

Are 'Human factors' Human?

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Does the research and development discipline called 'human factors in computer systems' really contribute to what could be called 'human endeavour'? The majority of research and development effort seems to fall down with respect to this question because it takes technology as its starting point. At the moment all we are doing is to adapt the technology to the known 'so-called' 'human weaknesses' in order to reduce the resistance to using the technology, rather than providing a technology which will help to liberate the intellectual capabilities of human beings.

The following paper addresses the question by discussing first what we should understand by human objectives, then appraising the limits of our present theories, methods, outlines and applications (which give an understanding of the limits of technology in its present form) and proposes a research/development project based on a 'Scandinavian Model' which takes us at least one step in developing technology towards attaining true human values.

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1. INTRODUCTION

The idea behind the provocative title of this paper is to question whether the research and development discipline called 'human factors in computer systems' is really contributing to what could be called 'human endeavour'. This concern was brought into focus by the first IFIP Conference on 'Human/Computer Interaction' in 1984, where many of the research papers, in the author's opinion, fell short of contributing to 'human endeavours'.¹

The first question to be raised is whether all our intellectual capacity, energy and other precious resources are genuinely contributing to the attainment of true human values or are merely being utilised to soften the technology to make it more compatible with human beings (through removing the flicker in order not to damage the eyes, detaching the keyboard in order not to damage the spine of the operator, making it so easy to use that 'even a child or a mentally retarded person can use it' etc.), in this way providing a sugar coating on the pill so that it may be swallowed more easily. In other words, are we just doing our best to adapt the technology to the known so-called 'human weaknesses' to reduce the resistance to using the technology, or are we working on providing a technology that will help to liberate the intellectual capabilities of human beings?

The majority of research and development effort seems to follow from the first line of reasoning by taking the technology as a starting point.

This paper has three parts to it. After discussion about what we should understand by human objectives (i.e. the vital issues to which we ought to address ourselves), there follows an appraisal of the limits to our present theories, methods, tools and applications, in order to understand the limits to technology in its present form. Finally, a proposal is outlined for a research/development project based on a so-called 'Scandinavian Model', which will take us at least one step in developing the technology in the direction of an attainment of true human values.

The economic rationale for this article may be found in Figure 1. The figure shows that if the total cost of an information systems project is broken down into the three categories, hardware, software and 'orgware' (the

latter encompassing costs of determining information requirements, training, restructuring of work procedures and other implementation procedures), we find that the relative costs of hardware are doing down and the relative costs of software are increasing slightly (and will do so for some time to come). However, the costs of orgware will increase to a level exceeding the costs of the other two elements.

This is the economic argument for why we have to see the area of 'human factors' as crucial. However, the main argument for a human strategy is not an economic one, it is a moral/ethical one. Unless priority is given to human, organisational and societal values in the design and implementation of hardware and software, we shall run into even greater conflicts in the future, when someone starts crying out 'He has got nothing on', like the innocent boy seeing H. C. Andersen's emperor taking a walk in his new clothes. The contribution of 'our' technology to the attainment of societal values may be just as thin as the invisible dress worn by the emperor.

2. WHAT IS A HUMAN SYSTEM?

In order to answer the question about what constitutes a 'human system', one can start by pointing out some of the inhuman characteristics of systems. By stretching the concept of ergonomics, these can be classified into three categories: workplace ergonomics, organisational ergonomics and societal ergonomics.

Within the area of workplace ergonomic issues we all recognise an inhuman system when we see one. There are the health hazards of: typing/keying on a terminal with a thick keyboard placed on an ordinary desk, producing a strain on the wrists; flicker and light problems, straining the eyes; heat problems, affecting general well-being; fatigue problems from sitting too long in the same chair, and fatigue problems from working all day at a VDU.

All these problems can be solved, but in many cases they remain unsolved due to ignorance, lack of skill or lack of costs. Without having scientific proof, it is the author's impression from visits to offices, in the UK for example, that the majority of secretaries are still typing

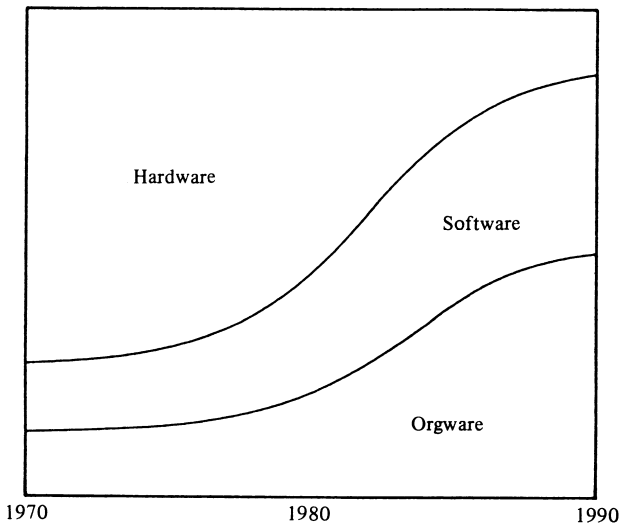


Figure 1. The distribution of total costs of an information systems project.

on typewriters placed on an ordinary desktop, which means that their underarm is not horizontal. Another example was cited to the author during a visit to Australia (Spring 1984) where 15,000 women were working in the public sector in Canberra doing nothing but enter data at 11,000 keystrokes per hour for eight hours per day. In spite of the 'exploding number of instances of tenosynovitis', the managers responsible were not prepared to face the economic consequences of putting an upper limit to the number of hours one might work at a terminal every day, 'as there was no other task that these women could do for the remaining hours of the day'! In both these cases, as in most other cases of traditional ergonomic issues, it is possible to solve or at least substantially ameliorate the problems if the political will is there.

While workplace ergonomic issues typically deal with the 'how' issues, organisational ergonomics deals a lot more with the issues of 'what' the system should do. This is the organisational purpose of the system, the objectives to be attained from using the system. The importance of purpose is obviously crucial. In a recent study in the US it was found that 60 per cent of the more than five million private citizens who own a home computer do not use it. It sits in the cupboard together with the slide projector, cine camera and the golf clubs.

The reason for home computers not being used is clearly not because of a bad interface. The author was even prepared to put up with the 'supercharged bumblebee noise' produced by an ordinary tape-recorder when using his first Sinclair ZX80. But the reason why it was not used for long was that it had very little useful application. In other words, as proponents of Information Technology (IT) we must be a lot more concerned about what the system is used for than just how it is used.

Under the heading of organisational ergonomics, there are three vital areas where options exist and where it is mandatory that deliberate choices are made if we are to achieve human objectives. These issues are: (1) Social contact, (2) Synthetic environment, and (3) Job content. These issues are dealt with in greater detail elsewhere.²⁻⁷

In the traditional literature on man/computer

interaction, the fact that the man is a social animal is often neglected. In studies of job satisfaction and computer systems it has been shown that social contact was the most important factor contributing to the overall job satisfaction of employees.⁴ Human contact is required in order to develop our self-image and to form our values and personality. When designing information systems it is therefore necessary to make sure that the possibilities for social contact are enhanced. Almost all organisational development programmes embarked upon in order to make the organisation better able to handle external demands in an increasingly complex world are based on increasing communication horizontally and vertically in organisations, especially in 'power-equalisation mode'. As change-agents, with IT in our toolbags, it is important not to counteract this development.

The second issue concerns the synthetic environment. One of the main features of the 'information society' is that a lot of people are freed from actually carrying out the task themselves and are monitoring and supervising processes instead. This means that we are freed from a lot of dangerous, hard, routine work. But there are also instances where the craft of the worker or the know-how of the well-educated academic is expropriated into the system. The feel for the product disappears when the physical product goes out and the operator is left with the conceptual model or representation of the product. The tacit knowledge of the product might vanish. Again, this is not arguing against automation, but we must make sure that it remains possible for the operator to maintain his/her tacit knowledge in order to be able to develop the process further.⁸

In a lot of cases there can be great advantages in simulating reality: airline pilots training to operate a new aircraft, architects trying out new challenging structures, and accountants testing different financial models are all worthwhile examples. Some might feel that the travel agent simulating the package tour for a potential customer is stretching the limit – although the step to the three-dimensional TV, as described by Bradbury in *Fahrenheit 451*,⁹ seems quite small.

The third area of organisation ergonomics concerns job content. Several issues are important and it seems clear from many studies that there is no technological determinism, but perhaps an economic determinism in the form of 'one, most economic, and therefore best, way of doing things'. Some of the most obvious risks to operators are: specialization, e.g. one operator is left with one specialised task instead of job enlargement; structuring of the task – discretion is removed from the operator, and the task is programmed and preplanned; and monitoring of the performance of the operator is sometimes introduced either continuously or as spot checks.

In all three areas it is important to realise that as software is developed for wider and wider parts of the tasks in the office, we are also closing more and more options. When the division of labour between the human being and the machine shifts more in the direction of the machine, it is also necessary to increase preplanning and programming of the particular part of the task of the employee. In this process it is important to be aware of the assumptions the system is being built upon and the values guiding the choices of particular characteristics of the system.

To sum up, many systems that have been investigated in the past do not satisfy the most basic demands seen from an organisational ergonomics point of view. These systems cannot be classified as 'human', even though most studies show that employees would prefer the new system rather than return to the old one. This is not satisfactory, even though it might be possible to get people to work with such systems, just as we shall not feel content with hazardous jobs, e.g. in the asbestos industry, even though men are prepared to go and work there at the risk of their lives.

Finally, we shall briefly consider the issue of societal ergonomics. This is stretching the concept of ergonomics, but much more important is the issue of unemployment. It is quite clear that, today, we are in a situation where it is possible to automate at a far greater speed than society can adapt to. During the Interact '84 conference, a top manager from one of the three largest UK manufacturers of microelectronic equipment said to the author: 'I can automate any job you will care to point to – how can I make the politicians understand this fact and make them act on it?' There is no easy answer, but it is true that IT has such a capacity for innovation that it is difficult to foresee how the present Western economic and political system can survive the rapid growth in the application of IT. Nobody seems to have a clear idea about how the transaction can take place in a socially acceptable way – for some ideas see ref. 5.

It is still possible to handle most of the problems mentioned above, but it is time for these issues to be addressed in a more fundamental and forceful way. As proponents of the new technology, we have the obligation to do this.

3. INADEQUACY OF OUR PRESENT APPROACHES

There are three main reasons why we fail to do enough about the issues mentioned above. They are the narrow engineering approach to the area of human/machine communication, the instrumental approach to communication and its purpose, and finally the naive assumption that our technology is neutral.

When participating in the first IFIP Conference on 'Human/Computer Interaction' in September 1984, it was quite astonishing to find that many papers and presentations were employing what could be classified as an exclusively engineering perspective in the area of human/computer interaction. To give an example, some of the work reported on task analysis was extremely detailed in its objective analysis of individual behaviour at finger movement level. It is a cause for concern when a piece of work, such as providing the instructions for hard-copy printing, is called a task, is broken down into 20 separate task attributes and the analyst does not consider any other level between this 'task' and the total job. Change the setting from the office in London to Bethlehem Steel, Pennsylvania, the time from 1984 to 1910, the costuming from grey skirt to grey overall, and the task from routine work to simple physical work. Then turn the office clerk into worried labourer Schmidt and supplant the computer with the stopwatch. Frederick W. Taylor would indeed fit nicely (idea borrowed from Leavitt).¹⁰

It is a pity that such a strategy might very easily lead

to intransigence, where 'obvious' decisions – like sitting eight hours each day doing data entry at a conventional keyboard – 'have to be taken' for economic and technical reasons. This does not mean that it is always wrong to use a fragmented and piecemeal approach. But it is worrying if the researcher is not aware of the serious limitations of his or her strategy and if the research strategy is being used exclusively under the assumption that somebody else takes care of the wider implications.

For an excellent critique of the existing poverty of natural science paradigms as the only ideal of academic enquiry in the field of information systems, see ref. 11.

Secondly, it might seem trivial to point out that communication handled via electronic means is poorer than human-to-human communication. But it is necessary to state the point when viewing many of the papers presented at the Interact '84 conference, especially some of the papers on teleconferencing systems. The evaluation criteria used to claim success for these systems are often too limited. In order to use the systems in a proper way, we must be aware of these limits, however attractive the systems might seem at first, and – as researchers – we must address the limits to this communication.

Communication via electronic means is one-dimensional as long as it is transmitted as strings of text. Accordingly, this communication does not take into account issues like non-verbal communication (body language, mimics, gestures etc.) and enrichments of communication (intonation, stressing of certain words/syllables etc.).

To some extent, irony and double-talk are perceived in that they are often apparent from the words and their context (but not from non-verbal communication and enrichment of communication).

This does not mean that there is something wrong with communication via the computer, but it is important to be aware of its limitations. Employees do not just act on a certain piece of information; they act because they are committed and the types of information they require are not readily apparent from the types of decision they have to make. Information is used for many other things, like forming opinions and discovering values different from the ones we have now. Therefore, it is important to realise the value of personal communication and ensure that no matter which telecommunication system is designed, we also make provisions for individuals to communicate to common goals.

Finally, the development and use of IT cannot be seen as neutral in relation to developments in organisations and in society. Space does not permit a lengthy debate here (interested readers are referred to Markus *et al.*).¹² Power is exerted in a number of different situations which we may not always appreciate. For example, this power may be exerted:

Directly in relation to concrete decision situations (meetings) or indirectly in the sense that the conditions are influenced in such a way that when it comes to concrete decisions, 'the result is given' as there seems to be no 'viable' alternative (acting in accordance with 'his master's wish').

Consciously or unconsciously to the power holder (the one actually exerting power over somebody else) or to the victims who are subjected to the exertion of power.

These two dimensions can be used to form a two-by-

two matrix which has been used to give a series of examples of the exertion of power in relation to the introduction of computer-based information systems. Figure 2 indicates the importance of taking the political dimensions into account when developing, evaluating and implementing IT. Our technology is not neutral and we have to ask ourselves for whom we are working and for what purpose.

4. DEVELOPMENT OF A PROTOTYPE

In a recent study, Schneider¹³ made a comparative study of advertising strategies for office automation in the US and in the Scandinavian countries. She found that a particular piece of equipment was sold in the US emphasising cost efficiency and ease of learning (reducing training costs).

The same product, in the Scandinavian countries, was sold with the emphasis on creating a better work environment and reducing routine work and creating more challenging jobs.

This reflects, at least to some extent, a difference in attitudes. One might ask whether the same piece of equipment is capable of meeting all criteria or whether the optimising of one criterion (e.g. cost efficiency) hampers the possibility of achieving other objectives.

This difference in attitudes is reflected in the hardware and software produced in North America and sold, for example, in Scandinavia, and accounts for the de-

humanising and dequalifying features of many present systems by unnecessarily formalising, standardising and structuring the work role. There exists an alternative way of designing office automation systems that does not have these consequences and our objective is to explore the possibility of such a design.

The alternative strategy can be called a 'Scandinavian model for the office of the future'. The reason for this is that there is very strong interest in the Scandinavian countries (political parties, trade unions and even to some extent employers) in the latter two objectives mentioned above: better work environments and more challenging jobs.

The Scandinavian Model (SM) has two important elements relating to the process and the result respectively, and as a first approximation the following characteristic of a SM is suggested. The process by which new office equipment is introduced should be fundamentally democratic. Many problems in relation to the introduction of office automation are related to the fact that experts are designing something for others to use. Users should design their own systems. This means that the role of computer experts ought to be changed to a consultation role and that users should be given the necessary educational background for analysing their needs, evaluating the technology and specifying the requirements based on explicitly formulated alternatives.¹⁴

As the design process is to be controlled by the users it would not be possible to determine in advance the

Degree of consciousness with regard to exertion of power	
Conscious exertion of power	Unconscious exertion of power
DIRECT EXERTION OF POWER IN SPECIFIC DECISION SITUATIONS	
Limit discretion of operators in new systems, e.g.	Methods and procedures
Higher dependence on work of others	Narrow problem definition excluding organisational and social issues
Stricter rules/procedures	Use of experts
More detailed plans, goals	Use of reductionistic methods that will focus on detail without seeing the larger picture
More control of performance	
Influence joint decision making	Attitudes
Provide information	Technology appreciation training without giving background for understanding or evaluating the technology
Regulate participation	Emphasis on mutual interests
Restrict alternatives	
Use of influential friends	
Prevent unwanted decisions from being implemented	
INDIRECT EXERTION OF POWER BY INFLUENCING THE ENVIRONMENT	
Issues are not allowed to reach the decision-making stage as:	Structure
fundamental problems are never identified;	Norms, habits and routines restrict the individual
inequalities are not questioned;	Legitimacy of power holders is never questioned
critics are intimidated or coopted	'High priest language' is used
Values	Attitudes
Humanistic, social, cultural and aesthetic values are not defined as legitimate	'Technology is progress and who is against progress?'
Productivity and rationalistic values are furthered	Socialisation processes through school, family and mass media

Figure 2. Different types of power exertion related to (increased) use of information technology.

outcome, i.e. the characteristics of the system. However, based on our experience from cooperation with users and trade unions over a long period, it is to be expected that the hardware and software which users themselves will demand in the future will have the following characteristics based on democratic and humanitarian values.

(1) *No monitoring.* Systems should not be used for a second-by-second monitoring of the activities and performance of the individual. Otherwise, the employees will use their creative skills in trying to beat the system instead of doing their job.

(2) *Assume knowledge.* Almost all efforts by manufacturers are aimed at making the systems 'user friendly' by lowering user requirements. As a secretary remarked: 'It is as if the systems with intelligent terminals are designed on the assumption that there is no intelligence in front of the VDU'. Systems should be designed on the assumption that users have a substantial functional knowledge about their task whereas knowledge about structural aspects of systems is less important.

(3) *High discretion.* A real alternative to most systems today would be a system giving the user more discretion and autonomy instead of reducing it. This has important job satisfaction value but is furthermore important as 'competence about the user problem is something that the manufacturers think users do not have and that users of the system later discover that the manufacturers did not have' (user definition).

(4) *Possible to modify.* As no system can be expected to fulfill user needs over a long period of time, it should be possible for users to modify the systems easily. This means that users should be given extensive training and not just the usual appreciation and operation courses.

(5) *Transparency.* The method of operation of the system should be transparent to users in order to make it possible for them to handle the unusual situation and to modify the system.

(6) *Support learning.* Systems should lead to a requalification of the labour force by stimulating learning about how to take better care of one's own situation, e.g. by making oppression mechanisms more explicit.

(7) *Support feelings and intuition.* IT is traditionally a

technology supporting only the cognitive characteristics normally associated with the left-hand half of the brain. It seems vital to ensure that this is not hampering the cognitive characteristics associated with the right-hand side of the brain: feelings, emotions, creativity etc.

(8) *Social contact.* Many systems today decrease social informal contact. This is most unfortunate as it alienates users and deprives them of their ability to modify and test their values in dialogue with others. With the newest technologies, it is possible to change work environment characteristics so that social contact may be increased instead.

A joint Scandinavian research project along these lines was launched in the autumn of 1984, involving universities, user organisations and hardware and software suppliers.

5. CONCLUSION

The main objective of this paper has been to convey the message that most of the present trends in 'human factors' do not really contribute to human endeavour. We are not utilising the potential of the technology for liberating human beings – unfortunately we often see just the opposite. This is a collision course that will increase social tensions and conflicts in organisations and in society. To reverse this unfortunate trend, it is essential that we see our field of investigation in a broader context. A 'human' is much more than eye and finger movements. Secondly, we should start to see our field of investigation as a social science discipline too, which means taking social science methodologies into account in a much more profound way than hitherto. Only if this is done, can the full potential of technology be realised.

Acknowledgement

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