Socio-technical systems theory: an intervention strategy for organizational development

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Integrating organizational development (OD) and technological intervention into a total system is one of the more difficult tasks for an executive or consultant to execute. Organizations are profoundly affected by technological advancements and require a flexible customized change model to fit the social network of the specific organization into which technology is being introduced. Examines socio-technical systems (STS) theory and presents classical organization theories of Burns and Stalker, Woodward, Perrow, Thompson, and Trist to develop a contemporary OD intervention in terms of self-regulating work groups (self-leading or self-managing teams) performing interrelated technological tasks. Finally, presents some pointers for executives and consultants in assessing STS interventions via 31 diagnostic questions intended to identify interactions among elements of the system.

The organization as a socio-technical system

Integrating organizational development (OD) and technological intervention into a total system is one of the more difficult tasks for a consultant to execute. This challenge demands that the OD consultant possess expertise and judgement in social, technological and systems theory and practice. This type of change is a complicated and delicate process. It is complicated because of the many areas and systems involved and it is delicate because of the dynamic relationship among these systems within the environment. Changes that support organizational development goals must consider how relationships among the various systems will be affected as they all are interdependent.

An element common to organizations is the need to remain viable. To do so, organizations need to utilize new technologies to gain a competitive advantage. Massive technological changes are apparent in areas including manufacturing processes, computer-assisted design, data transmission, advanced communication links, sophisticated information systems, etc.[1, p. 35]. Organizations are thus profoundly affected by technological advancement. As a result, appropriate change methods and techniques that help individuals and groups make the best use of available technology are needed. Organizational change, with respect to technology, requires a "flexible, customized change model ... examined from a socio-technical basis" which can "be customized to fit the social network of the specific organization into which [technology] is being introduced"[1, p. 41]. The purpose of this paper will be to explore socio-technical theory in general in terms of design, impact on and influence of the environment and technology. A historical exploration of classical organizational theories of Burns and Stalker, Woodward, Perrow, Thompson, and Trist will follow.

STS theory as an organization development activity will be explored in general, and self-regulating work groups as an OD and STS application, in particular. Finally, several pointers for executives and consultants are given in assessing STS interventions.

A return to the classical socio-technical theory, principles and approaches provides a framework for successful organizational change with respect to technology. This theory makes major contributions to work redesign for self-regulated work groups and as such is useful for incorporating technological advancement into organizations. A thorough understanding of these basic change principles and approaches is necessary to avoid misuse or partial application of this intervention technique. The organization as well as the consultant can avoid an unsuccessful change programme by thoroughly examining socio-technical theory as a systems approach. Hackman and Oldman suggest that it is preferable to start a change project with a theoretical approach that can be an aid for planning for change[2, p. 226]. After analysing the specific situation in any given organization, "the organizational development consultant can determine that some or all elements of a traditional model may be useful for the organization in question"[1, p. 41].

STS theory is probably the most extensive body of conceptual and empirical work underlying employee involvement and work design applications today. Originally developed at the Tavistock Institute of Human Relations in London, this approach to designing work has spread to most industrialized nations in a relatively short period of time. In Europe and particularly Scandinavia, STS theory is almost synonymous with work design and employee involvement. In Canada and the USA, STS theory has become the major underpinning of efforts involving work design. Cincinnati Milacron, Amoco, USAA, Stanley Works, General Electric, and Caterpillar are among many organizations using STS theory to design work[3, p. 352].

Over 30 years ago, the early contributions to socio-technical theory by Emery and Trist or by Chern's included approaches to design of jobs and work systems. More recently, there seems to be frequent reference to STS, given the inevitable infiltration of technology into organizations in all industries. Often though, STS approaches appear to be fragmentary and only loosely reminiscent of the original theory. The techniques used in socio-

Management Decision
35/6 [1997] 452–463

[ISSN 0021-1747]

technical analysis and design can be numerous and demanding and have led to some attempts to compress or abridge the phases or processes required for work redesign[4, p. 153]. Wide application of the socio-technical approach is due to its generality and so has the capacity to be "adopted with ease to almost any organizational situation… and remains open to continual improvement and revision[2, p. 63].

Design of STS

Socio-technical system design is based on the premiss that an organization or a work unit is a combination of social and technical parts and that it is open to its environment[5]. Because the social and technical elements must work together to accomplish tasks, work systems produce both physical products and social/psychological outcomes. The key issue is to design work so that the two parts yield positive outcomes; this is called joint optimization. This method contrasts with traditional methods that first design the technical component and then fit people to it. The traditional methods often lead to mediocre performance at high social costs.

In addition to joint optimization, STS design is also concerned with the work system and its environment. This involves boundary management, which is a process of protecting the work system from external disruptions and facilitating the exchange of necessary resources and information.

The creators of STS design have developed the following guidelines for designing work[4]:

- Work should be organized in a way that is compatible with the organization's objectives. This often leads to a participative process that promotes employee involvement in work design.
- Only those features needed to implement the work design should be specified. The remaining features should vary according to the technical and social needs of the situation. This helps employees control technical variances quickly and close to their sources.

According to Barko and Pasmore[6], employees who perform related tasks should be grouped together to facilitate the sharing of information, knowledge and learning. Moreover, information, power and authority need to be vested in those performing the work to reduce time delays in responding to problems and to enhance employee responsibility. Workers should be trained in various skills so they are flexible in changing conditions and so they have the necessary expertise to control variances. This also results in less need for supervision and staff.

The key principles of STS that have contributed to our understanding of effective work design may be summarized as follows[7]:

1 Overall productivity is directly related to the system's accurate analysis of social and technical needs and requirements.
2 An accurate analysis of the social and technical needs usually leads to work designs with the following characteristics:
   - *Minimal critical specification of rules* – this principle has two aspects, negative and positive. The negative simply states that no more should be specified than is absolutely essential; the positive requires that we identify what is critical to overall success. In practice this means the work design should be precise about what has to be done, but not how to do it. The use of rules, policies and predefined procedures is kept to the absolute minimum.
   - *Variance control* – variances, or deviations from the ideal process, should be controlled at the point where they originate. This recognizes each individual as the first line of defence for his or her respective core tasks and the manager as the first line of defence for most boundary-related tasks.
   - *Multiskills* – each member of the system should be skilled in more than one function so that the work system becomes more flexible and adaptive. This allows a function to be performed in many ways utilizing different people.
   - *Boundary location* – roles that are interdependent should be within the same departmental boundaries. Interdependence may be a function of both knowledge and expertise. Boundaries are usually drawn on the basis of one or more of three criteria: technology, territory or time.
   - *Information flow* – information systems should be designed primarily to provide information to the point of action and problem solving. This is in contrast to most systems, which provide information based on hierarchical channels.
   - *Support congruence* – the social system should be designed to reinforce the behaviours intended by the new structure. Rewards, hiring practices, departmental structures, training systems, and so on all need to be congruent with the basic work design and work group structures.
   - *Design and human values* – the design should achieve high results by providing

a high quality of work life to fulfil individual needs. This is the very heart of STS theory. Superior results come from the joint optimization of individual and organizational needs.

Changing from a traditional work design or organization to one based on STS principles requires a transitional structure for managing the change process. This transition organization helps employees to gain new skills and knowledge and facilitates the learning necessary to make the new design work. The transition period involves considerable innovation, learning and change and is usually both different and more complex than either the old or new design. STS designing is never really complete but continues as new things are learned and new conditions are encountered. Thus, the ability to continually design and redesign work needs to be built into existing work teams. Members must have the skills and knowledge to assess their work unit continually and to make necessary changes and improvements. From this view, STS designing rarely results in a stable work design but provides a process for continually modifying work to fit changing conditions[3, p. 356].

Some background on STS via seminal work in organization theory is an important commencement point for OD theory and interventions. An encapsulated summary of five theoretical foundations will serve as the springboard for later applied OD which can be defined as a "long-term, system-wide application of behavioural science techniques to increase organizational effectiveness"[8, p. 81]. Socio-technical theory is one such system approach that "focuses on the interdependencies between and among people, technology and environment"[9, p. 268]. This approach seeks to optimize both the social and technical elements in organizations.

Environment and technology: conceptual theories

Before applying STS theory as an OD technique, it will be necessary to explore the organization's external environment and how it influences the performance of the organization. Decisions and strategies taken to manage the external environment must be congruent and also compatible with the organization's structure. Employees' attitudes and behaviours are influenced by the immediate circumstances in their work units, such as tasks, intragroup relations, rules and policies. The circumstances that define these subenvironments within the work unit are, in turn, determined by diverse facets of the larger organizational structure. The application of these theoretical constructs results in the management of change via organization development in STS.

A historical examination of the theories of Burns and Stalker, Woodward, Perrow, Thompson, and Trist will yield an historical and theoretical underpinning for understanding the application of STS as a contemporary organizational development change strategy.

Burns and Stalker

A contingency approach, which incorporates technology as a contingency variable but still moves beyond a strict technological imperative, had been developed by Burns and Stalker[10]. The essential idea was that when change occurs more rapidly, as in turbulent fields, a different organizational structure is needed than when the situation is more stable. Change is defined as occurring both in technology and in market. High rate of change call for organic structures, while mechanistic structures are more suitable when change is minimal. Characteristics of these mechanistic and organic structures are set out in Table I.

Organic forms are more unstructured and informal; there is more ambiguity, but more flexibility as well. As technological change increases, people within the firm need to be free to communicate more; and as market change increases, a firm needs more points of contact with external markets.

Mechanistic-organic theory had enjoyed considerable popularity, yet it has some problems. When both technological change and market change are used as contingency variables, it is hard to know what to do when one is changing and the other is not. Organic systems are characterized by considerable role ambiguity, which can create major difficulties. Furthermore, mechanistic types of organizations can actually innovate and cope with change, especially in the area of administration, much more effectively than Burns and Stalker believed[10]. For these and perhaps other reasons, studies have not found consistent relationships of the kinds hypothesized by Burns and Stalker[10]. Specifically, it is not generally true that organic firms do best under conditions of rapid change and mechanistic firms do best under stable conditions. The world is more complex than that. Yet the mechanistic-organic distinction itself is a useful one.

Joan Woodward

The initial interest in technology as a determinant of structure can be traced to the work of Joan Woodward. She studied nearly one hundred small manufacturing firms in the

Table I
Characteristics of mechanistic and organic structures

Characteristics of mechanistic structures	Characteristics of organic structures
Highly specialized and separate jobs	Individuals contributing as appropriate to overall goals
Jobs pursued as distinct from company as a whole	Jobs relating directly to company's current situation
Co-ordination by hierarchic supervisory authority	Co-ordination by mutual adjustment
Precise definitions of rights and responsibilities	Wide sharing of responsibility for outcomes
Responsibility and commitment attached only to a single job	Responsibility and commitment to company as a whole
Hierarchic control, authority and communication	Network structure with pressure to serve the common interest
Knowledge focused at top of hierarchy	Knowledge located anywhere, creating its own centre of authority
Primary vertical interaction	Lateral communication flow resembling consultation
Work behaviour governed by superiors' communications	Communications in the form of information and advice
Insistence on loyalty and obedience	Commitment to company goals valued over loyalty and obedience
Local, company knowledge and experience most important	Knowledge and experience from wider professional and industry arena most important

south of England to determine the extent to which classical principles such as unity of command and span of control were related to firm success. She was unable to derive any consistent pattern from her data until she segmented her firms into three categories based on the size of their production runs. The three categories, representing three distinct technologies, had increasing levels of complexity and sophistication[11]. The first category, unit production, was composed of unit or small-batch producers that manufactured such custom products as tailor-made suits and turbines for hydroelectric dams. The second category, mass production, included large-batch or mass-production manufacturers that made items like refrigerators and automobiles. The third and most complex group, process production, included continuous-process producers like oil and chemical refiners.

Woodward found that distinct relationships existed between these technology classifications and the subsequent structure of the firms and that the effectiveness of the organizations was related to the "fit" between technology and structure[12, p. 208].

For example, the degree of vertical differentiation increased with technical complexity. But not all the relationships were linear. As a case in point, the mass-production firms scored high in terms of overall complexity and formalization, whereas the unit and process firms rated low on these structural dimensions. Imposing rules and regulations, for instance, was impossible with the non-routine technology of unit production and unnecessary in the highly standardized process technology.

After carefully analysing her findings, Woodward[11] concluded that specific structures were associated with each of the three categories and that successful firms met the requirements of their technology by adopting the proper structural arrangements. She found there was no one best way to organize a manufacturing firm. Unit and process production are most effective when matched with an organic structure; mass production is most effective when matched with a mechanistic structure[12, p. 208]. A summary of Woodward's findings is shown in Table II.

Charles Perrow

One of the major limitations of Woodward's technological classification scheme[11] was that it applied only to manufacturing organizations. Since manufacturing firms represented less than half of all organizations, technology needed to be operationalized in a more generic way if the concept was to have meaning across all organizations. Charles Perrow suggested such an alternative.

Perrow directed his attention to knowledge technology rather than production technology. He proposed that technology be viewed in terms of two dimensions:

1 the number of exceptions individuals encountered in their work; and
2 the type of search procedures followed to find successful methods for responding adequately to these exceptions.

The first dimension he termed task variability; the second he called problem analysability[13].

The exceptions in task variability are few when the job is high in routineness. Examples

Table II
Woodward's findings on technology, structure and effectiveness

	Unit production	Mass production	Process production
Structural characteristics	Low vertical differentiation Low horizontal differentiation Low formalization	Moderate vertical differentiation High horizontal differentiation High formalization	High vertical differentiation Low horizontal differentiation Low formalization
Most effective structure	Organic	Mechanistic	Organic

of jobs that normally have few exceptions in their day-to-day practice include a worker on a manufacturing assembly line or a fry cook at McDonald's. At the other end of the spectrum, if a job has a great deal of variety, it will have a large number of exceptions. This would characterize top management positions, consulting jobs, or jobs such as putting out fires on offshore oil platforms[12, p. 209].

The second dimension, problem analysability, assesses search procedures. The search can, at one extreme, be described as well defined. Individuals can use logical and analytical reasoning in the search for a solution. They then will have to rely on their prior experience, judgement and intuition to find a solution. Through guesswork and trial and error, they might find an acceptable choice.

Perrow used these two dimensions, task variability and problem analysability, to construct a two-by-two matrix, shown in Figure 1. The four cells in this matrix represent four types of technology: routine, engineering, craft and non-routine.

Routine technologies (cell 1) have few exceptions and have easy-to-analyse problems. The mass-production processes used to make steel and automobiles or to refine petroleum belong in this category. Engineering technologies (cell 2) have a large number of exceptions, but they can be handled in a rational and systematized manner. Craft technologies (cell 3) deal with relatively difficult problems, but with a limited set of exceptions. Shoemaking or furniture restoring fits in this category. Finally, non-routine technologies (cell 4) are characterized by many exceptions and by difficult-to-analyse problems. This technology describes many aerospace operations, such as Rockwell International's initial development of the space shuttle[12, p. 210].

In summary, Perrow[13] argued that if problems can be systematically analysed, cells 1 and 2 are appropriate. Problems that can be handled only by intuition, guesswork, or unanalysed experience require the technology of cells 3 or 4. Similarly, if new, unusual, or unfamiliar problems appear regularly, they would be in either cells 2 or 4. If problems are familiar, then cells 10 or 3 are appropriate. Using the mechanistic-organic classification, Perrow would suggest that cells 1 and 2 fit with mechanistic structures and cells 3 and 4 align with organic structures[13, p. 210].

James Thompson

Another approach to technology was proposed by James D. Thompson. His technology categories, which he argued could be used to classify all organizations, are long-linked, mediating and intensive.

Figure 1
Perrow's two-by-two matrix

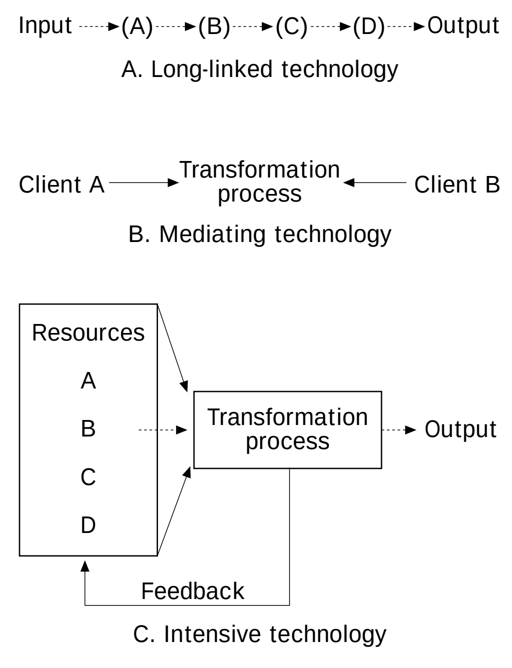
Problem analysability	**Task variability** Few exceptions	 Many exceptions
Well-defined	Routine 1	Engineering 2
Ill-defined	3 Craft	4 Non-routine

If tasks or operations are sequentially interdependent, Thompson called them long linked. This technology is characterized by a fixed sequence of repetitive steps, as shown in Figure 2(A). That is, activity A must be performed before activity B, activity B before activity C, and so forth. Examples of long-linked technology include mass-production assembly lines and are given in Thompson[14].

Thompson identified mediating technology as one that links clients on both the input and output side of the organization. Banks, telephone utilities, security brokerage firms, most large retail stores, computer dating services, employment and welfare agencies, and post offices are examples. As shown in Figure 2(B), mediators perform an interchange function, linking units that are otherwise independent. The linking unit responds by standardizing the organization's transactions and establishing conformity in clients' behaviour. Banks, for instance, bring together those who want to save (depositors) with those who want to borrow. They do not know each other, but the bank's success depends on attracting both.

Thompson's third category – intensive technology – represents a customized response to a diverse set of contingencies. The exact response depends on the nature of the problem and the variety of problems, which cannot be predicted accurately (see Figure 2(C)). This includes technologies dominant in hospitals, universities, research labs, full-service management-consulting firms and military combat teams[12, p. 211].

Figure 2
Thompson's technology categories



Thompson was not directly concerned with demonstrating a link between his technology categories and structural options. Rather, he was most recognized for suggesting that organizations arrange themselves to protect their technology from uncertainty. He proposed that technology determines the selection of a strategy for reducing uncertainty and that specific structural arrangements can facilitate uncertainty reduction. So, for example, organizations using long-linked technology might vertically integrate to ensure the availability of inputs and the ability to dispose of its outputs[8, p. 212].

While Thompson[14] did not directly address structural options, it is not difficult to make the connection. It seems logical that long-linked and mediating technologies tend to fit best with mechanistic structures, while intensive technology is best matched to the organic form.

Eric Trist

Trist and his associates at the Tavistock Institute in the UK are well known for conducting a series of studies that led to a new, insightful approach to understanding organizational functions[15]. These studies, which focused on the coal-mining industry in the UK, examined the interaction of technological systems and social systems.

As technology advanced, newly developed mining equipment dictated a radically different approach to coal mining. In this new long-wall method, the miners were reorganized into large shifts of specialized workers. During the first shift of the day, all miners performed the same operation: cutting into the coal wall. The second shift was responsible for shovelling coal into a new type of conveyor. The miners on the third shift worked exclusively at advancing the face of the wall, enlarging gateways and building roof supports (relatively low-prestige tasks)[16, p. 606].

In addition, the miners on each shift were spread out along the face of the wall at such distances that they could not easily communicate with one another. Similarly, the single supervisor of an entire shift group, consisting of 40 to 50 miners, was not able to monitor the activities of each miner because of the manner in which the men were dispersed.

Although the long-wall method had promised to raise productivity, a norm of low productivity emerged. With reduced variety and challenge, the miners found the redesigned work to be unpleasant. They preferred to operate autonomously and to perform all tasks rather than to be solely performing the tasks of cutting, shovelling or filling.

While the Tavistock researchers eventually helped to ameliorate the negative consequences of the long-wall method, the message was clear: a technological change that appears quite rational from a purely engineering perspective can disrupt the existing social system so as to reduce greatly the anticipated benefits of the new technology. Of more fundamental importance is the insight gained by the Tavistock researchers[15] on the interplay of technical and social systems or the notion of a socio-technical system. Attempts to change the technological and/or social system must be mindful of the relationship between the two systems[16, p. 607].

The socio-technical approach had much to suggest to job redesign. In fact, the approach had been employed in numerous job redesign efforts. Some of the better-publicized redesign efforts had been attempted at General Foods, Rushton Mining, and General Motors. At the Kalmar plant of Volvo, automobile assembly procedures were radically altered from traditional technological systems. By and large, the results of these efforts have netted reduced turnover, absenteeism, and accident rates and superior product quality and efficiency[17, p. 24].

Socio-technical theory as a technique for OD

Organizational development can be defined as a "long-term, system-wide application of behavioural science techniques to increase systems" but "neither system should operate at the expense of the other. Co-ordinated and integrated human and technical activities are possible when one system is supportive of the other"[2, p. 62]. Because all subsystems are interdependent, changes in one area affect and influence other system elements[8, p. 49].

The social system aims to design a work structure that is responsive to the psychological needs of the employees[9, p. 269]. It supplies a sense of belonging, meaningfulness to the work and responsibility for outcomes[2, p. 82]. The social system is experienced through the organization's culture, norms, roles and communication patterns as well as through a network of social relationships and behaviour patterns that develop[8, p. 50].

The result is a work structure that relates people to the organization's technology. The technical system includes the equipment and methods used to transform raw materials into products or services[9, p. 268].

Another important feature for socio-technical design is that the organization is embedded in and affected by the external environment as previously discussed. This interdependent relationship can affect the attainment of any one of the systems goals[9, p. 269]. This fact, clearly recognized by Emery and Trist[18] stresses the importance that organizations are "open socio-technical systems"[9, p. 265]. Changes arising in the external environment exert influence and must be accommodated by the organization in the least disruptive manner. Emery and Trist suggest that detailed attention to the requirements of both the social and technical systems are required if the organization is to maximize its total production system. Given a particular task and an available technological system, certain social systems are more apt at coping to meet these demands.

Self-regulating work groups within socio-technical systems

An important outcome of Emery and Trist's early work is that developing semi-autonomous work groups in organizations can lead to greater productivity and to worker satisfaction[9, p. 268; 19]. They revealed that improvements in the technical system do not always result in higher productivity or effectiveness if the social system is not supportive and able to cope with any stresses it places on its members[9, p. 287]. The use of work groups as the basic building block for work design can give the organization the ability to meet the demands stemming form either the environment or the interdependent social and technical components.

Probably the most popular application of STS theory has been the development of self-regulating work groups[19]. Alternatively referred to as self-leading or self-managing teams, self-regulating work groups include members performing interrelated tasks[20]. Such groups can control members' task behaviours. They have responsibility for a whole product or service and can make decisions about task assignments and work methods. In many cases, the group sets its own production goals, within broader organization limits, and may be responsible for support services, such as maintenance, purchasing, and quality control. Team members are generally expected to learn all of the jobs within the control of the group and frequently are paid on the basis of knowledge and skills, rather than seniority. When pay is based on performance, group rather than individual performance is used.

Self-regulating work groups are being implemented at a rapid rate in such

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organizations as Sherwin-Williams, General Foods, General Mills, Procter & Gamble, and Motorola. A 1990 survey of *Fortune 1000* companies found that 47 per cent of these firms were using self-managing work teams, up from only 28 per cent in 1987[21].

Self-managing work teams are most frequently found in manufacturing settings, although this team design is applicable to any situation in which people in groups are interdependent and thus can be made collectively responsible for producing a product or providing a service to an external or internal customer. Examples include production teams, assembly teams, administrative support teams, customer sales and service teams, professional support teams, and management teams. An executive team, whose members are collectively responsible for the internal operations of the company and have shared performance goals, is a self-managing team.

Self-managing work teams have been implemented by organizations that use a socio-technical or a job enrichment approach. Their design is intended to optimize the organization's social and technical systems jointly[9]. They work because this way of organizing work is intrinsically motivating and satisfying and increases the level of effort, knowledge and appropriateness of strategies of task performance, as applied to the collective task[22], as well as helping to reduce unnecessary overhead costs. Both socio-technical approaches and job design theory suggest the same causal mechanisms, and some researchers have argued for a synthesis of the two approaches[9,23,24]. High-commitment organizations, interested in maximizing the level of employee involvement, tend to use self-managing work teams.

One recent study found that 46 per cent of *Fortune 1000* companies use self-managing teams[9]. Where they have been implemented, the vast majority of such teams have been limited to involving less than 20 per cent of the workforce. Most of these applications have been in manufacturing and involve first-level employees; 25 per cent of the service companies in the sample (compared with 36 per cent of the manufacturing firms) use self-managing team designs. A historical study of the Fortune Service 500 and Industrial 500 revealed that 25 per cent of these companies used executive-level teams between 1980 and 1984[25].

In a recent study comparing 63 matched pairs of self-managing teams to traditionally managed teams that perform the same work in a telephone company, it was found that self-managing teams were rated higher in effectiveness (productivity, costs, customer service, quality and safety) than their matched pairs, both by team members and by upper-level managers. Participants in self-managing groups evaluated them more highly in outcomes related to quality of work life, such as growth satisfaction, social satisfaction and trust, than the participants in traditionally managed groups rated their own groups[26]. No significant differences were found in absenteeism. In general, the findings form this study are consistent with Goodman *et al.*'s conclusions[27].

Managers of self-managing work teams may need assistance in understanding their new role. Simply telling managers to become coaches or facilitators, rather than bosses, may not be sufficient to support behavioural change[28]. Instead, managers may need help understanding the specific requirements of their new roles, as well as training to improve their participation and delegation skills. If the role of the manager is to encourage self-management, then the manager must have the skills to perform the requisite behaviours, such as encouraging goal setting or self-evaluation[29]. Training can help managers support self-managing work teams more effectively.

Using the work group is often necessary given that the technologies require co-operation, mutual adjustment and sharing of equipment and information to complete a task (as discussed in [10,11,13] or [14] concerning technology and organizational structure). A mid-point study was presented in Cummings[9], in which three conditions that affect a group's capacity for self-regulation were outlined. If certain factors are present, designing an effective work group can increase the likelihood of goal attainment through the group's ability to "respond to technical and environmental variances"[9, p. 271]. The first condition is related to the nature of the task itself. A less differentiated task "facilitates technically required co-operation by bounding interdependent tasks into a common unit"[9, p. 270]. The second condition for self-regulation is if the group can control and influence the boundaries of the task environment. Groups who have their own territory, possess a repertoire of skills and are responsible for the quality of their work are able to "protect their work boundaries from external intrusions and perform selective environmental transactions"[9, p. 270]. The final condition contributing to self-regulation is when workers can choose how the work is done, have the freedom to modify work procedures as necessary and are given feedback on the group's performance so they can develop goal-directed behaviour[9, p. 271].

Hackman and Oldman's[2] theory of job design is another theoretical approach which is similar to and may strengthen socio-technical approaches to designing self-regulating work teams. When work content is high on core job characteristics (i.e. skill variety, task identify, task significance, autonomy and feedback) outcomes such as work effectiveness and job satisfaction result[2, p. 90]. The similarity between the two theories reveals that work variables can be designed to contribute to both motivation and self-regulation. The point is made that individual psychological needs can impact on a group's ability to develop a work structure for coping with technical and environmental demands[9, p. 273].

Designing self-regulating work teams must be distinguished from job design/redesign. Individual jobs may be improved by techniques such as job enrichment to affect employee's motivation, satisfaction or work effectiveness[2, p. 110]. On the other hand, designing work for self-regulating work teams becomes more of a process-oriented task and "development of an effective social system needs to be an explicit part of the design process"[9, p. 272]. Although the feasibility of either individual or group design is usually determined by the nature of the work itself, Hackman and Oldman[2, p. 223] suggest that if there is room for choice and both seem feasible, then group design favours over "the best possible individual design".

Designing work groups requires examination of the criteria for efficiency as well as an examination of organizational contexts that are hospitable for self-regulating work groups. Hackman and Oldman[2, p. 170] have developed a model for building an efficient work group and indicate three key aspects in the design of a group. An effectively functioning group meets or exceeds organizational standards of quality and quantity, provides a group experience that satisfies members' needs, and is able and willing to carry on together on subsequent tasks.

Designing the group task is the first key design feature. The technological system changes can be used to create conditions for high work motivation by removing boring and frustrating or unpleasant tasks. A second key design feature is the composition of group members who have task-relevant knowledge and interpersonal skills, the right "mix" of group members can be selected given that the organization has the appropriate personnel policies and resources to do so. Well-composed teams often are involved in the selection and training of subsequent group members. A third key design feature to help the group development is to devise and implement performance strategies appropriate for the work[2, p. 179].

Some pointers for executive and consultants in assessing STS interventions

Organization development professionals who are exposed to STS thinking as a planning and decision-making tool quickly realize the strategic orientation of the approach. To use Ackoff's[30] terminology, they become "interactivists", that is, they begin to perceive planning as the design of a desirable future and the invention of ways to bring it about, rather than accepting the future that appears to confront them.

If we are convinced that STS thinking represents an appropriate basis for our strategies, an array of implications for practical work results[31, p. 224]. The following questions are suggested for identifying interactions among elements of the STS. They may be used for diagnostic purposes as well as an intervention strategy:

Environment:

1. What are the major factors in the organization's environment that influence the work?
2. What characteristic environmental problems arise?
3. In which elements of the system are the interactions with the environment most visible?
4. What is the organization's greatest strength *vis-à-vis* the environment (competitive advantage, labour market, productivity, etc.)?
5. What is the organization's most obvious weakness?

Goals/tasks:

1. What factors within the system most influence goal attainment (positively/negatively)?
2. Which elements of the system are most affected by changes in goals and tasks?
3. Are the rest of the elements co-ordinated with respect to the goals/objectives and tasks?
4. Where are the strengths and weaknesses in the interactions among elements?
5. What are the sensitive points that repeatedly cause friction, problems, or conflicts?

Structures:

1. Are the existing structures useful for the attainment of the goals and tasks?
2. How do people adapt to or cope with these structures?
3. Are the structures supportive of the needs and capabilities of the leadership (management) and the workforce?
4. Do the structures encourage co-operation and collaboration?

5 Do the structures facilitate a rational use of resources and technologies?
6 What major strengths/weaknesses result from the structures interacting with other elements in the system?

Leadership procedures:
1 Are the existing leadership procedures and processes focused on the specific goals/objectives and tasks?
2 Do these procedures fit the organization's specific social and technical realities (technologies, other procedures, composition of workforce, etc.)?
3 Are managers sufficiently trained in using the procedures (e.g. performance evaluation)?
4 What influences and changes from the outside are expected? What re- examination of the present procedures might these changes entail?
5 What are the most significant strengths and weaknesses in the leadership procedures and their application?

People:
1 What is the basic attitude of various employee groups towards the organization?
2 What are the effects of these attitudes on performance and teamwork?
3 How do managers and their subordinates adapt to the existing structures?
4 Do the employees feel that the structures, technologies and procedures serve as an incentive to full involvement (motivational effectiveness)?
5 Where are the biggest obstacles, problem areas and sources of conflict?

Technologies:
1 How do changes in procedures and support systems affect people and structures in the organization?
2 Do changes produce resistance?
3 When technological changes occur, are the structures and processes adapted or modified accordingly?
4 Is there a timely attempt to prepare people for technological and organizational changes, e.g. through personnel management, training or participatory decision making?
5 What and where are the most important strengths and weaknesses between technology (including processes and procedures) and the other elements of the system?

The OD professional (executive or consultant) must measure his or her competence in the field in terms of the requirements of the socio-technical system. In order to conceptualize intervention and interaction strategies with a behavioural-science focal point, the consultant must be acquainted with the influences and dependencies of all processes. Only then is he or she likely to be successful in avoiding the following mistakes:
- Creating new problems while attempting to solve others.
- Enhancing, rather than reducing, the bias of those with whom he or she engages in debate and conversation.
- Looking for problems in areas in which the consultant feels competent instead of where they actually exist.
- Developing patient remedies and marketing them, rather than facing the challenges of a continuous learning process and living with the uncertainty such growth entails[31, p. 224].

It would be a mistake to assign to the professional all the responsibility for the success of STS approaches. The most essential prerequisite appears to be the readiness – oriented to past, present, and future – to wrestle continually with reality and to refrain from attempting to project Utopia on to reality.

In order to be able to solve concrete problems arising from an ineffective interplay among the elements in a socio-technical system – or between the system and the environment – one must define the premisses that are amenable to analysis. According to a study by von Clare Graves (quoted in Mitchell[32]), stress is indispensable for change and development. A primary task of the consultant is to help the client learn how to cope with stress and uncertainties.

Three prerequisites must exist for this to be possible:
1 Dissatisfaction with the present state (i.e. stress) as a motivational basis for change.
2 Energy and courage as positive forces to initiate the development of a proactive and reactive mode.
3 A conscious and insightful motive that is based in reality, to achieve concrete, planned changes.

When one of these three conditions is lacking, there is little chance for development or for solving existing problems. The necessary diagnostic work to examine the existence or absence of these conditions is an important part of the start-up of an OD (STS) project. It requires expertise, well-established diagnostic instruments (e.g. Figure 2), and the development of a workable relationship between the client and the consultant[31, p. 225].

Concluding remarks

Whatever the future may hold, the basic challenge of STS design is still relevant: humanism and effectiveness must be linked together in the design of work and work systems[33, p. 16]. STS theory as an intervention strategy has many strong points, but must be utilized within a strategic change plan for organizational development rather than an isolated strategy for organizational development.

Self-managed teams are not easy to implement. They require organizational changes and investments of time and resources in order to make them work. Without changes in job design, work may not be organized so that a team is collectively responsible for a product or service. Without changes in management philosophy, a team may not be given the authority to make decisions about how to execute its task. Without additional training, managers may not be able to provide coaching to a self-managing team and may undermine its efforts. The reward, education and information systems may have to be modified to support effective teamwork. These changes and contextual supports require organizational commitment and investment. Without the willingness to make this investment, an organization is unlikely to sustain the performance and quality benefits that can arise from the implementation of work teams.

Once self-managing teams are implemented and supported by the organization's reward, education and information systems, they become relatively easy to sustain. They create a momentum of their own. This strength, however, can become a weakness, if change has to occur. The mature self-managing team is a relatively self-contained unit with a team identity and *modus operandi*. Members may be unwilling to transfer to other teams, even if marketplace demands require different assignment of resources. They may be unwilling to apply different methods to team tasks once habitual patterns have been established. This can be managed, to some extent, by providing teams with ongoing performance and customer feedback, by making sure that team representatives participate in forums with representatives of other teams, and by providing rotational opportunities.

Because the future will demand empowerment and flexibility, participants in teams and networks must have decision-making authority. Future team and networked designs must be self-managing. Temporary and fluid designs should be used more. Organizations should use work teams where tasks can be self-contained. Project teams and internal networks should be responsible for accomplishing work in the rest of the organization. Organizations must continually initiate, disband and modify project teams and networked designs. Handling the changing configurations of flexible structures is the greatest challenge that management faces. STS provides the required technique and intervention to actualize this challenge[34].

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Application questions

1 Think of an organization you know well using the Socio-Technical Systems Theory frameworks. What is its applied use?
2 As a senior manager, where should attention to organizational design come on your list of priorities? Where does it come in reality? What are the one or two most crucial areas for attention of leaders in orgnizations?