The story of socio-technical design: reflections on its successes, failures and potential

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Abstract. *This paper traces the history of socio-technical design, emphasizing the set of values it embraces, the people espousing its theory and the organizations that practise it. Its role in the implementation of computer systems and its impact in a number of different countries are stressed. It also shows its relationship with action research, as a humanistic set of principles aimed at increasing human knowledge while improving practice in work situations. Its evolution in the 1960s and 1970s evidencing improved working practices and joint agreements between workers and management are contrasted with the much harsher economic climate of the 1980s and 1990s when such principled practices, with one or two notable exceptions, gave way to lean production, downsizing and cost cutting in a global economy, partly reflecting the impact of information and communications technology. Different future scenarios are discussed where socio-technical principles might return in a different guise to humanize the potential impact of technology in a world of work where consistent organizational and economic change are the norm.*

Keywords: socio-technical design, action research, impact of information and communications technology

SOCIO-TECHNICAL DESIGN AND ACTION RESEARCH

The story of socio-technical design is closely allied with action research. This is more a philosophy than a methodology. It describes a process and a humanistic set of principles that in our context is associated with technology and change. It can be used to contribute to most problem-solving in work situations, providing that both the innovators and recipients are willing to use a democratic approach. It will be difficult to use successfully if the parties involved are hostile to each other, disinterested in developing strategy and unwilling or unable to cooperate. As the name implies, the research approach has an action component: either the research is intended to lead to change in the work situation or it produces change inadvertently because the action research has taken place.

The term 'action research' seems to have been first used by members of the London Tavistock Institute in the early 1950s when deciding that their attempts to change current industrial practice should include both research and therapy. The Tavistock pioneers believed that their research projects should not only be attempts to increase knowledge, but that they should also embrace the improvement of work situations that were unsatisfactory in human terms. This decision led them to develop an approach and methodology which they called 'socio-technical'. This meant that technology, which, in their definition, covered both machines and the associated work organization, should not be allowed to be the controlling factor when new work systems were implemented. Equal attention must be paid to providing a high quality and satisfying work environment for employees. Many researchers followed the Tavistock example, and William Foote Whyte (1956) was one US pioneer.

Sixty years ago, a common example of a deterministic technology was the moving assembly line. Here the worker made the same repetitive movements all day, while being forced to maintain the pace of work set by the moving belt. This method of working is still to be found in some automobile assembly plants, despite attempts in the 1980s by Swedish manufacturers such as Volvo to eliminate the moving line and substitute group work that was not machine paced. In the 1970s, socio-technical principles were applied to office systems, and this became the author's principal area of interest.

The results of socio-technical design were always closely monitored and recorded to establish if it had led to both the efficient use of the technology and an improvement in the quality of working life of affected employees. This, in turn, led to the careful formulation and testing of theoretical concepts that could provide a better understanding of the meaning of the term 'quality of working life'. In practice, a primary objective of socio-technical projects was to ensure that both technical and human factors should, whenever possible, be given equal weight in the design process. Socio-technical design also had an important democratic component: employees who used the new systems should be involved in determining the required quality of working-life improvements.

The action research which the author has been involved with since the 1960s is concerned with the introduction of new computer systems. Following the Tavistock model she has always tried either to use good practice as a means for developing better behavioural theories or to test out the validity of theories by trying them out in real world situations. She has also always followed the socio-technical democratic model by involving the future users of new systems in their design.

In the 1970s, almost all of her projects were concerned with helping lower level clerical staff to reorganize work around systems that were being introduced to handle sales accounts, stock control, invoicing and simple kinds of information systems. These often affected large numbers of white-collar workers. The research situations included manufacturing firms, hospitals, banks and companies in service industries. A number of these, e.g. the Digital Equipment Corporation in the USA and ICI, at that time Britain's largest chemical industry, had had previous experience in using socio-technical approaches (Mumford & MacDonald, 1989).

These companies were interested in socio-technical design for a variety of reasons. Many were introducing new computer systems, knew little about these, and were anxious that their

staff should welcome them and use them effectively. They also recognized that the introduction of new technology would require some reorganization of work. A major part of most of these computer systems was designed in-house, and it was logical for democratically minded systems designers to involve users in the design process. This would help avoid systems failure and industrial relations problems. In most British firms at this time, trade union reaction to change was an important factor.

In some companies – and here the Digital Equipment Corporation in the USA was an important later example – powerful groups would be affected by the new systems and their positive reaction was essential. In the early 1980s, Digital began investigating the possibilities of using expert systems and its first applications were in manufacturing plants and sales offices. It was essential that important staff should welcome and cooperate with the change. Some of these firms had histories of using a socio-technical approach and were anxious to associate this with the introduction of new technology. In Britain, this was true of both ICI, Britain's largest chemical company, and Shell Oil, which was concerned about the environmental consequences of some of its systems (Hill & Emery, 1971).

In this paper, we first look at the early history of socio-technical design, which stems from the Tavistock Institute with its hopes of improving the quality of working life with technical change, rather than its deterioration as associated with Taylorism. The main principles of socio-technical theory are described, followed by examples of the theory in action in the 1960s and 1970s in Scandinavia, Western Europe and the USA. The reasons for its decline in the 1980s and 1990s are described, followed by a discussion of the present environment and the possible future impact of a different kind of socio-technical approach attuned to possible future scenarios.

EARLY HISTORY OF SOCIO-TECHNICAL DESIGN: PROMISES AND POSSIBILITIES

Socio-technical design is now more than 50 years old. It began with the desire of a group of therapists, researchers and consultants to use more widely the techniques they had developed to assist war-damaged soldiers regain their psychological health and return to civilian life. This group, most of whom had been associated with the London Tavistock Clinic before the war and some of whom were medically qualified, believed that the therapeutic tools and techniques they had developed could usefully be applied to the organization of work in industry. They saw this as restricting and degrading many lower rank employees who were forced to spend their days carrying out simple, routine tasks with no possibility of personal development or job satisfaction.

The Tavistock Institute of Human Relations was founded by this group in London in 1946 with the aid of a grant from the Rockefeller Foundation. It was set up to bring together the psychological and social sciences in a way that benefited society. In 1948, when the Tavistock Clinic became part of the UK Health Service, the Institute became a separate organization (Trist & Murray, 1993).

Because many of the original members were psychiatrists, all early members of staff were required to undergo psychoanalysis. There was a belief that they had to understand themselves before they could assist with the problems of others. Both the Clinic and the Institute focused on group rather than individual treatment. This was partly because of a shortage of staff and partly because group therapy was a recognized and successful method of helping with problems. This therapeutic background meant that staff were interested in results as well as theories. This led them in the direction of action research in which analysis and theory is associated with remedial change. The Institute believed that there should be 'no therapy without research and no research without therapy'. Today, this could be restated as 'no theory without practice, no practice without research'. In 1947, a publishing company, Tavistock Publications, was founded and a new journal, *Human Relations*, was created in association with a research group led by Kurt Lewin and located at the Centre for Group Dynamics at the University of Michigan.

In 1972, the socio-technical movement was formally internationalized by the creation of a Council for the Quality of Working Life, which had members, usually academics, from many countries throughout the world. A number of academic groups became actively interested in socio-technical research. These included the Work Research Institute, Oslo, and groups at the Universities of Pennsylvania in the USA, York University in Toronto, Canada, and the Centre for Continuing Education in Canberra, Australia. Kurt Lewin, at the University of Michigan in Ann Arbor, also had a considerable influence on thinking and action.

When socio-technical design was first developed after World War II, it was seen by its creators as a means for optimizing the intelligence and skills of human beings and associating these with new technologies that would revolutionize the way we live and work. This did happen in the 1970s when many industries tried to implement socio-technical methods of working. But initiatives gradually faded away so that today we still have many people working on jobs that are routine, tightly controlled and provide few opportunities for personal development. Two important questions need to be asked. The first is 'why did interest in socio-technical design diminish in the 1980s and 1990s?' The second is 'can interest in it be revived to meet the challenges of the 21st century?' All businesses are surrounded by powerful economic climates that greatly affect the way they operate. They also have strong cultures that have developed over the years and are difficult to change. It is believed that the efficient production of goods and services requires the clear specification of goals, prescribed ways of doing things to achieve these and controls to ensure that deviations do not occur. Although visionary groups have suggested that goals can be achieved in different ways, much of industry thinks that there is 'one best way' that is based on an adherence to bureaucracy. This can mean that social risks are neglected or not seen. There is often a strong, but unspoken, belief that they, the workers, will put up with almost anything, provided that jobs are available (Beck, 1992).

The socio-technical school wanted to change these perceptions. They believed in flexibility and intellectual growth. Individuals and groups could reorganize and redevelop to meet new challenges in changing environments, and this change process need not be too demanding and difficult. Many companies accepted this message and tried to restructure their procedures and change their cultures to meet new kinds of objectives, both human and technical. Unfor-

tunately, few of these endeavours had any long-term success. The attraction and validity of bureaucracy was seen as stronger and safer and the new humanistic approaches as over-risky. This paper will trace the history of socio-technical design as it moved from success to failure, attempt to find some explanations for why an approach that seemed to offer so much never realized its potential in the past and make some predictions about its relevance for the future.

Socio-technical theory has been continually developed and tested since the London Tavistock Institute was founded in 1946. Throughout its history its practitioners have always tried to achieve its two most important values: the need to humanize work through the redesign of jobs and democracy at work. In order to realize these goals, the objective of socio-technical design has always been 'the joint optimization of the social and technical systems'. Human needs must not be forgotten when technical systems are introduced. The social and the technical should, whenever possible, be given equal weight. Over the years, this objective has been interpreted in many different ways, but it is still an important design principle. The definition of human needs should come from the employees associated with, and affected by, technology and new work organization. This means that democratic and participative communication and decision-making must be available to give these people a voice.

The technical system was seen as covering technology and its associated work structure. The social system covered the grouping of individuals into teams, coordination, control and boundary management. Also the delegation of responsibility to the work group and a reliance on its judgement for many operational decisions. A distinction was made between semiautonomous groups and self-managing groups. The former are given authority for decision-making but may lack the means, e.g. an effective information system, to achieve this. The latter have both authority and the necessary knowledge to control their own activities.

THE EVOLUTION OF SOCIO-TECHNICAL CONCEPTS

Socio-technical researchers have always tried to test and develop theory. One of their first important concepts was the notion of 'open systems'. This recognized that every socio-technical system is embedded in an environment that affects the way it behaves. If this environment is the department of a firm, it will include the surrounding departments and all other activities that enable the company to run effectively. It will also include the environment external to the firm. This notion of an 'open system' was greatly influenced by the work of the Austrian biologist Bertalanffy (1950). The open system concept, as formulated at this time, accepted the theory of 'homeostasis'. This suggests that systems evolve and become increasingly complex but eventually settle for a steady state in which they can accommodate change without disruption (Davis & Taylor, 1972). The notion of homeostasis is questioned today. It is now argued that stability is not inevitable. Systems can become increasingly chaotic as they progress from one state to another.

The open systems concept considered technical structures and work roles as two systems that were both part of one inclusive system. The researcher or consultant must always consider them together. Relationships between the two systems, and between them and the out-

side environment, must also be carefully analysed. This approach led to the development of a complex method for analysing work systems, which went through a number of stages. Unit operations, or groups of tasks that fitted logically together into a discrete work activity, were first identified. Each of these unit operations was made the responsibility of a work group. Next, variances–problem areas where what did happen deviated from what should happen–were noted as areas for improved control by the work group. Supporting activities such as maintenance and the acquisition of supplies were also brought into the analysis. All of these were to become the responsibility of the work group. Key executive functions such as coordination and control of the wider system were left as the prerogatives of management. Some, but not a great deal, of attention was paid to interpersonal relationships and workers were asked to describe how they saw their roles. The underlying theory here was that alienation and job dissatisfaction were a result of a lack of personal control.

These design principles were constantly added to as research and action progressed. Many were the result of creative thinking by Fred Emery, an early member of the Tavistock, who later moved to Australia (Emery, 1978). He produced the notion of 'redundancy of functions' or multiskilling. Groups and individuals should have the ability to carry out a number of different tasks even though they did not always need to use these. This redundancy would make systems more reliable as they could now cope with unexpected occurrences. Emery believed that turbulent environments required redundancy as this enabled them to be adaptive, and that redundancy was easier to achieve in self-managing groups than in individual work activities. These ideas led to a principle of 'adaptive strategic planning'. Planning now had to fit the values and goals of the organization. It required the identification of shared values.

Another new concept was that of 'minimal critical specifications'. This was developed by Herbst (1974), who maintained that overspecified work designs were obsolete. Workers should be told what to do but not how to do it. Deciding this should be left to their initiative. He also produced an alternative to work hierarchies that is still in favour today. This involved work groups, matrices and networks. Primary groups are when all the members can learn all the tasks; matrices are when some tasks are done by everyone and others require specialists; networks are when people do not know each other and may be physically distant, yet they are still able to collaborate (Davis & Taylor, 1972). These principles were used and developed in the 1962 Norwegian Industrial Democracy Project.

Albert Cherns (1976), an associate of the Tavistock Institute, described the socio-technical design principles in an article in *Human Relations*. These were:

Principle 1. **Compatibility.** The process of design must be compatible with its objectives. This means that if the aim is to create democratic work structures then democratic processes must be used to create these.

Principle 2. **Minimal Critical Specification.** No more should be specified than is absolutely essential. But the essential must be specified. This is often interpreted as giving employee groups clear objectives but leaving them to decide how to achieve these.

Principle 3. **The Socio-technical Criterion.** Variances, defined as deviations from expected norms and standards, if they cannot be eliminated, must be controlled as close to their point of

origin as possible. Problems of this kind should be solved by the group that experiences them and not by another group such as a supervisory group.

Principle 4. The **Multifunctionality Principle.** Work needs a redundancy of functions for adaptability and learning. For groups to be flexible and able to respond to change, they need a variety of skills. These will be more than their day-to-day activities require.

Principle 5. **Boundary Location.** Boundaries should facilitate the sharing of knowledge and experience. They should occur where there is a natural discontinuity – time, technology change, etc. – in the work process. Boundaries occur where work activities pass from one group to another and a new set of activities or skills is required. All groups should learn from each other despite the existence of the boundary.

Principle 6. **Information** must go, in the first instance, to the place where it is needed for action. In bureaucratically run companies, information about efficiency at lower levels is collected and given to management. It is preferable for it to go first to the work group whose efficiency is being monitored.

Principle 7. **Support Congruence.** Systems of social support must be designed to reinforce the desired social behaviour. If employees are expected to cooperate with each other, management must also show cooperative behaviour.

Principle 8. **Design and Human Values.** High quality work requires:

- jobs to be reasonably demanding;
- opportunity to learn;
- an area of decision-making;
- social support;
- the opportunity to relate work to social life; and
- a job that leads to a desirable future.

Principle 9. **Incompletion.** The recognition that design is an iterative process. Design never stops. New demands and conditions in the work environment mean that continual rethinking of structures and objectives is required.

William Pasmore, writing in *Human Relations* (Pasmore, 1985), provides a positive assessment of what the socio-technical approach has achieved over the years. He describes the key insights provided by the early researchers as a recognition that the work system should be seen as a set of activities contributing to an integrated whole and not as a set of individual jobs. As a result, the work group becomes more important than individual job holders. Control should be devolved downwards with the work system regulated by its members, not by external supervisors. This would increase both efficiency and democracy. At the same time, flexibility and the ability to handle new challenges would be enabled through a work design philosophy based on skill redundancy. Work group members should have more skills than normal production required. (Today this is called multiskilling.) Work activities should not be restricted to routine tasks. Work group members should have as many discretionary as prescribed tasks to perform. And, most importantly, the individual member of any team must be seen as complimentary to any machine, not subordinate to it. This would remove the dictatorship of the moving assembly line. Lastly, because an important objective of the socio-technical approach is to

increase knowledge, the design of work should lead to an increasing amount of variety for the individual and group so that learning can take place.

At a later date, Fred Emery simplified these insights by stating that each member of the work group should have an optimal level of variety; learning opportunities; scope for making decisions; organizational support such as training and good supervision; a job recognized as important by the outside world; and the potential for making progress in the future.

INTERNATIONAL DEVELOPMENTS IN THE 1960S AND 1970S

In Europe, in the 1950s and 1960s, industry was weak and was being rebuilt. The strength and productivity of the USA was greatly envied and believed to be a product of better management. European industry was seen as centralized and authoritarian, while American industry was becoming more democratic through the influence of the human relations movement (Heller, 1998). The principal initiators of socio-technical design were the Scandinavian countries. Their approaches had marked similarities. Norway, Sweden and Denmark, although using different methods and emphasizing different aspects of work, all had a common set of values (Cooper & Mumford, 1979). These values were made explicit in legislation, and management and trade unions were required to cooperate in achieving improvements in the work situation. The emphasis was on the participation of all employees at all levels of decision-making, from corporate strategy to shop floor problems. Work design, although an early manifestation of the desire to improve the quality of working life, was only one aspect of the process of joint decision-making.

Different groups were interested in these European experiments for different reasons. Industry was expanding and many firms had labour difficulties. They had problems in obtaining staff and were scared of losing those they had. Technologists and engineers were presented with new design options and many were becoming interested in developing more flexible and friendly production systems than those currently in use. Howard Rosenbrock, a Professor of Engineering at Manchester University, was a notable pioneer here. Ergonomists interested in man–machine interaction also wanted to understand the socio-technical approach while many more academics were becoming concerned with research in industry.

In academic circles, a great deal of optimism was associated with these new ventures. Geert Hofstedte, a Dutch expert, believed the humanization of work could become the third industrial revolution. He saw the first as the move from muscle power to machinery in the 19th century, the second as the arrival of information technology and the third as these new approaches to work (Hofstedte, 1979).

Let us now examine the experiences of the principal participating countries in more detail.

Norway

Norway was a major pioneer in the humanization of work. In 1962, a group of Norwegian researchers, headed by Einar Thorsrud and assisted by Fred Emery, initiated what was called

'The Norwegian Industrial Democracy Programme'. This was a three-phase programme focusing on, first, creating improved representative systems of joint consultation. These involved the creation of worker directors. Next, the programme progressed to workplace democracy with employees gaining the authority, power and resources to change their own work organization, when and where this was appropriate. This led to four major experiments in work restructuring in Norwegian industry.

A national strategy for the humanization of work was a product of these initiatives. This incorporated a Norwegian law on working conditions that gave workers the right to demand jobs conforming to socio-technical principles of good work practice – variety, learning opportunity, own decision power, organizational support, social recognition and a desirable future. Following on and responding to this, came a programme for increasing trade union knowledge about technology and, as a result, union bargaining power. This programme was led by a group at the Norwegian Computing Centre headed by Christen Nygaard (Eldon, 1979). The industrial democracy project was stimulated by the fact that in the 1970s much of Norwegian industry was being taken over by multinationals and the environment had become very turbulent.

Although the work design experiments were generally successful, Norway experienced two kinds of resistance to the democratization of work. There was a general belief on the part of workers that any management-inspired change must be for the worse, while engineers and technologists saw some of the changes as threatening to their positions and status. As Emery (1978) shows, these problems have dogged many other change programmes.

Sweden

Sweden was in the same situation as Norway and copied its example. By 1973, between 500 and 1000 work improvement projects were taking place in Swedish industry. Sweden had made its first efforts towards the democratization of working life through the establishment of joint industrial councils in 1946. In the 1970s, the Swedish government took this further by introducing the Joint Regulation of Working Life Act. This was implemented in 1977. Both management and unions now needed some guidance on how to proceed in the new areas of codetermination. These were wide ranging, covering the interests of employees, with an emphasis on self-managing groups. They also included better personnel management, better strategic planning and increased productivity (Apslund & Otter, 1979). A programme was agreed that encouraged unions and management to broaden the activities of joint councils so that these could develop new strategies for organizational redesign and business improvement. It was also agreed that unions did not have to rely on the goodwill of management. If management did not make sufficient progress with implementation, then the unions could apply pressure.

A major breakthrough was a move from job design to organizational design. It was in the later 1970s that Per Gyllenhammer created his new 'dock assembly' work system at Volvo's Kalmar Plant. This removed the traditional flow line system of car production and substituted group working, with a single group assembling an entire car (Lindholm & Norstedt, 1975). The project also developed the idea of worker directors, which the Swedish government required in

state enterprises. An important piece of knowledge acquired during this project was that self-managing groups separated by space and time have more difficulty in coordinating and controlling their activities than those organized bureaucratically. They require excellent information systems to assist their self-management. These groups must also be able to set clear production objectives that are acceptable to management. Another problem is how to manage the interface between the workers and the technical systems when there are no foremen, production planners or quality controllers. The group has to manage all these activities itself. Negotiation now has to replace orders as the primary tool of management and this in itself is very difficult to manage. Success with these new work systems requires the enthusiasm of both management and unions.

Denmark

Formal management–worker cooperation on job content and job design began in Danish companies after World War II. An agreement in 1947 led to consultative committees with equal numbers of employer and employee representatives being set up in a number of large companies.

In 1970, a new agreement was made between the Danish Employers Confederation and the Danish Federation of Trade Unions. This required a focus on both production and job satisfaction. It also gave employees the opportunity to become decision partners in the design of their own work situations. A number of factors influenced this move towards work humanization. They included increased interest from management and unions, who both saw advantages in a more contented work force. Stable conditions of employment also played their part.

The results, although encouraging, indicated that work humanization could not be achieved without overcoming a number of difficulties. Not all groups of employees had the same interests and wanted the same solutions. A lack of support from senior management or from the trade unions could also slow down progress, as could changes in a company's marketing or economic situation. Danish experience suggested that certain conditions were required for success. These included company stability and financial health. Change was extremely difficult if workers were being laid off. As in Sweden, good relationships and a history of cooperation, together with an enthusiastic top management and positive union officials, were also necessary. Technology must not act as a design constraint and there must be a wage payment system that reinforced group working. Employees should also have a good level of education.

France

In the 1970s, France was also interested in the humanization of work. A survey of 18 companies in 1975 and 1976 showed that a great many jobs had now been enlarged, enriched or rotated (Trepo, 1979). The principal reasons for this effort were a search for production gains and a recognition of the need to reduce labour problems, including absenteeism, industrial conflict and poor quality work. In an attempt to overcome these, the French government introduced legislation requiring employers to demonstrate how they had improved working conditions and how

they proposed to improve these further. But the French trade unions were suspicious of these job design efforts, seeing them as yet another possible means to exploit workers.

Italy

Italy was a rather different situation from France. In Italy, the existing rigidly structured and tightly controlled form of work organization, often called Taylorism, was seen as a product of Fascism. The Italian unions, in contrast to unions in other countries, were prepared to fight against this and were determined to secure control over the organization of work (Rollier, 1979). Initiative for change therefore came from the unions with management as reluctant partners. The union became a major force pressing for change and also the focal point for the promotion and spread of organizational research. Agreements in the early 1970s with companies such as Olivetti and Fiat paved the way for experiments similar to those at Volvo with 'production islands' and flexible work cycles. As might be expected, there was resistance from employers, although Olivetti was an exception. The company was converting from engineering to electronics and needed new forms of work organization.

All large Italian companies were afraid of the trade unions and most produced suggestions for work changes, but there was little conviction that the new work system would lead to increases in production. In 1974, Italy had a major economic crisis. Management became frightened of the economic situation and started reshaping their production systems with the aim of breaking the unions. This meant restoring the old Taylorist model and abandoning the proposed changes.

Germany

Strategies to improve the humanization of work in West Germany began in the early 1970s. These were strengthened in 1973 by a major strike in I.G. Metall over the humanization of work and worker participation. The result of this was that Works Councils now had a say in corporate developments and that these subjects became a part of collective bargaining. They also led to discussions between parliament, government and the trade unions (Leminsky, 1975). It was increasingly recognized that work was of central importance to a satisfactory life and that rewarding work must contain opportunities for autonomy, freedom and choice.

This meant that the content of work had to be changed. There must be better training, job enrichment and the organization of work around groups. Production, repairs and control would now all be carried out by these groups. These reforms were implemented through new laws and by making Works Councils responsible for their introduction and for monitoring their effectiveness. A programme for the humanization of work was introduced by the Federal Ministries of Labour and of Science and Technology in May 1974. This programme had three components. The first was the development of standards and minimum requirements for machines and workplaces. The second was the development of technologies, including computers, to meet human requirements. The third component consisted of case studies and models for the organization of work, based on the socio-technical analysis used in Britain and Norway. Firms

that were willing to introduce new forms of group work that included more job variety would receive subsidies to meet part of the cost of these experiments. These changes were facilitated by new legislation that formalized and ratified workers' rights.

Works Councils were the principal change agents and any plans for reorganization made by the employer had to be agreed by the Works Council. This meant that the trade unions had to train their Works Council members in the management of change and in how to influence policy. The unions also succeeded in gaining *Mitbestimmung* – the equal representation of labour on supervisory boards and labour directors on executive boards. These became the new worker directors. This humanization of work programme continued successfully for some years but was criticized by socio-technical consultants in other countries for excluding the worker on the shop floor from discussions. Everything was left to the trade unions.

Netherlands

The Netherlands has always taken a lead in work humanization, and a major European pioneer in socio-technical design in the 1960s and 1970s was Philips in Eindhoven. The company had many programmes that incorporated what the firm called work restructuring and work consultation (Mumford & Beekman, 1994). Today, we might call these work design and participation. These programmes were the responsibility of a special department called Technical Efficiency and Organisation (TEO).

The commitment of this department to technical change began in 1976 when the company first noted signs of unrest amongst blue-collar workers who were doing boring and monotonous jobs. Management, and in particular the director of TEO, were determined to overcome this. Philips believed strongly in the socio-technical principle that the social must have the same importance as the technical, and the company also understood the relevance of the social sciences to good management.

In the 1970s and 1980s, most manufacturing companies defined industrial engineering as a form of work study. Philips adopted a quite different approach. Management saw the behavioural sciences as providing a supporting and humanizing underpinning for industrial engineering. Philips hoped that as result of this philosophy all kinds of new organizational forms would emerge and be tried out. The result of this development and experimentation would then be a flexible and organizationally advanced company. Philips recognized that work restructuring and participation required major change in attitude from both management and workers. This new perspective was achieved through meetings, discussions and lectures, all of which included the Works Council and the trade unions. Although in the 1980s many of these high hopes for the spread of job enrichment and employee participation diminished for harsh economic reasons, in the 1970s Philips was providing an inspiring example of socio-technical design (Mumford & Beekman, 1994).

UK

In 1949, the Tavistock Institute pioneered two action research projects. One was a study of joint consultation at the Glacier Metal Company; the other was an investigation of the organization

of work in the newly nationalized Coal Board (Jaques, 1951). The chief researcher in the first project was Elliott Jacques and in the second, Ken Bamforth, who had worked as a miner and found many ideas for the redesign of work in his mining experiences (Trist & Murray, 1993).

These projects were both successes and failures. New patterns of consultation worked successfully at Glacier but were restricted by the authoritarian attitudes of senior management. Jacques eventually left the Tavistock as he came to believe that the authority structure of British industry, supported by a legal framework, made any fundamental employee democracy difficult if not impossible. The coal mine research had a mixed reception. Group work involving multi-skilling and a degree of self-management worked well on experimental faces but was not viewed favourably by the trade union as it conflicted with wage negotiations which were based on traditional work structures. The Coal Board was not enthusiastic either as it did not want trouble with the unions (Mumford, 1996a,b).

In 1965, a large-scale socio-technical project took place in Shell UK with the assistance of the Tavistock. Shell UK was interested in a new management philosophy that incorporated the idea that 'that the resources of a company are also the resources of society' (Hill & Emery, 1971). The company set out to redefine its objectives in terms of this philosophy. It was decided that these social and business objectives could best be achieved through the use of socio-technical concepts. An important factor here was the need to rethink the operation of the plant and its production equipment before further automation (Davis & Cherns, 1975). Management had become concerned that its employees were both alienated and performing badly yet it needed to have a totally committed workforce if it was to automate its refineries. It was decided that there must be changes in the attitudes of both management and workers, a participative management philosophy and style must be introduced and proposals must be drawn up for target setting and performance review. The Tavistock principle of seeking to achieve the joint optimization of technical and human factors was to guide implementation of the programme. This project lasted for 4 years in the UK and the experiments then continued in Shell plants in Austria, Holland and Canada. They are still taking place.

USA

In the 1960s and 1970s, the notions of organizational development and the human relations model were extremely popular in the USA, but as the business environment changed these became less relevant. In 1972, interest in the socio-technical approach was awakened. A decline in productivity was associated with unhappy employees who were alienated from their work. At the same time, competition from Japan and West Germany was increasing. Socio-technical projects in the USA were usually initiated by management without union or worker participation and were directed at increasing organizational effectiveness as well as the quality of working life. Most unions viewed these new policies with suspicion, seeing them as an attempt to undermine their interests or to increase productivity to the disadvantage of the worker (Davis & Cherns, 1975). But there were exceptions. The United Automobile Workers' Union negotiated contracts with General Motors, Ford and Chrysler in which clauses were included establishing joint management–union committees to improve the quality of working

life and to encourage and monitor experiments in job redesign. These projects continued for a number of years.

In the 1980s, an influential group of American researchers, managers and consultants formed themselves into the Socio-technical Round Table. This group was originally sponsored by the Society of Manufacturing Engineers, and managers from both the Digital Equipment Corporation and General Motors played a major part in its early activities. Socio-technical researchers and practitioners from other countries were invited to join. It played a major role in communicating the socio-technical message to American industry. This group is still active today.

Socio-technical projects were not restricted to Europe and the USA. India was one of the pioneers in work redesign. An early project was carried out in a cotton mill in Ahmedabad. Here a group of workers became responsible for a group of looms, work was reorganized and an increase in productivity occurred. These new methods did not last, and a visit to the firm by Tavistock researcher A.K. Rice in 1963 found that the old methods had returned. A new management was reluctant to give up power (Rice, 1953). However, socio-technical initiatives continued, led by an Indian supporter of the Tavistock approach, Professor Nitish De.

WHY WAS SOCIO-TECHNICAL DESIGN SO POPULAR IN THE 1970S?

By the end of the 1970s, there was evidence that socio-technical ideas were becoming accepted. The reasons for this interest were similar in all participating countries. Industry was expanding and many firms had labour difficulties. There were problems in obtaining staff and firms were scared of losing those they had.

Projects were spreading from manufacturing to service industries and it appeared that workers were becoming increasingly dissatisfied with the old methods of production. The socio-technical supporters believed that 'quality of working life' was an emergent value and that human development could be fostered through work. In their view, the technical imperative would eventually fade away and labour and management would not continue to operate in an adversarial mode. They must and could collaborate. But the socio-technical group was over-optimistic. Progress was not as great as its members believed. It was true that many projects were taking place, but these were usually on a laissez-faire basis. Innovative managers were allowed to go ahead but without much organizational support. Initiatives usually came from individuals at the top of a company anxious to achieve stability and harmony and, even more important, to reduce labour shortages. These initiatives would become fewer once the labour market changed and many were seeking work. A major difficulty during this period was that few trade unions embraced the socio-technical concept. Many saw this as a threat to their power and influence.

Socio-technical systems design in the 1970s had many of the characteristics of a new social movement and a social ethic. There was a widely accepted belief in the group as a source of learning and creativity and a belief in scientific thought as a means of achieving these things (Whyte, 1956).

A group that acted as an effective communicator and facilitator for socio-technical design at this time was the Quality of Working Life Council. This international group was drawn from many different European countries as well as India, North America and Australia. It was chaired by Einar Thorsrud, a leading Norwegian academic, and spread the quality of work message throughout the world through meetings, training sessions, books and articles. Its members worked with many different companies, initially helping them to introduce socio-technical projects onto their shop floors and later into offices. Einar Thorsrud had work design projects in Norwegian schools and in the Norwegian shipping industry. Group relationships were nourished and sustained by Dr Tommy Wilson, one of the founders of the Tavistock Institute who later became Social Science Adviser to Unilever. This group was very influential. It had a common purpose and a strong network of relationships. The members acted as information conduits in their respective countries and through attendance at international conferences.

THE 1980S

Strategies that work well at one time may not be successful at another. Both culture and the business climate can change. Many researchers have seen the 1980s as a disappointing time for organizational innovation. Industry came under pressure to cut costs and socio-technical approaches were increasingly seen as expensive and risky. Computer-assisted clerical and production systems were becoming very popular and an era of what has been described as 'computer aided neo-Taylorism' arrived (Moldaschl & Weber, 1998). The work of many clerks was routinized as computers moved into offices and a new shop floor technology called 'lean production' took over the car plants. Lean production involved teamwork of a limited kind, also multiskilling, direct feedback and continuous improvement, but work was not made more flexible and interesting. It became faster, more streamlined and more stressful (Stace, 1995). The principal differences between socio-technical design and lean production were the methods for controlling and coordinating work. Socio-technical design created decentralization of control and coordination by the user group. In contrast, lean production focused on the standardization of work processes (Niepce & Molleman, 1988).

Although there were few socio-technical initiatives in Britain during this period, a number of researchers, including the author, successfully carried out projects to assist the introduction of new computer systems. All of these followed the socio-technical model. They were participative in that future users at all levels played a major role in the design task, in particular rethinking the design of jobs and work processes for their own departments before new systems were installed. These user design groups, aided by systems analysts who acted as advisers on technical issues, tried to give equal weight to technical and human concerns and introduced teamwork, multiskilling and a degree of self-management (Mumford, 1995; 1996a,b). These projects included large companies such as Rolls Royce, ICI and a number of major banks and hospitals in the UK, together with the Digital Equipment Corporation in the USA. In both countries, these socio-technical design projects were brought to a successful conclusion and imple-

mented. One of the largest and most significant of these was the participative design of XSEL, one of Digital's first expert systems. This was developed to assist the sales force to conax computers and was designed for worldwide implementation (Mumford & MacDonald, 1989).

Unfortunately, the International Quality of Working Life Council broke up at the beginning of the 1980s. They did this with the best of intentions, believing that a new, younger group should take over and carry on developing the message. But the members had paid little attention to nurturing their succession and, when they resigned, there was no younger group to take over. At the same time, interest from industry weakened as recession set in and labour shortages became a thing of the past. Both of these factors put a brake on future progress.

The socio-technical initiative now became dispersed and centred on smaller groups in different countries. The Tavistock retained its influential role; projects in Scandinavia continued; Eric Trist was in the USA and Fred Emery in Australia; the American Socio-technical Round Table was created; and Federico Buttero set up a consultancy in Italy. But the international impact was now greatly reduced. No one was seriously pushing an integrated message internationally.

In the 1980s, industry's principal objective became cutting costs to compete in increasingly challenging international markets and maintaining or raising the price of their shares. Reducing costs through reducing staff numbers was one way of doing this, and socio-technical approaches were seen as having little to offer (Mumford, 1996a,b).

THE 1990S

The 1990s proved very frustrating to the exponents of socio-technical design. Companies recognized the need for change and were motivated to make changes but chose methods such as lean production and 'business process reengineering' that took little account of employee needs and did not produce good human results. There were, however, exceptions. Despite difficult economic circumstances, a number of companies in the USA, Europe and Australia continued with socio-technical projects, remodelling these to fit changing economic and social conditions. Today, the emphasis in Australia is on participative design, Scandinavia favours a democratic dialogue between management, and workers and the expert group of socio-technical consultants belonging to the Socio-technical Round Table assists American companies. Many US projects are based on the development of high commitment and high-performance work groups based on the cooperative sharing of power between workers and management.

Socio-technical theory continues to be of interest to researchers. In the Netherlands, an approach called modern socio-technical theory, which focuses on production structures as the main determinant of any socio-technical programme, is being developed. The theory behind this approach is that most production systems are overcomplex and cannot be easily controlled, and need to be simplified (Eijnatten & Zwaan, 1998).

Sweden has also been developing the socio-technical concept by bringing the company's business environment into the redesign task. Volvo now uses the phrase 'Delivery, Quality and Economic Results' to describe its objectives, which are primarily related to cost control. Results

are achieved through achieving direct contact between work groups and groups in the external market, such as customers and suppliers. Business goals are carefully formulated and group competences are developed and increased. The proposed next step is to develop socio-technical systems for business. Adler & Docherty (1998) suggest that the dominant socio-technical research tradition has shifted over time from a social dimension in the 1970s to a technical dimension in the 1980s, greatly influenced by the Dutch, and a business dimension in the 1990s developed by research groups in Scandinavia.

Despite these initiatives in Scandinavia and the Netherlands, few companies in other countries have been interested in extending the use of socio-technical design as a general design principle. The prevalence of 'downsizing' in the 1990s has led to flatter hierarchies in many firms, and it has been recognized that innovative companies require highly skilled groups who can work as members of high-performance teams. These give their members responsibility and autonomy, but they are usually privileged groups in senior positions, often working in high-stress conditions.

WHAT IS THE FUTURE IN THE GLOBAL ECONOMY?

In order to assess how socio-technical principles and practice can assist companies in the future, we need to predict what the future will be like. Unfortunately, the future is hazy and uncertain, with scenarios ranging from the pessimistic to the optimistic. However, with the exception of George Soros, the international financier who believes that capitalism is now becoming so unstable that it may soon break up and disappear leaving chaos behind, most experts see the present global capitalism as continuing and becoming even more powerful in the future. Soros's view is that capitalism is essentially unstable because it is changing so rapidly and is totally focused on the pursuit of money, while taking no account of social and political factors. Social goals such as providing employment take second place, while industry focuses on company consolidation, short-term goals and increasing profits. Soros believes that the contradiction between the global scope of financial markets and the national scope of governments will eventually lead to a breakdown of the system. He sees the 1998 breakdown of financial systems in the Far East as a warning for other parts of the world. Catastrophe will only be avoided if international financial authorities are created which can hold the system together (Soros, 1998). Soros is not alone in his pessimistic predictions. Other internationally famous commentators such as J.K. Galbraith also share his views (Galbraith, 1994).

Today's global capitalism is relatively new. It emerged in the 1970s when the oil-producing countries banded together to raise the price of oil. It was encouraged in the 1980s by Margaret Thatcher and Ronald Reagan's policy of removing the state from the economy so that market mechanisms could work more freely. Since then global capitalism has been growing and flourishing with consequences that are difficult to foresee. Its distinguishing feature is the free movement of capital. At the end of World War II, economies were largely national in character, international trade was small and there was little investment. Today, it is very different. The

free-market situation that has now arrived operates on the basis of its own rules. Soros (1998) sees these markets as a threat to liberty, democracy and law.

He sees two possible scenarios ahead. The first is that the global capitalist system will survive and dominate the world economy even more than it does today. Severe competition will then not allow multinational corporations to pay much attention to social concerns. The second is that the system will collapse. Political groups will seek to take over the multinationals and restore national wealth. A major factor influencing the future will be the ability of the international monetary authorities to hold global capitalism together. Soros is not optimistic. He believes that there will either be a cascading decline of the stock markets or a gradual deterioration. Another destabilizing problem will be the declining ability of countries to look after the welfare of their citizens. This will be exacerbated by the ability of capital to escape taxation and onerous employment conditions by moving elsewhere.

It is interesting that many commentators do not see technology as a major driving force for change. Their view is that technology acts as a facilitator by increasing output, reducing the number of employees required and assisting the movement of capital across the world, but it is not the primary influence. This pursuit of money and the development of a system that increases the possibility of a group of people making this in large quantities. For many, this is the ideology that drives today's definition of progress.

As Soros has, himself, been one of the prime financial beneficiaries of global capitalism, his views are important, especially as he is now pleading for a stronger sense of social ethics and greater democracy in the future. Other experts, while accepting that global capitalism will continue, have very different ideas on the form it will take. There are two scenarios here. The first is that economic activity will be internationalized in an increasingly borderless world. The second is that there will be a reintensification of regionalized economic growth (Scott, 1999). Will companies become truly international, moving round the world to find cheap labour and new commercial opportunities, or will most successful international companies still retain their national allegiances? Stenberg points out that, despite their global market vision, most successful international German and Japanese companies retain their national allegiances. They keep their headquarters in their home countries (Stenberg, 1999). He also makes the point that, although we are moving into the knowledge economy stimulated by the growth of information technology, manufacturing industry will still remain extremely important. Information technologies cannot be created without manufacturing technologies to produce the necessary hardware.

While Manuel Castells has argued that what he calls the 'spaces of places' is being replaced by 'space of flows', meaning that anything can be moved anywhere with ease, Dicken points out that the world economy still organizes itself around the three centres of Europe, North America and East Asia (Dicken, 1999). International companies may operate across borders, but the role of the state and its economic objectives remain central to these decisions. However, the power of the individual state is waning and is being replaced by economic alliances such as the European Union and the North American Free Trade Agreement. In Dicken's view, three important external factors influence this industrial reorganization: the existence of efficient external sources of required raw materials; the availability of trained and disciplined labour; and opportunities for learning and innovation (Scott, 1999).

There are also different views on the consequences for global society of this major industrial reorganization. There appears to be a new internationalization of labour, with the economically advanced countries specializing in high-wage, white-collar work while the less advanced countries are left with low-wage, blue-collar jobs. Despite this movement, many leading economies also have a multitude of low-wage sweatshop jobs and the emigration of unskilled labour from poor to rich areas of the world continues unabated.

ORGANIZATIONAL CHANGE

There are also major organizational changes within industries. Companies are moving away from hierarchies to networks (Castells, 1996) and from centralized to decentralized 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 decentralized 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.

There is clearly a problem in managing these new organizational forms that we do not fully understand. For example, who is responsible for major decisions in these systems and how is performance evaluated? (Dicken, 1999). 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 (Halal & Taylor, 1999). As yet, there are few examples of these principles working in large multinational companies, but we can learn from the Scandinavian countries, which, for many years, have managed to combine efficiency with democracy.

Proponents of a new approach and new organizational 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, organizations 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.

The British Department of Trade and Industry (DTI) offers two alternative scenarios for the organization of industry in the future (DTI, 1999). First, there is the notion of a ‘wired world’. In this scenario, 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 and sell those skills to other individuals or companies. 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. The success of these arrangements depends on the

creation of secure communications structures and 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, community groups, professional associations or new kinds of trade unions.

The DTI's alternative to a 'wired world' is the 'built to last' company. These are stable, relatively large organizations 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.

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.

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 (DTI, 1999). It is predicted that the largest occupational growth in the immediate future will be in the personal and protective services. Most of these jobs are not greatly affected by technology.

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 alienated 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 organizational change that industry has experienced in recent years through downsizing, flatter hierarchies and short-term work contracts has already started to create a great deal of employee disaffection. A job satisfaction survey 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. Forty per cent want to change jobs which the journal describes as 'strain drain', 49% think that morale in their organization 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, 1999) 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 reports that many employees and bosses have lost any feelings of mutual trust and respect. Loyalty cultures in work have all but vanished.

A report by the Joseph Rowntree Foundation suggests that in Britain there is now a reviving employee interest in trade union membership, particularly white-collar membership (Joseph Rowntree Foundation, 1999). 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. Thurow suggests 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 antisocial. 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.

WHAT KIND OF A FUTURE IS AWAITING US?

This we do not know. The predictions of global financial breakdown, made by Soros, Galbraith and other economists, suggest an unpredictable future with very severe problems. 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 organizational and social adjustments. Self-confident entrepreneurs may like the challenge of this kind of change, but many of us will find it stressful or will be excluded from participating. In contrast, the 'built to last' scenario is not too organizationally different from much of present industry. Both of these scenarios will be 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.

WHAT CAN SOCIO-TECHNICAL DESIGN CONTRIBUTE?

The most important thing that socio-technical design can contribute is its value system. This tells us that although technology and organizational 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 that 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 organization. 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 stabilizing mechanisms required to bring them about. 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 organizations? (Halal & Taylor, 1999).

There are now a number of models of how change can be managed without excessive trauma. Socio-technical supporters have always argued that the means are as important as the ends. If the desired end product is to be a humanized, efficient and innovative workplace, then humanistic strategies must accompany the change process. It will not be easy to achieve these. The British Demos Group describes some of the problems of implementing major change (Murray, 1999). First, there is the problem of inflexibility; many companies find it difficult to change. This may not be true of 'wired world' organizations, but change will not be easy for those in the 'built to last' category. Organizational 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 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', 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; many others support them. Etzioni describes an approach which he calls 'voluntary simplicity'. Voluntary simplicity describes a set of values that is prepared to limit expenditure on consumer goods while emphasizing the importance of quality of life, self expression and participation. It is a manner of living that is outwardly simpler and inwardly richer (Elgin, 1981).

Another approach to humanistic values is called 'associative democracy'. This aims to change the relationship between the state and its citizens by creating a participative welfare society (Pestoff, 1999). It does this by giving citizens a more powerful voice in decisions on publicly financed social services. This is possible in a community-oriented economy, which transfers power from big government to civic groups and from big corporations to self-governing local organizations (Bruyn, 1999). Pestoff, commenting on the Swedish experience, maintains that democracy rests on a moral base that grows when used but dwindles when ignored. For it to work, citizens must participate in real world situations where, sometimes, they are forced to make hard choices (Pestoff, 1999).

Profit sharing and co-ownership can make industrial and commercial enterprises more democratic. The best known European example here is the Mondragon Corporation. First set up in 1956 as a worker cooperative, Mondragon today is one of Spain's leading companies. It employs 20 000 workers, all of whom share in profits and can decide where to invest capital. Cooperatives of this kind have strong links to their local communities and this influences the strategic decisions that they take. They are not primarily concerned with shareholder value.

These examples, together with the socio-technical approach, would all fit into a humanistic value system that placed great importance on democracy, the equitable distribution of assets and a concern for personal development and happiness.

The models are there. How likely are we to adopt them in the 21st century? The answer seems to be that, as with socio-technical design in the 1970s, there will be pockets of use, with a few enlightened firms and communities accepting democratic value systems of this kind. But these are unlikely to be either opinion leaders or models for the majority. Most companies, whether part of the 'wired world' or 'built to last', will compete vigorously with each other and, as today, place great importance on their profit and loss accounts and the price of their shares.

Major human relations change will only come from a shift of values resulting probably from a severe shock of some kind. Democracy and humanism may happen on an increasing scale, but this will not be solely for ethical reasons but because, as in the 1970s, valuable, highly skilled labour need to be attracted to the company and retained once it is there. However, there are always countervailing forces and revolutionary change may come about for two important reasons. First, if Soros's pessimistic predictions regarding the collapse of the capitalist system come true, then many countries will experience the traumas of social chaos and breakdown. Russia already provides an example of this. Second, even if Soros is wrong and capitalism survives, a growth in the gap between the 'haves' and the 'have nots' may lead, in many countries, to increasing and unacceptable social disorder.

The notions of 'wired world' and 'built to last' are useful descriptive organizational concepts, but we badly need a more specific human concept than the notion of humanism. Here the 1776 American Declaration of Independence has a great deal to offer. It tells us that our governments are there to:

- form a more perfect union, establish justice, ensure domestic tranquillity;
- provide for the common defence, promote the general welfare; and
- secure the blessings of liberty to ourselves and to posterity.

Is this not what we are desperately seeking?

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Biography

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