are necessary, effective and acceptable under one set of conditions may no longer be so under another. The recommended study would do well to investigate how a continuous "watchdog" function could be achieved, in order to ensure that societies protective reaction remains appropriate.

OVERLOAD

The information handling capacity of all systems, whether single cells, individual human beings or complex societies, has limiting factors. When these limits are exceeded, we reach a condition qualified as information overload. The absolute amount of information to which all of us are exposed, as well as its importance and variety, are however increasing exponentially. This will inevitably result in information overload for society as a whole. The effect of information overload, and mechanisms developed to cope with it, have been extensively studied in the laboratory and in simulated real-life conditions (Miller 1978:173, et seq.). These studies have, however, been directed mainly to the individual and have only rarely addressed the question of how entire social systems are affected by, and can deal with, information overload. Experiments have indicated that individuals subjected to information overload, particularly in the presence of competing stimuli, will react in a psychotic manner. It has also been postulated that information overload is a triggering cause for withdrawal, and even catatonia, in schizophrenic individuals (Yates 1966). This raises the question of whether movements towards withdrawal or non-involvement on the part of certain segments of society might not be, at least in part, a reaction to increased information load. The attitude of "Turn on — Tune in — Drop out," which characterized so much of the Hippie movement in the early 1960s, might be seen in that light. The growing interest in simple, self-contained communities, sheltered from many of the stimuli resulting from close linkage with the rest of society, may be another manifestation of this reaction. Increased tendency toward violent "solutions" of conflicts, as highlighted by terrorist acts across the entire political spectrum, may also be in part a reaction to information overload on basically unstable segments of society. This would not be dissimilar to the towering rages and uncontrollable fits of violence which schizophrenics frequently suffer as a result of stimuli with which they cannot cope.

The entire question of societies reaction to information overload is an intriguing and vital one. It is truly one of those areas where unforeseen and significant impacts may be experienced. Much work remains to be done in this area, particularly in determining elements contributing to overload and in devising strategies to cope with it.

As an initial step it would undoubtedly be useful to investigate the proportions of time which individuals in selected categories spend in creating new information as contrasted to time spent on information processing. Categories of individuals selected should be those whose activities are most information intensive, such as scientists, upper-level industrial management, government officials, etc. The information processing function should include communicating with others, reading, writing reports, disseminating the results of his own work, etc. An analysis should then be made of the division of effort which will provide maximum information productivity in a societal context. (Which, of course, also raises the question of defining and measuring information productivity, another matter bearing investigation!) For there is, of course, a cross-over point; a point of diminishing returns. A scientist, for example, who spends all of his time on research and experimentation, and absolutely no time on dissemination of the results of his work, must by most accepted standards be rated low on the scale of effective social information productivity. At the other extreme, a scientist who spends all of his time reading or communicating with colleagues, with a minimum of original work, will have a similarly low rating. A point of diminishing returns, in either direction, must exist. Rather than being a definite point, this will certainly be an area beyond which "productivity," however defined, falls off. And this area itself will have diffuse borders, varying with the individual and the field of work. A non-communicating scientist may have results of his work communicated by others; students or co-workers, for example. [Though in this case the time spent teaching or coordinating with others could be considered a communicating activity.] Or his results may lie fallow, to be discovered and used at a later time, as was the case with Gregor Mendel, who could only with difficulty be considered non-productive. On the other hand, a scientist whose time is spent mainly in reading and corresponding with others may be a stimulating and thought-provoking correspondent, noticeably raising the "productivity" of his colleagues through these contacts. He too must be rated as "productive" on any reasonable scale.

Even recognizing the difficulty of clearly defining the area of maximum effectiveness, it would be useful to investigate general criteria which individuals or organizations may use to determine whether they are roughly in that area or, if not, in which direction they should move to approach the optimum area.

Ways in which the information load may be lightened, or efficiency in dealing with it increased, should also be investigated. This may, for example, include analysis of the productivity of general use throughout an organization of a computer mediated teleconferencing facility, as contrasted with a gateway approach in which individuals are buffered by a screening or filtering function designed to present the individual significant information only. The problem of determining significance is, of course, a second order effect — and not the less important for that! —

which must also be considered.

Another matter worth investigating is the efficiency of transmission of information through written language. Scientists, executives, government officials, administrators and many others in information intensive fields spend much time reading and writing reports, recommendations, position papers, enquiries, etc. But these papers are written and read by individuals with varying skills with the language in question, particular vocabularies, individual ways of organizing sentences and thoughts, and even peculiarities of punctuation. In effect, when we read something written by someone else we must, as it were, translate this communication into our own language in order for us to fully comprehend and act upon the information it contains. This translation poses problems similar to, though significantly simpler than, translation from one recognized foreign language to another. Much work has been done, with limited success to date, on machine translation between widely disparate languages. The techniques thus developed for recognition and representation of knowledge could be applied to revision and editing of documents intended primarily to convey factual information. Development of such capability would enable the documents to be prepared more quickly by their originators, and to be assimilated more quickly and correctly by those to whom they are directed. Distortion in the transmission channel would effectively be minimized. The individual would be freed from this "translation" effort and his work load would be eased, thus mitigating the effects of information overload. Misinterpretations and ambiguities would be reduced and, with more sophisticated systems, gaps in data or faults in reasoning might even be revealed. [Computers can detect non-sequiturs!] In addition, the experience gained in designing and implementing such a facility would contribute greatly to solution of the much more intractable problem of translation between completely different languages.

PRESERVATION OF SERENDIPITY

Informal, unplanned or chance encounters presently play a significant and generally unappreciated role in our information gathering. They frequently awaken new interests, and provide differing insights into problems we may have been attacking in an habitual manner. Many such opportunities will be jeopardized, or at least changed in character, when society is swimming in an electronic sea of information which replaces much of our day-to-day contact with other individuals. But Information Technology also provides a potential mechanism for vastly increasing the number and variety of such encounters. One has only to think of the (almost) completely informal but dense web of communications and contacts which developed with use of Citizens Band (CB) radio in the United States, particularly by truckers and other frequent users of the major highways. Information in this network is freely exchanged, amplified, complemented, requested, verified and corrected between people who are frequently complete strangers, and who may never reestablish contact after that one exchange. It is true that much of the information may be considered frivolous — though we must be cautious about making value judgments — dealing, as it does, with matters such as weather, traffic

conditions, police "speed traps," places to eat, etc., but it does represent a creative application of electronic possibilities to provide unstructured information exchange. And any exchange inevitably enriches the information pool in which each individual swims.

The worldwide amateur radio network represents another example of creative use of electronic capabilities, to provide a relatively unstructured facility for information exchange. Certain radio frequency bands have been allocated for exclusive use by amateurs. International communities have grown around these bands, and individuals have established contacts which would otherwise have been impossible. Much information is exchanged via this network; not necessarily information dealing primarily with radio technology, it should be noted.

In both of the cases mentioned above, it was sufficient for an opportunity to be presented for individuals to create new forms of information exchange, using electronic media; radio, as it so happens in these cases. This was achieved by administrative action allocating certain frequencies for such use, subject to minimal necessary regulation in regard to power, licensing, modulation characteristics, etc. The important step was to provide the freedom for creative, unstructured use of the medium. Information, too, abhors a vacuum. If there is a vessel, a medium, a channel, into which it can flow, individuals or organizations will fill that vessel. Man is a communicating animal; he will inevitably take advantage of available facilities to communicate informally. The important thing is to preserve, even to foster, such facilities.

Studies of the possibilities available for informal exchanges, as information technology expands both in complexity and social penetration, are not only warranted but necessary if we are to preserve the valuable element of serendipity. The studies should, *inter alia*, focus on identifying communities which would benefit from, and could be expected to use, such informal networks. Their needs for informal communication should be investigated, as well as the mechanisms they are already using to meet these needs; e.g., mails, clubs, specialized publications, social meetings, chance encounters, etc. Communities to be considered may be linked by common characteristics of age, profession, national origin, personal interests, etc. Nor should any informal facility be conceived as for the exclusive, or primary, use of any one community. All can use it and, in fact, the cross-fertilization resulting from "accidental" crossing of community barriers will probably be one of the most valuable products of such a facility. The technical, legal and administrative framework in which existing or proposed information services operate should also be investigated in order to determine changes which may be necessary in order to permit such informal networks to be established and to operate. This may involve matters such as modification of messaging systems, establishing "free-floating" databases or bulletin boards on videotex systems, requiring cable system operators to provide open access interactive channels, etc. The available possibilities will become apparent, and change, with evolution of information technology. For this reason it is advisable for such studies to be undertaken on a regular basis, or at least to be reviewed periodically. The results and recommendations flowing from such studies will provide an input which would otherwise be lacking when decisions must be made regarding information facilities to be

provided, structures of networks, administrative procedures, and research to be supported. The teams making the studies should, ideally, include specialists in the social sciences and communications, as well as members whose primary background is in the technology involved. It is necessary not only to know what needs to be done, but what it is technically possible to do. Far too many studies of complex questions have strayed from reality by ignoring this dual aspect of the problem.

MORALITY, ETHICAL STANDARDS

We all have certain standards of honesty, frankness, reliability, etc. when dealing with other people. Our social training sees to that, though the standards may vary widely between individuals. Will we feel the same when dealing with a machine? I doubt it. We have all had the experience of a coin phone which returns money you never paid, or digests money for a call which was never completed. In the first case you — or at least I — pocket the windfall and say: Well, I won this time. In the second case the most common reaction is to bang the coin box once or twice, jiggle the switch a couple of times, and then shrug off the loss. In neither case is any moral judgment exercised. This is, of course, a trivial case, but may be indicative of our attitude towards a machine. It has no morality; why should we? Will this attitude persist when our dealings with machines involve more substantial transactions? Paying for goods, ordering services, making appointments, answering calls for information, requesting information? All of these involve certain commitments when between human beings. Will this sense of commitment be maintained in interchanges with machines? If not, will it erode the moral basis of relationships between human beings?

This will be a difficult and subtle matter to investigate, but is one having potential long-term implications for society. A start may be made by designing a series of subjective tests which will serve to determine absolute and relative moral values held by individuals. These tests can then be applied to selected groups, having greater and lesser interaction with computers or computer controlled machinery. The tests must be repeated regularly and the results analyzed to detect any indication that long-term exposure to non-human contacts may affect standards of conduct between individuals. It should not be necessary to point out that any such "findings" must be treated with extreme reserve as the entire question of measuring human attitude is fraught with pitfalls and ambiguities, compounded by the inescapable prejudices of the measurer. It is nevertheless an interesting, perhaps an essential, investigation.

LANGUAGE

Soon people may be having more "conversations" with computers than with other human beings. But computers are very intolerant of ambiguity. They are built around very simple elements, however complex their final assembly, and these simple elements recognize only two states: on or off, zero or one. Nothing in between. This characteristic is maintained throughout the system. You must give a computer unequivocal information and instructions if it is to perform its task. But human interchange is loaded with ambiguity. Simple words, which you and I use in common, have a somewhat different freight for each of us. This ambiguity has its use, its value. It is perhaps even essential in order for us to exchange ideas. Think how inhibiting it would be if it were necessary, every time we opened our mouths, to be certain that every idea we expressed was capable of only one interpretation; that every statement was complete and unequivocal. But as we are exposed more and more to machines which demand that we express outselves in that manner — and which respond in the same way — it is possible that our language, and hence our way of thought (for language is the mirror of thought) will be subtly modified (De Marco 1978). Some of the richness, some of the wellspring of creativity, may be lost. If this thesis has any validity, and if such a development is perceived as dehumanizing (because I am certain there will be those who would view it as an advance in the nature of human beings, the only creatures endowed with reason), then perhaps some thought should be given to ways of counteracting it. It is difficult to see how this might be done. Perhaps what is called for will be specially designed programs which *demand* a level of subtle ambiguity in order to operate; programs which then make random interpretations in order to present the user with surprises, new insights, etc. And it might be necessary to limit these programs to less "vital" areas, such as art, education, etc.

DUPLICATION OF LIFE PROCESSES

We have innocently, perhaps naively, certainly unintentionally, been moving towards what, by some definitions, could be called creation of life. Very large scale integrated circuits could not be designed and, if designed, could not be manufactured without recourse to computers. Computers, in turn, become more complex and powerful, more evolved, by use of the very chips they are instrumental in producing. And work is currently under way on making the chips themselves self-repairing (Branscomb 1982), whether for defects in manufacture — which could be likened to genetic defects — or for defects developing during the lifetime of the chip — which could be likened to disease or trauma. Thus, in a very limited sense, electronics may be perceived as having taken the first steps towards self-replication and maintenance. Admittedly a hollow shadow of basic life processes, but one which must give thoughtful people pause.

This development may give rise to either an irrational, Luddite, type reaction, or to opposition on moral and religious grounds. More apparently reasoned opposition may also arise based on the claim that when a technology reaches a stage of complexity beyond that which can

be grasped by human intellect, the possibility of human intervention and control is threatened. It then becomes equally impossible, so the argument runs, to ensure that the technology is used in the most effective and beneficial manner. It will be appreciated that this argument has strong religious overtones, though it may not be presented in apocalyptic terms of "...technology running wild and becoming our master."

In any case, public debate on the issue may be expected to increase, with demand for controls, if not restrictions, on research and development in this area. This would not be unlike the uneasiness felt in some circles over research and development in the field of genetic engineering and gene splicing, where there have recently been calls for controls, if not for a total halt to work.

It is difficult to predict when or at what point this debate will pass from smoulder to fulmination, for it will no doubt be linked with extraneous questions — such as who controls the technology. But in order for the debate to cast some light, in addition to the heat and smoke it will doubtless generate, it is necessary for it to be informed by at least a modicum of dispassionate analysis. This analysis should:

- Point out the origins and motives behind the arguments being presented, for in making decisions it is important to be aware of the relative weight of emotional and intellectual considerations involved.
- Review the validity of the individual arguments being presented.
- Make an independent and — insofar as possible — dispassionate analysis of the benefits, dangers and probable outcome of continued development of life-imitating aspects of information technology.
- Make recommendations regarding decisions or action to be taken by relevant authorities.

TRIVIALIZATION

One intriguing possibility is that development of more sophisticated and yet more approachable (user-friendly is the term most frequently employed) devices and programs for interaction with computers and for information handling may result in electronics replacing the automobile as a status symbol in highly developed countries. To some extent this tendency is already evident in the popularity of computer games. If it continues, networks and services may be designed with major consideration given to meeting such requirements, possibly at the expense of other types of use. This could result in trivialization of the entire system and its application. Such a development would, however, not be without precedent nor it is easy to sustain the philosophical argument that it would represent incorrect or counterproductive use of technology. It may in fact be the most logical, human and natural use of the technology! One has only to think of that most sophisticated and user-friendly computer — the human brain — and the uses to which it has been put! It would, perhaps, be overly sanguine to expect a vastly different panorama of applications to result immediately from interaction of these two computers, the human and the electronic.

This cautionary note is inserted not because the possibility of trivial use of information technology raises an issue which requires immediate further study. The nature, purpose and timing of any such studies are, however, difficult to define at present, and the matter is perhaps best left in abeyance until such time as the issues are more clear. My intention is rather to point out a matter which bears watching, for possible detailed study at an opportune point in the development of information technology. A further purpose is to give an example of the danger and difficulty of making value judgments regarding technical matters. It would be unforgiveable to abdicate human and moral responsibility for our standards and actions — even in regard to technical matters. That way lies perdition and dissolution of *all* standards. Equally pernicious however is the far too common tendency to impose our personal values on others, or on society as a whole. That is the road to intolerance and stifling of creativity. So we should perhaps be prepared to accept, to live with, possible trivialization of certain aspects and uses of information technology, in the long-term interests of its growth and diffusion, and in consideration of the "human nature" of its users.

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