Gaines, B. R. (1979). Computers and society: the basis for a systemic model. In Improving the Human Condition: Quality and Stability in Social Systems Ericson, R. F., ed, pp. 523-530. Society for General Systems Research, Kentucky.

COMPUTERS AND SOCIETY. THE BASIS FOR A SYSTEMIC MODEL

Brian R. Gaines

Centre for Man-Computer Studies,
13, Norman Way, Colchester,
Essex, U.K.

ABSTRACT

The role of the digital computer in man's world of knowledge is discussed, particularly the possibilities of various forms of collaborative man-computer activity. Karl Popper's model of "three worlds", of "things", "subjective experience", and "statements in themselves", is outlined. It is suggested that Popper's "world three" provides a particularly important conceptual framework in which to examine the role of computers. It is argued that computers have a peculiarly significant role in world three that is comparable in importance to that of engines in world one. Some developments in man-computer symbiosis that seem to point the direction for the computer-based development of world three are then outlined and used to indicate the direction of future developments.

1. EXPECTATIONS AND FEARS

Whilst general system theory by its very nature is "science-independent", it has been targetted throughout its development on applications to those sciences which are themselves under development at the time. Thus early applications to the physical sciences switched later to the biological, psychological and social sciences as the frontiers of science themselves changed. Today we note the growth of computer science as being the most rapid and the social impact of computers as being of great significance and concern. However, it would be fair to say that as yet general system theory has had little impact in these new growth areas.

On behalf of computers we have promised much - perhaps too much - perhaps too little. So much that many people are sceptical of any computer-based system: "Where are your management information systems, computer-based instruction systems, and so on ?"; "Where are your labour savings, contributions to profitability, and so on ?". Yet scepticism is now in many cases turning to fear as we actually begin to deliver - automation sells ultimately in so far as it saves labour and, in many economic climates, the labour saved may be equated quite directly with unemployment - large-scale governmental information systems offer efficiency, fairness and speed in social service, but there also stands the spectre of the super-efficient state that knows too much, and through its knowledge controls too much, of its citizens' lifes.

Neither the scepticism nor the fear is new. Dreyfuss (1972) and, more recently, Weizenbaum (1976) have put forward cogent arguments for fundamental limitations on the capabilities of computers in certain areas of intellectual activity. Catt (1973) goes down to far less gradiose aspirations and argues, using a range of examples, that there is a "discrepancy between the dynamic claims and the stagnant reality" - that Toffler's (1970) model of "Future Shock" is based on a "fallacy of accelerating change". Laudon (1974) in his book on Computers and Bureaucratic Reform reports a number of studies of actual systems and concludes that computers have had virtually no impact on bureaucratic reform.

All this scepticism is a healthy balance for the opposing viewpoint: that the computer will have a devastating impact on society. For example, Laudon's case studies seem to stand in direct contradiction to Mowshowitz's fears in The Conquest of Will that computer-based information systems will lead to:

> "..the alienation of individual responsibility which results from excessive bureaucratization of decision-making" (Mowshowitz 1976 p.x)

not because that was not a possibility, but rather because it was beyond our competence ! The long-term fears for the effect of computers on society were most cogently expressed in Wiener's (1950) The Human Use of Human Beings that the computer will have a devastating impact on society. His prophetic statements of 1950 are coming uncomfortably close to reality today:

> "the automatic machine...is the precise economic equivalent of slave labor. Any labor which competes with slave labor must accept the economic conditions of slave labor. It is perfectly clear that this will produce an unemployment situation, in comparison with which the present recession and even the depression of the thirties will seem a pleasant joke."

In the same book Wiener quotes a Dominican friar,

Dubarle, reviewing his earlier book, Cybernetics in Le Monde December 28, 1948:

> "conceive a State apparatus covering all systems of political decisions...In comparison with this, Hobbes' Leviathan was nothing but a pleasant joke. We are running the risk nowadays of a great World State, where deliberate and conscious primitive injustice may be the only possible condition for the statistical happiness of the masses: a world worse than hell for every clear mind. Perhaps it would not be a bad idea for the teams at present creating cybernetics to add to their cadre of technicians, who have come from all horizons of science, some serious anthropologists, and perhaps a philosopher who has some curiosity as to world matters."

Wiener discounts Dubarle's fears for total world domination, although the theme has become a recurrent one in the science fiction literature (including children's TV programs). He does, however, note the:

> "real danger...that such machines, though helpless by themselves, may be used by a human being or a block of human beings to increase their control over the rest of the human race"

a fear which is prevalent today and is leading, or has led, to highly restrictive legislation governing the access to, and use of, data on computers in many countries. A Luddite movement against computers is also conceivable and has again been a theme fascinating many science fiction writers. Weizenbaum's (1976) book on Computer Power and Human Reason has much in it to excite such a response:

> "Science promised man power. But, as so often happens when people are seduced by promises of power...the price actually paid is servitude and impotence."

Words that have struck a responsive chord and echo Butler's (1872) remarks of nearly a century ago about a previous era of high technology:

> "The servant glides by imperceptible approaches into the master; and we have come to such a pass that, even how, man must suffer terribly on ceasing to benefit the machines."

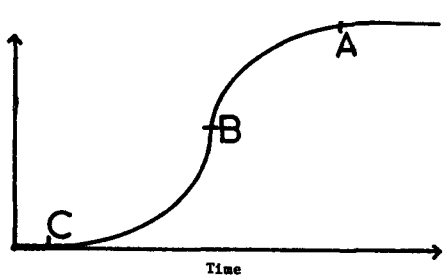

Fig. 1 Assimilation of Computer Technology with Time

I also said that we have possibly promised too little - such themes as Licklider's (1968) "man-machine symbiosis" and Sass and Wilkinson's (1965) "computer augmentation of human reasoning" have been around too many years and seem to more embarass us than excite us now, as do many of the possibilities of automation - perhaps because so little appears so far to have happened. However, we are all aware of the sigmoidal 'learning curve' that charts the progress of assimilation of any new technology. The key question is whether the current situation is that of point A in Figure 1 - assimilation of computer technology into society virtually complete and the early promise never to be fulfilled. Or whether it is, as most of us probably reasonably suppose, point B - assimilation of reasonable depth and maturity sufficient to show the main impact but with promise of more to come. I shall argue here that neither of these points reflects the true states of affair - we are still at point C where the 'learning curve' has risen so little that we have insufficient experience to judge the future rate of climb or ultimate effects and where the potential is still virtually unbounded.

2. PERSONAL COMPUTING

One major factor makes it reasonable to put forward a case for such a future potential of computers given the well-reasoned and damning inditements of Catt and others. This is the increasing availability in recent years of the personal computer allowing the switch from batch-processing to interactive computing to take place and at the same time vastly increasing the availability of computing. Both these changes were necessary before the computer could begin to play its natural role in human affairs. The batch-processing regime with erratic prima donnas intermittently available is the very environment to propagate the growth of mystique and the "computer religion" that Catt so vividly describes - such machines needed their priesthood and their temples ! Even the swing towards on-line, multi-access working has not led to close man-machine interaction for all but the privileged few - serial lines are generally too slow, alphanumeric terminals too restrictive, and the costs of being connected to the computer utility too great. In historic terms, Catt et al are correct - we tried to achieve too much too soon and generated expectations way beyond what we could deliver. Such has always been the way with new technologies - flying machines had an equally chequered history - but just when morale is at its lowest ebb, technologies, like the stock exchange, have an uncomfortable habit of taking off !

The rise of personal computing has been brought about by developments that Wiener could not foresee - the replacement of vacuum tube circuitry by integrated circuit chips whose ultimate production costs are virtually zero. These make even Wiener's optimistic price projections of 1950 look ludicrous today - he talks of a few thousand dollars for a machine that is ten dollars today - he talks in terms of production runs of tens and twenties where

we actually operate in terms of thousands per month. The computer has already gone beyond the wildest dreams of the father of cybernetics some 30 years ago, due to a technology he could not foresee (which itself well turn out to be only one more in a line of rapidly superseded circuit technologies for computers), and this strongly re-emphasises his sociological projections based on lower expectations than we have actually achieved.

I have recently analysed the future of increasing man-computer interaction (Gaines 1978a), and detailed the impact of the growing technology of the personal computer on business applications (Gaines 1978b). The first of these papers highlights informally the current trends in man-machine symbiosis emphasizing the role of the computer as a tool for the emancipation of cognition. The second details recent developments in low-cost interactive computer systems that are beginning to allow this to take place. That is, the first paper develops the principles of close man-computer interaction, and the second shows the current state of the art of the relevant technology. The overall message is that we do not yet have either the communications interfaces, particularly voice interaction, or the communications software, particularly 'world' models, that are necessary for full man-computer symbiosis. However, the message is also that we are moving rapidly in the right direction - raw processing power in small machines, colour graphic displays at low cost, and a variety of basic software modules to provide easy access to the power of the machine - these are already available to allow the individual to share some of his load in intellectual tasks with the computer. To a large extent we are already 'imagination-limited' - the "personal computer" can do far more for us now than is at all evident in current applications.

However, the lag of applications behind hardware/software technology is comparatively short - good systems have only been available for the last 3 years and the price is only now beginning to hit levels that are attractive to the 'non-professional' user (non-computer-professional, that is - many key first-time users are professionals in their own areas, doctors, accountants, clinicians). A pattern of use for the personal computer in the home and office is emerging from the dozen small business and hobbies magazines and journals now extant: text processing for correspondence and document production is one major application; tax returns for personal and business purposes another; there are also developments in "planning" packages that optimize delivery schedules, etc.

The most important feature of current forms of personal computing is that they are enabling key individuals to increase their own speed and flexibility of operation by decreasing their dependence on the availability and skills of others. It is the supporting services of a secretarial, clerical, acoounting, information-retrieval, nature that are being taken over by the personal computer. Previously, we seemed to have been entering an era of essential team-work where individual "acts of creation" were possible only through a mediating network of supporting staff. The personal computer is already changing this and the potential for further change is very great indeed. "Each man his own Leonardo" is now a realizable slogan in human terms - the 'team' is still there and still necessary but it is the 'record' of pooled human skill within the computer that forms the rest of the team not the people themselves.

It is in these aspects of personal computing that both the fears and the expectations arise most strongly. The computer itself cannot be regarded just as a tool for work on data processing. The tool is itself so significant that it will change our whole approach to knowledge and action. The tools of man are part of man himself and their evolution is inherently our evolution. In his book on The Abtract Society Zijderfeld (1970) remarks:

> "A relatively recent addition to this abstract world is the process of automation. Its influences on human labour and the structures of society have been sufficiently discussed. I want to stress here its profound influence on the knowledge of modern man. Whereas traditional man tried to understand his environment in terms of a kind of super-mind, modern man seems to operate the other way around...Today, the computer dos not resemble the human mind, but the human mind operates like a computer." (Zijderfeld 1970 p.77)

Zijderfeld does not seem to regard as healthy this evolutionary trend that he finds, and it is particularly interesting to note the remedy that he proposes:

> "Man today...to master mentally and emotionally the forces he has created...requires a new form of consciouness. First, modern man must learn to regain control over the process of segmentation that has effected his life and mind in the form of specialization and professionalization. Secondly, he must learn to control his emotionality and find a balance between rationality and irrationality. " (Zijderfeld 1970 p.162)

He quotes Weber and Goethe as "professional amateurs" who made important contributions to knowledge through their breadth of interest, and notes the remark attributed to Goethe, that dilettantes promote the causes of science and technology because they know how to combine play with seriousness.

It is no coincidence in terms of Zijderfeld's remarks that one major impact of the personal computer has been in the hobbies market where play is indeed melded with intense seriousness, and that computer professionals are already expressing fear (Dijkstra 1977) that the availability of cheap microprocessors will "de-professionalize" computing. So they will but that is good both for the development of computing and for that of man. It is also no coincidence in terms of his second requirement that significant examples of the use of personal computing to date lie in areas close to

psycho-therapy (see section 4) - the potential for man-computer symbiosis in self-control of emotionality and the balance of rationality is very great.

Thus within the technology that is so often blamed for creating new sociological problems, there is also the germ of a solution to those same problems. The "new form of consciousness" is possibly closer than we realize. As a 'stand-alone' data-processing system the computer is already a powerful and important tool. As a 'personal computer' that becomes a closely coupled complement to the mind of man, however, it generates a new kind of creature whose capabilities are yet beyond our imagination. Currently we are able to add the data-processing power of the computer to the thought processes of man. At the next stage we shall effectively multiply the two together and generate a quantity with new dimensions. Zijderveld quotes Gehlen's (1962) notion that such changes in human consciousness have already taken place during the transition to an industrial society, comparable to those of the Neolithic revolution from a nomadic existence to a domestic way of life.

To capitalize on the availability of the personal computer, however, and to accelerate the changes it is already bringing about, we have to move from rhetoric to knowledge. We need some model of our world, and our existence in it, that will enable us to formulate more closely the key aspects of the computer and our relationship to it.

3 POPPER'S THREE WORLDS

In attempting to come to grips with the problem of understanding the new opportunities that computers create, I have found Popper's "3 worlds" model (Popper 1968) of great value. In his autobiography he introduces it (Popper 1974 p.143) by quoting Bolzano's notion of "truths in themselves" in contradistinction to "those thought processes by which a man may...grasp truths", proposing that:

> "thoughts in the sense of contents or statements in themselves and thoughts in the sense of thought processes belong to two entirely different 'worlds'."

and making the three-fold distinction:

> "If we call the world of 'things' - of physical objects - the first world and the world of subjective experience the second world we may call the world of statements in themselves the third world (...world 3)." (Popper 1974 p.144)

Popper notes:

> "I regard books and journals and letters as typically third-world objects, especially if they develop and discuss a theory." (Popper 1974 p.145)

and stresses the key role of world 3 in the development of human "civilisation", giving two gedanken experiments on the destruction of civilization to illustrate the status of world 3:

> "(1) all machines and tools are destroyed, also all our memories of science and technology, including our subjective knowledge of machines and tools, and how to use them. But libraries and our capacity to learn from them survive...our world civilization may be restored...from the World 3 that survives"
>
> "(2) in addition all libraries are destroyed ...men would be reduced to the barbarism of primitive man in early prehistory, and civilization could be restored only by the same slow and painful process that has characterized the story of man through Paleolithic times" (Popper 1968 p.334)

This is in itself reminiscent of a central theme of Korzybski's (1933) Science and Sanity, that of "time binding", or the capacity to accumulate knowledge from one generation to the next. However, Popper sees such time-binding not just as an important phenomenon in its own right, but as itself stemming from the independent existence of world 3. He emphasizes the distinct ontological status of world 3:

> "I regard the third world as being essentially the product of the human mind. It is we who create third-world objects. That these objects have their own inherent or autonomous laws which create unintended and unforeseeable consequences is only an instance (although a very interesting one) of a more general rule, the rule that all our actions have such consequences." (Popper 1974 p.148)

Wolff (1976) in his highly perceptive essays on Surrender and Catch describes much of what it is to enter into world 3:

> "From the standpoint of the world of everyday life, the mathematician, as we often put it, lives in the 'world of mathematics', dealing with 'nonreal' elements, notably numbers, whose relation to 'real' things, to 'reality', is not part of his concern... the student of mathematics - his or her individuality, including motives and attitudes - is irrelevant to our understanding" (Wolff 1976 p.163)

He makes the key point that not only does the real world, the object, disappear to be replaced by the world of, in this example, mathematics, but also that, in entering into this world, the person 'doing mathematics', the subject, also disappears to be replaced by a new entity, 'the mathematician'. Wolff's collection of material throws much light on the nature of world 3 and, in particular, on its interface to world 2 - that our subjective experiences through entry into world 3 are very different, but of equal ontological status, to those through entry into world 1.

Popper's model of three worlds provides a very important framework within which to analyse the role of the computer and man-computer symbiosis. The computer itself can be seen to provide a new

dynamic for world 3 just as did the harnessing of energy in world 1. It brings world 3 into the demesne of man just as did the steam, internal combustion, and jet engines, world 1. That is we can move about in, conquer, control and fabricate to our needs the lands and materials of world 3 using computers in a way that makes our previous efforts, all but a few, look feeble. Those few we shall shall look back upon in wonder as we do the construction in world 1 of the Egyptian pyramids, equalled in world 3 by Greek philosophy. However, such 'impossible' achievements prior to the harnessing of inhuman energy and inhuman intellect will be surpassed in achievement, if not in wonder, through our control of mechanisms that give us control of the worlds in which they exist: the energetic engines of world 1 and the informatic engines of world 3.

The role of computers in world 3 can be seen most clearly by contrasting information within a library with that in a computer database. The library itself is passive, waiting for scholars and technicians to tap its stored information, but powerless to process that information in any way, to classify it, extend it, and correlate it, except through human mediation. The database contains the same information as the library but may also itself be active through processes that interact with that information without necessary human mediation, sifting through the stored data structures, analysing and comparing information, and building new structures to enhance and extend those already present. The library is like a museum of preserved flowers, a static record of unchanging knowledge, whereas the database can be a living garden subject to growth and evolution, changing even as we study it.

The contrast becomes most pointed if we look at the exceptions that prove the rule. Librarianship is the art of preserving the static garden and also of cultivating it as much as is possible by preparing indexes, concordances, and so on, and also making it maximally available and attractive to scholars who will cross-pollinate and extend it - a good library is one where much effort is put into overcoming its intrinsic stasis. On the other hand, current databases are going through that usual stage of computer-based systems where they are designed primarily to mimic that which exists, the static library. Research on inference-based "knowledge structures" in artificial intelligence research is moving in the right direction, but we still have a long way to go before the potential of the computer database begins to be realized (Gaines 1978c).

However, the important thing is that the potential exists and that we have mechanisms capable of doing routinely and on a large scale what good librarians and scholars are currently only able to do with difficulty and on a small scale. Speeding up the processes of scholarship will have the same effect on world 3 that speeding up the processes of transport has had on world 1. Our physical world is a very different place from that of 100 years ago - we are able to take actions in it that disregard boundaries of size and distance because we have, to a very large extent, conquered both. A similar phenomenon has taken place in world 2 where modern communication techniques allow us to share subjective experiences through film and television - to live out vicariously the pleasures and horrors of the lives of others without actually doing so. Popper has pointed to the independent existence and impact of world 3 even as a static store - the ideas of Plato, Hume, Hitler and the Beatles, are active today in so much as they reach into world 2 and germinate in the minds of men. How much more active they will become as world 3 itself becomes energized with its own power sources such that the small energies of world 2 are able to control far greater powers in world 3 as they do in world 1. Power has its dangers - we may yet destroy world 1 and there are no doubt similar possibilities in world 3 - but danger is a necessary face of humanity and the last aspect of any world that should make us wish to avoid it.

4 STEPS INTO WORLD THREE

We have a long journey of technological development to make before the full role of the computer in world 3 may be realized. Early telegraphy and the "Flyer" showed the promise of new worlds of rapid communications, but much further development was necessary to give us the communications and transport systems of today. All one can do at the moment is review briefly a few of the projects that seem to indicate fruitful directions for the use of the computer in the conquest of world 3. Personal computers provide a bridge from world 2 into world 3 that the previous generation of centralized off-line machines did not. It will be the growing demands for this bridgehead to be be strengthened and extended that will lead us into new territories.

There are several uses of computers already that seem to me to point the way:

David Mulhall's (1977) use of data-processing in the treatment of disturbed inter-personal relationships is a clear example of the role of the computer in the "emancipation of cognition" to use Habermas' (1968 p.308) apt terminology. The graphical presentation of the social consequences of actions and interactions has proved to be both acceptable and effective. By seeing the world 2 situation that they have created for themselves in world 3 terms individuals are able to make changes through their own choice and decision. This is far removed from the "technical cognitive" approach of aversion therapy that treats people as objects in world 1.

Mildred Shaw's work with Laurie Thomas (Shaw & Thomas 1978) on the interactive construction and analysis of repertory grids again puts into the hands of the individual, and groups of individuals, a tool by which they may construct a world 3 model of their own views of worlds 1, 2 or 3. This is a particularly exciting development because it takes Kelly's(1955) insight into the world 2 nature of all our knowledge and applies

it flexibly, but uniformly and rigorously, to that knowledge, whatever its source or content: the "Focus" system and its variants can be used to model and externalize (in world 3) the personal and group knowledge that we have (in world 2) of the physical world (world 1), inter-personal relations (in world 2) or scientific constructs (in world 3).

Systems that successfully analyse and encode professional skills and make them available to others less skilled are also pre-cursors of those which will conquer world 3. Mycin (Shortliffe 1976) is currently an outstanding example, but its success has lead to this area of development becoming one of major activity and we may expect to see more and more general systems for encoding and activating professional knowledge skills become available.

These examples are all ones whereby world 3 is built out of the material of world 2 and hence may be a world of fantasy just as easy as one of reality, i.e. the computer is not itself directly interacting with world 1. Popper himself notes the role of such fantasy in world 3:

"Even theories, products of our intellect, result from the criticism of myths, which are products of our imagination: they would not be possible without myths; nor would criticism be possible without the distinction between fact or fiction, or truth and falsity. This is why myths or fictions should not be excluded from the third world. So we are led to include art and, in fact, all human products into which we have injected some of our ideas, and which incorporate the result of criticism, in a sense wider than a merely intellectual one." (Popper 1974 p.155)

It is this acquisition and processing of 'knowledge' by computer systems through interaction with world 2 that I would rate as having the most immediate importance and potential rather than any direct interaction with world 1. It is only after substantial developments in the computational structures necessary to fully interface with world 2 that we shall be able to fabricate systems that can be comparable to ourselves in having independent and meaningful access directly to world 1. That is, we shall build companions and colleagues long before we build robots, and the robots we eventually build will be nothing like those we currently envision since the conquest or world 3 will change our entire relationship with world 1.

I have blurred the distinction between the individual and the group in the above discussion and feel that this distinction will become increasingly blurred. World 3 has always been the creation of many minds and modern communications equipment may be seen as amplifying our capabilities to form 'group minds'. The computer takes this a step further in allowing us to communicate not just with passive records of the state of an individual's mind but with an active process that replicates the activities of his mind. However, the effect of this on individuals is to enhance their individualism not erode it - by being freed from dependence on the availability of others (i.e. their physical presence, attention, interest, co-operation, etc.) we are able to operate more effectively ourselves. We shall never be, nor ever wish to be, freed from our dependence as such on others - world 3 is the sum total of all our acts of creation, but once created it exists independently of us - the computer provides the means to faithfully record and make available far more of world 3, both its passive and active natures, than has any previous technology.

5. CONCLUSIONS

I have attempted in this paper to give a wide-ranging and balanced appraisal of the role of computers, particularly in their relationship to people and knowledge. The balance is important because none of the extremes of: unthinking enthusiasm, dogmatic scepticism, or uncomprehending fear, are at all productive. We must remember even that what we may regard as the natural enthusiasm of civilized man for world 3 is not itself universally shared. Zijderfeld quotes Gabel (1962) as arguing, "that the reification of abstract phenomena can be interpreted in psychiatric terms as schizophrenia, that is, as a kind of logical disease in which man constructs an abstract world but treats it as if it were real and concrete." (Zijderfeld 1970 p.51). Dostoyevsky's underground man bitterly remarks:

"Leave us to ourselves, without our books, and at once we get into a muddle and lose our way - we don't know whose side to be on or where to give our allegiance, what to love and what to hate, what to respect and what to despise. We even find it difficult to be human beings... and are always striving to be some unprecedented kind of generalized human being...Soon we shall invent a method of being born from an idea." (Dostoyevsky 1972 p.123)

How prophetic these notes of the 1840's now seem. Yet they are also extremely one sided - the underground man has surrendered to despair, to be an unwilling passenger in world 3, not an architect, a builder, or even a free-wheeling traveller within it.

Wiener himself, in God and Golem voices similar fears which might be applied to the very examples of significant developments that I gave in the previous section:

"the motive which the gadget worshipper finds for his admiration of the machine...is the desire to avoid personal responsibility for a dangerous or disastrous decision by placing the responsibility elsewhere: on chance, on human superiors and their policies which one cannot question, or on a mechanical device which one cannot fully understand but which has a presumed objectivity." (Wiener 1964 pp.59-60)

We should all be less than honest if we failed to

discern this motive as part of our makeup, and yet should we damn what is an essential component in inter-personal relations, partnership and companionship amongst people ? It is imbalance in our relationships with people, and with machines, that is dangerous - the unthinking and uncaring surrender rather than the "cognitive love" that Wolff (1976) so deeply describes.

The heart of Mowshowitz's presentation anti-computer is in his quotation from Blauner (1964, 6 p.100):

> "Alienation exists when workers are unable to control their immediate work processes, to develop a sense of purpose and function which connects their job to the over-all organization of production, to belong to integrated industrial communities, and when they fail to become involved in the activity of work as a mode of personal self-expression. In modern idustrial employment, control, purpose, social integration, and self-involvement are all problematic." (Mowshowitz 1976 p.15)

With regard to these factors the computer itself is strictly neutral. Our previously enforced use of it in a remote batch mode does have inherent problems of just the form of alienation that Blauner describes, although there are case histories where even these have been overcome. The personal, interactive computer has no such inherent problems - quite the converse, it is in a position to guide, help, patiently allow the individual to explore the world 3 environment of which he is part through his employment in a way generally impossible without such technology.

Whether we take advantage of this potential for participation and the emancipation of cognition is up to us as system designers. Computers faithfully record and replay our approaches and attitudes - their personalities are our personalities. The responsibility is great and we cannot avoid it - the arguments outlined in this paper are relevant to the activities of all those who deal with the interface between computers and people. In his keynote address at IFIP in Toronto, 1977, Josef Kates remarked:

> "You are the revolutionaries who will irrevocably transform today's society, and who must communicate to others not only the technical but also the social, economic, and even the philosophical implications of your discoveries."

One cannot dismiss this as rhetoric - neither can one assume that there will be any such implications without much hard work. We have to go forward with the right balance of enthusiasm, scepticism and fear - ours is an exciting and a dangerous technology that is probably also fundamental to the future of man and society. The model that Karl Popper and others have developed of the world of knowledge and its relationship to man is a significant framework within which to understand both our opportunities and our problems.

REFERENCES

Blauner, R.
1964 Alienation and Freedom: The Factory Worker and His Industry. University of Chicago Press.

Butler, S.
1872 Erewhon.

Catt, I.
1973 Computer Worship. Pitman, London.

Dijkstra
1977 "Dijkstra Articulates the Voice of Reaction." Computer Weekly 25th August.

Dostoyevsky, F.
1972 Notes From Underground. (trans J.Coulson) Penguin Books.

Dreyfuss:, H.L.
1972 What Computers Can't Do: A Critique of Artificial Reason. New York: Harper & Row.

Gabel, J.
1962 La Fausse Conscience. Les Editions de Minuit, Paris.

Gaines:, B.R.
1978a "Man-Computer Communication: What Next ?." Int. J. Man-Machine Studies 10: 225-232.

1978b "Minicomputers in Business Applications in the Next Decade." in Infotech State of the Art Report on Minis Versus Mainframes. Infotech International, Maidenhead.

1978c "Nonstandard Logics for Database Systems." EUROCOMP 78 Proceedings. Online Conferences, London.

Gehlen:, A.
1962 Die Seele im Technischen Zeitalter. Rowohlt Verlag, Hamburg.

Habermas, J.
1968 Knowledge and Human Interests. (trans.J.J.Shapiro) Heinemann, London.

Kelly, G.A.
1955 The Psychology of Personal Constructs. Norton, New York.

Korzybski, K.
1933 Science and Sanity. International Non-Aristotelian Library.

Laudon, K.C.
1974 Computers and Bureaucratic Reform. John Wiley, New York.

Licklider:, J.C.R.
1968 "Man-Computer Symbiosis." in Conversational Computers. (ed. W.D.Orr) John Wiley, New York.

Mowshowitz, A.
1976 The Conquest of Will: Information Processing in Human Affairs. Addison-Wesley, Mass.

Mulhall, D.J.
1977 "The representation of personal relationships: an automated system." Int. J. Man-Machine Studies 9: 315-335.

Popper, K.R.
1968 "Epistemology Without A Knowing Subject." in Logic, Methodology and Philosophy of Science III. (ed. B.van Rootselaar) North Holland, Amsterdam.

1974 "Intellectual Autobiography." in The Philosophy of Karl Popper. (ed. P.A.Schlipp) Open Court, Illinois.

Sass, M.A. & Wilkinson, W.D. (eds.)
1965 Computer Augmentation of Human Reasoning. Spartan Books, Washington.

Shaw, M.L.G. & Thomas:, L.F.
1978 "Focus on education." Int. J. Man-Machine Studies 10: 139-173.

Shortliffe, E.H.
1976 Computer-Based Medical Consultations: MYCIN. Artificial Intelligence Series, Vol.2, Elsevier, New York.

Toffler, A.
1970 Future Shock. Bodley Head, London.

Weizenbaum, J.
1976 Computer Power and Human Reason: From Judgement to Calculation. Freeman, San Francisco.

Wiener, N.
1950 The Human Use of Human Beings. Houghton Mifflin.

1964 God and Golem, Inc. Chapman & Hall, London.

Wolff, K.H.
1976 Surrender and Catch: Experience and Enquiry Today. D.Reidel, Holland.

Zijderveld, A.C.
1970 The Abstract Society. The Penguin Press, London.