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A Socio-Technical Approach to Systems Design

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This paper examines how the structure of organisations is changing as a result of the global market and new technology and it discusses how these changes are affecting the nature of work. It identifies systems design as a problem-solving activity that requires a multi-disciplinary approach, examines the current and new problems of complex systems design and describes how a socio- technical approach which takes account of technical, organisational, economic and social needs can assist the creation of humanistic and effective systems for tomorrow's world.

Keywords: Changing work; Company structure; Socio-technical; Systems design

1. Introduction

Socio-technical design is an approach that aims to give equal weight to social and technical issues when new work systems are being designed. This paper discusses how it can be used to assist the design of successful information systems in today's and tomorrow's business environment [1,2].

2. Organisational Change

Major organisational change is taking place within industry. Companies are moving away from hierarchies to networks [3] and from centralised to decentralised structures in which parts of a company are run as semi-autonomous units. These changes are not necessarily new. When Ken Olsen created the Digital Equipment Corporation in Boston his original format was a decentralised network structure, each part responsible for its own management, products and profits. As the firm grew this was changed to a more conventional hierarchical structure. The network approach was found to lead to duplication of resources and dysfunctional competition between the different units [4].

There is clearly a problem in managing these new organisational forms that we do not fully understand. For example, who is responsible for major decisions in these systems and how is performance evaluated [5]? Yet, the theory behind network structures is very appealing. The belief is that complexity can be managed through freedom, that cooperation is economically efficient, and that knowledge comes from attitude and opportunity [6]. As yet there are few examples of these principles working in large multinational companies but we can learn from the Scandinavian countries who, for many years, using socio-technical strategies, have managed to combine efficiency with democracy.

Proponents of a new approach and new organisational structures argue that the present industrial situation is becoming less and less tenable. There is resistance to change, poor economic gains and alienated staff. Today, organisations are pulled in conflicting directions. Managing complexity requires flexibility and diversity while profit generation requires efficiency and control. These two sets of needs are difficult to combine. Also, networks and democracy run counter to the ideology of capitalism where the objective of industry is profit for the shareholders.

A recent report by the British Department of Trade and Industry offers two alternative scenarios for the organisation of industry in the future [7]. First there is the notion of a 'wired world'. In this networks of self-employed individuals come together via the Internet to work on common projects based on temporary contracts. The wired world is a world of portfolio work where individuals develop sets of skills and a knowledge base

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and sell those skills to other individuals or companies. The success of these arrangements depends on the creation of secure communications structures but also on the development of human relationships based on trust. Because the people in these networks will be working as individuals rather than as members of teams and may have little job stability, it is believed that systems of social support and protection will need to be created. These might take the form of the old guilds, such as the masons, of community groups, professional associations or new kinds of trade unions.

The 'wired world' scenario, with its focus on individual contractual work of a constantly changing nature, is a new situation with which we have little experience. It will require major organisational and social adjustments. Self-confident entrepreneurs may like the challenge of this kind of change but many of us will find it stressful or be excluded from participating. The DTI's alternative to a 'wired world' is the 'built to last' company. These are stable, relatively large organisations not very dissimilar to the successful companies of today. Their principal aim is to prosper through the collection of knowledge. This means they place a high value on the development of knowledge and they are anxious to keep the employees who possess this. They are therefore likely to offer long-term careers and job stability. The 'built to last' scenario is not too organisationally different from much of present industry. Both of these scenarios will accompanied by a growth of service industries and these may provide the bulk of work for a majority of people. This kind of work is individual or small group and places very little reliance on technology. Human skills of caring and support are much more important.

It is possible that a new global economy will contain both representatives of the 'wired world' and 'built to last' companies. Which model is chosen by an industry will depend on the nature of its objectives and markets. Wired world companies will be driven by entrepreneurs with innovative ideas. Built to last firms will go for market domination and an ability to continually satisfy customer needs.

3. What will Happen to Work?

The nature of work has been in a process of change for a long time. In recent years there has been a move from manufacturing to service jobs and from blue-collar to white-collar occupations. There has also been a growth in highly skilled knowledge based jobs and in part-time employment, particularly for women [7]. It is predicted that the largest occupational growth in the immediate future will be knowledge workers. Because many of the new 'knowledge workers' will be self-employed the 'job for life' will disappear and individuals will have to become skilled at selling themselves, running their own lives and protecting their knowledge. People will not be seeking jobs, they will be seeking customers [8].

But the success of both 'wired world' and 'built to last' enterprises depends on the establishment and continuation of mutually beneficial relationships. If the employee–employer relationship is viewed as a contract then employers will want employees who are loyal, skilful and dedicated to the interests of the company. In return employees will want employers who provide them with acceptable remuneration, job satisfaction and the degree of job security that each individual regards as necessary.

Creating acceptable contracts of this kind will not be easy but a failure to do so will result in alien and disaffected employees who are not committed to the interests of their employer. Even worse, they may regard the interests of the employer as in conflict with their own interests. The relatively mild organisational change that industry has experienced in recent years through down-sizing, flatter hierarchies and short-term work contracts has already started to create a great deal of employee disaffection. A recent survey of the job satisfaction of 2000 of its readers by the British journal *Management Today* (August 1999) has produced disturbing results. This showed that a third of managers are unhappy with their jobs. 40% want to change jobs, which the journal describes as 'strain drain', 49% think that morale in their organisation is low, 55% say they face frequent stress at work, 30% think their health is suffering and half say they have too little time to build relationships outside work. The world of work appears to have become the world of the rat race.

In many companies this disaffection is located at every level. The British Advisory, Conciliation and Arbitration Service (ACAS) reports that while fewer employees are fighting back as groups through trade union action, large numbers are bringing individual legal actions against their employers. Over 10 years the number of individual legal cases that ACAS has dealt with has jumped 278% to its current tally of 136 000. ACAS report that many employees and bosses have lost any feelings of mutual trust and respect. Loyalty cultures in work have all but vanished [9]. Press reports suggest that in Britain there is now a reviving employee interest in trade union membership, particularly white-collar membership. Employees see themselves as expected to work harder, for longer hours, with greater responsibilities as members of teams while at the same time opportunities for promotion are diminished and employers provide few if any guarantees of job security. In this new world of global competition employees feel that they are at a disadvantage. The employer–employee work contract appears to have swung greatly in favour of the employer. Employees who see themselves as exploited may be expected to turn to collective action to protect their interests if other avenues of reform are not available.

Negative visions of the future suggest that there is a great deal of conflict and social unrest ahead. Global competition provides employment for many but it also results in unemployment for those who do not have the skills to participate in the world of the future. If firms continually move to those parts of the world where labour is cheapest there will be growing inequality in income and wealth with, possibly, the disappearance of the middle class. It may be that the only occupations that can resist being shifted to cheap labour areas are those where physical contact is an essential element, as in the professions and the service sector.

Another negative factor in the work situation of tomorrow is that the quality of work is unlikely to improve for all groups. For many years those associated with the socio-technical movement strove to persuade industry that interesting and challenging work at all levels would lead to more satisfied employees. Many middle-level employees now experience this through the introduction of enhanced responsibility and teamwork, even though this has often been accompanied by overwork and increased stress. Other groups have not been so fortunate. For example, teleworking, particularly that associated with selling and answering services, has brought with it new and unpleasant forms of routine work.

The socio-technical pioneers challenged routine work consisting of simple manual activities repeated constantly during the working day. These were monotonous, did not allow for personal development and subordinated the worker to the machine, but they were not usually anti-social. The author has worked on many assembly lines where routine mechanical tasks were accompanied by pleasant social chit-chat between adjoining workers. The advent of computers introduced a new, more onerous form of routine work by requiring data to be inputted manually so that it could be processed electronically. This needed concentration and accuracy and talking was not possible. Today, with teleworking, we have a new even more onerous form of routine work which requires employees in call centres to constantly answer or make telephone calls to potential customers. Often the number of calls handled is electronically monitored and the kind of responses the operator makes is listened to by a supervisor. Even worse it is now thought that constant use of the telephone can affect an operator's hearing, leading to deafness.

4 What can Socio-Technical Design Contribute?

The most important thing it can contribute is its value system. This tells us that although technology and organisational structures may change, the rights and needs of the employee must be given as high a priority as those of the non-human parts of the system. This principle must also be applied to those who are not privileged to have paid employment and rely on the state for security. The predictions of the 1960s and 1970s that technology would bring many of us an idyllic life of leisure and wealth in the future appear to have little validity. A second fundamental socio-technical value is that of democracy. Employees should be allowed and encouraged to participate in, and influence, decisions that concern them. In the 1970s and 1980s these decisions were seem as primarily concerned with work organisation. Today, they would have a much wider area of application and be concerned with health and comfort issues as well as the present and future environment.

Other socio-technical design principles need applying more generally. The importance of creating and developing knowledge and the advantage of working in teams, all important aspects of socio-technical design, is now accepted for elite groups but is not yet a general policy to be applied to everyone. This needs to happen. At present the employer–employee work contract has greatly deteriorated from the employee's point of view and this could lead to severe industrial conflict in the future if a balance is not restored.

Most important, how are these predicted and possible changes to be brought about? Scenarios describe end products, they do not address the very difficult public relations strategies and stabilising mechanisms required to introduce them. Change is always difficult. Major change can be so difficult that it leads to social breakdown rather than to an easy route to success. Can industrial companies handle revolutionary change without motivated workers and inspired leadership? Do today's managers have the knowledge to create bottom-up, entrepreneurial organisations [6]?

Socio-technical supporters have always argued that the means are as important as the ends. If the desired end product is to be a humanised, efficient and innovative workplace then humanistic strategies must accompany the change process. It will not be easy to achieve these. A recent publication by the British Demos Group describes some of the problems of implementing major change [10]. First, there is the problem of inflexibility: many companies find it difficult to change. This may not be true of 'wired world' type organisations but change will not be easy for those in the 'built to last' category.

Organisational change is often stimulated and reinforced by companies that take the lead and are prepared to take risks. Will these exist in the 'built to last' corporations of tomorrow. Government commitment to change is also a major factor and governments are not always knowledgeable on what are appropriate strategies at particular moments of time when faced with unforeseen circumstances. Change is also stimulated by the thinking and writing of consultants and academics and by the behaviour of competitors. But this kind of change can be just the latest fad of a powerful communicator – one who has little understanding of the consequences of what he or she is recommending.

There may also be the very difficult problems of personal relationships. The socio-technical approach recommends the participation of lower-level groups in decision making, yet the reality of power structures is that innovation is often halted when it is successful enough to threaten existing authority structures. Most challenging of all, change involves risk and this is something most large companies try to avoid. It is critical that all companies in the future, whether part of the 'wired world' or 'built to last', need to spend time and effort building the competencies that are required to handle change without excessive stress, trauma and failure. The world of socio-technical design is democratic, humanistic and provides both freedom and knowledge to those who are part of it. These concepts are not new, but they are, or should be, enduring.

5. Applying Socio-Technical Principles to Systems Design

Many systems design problems today are new, complex and difficult. They are outside the system designer's normal experience and there may be few experts available to give advice. Also the consequences of nor tackling them successfully may be a serious disaster. Recent UK examples of system failures are the new computer system in the Passport Office and the National Insurance Recording System. This caused thousands of pensioners to lose out on savings.

Complex projects often have similar characteristics. They affect large numbers of people, many of whom may suffer serious problems if the computer cannot deliver accurately and on time the service they expect. Only by understanding and tackling these kinds of problems can we succeed in producing systems which are both innovative and efficient.

A critical question is 'How can we make good decisions in these kinds of situations and, once these decisions have been taken and implemented, how can we live with the results?' Some of these results will be excellent, some satisfactory but others unexpected, challenging and disturbing. Taking system design decisions in today's complex world is not easy. It involves making choices and this always means taking risks. We are never certain of the consequences of a particular decision because we never know what the future is going to require. A design solution that may seem logical and appropriate at one moment in time may turn out to be inappropriate when new sets of circumstances unfold.

Three questions which have to be posed at the beginning of any major project are: how difficult will the system be to design and implement, what organisational and human changes will result from its use, and how serious are the consequences likely to be if the system does not work as expected immediately? The answers to all these questions require knowledge and sound judgement – attributes which may be in short supply.

How we solve systems design problems will depend to a large extent, but not entirely, on the nature of the problem that the new system is designed to solve and the results we hope to achieve. Socio-technical factors that can exert a major influence on decisions are the nature of the environment that will contain the new system, and the pressures and constraints exerted by this. Is it a stable, relatively slow-moving environment with competent users so that a system, once implemented, is likely to cause little future trouble? Or is it a complex, fast-moving environment in which a computer is aiding, even taking, decisions critical to the future success of the company?

Another source of future uncertainty are the beliefs, values and assumptions of the systems designers on what will provide a satisfactory solution. Are systems designers taking a socio-technical approach of aiming to achieve an improved quality of life for users or are they focusing solely on achieving internal economic goals? When there is a divergence between the views of designers and users here there will almost certainly be problems when the system is implemented.

Systems design is never simple and there is always likely to be a degree of uncertainty in the decisions that are taken, with no guarantee that the right decisions are being made. Also today's systems design is almost always taking place in situations which are in a state of change, often of rapid change. This can mean that systems design assumptions and plans have to be constantly reviewed. A successful system design has been achieved when a desired result is achieved with direct links between diagnosis, planning, design and use.

Experts tell us that today we are living in a risk society [11] and that we are constantly having to make choices between alternative risks. Systems design is a risk-prone activity and every effort must be made to understand the nature of these risks throughout the duration of the project.

6. Skills that Aid Systems Design

Three important skills related to successful systems design are 'capability', 'competence' and 'coordination'. Ideally both designers and users will have these although they may take different forms. By 'capability' is meant having the power, capacity and knowledge to achieve desired objectives [12]. This concept can be applied to the organisations contracting for new systems and to their ability to provide the necessary and appropriate knowledge and support both for their system users and for the systems designers who are responsible for the new system [13]. If a socio-technical approach is being used then an important capability will be the need to give internal and external users an improvement in aspects of their lives that they regard as important.

John Kay suggests that capabilities can be viewed as essential assets. It is important for them to be identified and their relationship to successful strategy formulation or problem solving recognised. The London *Times* of 6 January 2000 in a leader column comments on a report just published by the British Government House of Commons Public Accounts Select Committee. This describes how the failure of many government computer systems is, in the Committee's view, due to managerial incompetence. The leader states that 'the implementation of more than 25 public sector IT systems resulted in ''delay, confusions, and inconvenience to the citizen'' and ''poor value for money'' '.

The problem-solving ability of individuals has been called 'competence'. Competence has been defined by the philosopher Gilbert Ryle as 'knowing how' [14]. He argues that in every-day life we are much more concerned with people's competencies than with their intellectual brilliance or with their beliefs. What people can do is often more important than what they know for knowledge is only useful if it is applied. Competence implies that a person presented with a problem can think things through logically and get results. Socio-technical competence requires a knowledge of how to achieve social and organisational as well as technical goals.

'Coordination' is the third important socio-technical concept in problem solving and is particularly relevant to the design and implementation of information technology, where designers and users must collaborate closely if systems are to succeed. By coordination is meant the ability to work closely, democratically and creatively with other groups. This is an important socio-technical value and is seen by some management gurus as the one most related to organisational success in today's complex world [3].

7. Capabilities

Capabilities related to successful system design will include the following:

- *Knowledge capability:* The ability of internal user groups, particularly at senior management level, to understand the complexities of modern information technology systems design and to learn from the experience of both success and failure.
- *Resource capability:* An understanding of the skills required to create effective strategies for IT design and implementation and the management skills that are needed to ensure good project control. These skills will include technical, economic, organisational and social factors. If a company does not have these, a knowledge of where they may be obtained is necessary.
- *Psychological capability:* An ability to provide the necessary internal leadership, teamwork and good social relationships to ensure success. These are especially necessary between internal and external groups.
- *Organisational capability:* An ability to plan and think strategically in what may be a new area, to set objectives, to deploy resources effectively, to manage complex situations.
- *Ethical capability:* An ability to create and maintain a set of ethical values regarding working practices and relations with other groups. An socio-technical goal should be an improvement in the quality of working life for groups who will use, or be affected by, the new system.

These capabilities can be translated into the individual competencies of problem solvers in the following way:

- *Knowledge competence:* The ability of an individual to learn from experience and, as a result, to continually add to personal knowledge in the IT area.
- *Resource competence:* An understanding of the kinds of personal skills that are required. These will include management, technical, organisational and social.
- *Psychological competence:* An ability to work with, motivate and encourage both internal and external groups, to maintain personal morale in demanding and stressful situations and to persevere with difficult problems.
- *Organisational competence:* To plan and think

strategically about one's personal contribution and how this can fit with the needs of the total systems design situation.

- *Innovative competence:* An ability to think creatively, to approach new problems without prejudice and from different angles.
- *Ethical competence:* An understanding of, and willingness to communicate, personal ethical values where these are relevant to the needs of the project and those concerned with it.

8. Coordination

Successful systems design requires a great deal of 'coordination' with different groups working effectively together. Socio-technical design requires decisions to be taken, or influenced by, the groups most likely to be affected by them. These, according to how the project is organised, will range from software suppliers, outsourcing contractors and external consultants to internal managers at all levels and users of the system. Critical groups will be external users, or recipients, of the system, especially if they are customers or members of the public.

Internal and external groups concerned with design, implementation and effective use will need to identify and agree their areas of responsibility and be clear where their task boundaries are located so that responsibilities do nor overlap or get forgotten. An essential group will be one that ensures that the project objectives are acceptable and viable, takes responsibility for the project as a whole and monitors progress. The British government report found that Civil Service senior management often lacked the skills needed to manage complex IT projects. Departments paid outside contractors for over ambitious schemes, which were often embarked upon in too tight a time scale without any contingency plan in case of failure. Worse, confusion over what a new system should deliver meant that its specifications were sometimes changed in mid-development. These kinds of errors were repeated time and again without lessons being learnt. The result was massive financial losses. A new IT system for the British Ministry of Defence, which cost more than £40 million, was obsolete a year after completion and never used. If a new Benefit Agency system, designed to combat fraud, had been implemented on time, the government might have saved some £190 million in welfare payments.

Good communication and a sharing of information on a fast and continuing basis with all interested participants will be essential. Electronic information is no substitute for face-to-face contact, however, and meetings to discuss policy and progress should be regular events. The system designers of today and tomorrow must be able to operate in complex and volatile environments which contain many different interest groups. They have to be good at facilitating cooperation. Strategies likely to be effective, whether technical, organisational or social, will require networks of partners and contacts.

Companies are not always well organised or knowledgeable enough to deal with these new complex systems design problems: they may require external assistance. Here independent consultants who are expert in organisational design may be valuable additions to the technical advice offered by the software vendor or the outsourcing supplier [13].

9. Other Useful Attributes

The right capabilities, competencies and coordination facilities are essential requirements for today's and tomorrow's innovation, but other skills are required for successful systems design. Teamwork is also very important. With large, complex systems good teamwork is necessary.

Knowledge will need to be shared, strategies agreed and individual competencies used effectively. Lastly, motivation for both the group and the individual is essential. The systems designers and users must actively want to understand and solve the design problems and make a contribution to an effective and workable system. All aspects of good system design are dependent on knowledge. Success requires the ability to search for, analyse and synthesise relevant information and relate it to current and future needs. A socio-technical approach would ensure that all groups have knowledge relevant to their own use of the system. Knowledge should lead to considered action and an ability to work well in potentially stressful situations.

Effective problem solving also requires feedback and this is another concept of value to a socio-technical design team. Events must be monitored so that their impact is noted and understood. Effective feedback will provide the information to facilitate a constant adjustment of plans and actions. This adjustment will require creative responses in order to cope with new unanticipated situations. In a major system design project with the Digital Equipment Corporation to develop a company-wide expert sales system the problems that beset the design team were almost all organisational, rather than technical. Their solution required considerable political skill and adaptability on the part of the design team [4].

Major systems design, as it proceeds over time, usually produces many new and unanticipated problems.

These require the design team and system users to be continually vigilant, entrepreneurial and innovative, either to anticipate and prevent the occurrence of the problems or to solve them quickly when they appear. The need for cooperation with other groups can now be an advantage as this can itself secure consensus and lead to better problem solving. Poor problem solving in the systems design process can lead to the missing or neglect of important issues, factors or variables and to the introduction of new problems that might have been avoided.

10. Stages in Problem Solving

Seeing The Total Picture

Socio-technical designers always try to see complex systems design as a unified process. This means taking account of technical, economic, organisational and social issues at every stage of the design process. It also requires answering questions such as 'What is the nature of the problem we are trying to solve?' 'How did it arise and why does it need to be addressed now?' 'What difficulties are likely to be encountered along the design route?' 'What are the consequences of a successful solution and what will happen if the system is only partially successful or proves a failure?' Also, 'In what areas of the systems design process are the greatest risks likely to occur and what is the nature of these risks?' This process is similar to that of a doctor who practises holistic medicine. He or she will focus on the needs of the whole person and not just on one or two obvious symptoms or complaints [15].

Developing Strategies

Developing appropriate strategies for each stage of the design process is an important and critical process. Again, these should embrace technical, economic, organisational and social issues and lead to clear, structured thinking. Although most problems can be approached from a number of directions, coherent strategies that fit well together and provide operational guidelines are essential. In volatile situations where some variables are in a state of change, these strategies may have to be continually reviewed and adjusted. Muddling through is not an option.

This paper has stressed the importance of identifying the total picture and of managing the design process with a well thought out socio-technical strategy. Nevertheless there will be separate facets of the design problem that require sub-strategies before they can be addressed operationally. Large, complex systems are too challenging to be addressed as a whole. They need to be broken down into sub-activities.

Taking Action

It is useful to start design with a mission statement – one that provides a clear definition of the primary objectives of the design process and identifies the major tasks that have to be undertaken. It must always be remembered that a socio-technical approach requires the social to be given equal importance to the technical. A version of Stafford Beer's Viable System Model can be of value here. This enables the design task to be described as a six-stage hierarchy of activities. For example:

1. Identifying the basic, often routine tasks, that have to be handled in addressing the design problem.
2. Thinking through, and documenting, the likely difficulties that may occur and inhibit the successful completion of these tasks.
3. Identifying the critical success factors that provide guidance on what aspects of the problem should be given priority or maximum attention.
4. Understanding the nature of the information that needs to be collected and disseminated as the design process progresses.
5. Creating methods of evaluation – the monitoring checks and measures that can provide guidance on whether progress is being made and whether goals are being achieved.
6. Finally, there will be a need for a constant review of strategy to ensure that results are in fact being achieved [16].

The socio-technical approach is, as we have seen, in many ways similar to the approach of a good doctor. It requires a comprehensive picture of what is required in the design task to be established and an appropriate broad, overall strategy developed. Next, the many sub-problems will have to be identified, understood and managed with a recognition that each is likely to affect the others. Also, a number of groups will have to cooperate if progress to a solution is to be made. For example, in the past the Digital Equipment Corporation, an active user of the socio-technical approach, has had a policy of always using multidisciplinary teams for the solution of complex systems design problems. These teams would be set up before any new project got underway [4].

Risk analysis and management can also be useful tools in assessing the impact of possible design and implementation problems. They can provide an evaluation of the consequences of not being able to avoid, or deal quickly with, unexpected problems.

11. Design Methods

In addition to relevant capabilities and competencies, and good coordination, effective systems design requires design methods. These should enable a design team to move smoothly from analysis of the problem to implementation of an appropriate solution. Methods with a socio-technical philosophy and approach include Checkland's Soft System Methodology, Avison and Wood-Harper's Multiview and the author's ETHICS approach – ETHICS standing for Effective Technical and Human Design of Computer-based Systems [1,2,17,18].

ETHICS has been used to assist the technical and organisational redesign of many new systems including banks, hospitals, major companies such as ICI, the Civil Service and the British navy. A long-term project at the beginning of the 1990s assisted the Digital Equipment Corporation to develop an expert system, intended for worldwide use, to assist the Digital sales force to make accurate configurations when providing customers with financial estimates and the manufacturing plants with production specifications.

The ETHICS method always followed the socio-technical notion of user participation as an important feature of design. The nature of this involvement developed over time as the author worked with different groups and began to understand how they could be helped to diagnose their needs and develop solutions. A summary of ETHICS is shown below but its use varied according to the demands and needs of particular situations. Most design groups did, however, work through the different stages, usually requiring a time period of several months to complete these. Design group meetings were normally held at two-weekly intervals to give members of the group time for considered thought and to ensure their normal work commitments were not disturbed.

ETHICS

- Stage one – diagnosis of needs
  - Step 1. Why do we need to change? Discuss existing problems and the improvement offered by new technology.
  - Step 2. What are the system boundaries? Where do our design responsibilities begin and end?
  - Step 3. Make a description of the existing work system. It is important to understand how this operates before introducing a replacement or modification.
  - Step 4. Define key objectives. Why does this department or function exist? What should it be doing?
  - Step 5. Define key tasks and information needs. What are the tasks that must be completed irrespective of how the department is organised or the technology it uses? What information is required to complete these tasks?
  - Step 6. Measure pre-change job satisfaction. Here a questionnaire is used based on current theories of job satisfaction together with the pattern variables of Talcott Parsons. The design group gives this to everyone likely to be affected by the change.
  - Step 7. Measure efficiency. A second questionnaire based on the control theories of Stafford Beer is also given to everyone likely to be affected.
  - Step 8. Assess what is likely to change in the research situation in the future. Design must be for the future as well as the present.
- Stage 2 – setting of objectives
  - Step 9. Clear efficiency, job satisfaction and future change objectives are now set for the new system.
- Stage 3 – identifying solutions
  - The design group now identifies and discusses in detail a range of alternative organisational and technical design options. Socio-technical solutions will be included in this but these are not always the ones that are finally selected by the design group. At this stage the design options are likely to be discussed with the project steering group.
- Stage 4 – Choice and implementation of solution
- Stage 5 - Follow-up evaluation
- Stage 6 – Reports for the company and academic articles describing the theory and practice of the research

A contracted version of the method called QUICKethics was used when managers were defining their information needs. A great deal of personal information was collected through face-to-face interviews and discussion with individual managers, followed by two one-day meetings at which the group of managers identified and agreed their priority information needs. The reorganisation of work was not part of the agenda [19].

Readers who would like to have more detailed information about ETHICS are recommended to read the author's two books: *Effective Systems Design and Requirements Analysis: the ETHICS Methods* and *Systems Design: Ethical Tools for Ethical Change*, published by Macmillan in 1995 and 1996.

12. Concluding Thoughts

Complex systems design that takes a socio-technical perspective requires a continuing recognition of the interaction that is taking place between technical, economic, organisational and social factors when systems are being designed and, afterwards, when they are being used by groups that need the data they can provide. But it has to be recognised that some parts of complex problems may be difficult to handle because they have conflicting objectives. For example, a desire to cut costs may result in less than adequate technology being acquired; or a desire to meet certain user needs, particularly if the users are the public, may cause organisational difficulties. Choices now have to be made and making these is not easy.

Another feature of complex design problems is that they change over time. What are seen as urgent business problems at one moment in time may become insignificant at another while a second, more serious group of problems, replaces them.

Designing a major new system requires knowledge, especially knowledge of the nature and extent of the problem and of the means available for solving it. This knowledge will assist the development of an ethical position, a set of values and a series of practical design steps seen as achieving a desired result. It must never be forgotten that systems design is a difficult process that can always be improved. Criticism of the ways problems have been solved in the past can lead to improvements in the future. At the same time a knowledge of procedures and practices which have worked well in the past, and may still be relevant, can help improve the future. Socio-technical design is one of these.

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