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Designing for people in the age of information

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ABSTRACT

Some characteristics of the Information Age and the importance of human factors issues are outlined. Immediate questions for the next 7 years or so are discussed, including nine substantive areas needing research (from a recent survey) and the development and better implementation of design procedures. Longer term questions discussed are – the passing of paper, the reduction of writing, the victory of voice, the wired society and the expert in the system. Finally, some of the important broader issues are mentioned and the need for synergy by human and information engineers is emphasised.

1. Introduction

1.1. Aims

In this paper I aim to present a view of some of the problems and research needs in human–computer interaction as we move into this new age. After illustrating the importance of the human factors issues, I shall review some immediate questions which are evident over the next 7 years to 1990; and then in the following decade. Finally I shall mention some broader issues which should not be overlooked, and I shall emphasise my belief that the Information Age will prove to be a beneficial revolution, or rather evolution. Any such discussion of future possibilities must, of course, assume that there is no war or major nuclear perturbation, that there are no revolutionary social disruptions, and that any changes needed in social structures and institutions occur fast enough to ensure appropriate distribution of the economic wealth which could be produced in the Information Age.

1.2. Growth of the technology

The speed of growth has surprised everyone, even those directly involved. It was caused by the reduction in size of the switching unit fundamental to all electronic computers. The first three generations of basic components, the valve, transistor and large scale integration, are already passing, and the fourth generation of Very Large Scale Integration is already well advanced.

Evans (1979) nicely illustrated the change of scale by comparing it with the improvements in cars with advances in automobile engineering.

> But suppose for a moment", he says, "that the automobile industry had developed at the same rate as computers and over the same period: how much cheaper and more efficient would the current models be? If you have not already heard the analogy, the answer is shattering. Today you would be able to buy a Rolls Royce for 1.35, it would do 3 million miles to the gallon, and it would deliver enough power to drive the Queen Elizabeth II. And if you were interested in miniaturisation, you could place half a dozen of them on a pinhead.

This growth in power and speed, and reduction in size and cost, has led to enormous growth in the usage of the resulting equipment. The growth in usage rapidly led to the coining of the name "Information Age".

2. The Information Age

2.1. Introduction

But is this title merely newspaper hyperbole? Probably not, there is little doubt that the Information Age will be and indeed already is radically different from the other ages which have been identified as historical references. Essentially, the other ages involved an increase in the physical powers of mankind over material objects and forces, and the machines all enhanced or replaced human *physical* muscular capabilities. Whereas information is concerned with mental and logical powers in relation to human decisions and behaviour, Information Age machines will enhance or replace mankind's *intellectual* powers and capabilities.

Further, there have only been three major changes so far in the basic method of transferring information, since the oral tradition (the tribal memory transmitted by voice) of primitive times. These

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changes were successively the development of writing, and then much later printing, and now the changes just beginning with the technology of information. Although voice and text are still each a principal medium, information technology already facilitates many new and faster ways of preparing, transmitting, recording, indexing and retrieving such information. Further, the new facilities such as film and colour video recording provide cheap new ways of transferring information never hitherto available for most people. As Marshall McCluan succinctly said "it is the frame itself which changes with a new technology, not merely the picture within the frame".

The many ways in which the Information Age will be different from the others have been discussed by many writers (of whom perhaps the first and best was Toffler (1970, 1980), but see also for example Evans, 1979; Forester, 1980; Stonier, 1983). The latter summarises some important features at the end of his second chapter on the profile of the post-industrial economy.

> The technologically advanced sector of global society has moved into a postindustrial economy whose characteristics may be listed as follows:
> 1. It is primarily a service economy rather than a manufacturing one, with the knowledge industry predominating.
> 2. As a reflection of no.1, the labour force is no longer dominated by people who work with machines (machine operatives), but by information operatives.
> ⋮
> 6. The post-industrial economy is characterised by unprecedented affluence both at the private level and in the public sector.
> 7. Changes are taking place at an exponential rate rather than linearly.

2.2. What is information technology (IT)

It is very obvious that hitherto much more attention has been given to information *technology* than to issues concerned with information *science* or the Information *Age*. Although interest and work already existed, the strong focus of attention upon the coordinated concept of information technology, including major emphasis upon ergonomics/human factors, was stimulated by the conference upon Fifth Generation Computer Systems in October 1981 in Japan (Moto-Aka, 1982).

Following the Japanese stimulus, there have been developed two major schemes in Europe. The first is the European Strategic Programme for R&D in Information Technologies (ESPRIT); the second is the Alvey Programme in Britain (Alvey, 1982). Both these programmes place considerable emphasis upon human factors and the "man–machine interface" (under which term the organisers now recognise that all aspects of human–system interaction need to be considered). However, neither of these programmes offer a formal definition of information technology, so perhaps the following may be useful –

> Information technology is the coordinated application of knowledge about computers, communications and people, so as to research, design, install, operate and maintain integrated interactive systems which serve and satisfy human information needs.

That definition aims to counteract the pre-existing tendency for "technology push", which permeates the field of information technology, by placing emphasis upon the purpose in terms of human needs. The importance of the meaning and quality of the information, rather than the speed and cheapness of the transport mechanism, was nicely illustrated by Dr. Murray Laver in the 1982 British Library Research Lecture. He drew the analogy of the system technologists really being, as it were, removal contractors for the bits of information, which are handled very fast but without much interest in the quality or the meaning – rather like a removal man who might list the Venus de Milo as "one statue, weight 70 kg, arms damaged"!

2.3. The importance of the human factors issues

There is now no doubt about the importance of human factors in the eyes of the computer industry in the USA, where there is much greater development of human factors in industry than in Europe. This was particularly evident in the large numbers of human factors professionals from industry amid the more than 1000 audience attending the CHI'83 Conference (Boston, December 1983) on Human Factors in Computer Systems. Ironically, this rapid growth in attention to human factors in the US industry is attributable, at least in part, to an "ergonomic standard" which has been questioned by ergonomists in Europe, namely the German DIN standard for keyboard height to be not more than 30 mm. The recognition that an ergonomic standard could override all other considerations in the marketplace came as a big surprise and had a powerful effect on quite a number of US companies.

To illustrate this changed situation one merely has to note the marked change of emphasis upon human factors in IBM which was handed down from the very top. As a result, special conferences were held (e.g. see Chapanis, 1981; Shackel, 1981b; Smith, 1981; Wright, 1981), a worldwide programme of short courses for IBM engineers was instituted, and usability now became of equal importance with functionality in the IBM development and marketing philosophy.

The following excerpt is typical of the writings of quite a number of the ergonomists "crying in the wilderness" in this field some years ago, but it is taken directly from a lecture by the IBM Vice President and Chief Scientist (Branscomb, 1983):

> All that has changed. No longer the exclusive tool of specialists, computers have become both commonplace and indispensible. Yet they remain harder to use than they should be. It should be no more necessary to read a 300 page book of instructions before using a computer than before driving an unfamiliar automobile. But much more research in both cognitive and computer science will be required to learn how to build computers that are that easy to use. That is why our industry is paying increasing attention to the field of applied psychology called human factors, or ergonomics... Equally neglected has been human factors at the level of systems design. We know that system architecture has significant and widespread implications for user friendliness, but we know next to nothing about how to make fundamental architectural decisions differently, in the interest of good human factors... Thus the effort to design for ease of use could benefit enormously from basic research, not only in adaptive systems and computational linguistics, but above all in terms of controlled experiments involving actual use by representative end users – for you can't evaluate ease of use without use.

Again, the US Department of Defence has recently established the STARS program (see Computer, 1983) to achieve major improvements in software development. Within that program there is also a major commitment to human factors, so as to improve the usability of software tools, not merely for the end users but also for the software developers (Kruesi, 1983). Finally, in Britain the case has been presented in an authoritative and well-illustrated report by the National Electronics Council (1983). Several case studies are described to emphasise the need to design for people, and wide-ranging policy recommendations are made to stimulate action by the appropriate bodies (i.e. Government, manufacturers, user organisations, standards bodies, educators, users and human factors practitioners).

3. Some immediate questions

For convenience the main discussion is divided into two parts. For the next 6 or 7 years to 1990, the immediate questions are seen to be the need for much more research and the need to develop, test and improve the design procedures for ergonomics in information systems. For the subsequent decade the pace of change is such that one can only be tentative, but a number of more general questions seem to need the attention.

Incidentally, throughout this discourse adequate attention cannot be given to many areas of information technology. Therefore, I shall not mention such large fields as process control and factory automation and robots, but shall be referring primarily to the relevance of the Information Age for some aspects of business, commercial, and professional life and home and leisure activities.

3.1. Research gaps and needs

In the last 2 years several surveys have been made from which the conclusions indicate various major gaps in knowledge and needs for research (Committee on Human Factors, 1983; van Apeldoorn, 1983; Shackel, 1984a). I shall presume here only to summarise the results from my survey, for the Commission of the European Communities, on Information Technology Ergonomics in Europe.

My first approach was to gather and appraise a wide range of recently published and unpublished reports from as many relevant research groups as possible. A classification scheme for the domains of IT Ergonomics was devised, and then revised while analysing the contents of both the research reports and the information gathered during subsequent visits.

Then most of the principal research groups in Europe were visited, and the scope of their current work was recorded and similarly classified against the list of domains of IT Ergonomics. This analysis has shown that there are many gaps in the coverage. Out of 46 sub-domains in the classification scheme, there appears to be too little attention being given to 25.

During the visits made to the principal research groups, the experts visited were invited to give their suggestions about future research needs. From the many research needs suggested by the experts, some were suggested independently by at least one third to one half and so are seen as principal issues.

Combining these data gives a list of nine substantive areas needing attention:

(1) *Theory especially in cognitive ergonomics:* The need for major developments in theory, especially in cognitive ergonomics, was emphasised widely. The work of Card, Moran and Newell (1983) is a first step in this direction, which also shows how much is yet to be done.

(2) *Cognitive/software interface:* The recognition of the importance of the cognitive and software interface is shown by the recent attention to this subject by most research groups, and by the recent rapid growth of published work.

(3) *User variables and models of users:* Much basic work is needed, both empirical and theoretical, to develop our scientific understanding of the characteristics and performance of humans as IT users. It is generally agreed that models of user behaviour will be valuable, but the problem is to ensure that the research does not become too theoretical. Good solutions need a concrete task and situation for valid modelling; associating the research with designers may help to ensure that the models have practical relevance. A useful review has recently been presented by Laughery (1984).

(4) *Measurement methods:* Various shortcomings in measurement methods were emphasised. For example, Bernotat said "measuring methods have to be improved, especially concerning mental workload and influences from the social environment. Some agreement or even standardisation of basic measuring procedures would help to make data comparable". For example, the Mosso Ergograph established a "classic" procedure for measuring muscular fatigue. We have no equivalent reliable and accurate method to measure mental load and mental "fatigue" (cf. Moray, 1982, 1984).

(5) *Knowledge for usability design:* Views were expressed strongly about how much we have yet to learn about usability, so as to be able to produce valid guidelines. As Sanders said

> We need, but do not have, rules for how to design software to be easy to use; also we need rules of when and where to provide "short cuts" for skilled users, e.g. when using menus. But the real problem here is to understand, to have full knowledge of, the development of skill by the user in such situations.

We need extensive research studies of different types of users, doing different types of task, with different hardware and software tools, so as to establish a comprehensive understanding of the parameters of usability.

(6) *Procedures and tools for designers:* Given that appropriate knowledge is available, the next and equally important issue is the methods, procedures or tools by which that knowledge is applied during the design process. Faehnrich gave an example of a new method which needs to be developed much further to

> Produce rapid prototyping tools; the idea is to make trial versions or prototypes of human–computer interfaces as "real products" in the market sense, so that one can talk about "price" and "quality" and then ask users for an evaluation of the prototype against these and other factors.

However, Eason pointed out that "designers may need some help from us (and perhaps we need to develop and test appropriate procedures) so that the potential learning from prototypes and pilot schemes is actually obtained and used iteratively to produce a better final design".

(7) *Work, workplace and system operation:* Very little work was found in the literature on aspects related to system installation and usage, and to the work and workplace – especially user support, social issues and the influence of IT upon work, job and organisation structure and functioning.

(8) *Standardisation issues:* Standardisation is seen by many experts as of almost equal importance with improving knowledge and improving design methods. Several pointed out a tendency to move rapidly and perhaps prematurely into draft standards. Again, several emphasised that much testing work is needed on proposals for standards, to check them for many different types of user and usage so as to make them truly application independent. This is particularly important for the software interface.

(9) *Organisational and social issues:* The organisational and social aspects range very widely from, for example, the organisational consequences of word processor applications (cf. Simpson et al., 1980) to the potential for alienation and loss of identity implicit in the isolated monitoring jobs which may become typical of the

automated factory. There are even fewer simple answers to these organisational and social questions than to the other research areas identified above.

Although these are suggested to be some of the principal research issues to be addressed during the next 7 years to 1990, of course not all will be finished and many may well overlap into the following decade.

3.2. Design procedures

There is widespread recognition of the need to develop better design procedures (including evaluation), so as to design better information systems for people to use. It is also acknowledged that much more needs to be done to ensure widespread application of existing knowledge and methods; this leads to the question of how best to organise the design process to include human factors.

Regarding design methods, there is no comprehensive and generally accepted manual on how to design good human factors into computer systems. However the book by Damodaran et al. (1980) is a very promising first attempt; with feedback from evaluation during regular use it could be developed into a useful manual. A good text on design methods in general is that by Jones (1970). An approach to workstation design has been simply described in chapter two of Shackel (1974), and Golitz (1981) has produced a useful guide to the design of screen formats. The design of documentation by successive evaluation has been reported by Sullivan and Chapanis (1983). Finally, a comprehensive catalogue of ergonomic design methods reported in North America has been presented by Meister (1984).

Evaluation is an important design procedure; indeed some would say that design is nothing but "test and try again". Certainly the complexity of information systems and the speed of technological change is such that design must be a very flexible and iterative process, with evaluation at each stage. Good discussions and reviews of evaluation methods have been presented by Margulies (1976), Chapanis (1981) and Williges (1984).

The question of how best to organise within a commercial company, so as to ensure attention to human factors issues, has seldom been addressed in the literature. The general policies which companies might adopt were discussed briefly by Shackel (1966); however these were not specific to computers or information system design. Hirsch (1981) provides an excellent review of the facilities of a human factors laboratory and the way that these facilities can be used during product design and development. Finally Thomas (1984) has discussed exactly the issue in question and has presented his views on how to achieve good human factors in computer systems.

4. Some longer term questions

In relating our research on human aspects to the growth of technology in the Information Age, one especially important factor is timescale. There is little value in applied research if it is overtaken before completion by basic changes in the related occupation, equipment or environment. Therefore, we need to look ahead and consider what may be the general trends. The pace of change is such that one can only be rather tentative, but a number of more general questions will be considered which are already being raised and which to need considerable research if we are to produce good designs for human use.

4.1. The passing of paper?

The first of these is the possibility of the passing of paper. One of the misnomers in current talk about the Information Age is the phrase "the paperless office". It is true that Lancaster's (1978) excellent book was entitled Towards Paperless Information Systems, but his timescale was probably realistic, with the relevant chapter title being "Scenario for an Electronic information System for the Year 2000".

However, from another point of view it is certainly true that we need to move rapidly to use less paper; there is already some concern about the speed of net reduction in the world's total forest coverage. The technology is advancing rapidly to help, and the passing of the printed book is at least a possibility by the year 2000.

Already portable computers are nearly as small as books and can contain the storage for at least a full length novel. It will not be long before the Dynabook concept of Kay and Goldberg (1977) and Goldberg (1979) becomes a reality. The technology already exists to do this, but the best design for human use is not known. As just one example of the ergonomics issues which need to be investigated is the procedures involved to skim through the text and find various places. The present standard scrolling procedures on terminal screens are unsatisfactory and a best method has not yet been proved.

Related to this is the important question of browsing. It is right to ask, all the time, about various developments into the Information Age "What will the human user lose and what gain?". Clearly we should never lose worthwhile facilities, except if they are overtaken by a much greater gain. With the electronic book, we are in danger of losing the capability to browse unless appropriate methods are studied by ergonomists and implemented. Browsing is rightly regarded by many scientists, when asked, as an important feature – vital for serendipity. And serendipity is certainly important in science – Sir Fred Dainton illustrated this nicely if naughtily by saying that "Serendipity is going to look for a needle in a haystack and finding the farmer's daughter instead".

4.2. The reduction of writing?

The psycho-motor skill of handwriting is complex and slow. Children have considerable difficulty in learning it and have already been shown to produce written output much faster if they learn via a keyboard instead of by handwriting (Martin, 1981). Moreover, the potential for keying speed is much higher. Even inexperienced typists can produce output nearly as fast as handwriting, and skilled typists produce output three to four times faster than handwriting. Moreover, stenotyping which uses a chord keyboard and includes short forms of words can be 8–10 times faster than handwriting.

As a result, perhaps in time keying will become widespread and handwriting may gradually fade away. First, of course, there would need to be available widely and cheaply a suitable device to grip conveniently with one or both hands, and with touch pads or keys for operation by relevant fingers and thumbs. Research by Martin (1981) has shown the best allocation of characters to keys and an appropriate form of training. Users would need to have access readily to printers or word processors in almost any location; alternatively, the device would need to have built in word processing capability as does the Microwriter machine. However, the Microwriter is not optimised in its ergonomic design; neither the key positions nor the assignment of keys to letters and fingers is optimum.

The ultimate form of such a device would need to be produced to good aesthetic standards to gain acceptability. Having achieved a good prototype with the basic key layouts established ergonomically, industrial designers would produce a range of pleasing forms which could be held in one hand or both hands, kept in pockets and handbags etc.

Of course at the same time there would need to be an appropriate replacement for the handwritten signature. However this aspect is already covered; both fingerprint and voiceprint automatic detection and analysis systems are understood to be in development.

Again, we have little experience relevant to the consequences of the reduction of handwriting. There are many interesting issues to be explored.

4.3. The victory of voice?

It is rather generally assumed in technology circles that many problems of human–computer interaction will be solved when speech input and output have been perfected. It is only a matter of time, so the thought goes, that this will solve all problems. The technological position is as follows. Speech output devices are fairly well advanced, and by five years should be in good shape. However, the current position with speech recognition is not so far advanced; the best devices give recognition at 92–98% success rate, with vocabularies of about 250 words (some claim 500–1000 words), but for separate utterance only. The general view is that it will be at least five to ten years before efficient, reliable recognition of continuous speech is available.

However even more important questions are whether in fact people will find this interaction medium better, and what are its characteristic constraints, advantages and disadvantages, in relation to human interaction with information systems? Chapanis (1976) ran an elegant series of experiments which showed that problem solving tasks involving two persons collaborating are significantly impeded if the voice medium is removed from the available communication channels. Van Nes and van der Heijden (1978) and Moore and Ruth (1984) have shown the potential advantages for certain types of task even with existing limited speech recognition devices. However, Braunstein and Anderson (1961) ran an experiment on data entry and found their subjects preferred keyboard data entry and did not like voice data entry. Again, Crane (1984) compared voice and touch screen for data entry on a C^3 display and found no advantage for voice. Recently Lambert (1984) has written a useful review of the general advantages and limitations of voice data entry and of the issues to be studied before adopting the method.

Clearly there is ample scope for valuable research. For which tasks and situations is speech input to an information system appropriate and for which not? Under what conditions can this method best be used, and what are significant contra-indications? Again, are there fundamental differences in *speaking* with machines compared with any other type and mode of interaction? The point is that with all other machines and tools used by humans, the control or the interaction is mediated mechanically. Only *live* objects respond to the human voice. Is this difference fundamental, and if so what are its implications?

4.4. The wired society?

The development towards what Martin (1978) called "The Wired Society" has been growing for some time (e.g. see Hiltz and Turoff, 1978; Johannsen, Vallee and Spangler, 1979; Vallee, 1982). In this very wide subject area only a few aspects will be mentioned, and for example the whole field of public service broadcasting will not be considered.

With names like electronic mail, electronic conferencing, electronic journals, etc., it is hardly surprising that people are sometimes confused. In fact the electronic versions are not dissimilar from the traditional forms, but there is at least one fundamental difference; the mail, the conference reports and the journals are not delivered to you in your absence – you have to call up and "log in" to a network or computer somewhere and identify yourself, usually with a password, so as collect your material (rather like calling at a post office to collect mail from a P.O. box number).

The BLEND programme (Shackel, 1982) is an example of ergonomic research related to information systems. An electronic conferencing system is used as the basis for exploratory experiments upon the electronic journal concept. During the three years to date, the BLEND team and the 50 scientists participating have developed a monthly newsletter, a Refereed Papers Journal Computer Human Factors, a Poster Papers Journal, a References Abstracts & Annotations Journal, and have participated in a number of teleconferences (Shackel et al., 1983).

Many other kinds of network activity are developing. The Prestel activity is well known in Britain, as is "Compuserve" and "The Source" in the USA. However the computer hobbiest and news network operating within Prestel, called Micronet 800, is perhaps not so well known. Among the many future uses for networks, the provision home teleshopping and home banking have been proposed. There is already an exploratory service for these, again via Prestel, called Homelink and being operated by the Nottingham Building Society.

However, these exploratory developments are somewhat overshadowed by whole community experiments. Lee (1983) describes the "HiOVIS" experiment in Japan, in which a township near Nara was built as an experimental "wired society", comprising a two-way interactive communication system complete with a TV set, a camera, a microphone, and a keyboard at each home terminal.

Again, as an example of larger issues, the problems of structuring and organising the information in the various systems for clarity, easier retrieval by users, etc. is easy to state but will undoubtedly need plentiful research. Many issues of wider societal and political consequence are raised in an interesting and amusing way by Vallee (1982). Ultimate issues, such as the potential for alienation – with the loneliness of the self epitomised in the isolation at the end of a communication cable – is explored by Michael Frayn in his novel "A Very Private Life" (1968).

4.5. The expert in the system?

An expert system, as defined by Michie, is a machine embodiment of some branch of human expertise, not only by the criterion that it can answer questions reliably in the relevant problem solving area ("What is wrong with this patient?", "Are there precedents for this application of patent law?", etc.) but also by the criterion that the system represents the problem domain in something like the conceptual terms used by the human expert. The key consequence of adopting a human style of knowledge representation is that it is then capable also of answering, in ways which make sense to the human user, questions of the quite different form "How did you work that out?".

There are at present relatively few examples of successful expert systems. Much research is being stimulated by the Japanese Fifth Generation programme and by the British Alvey programme. Nevertheless, the work is complex and abstruse, and the number of researchers available is low. Even fewer are the number of researchers in ergonomics with sufficient understanding to collaborate directly with expert system design groups. Attention needs to be given to this developing situation of human and computer as interacting knowledge systems, which at last will come closer to Licklider's (1960) vision of symbiosis, so as to develop research and expertise amongst ergonomists about this subject.

Another aspect is the potential use of expert systems to convey human factors information. We can certainly envisage considerable advantages if guidelines for designers and if system documentation can be developed in the form of expert systems. Incidentally, a final thought comes to mind about the expert in the system. Given the cost of developing such systems it is likely that only one will be developed for each major area of usage, but given one expert system for medical diagnosis – where does one go for and how does one obtain a genuine medical second opinion?

5. Conclusions

This paper and this conference deals principally with technical matters, as it should. But design does not operate in a vacuum, and designing for people must include recognition of many broader issues not considered here. Among these the questions of control (who is in control, the human or the computer), work and leisure are discussed briefly elsewhere (Shackel, 1984b).

The fundamental reason why I, as an ergonomist, welcome the Information Age is that at last we can foresee machines doing the tedious work which no-one wants, with people able to concentrate on what they prefer and only they can do well for each other. What that means basically is all the activities where person-to-person interaction is the principal feature, for example: teaching (all levels of education for computer aided instruction will only be a useful *tool*, however sophisticated, and not a replacement); nursing (and medical services generally, but nursing above all); caring for others, for example for the young and for the old, for example hotels, restaurants and holiday services, etc.; and also managing – because, despite the uses of computers to aid management, studies widely have shown that about 70% of a manager's work is interacting with people. But to achieve this we must break the equation "work = job" or "work = employment". Until we can move on from the traditional work ethic, we shall not even start to address the many other changes in attitude, in societal and economic organisation, and in industrial and even personal relationships, which are needed if we are to enter the Information Age with success and enjoy it.

Finally, we must develop a true synergy and symbiosis between workers in human engineering and in information engineering. I believe that the potential will exist to allocate many boring, dangerous, undignified or meaningless functions and tasks to the machine, and thus to enable people to be released and to grow. But I am convinced that this will not be achieved successfully by the computer and information scientists and technologists alone – the human sciences and ergonomics have a fundamental part to play. This is well summarised by the Duke of Edinburgh (1984) at the end of "Men, Machines and Sacred Cows" – "The real truth is that, whatever our material achievements, we are still human, and that it is the facts of human nature and not the binary system which must govern human affairs".

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