

# Holistic and participative (re)design : contemporary STSD modelling in the Netherlands

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## 9 Holistic and participative (re)design

### Contemporary STSD modelling in The Netherlands

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#### INTRODUCTION

Socio-technical systems design (STSD) is again at a parting of ways. Some forty years have elapsed since its conception at the London Tavistock Institute (Trist and Bamforth 1951; Trist and Murray 1991). The classical STSD views and change methodologies, well documented in the literature, are becoming less and less popular. Conceptual inadequacies, restrictive emphasis on the work group level, and expert-led application scenarios have gradually been identified as the major weaknesses of the original approach (Van der Zwaan 1975; Emery, M. 1989; De Sitter *et al.* 1990). After four decades our models and methods are much more elaborated. Rapid technological and cultural change have called for further adjustments and regional developments of the socio-technical inheritance, and we now have more solidly anchored systems concepts, multi-level design options, and participative change procedures. In North America, Australia and Europe, new and innovative STSD approaches have been emerging, mainly on a local level.

This chapter is about contemporary STSD modelling in The Netherlands. It reports on developments of the approach to flexible productive systems (AFPS), a practical Dutch socio-technical systems variant which recently has evolved towards a multi-level method of integrating task design (Van Eijnatten 1986) and organization design (De Sitter *et al.* 1986). After discussing some relevant literature, the core of the chapter consists of a method for integral organizational (re)design, based on an analytical interface model and design-oriented methodology (Van Strien 1986; Den Hertog and Van Assen 1988). A short case illustration shows how the method is working.

**STSD PARADIGM: SOME ESSENTIALS AND (PRE)JUDGEMENTS**

STSD is an organization renewal paradigm aimed at supporting more integrated analysis and co-design of manufacturing process and work organization. It stresses the importance of 'joint optimization' or integration of social and technical aspects of production systems. Central to STSD is its method. Self-management and self-design are its ultimate goals.

The STSD paradigm, which is based on action research, has gone through a number of phases, as reported in the literature (Trist 1981; Emery, M. 1989; Van Eijnatten 1990, 1991). During the pioneering phase (1950–60) the semi-autonomous work group was emphasized (Trist and Bamforth 1951; Trist *et al.* 1963).

More elaborated concepts and expert methods were tested in the period of classical STSD (1960–75) – demonstration experiments in Scandinavia (Emery and Thorsrud 1964, 1975), work structuring experiments in The Netherlands (Van Beinum 1963; Van Beinum *et al.* 1968; Allegro 1973; Den Hertog 1977), and socio-technical consultancy practices in North America (Pasmore *et al.* 1982). From Australia, participative design first came to the fore (Emery and Emery 1974, 1975, 1976; Emery, M. 1982, 1989), giving birth to the phase of modern STSD (1972–89). Contemporary STSD is a mixture of classical concepts, local theories and participative methodologies. In Scandinavia currently a new phase is emerging, stressing democratic dialogue and large-scale change (Van Beinum 1986; Gustavsen 1985, 1988; Engelstad 1990).

In the literature, STSD is associated most often with the early Tavistock pioneering work. Several authors have criticized the initial conceptualizations, which indeed suffer from the growing pains of systems thinking in the 1950s and 1960s. The conceptual roots of the traditional STSD paradigm lay in biology, cybernetics and neurophysiology (Litterer 1963; Herbst 1974; Lilienfeld 1978). Although epoch-making insights, like the open-system conception, steady state, and equifinality (Von Bertalanffy 1950), the law of requisite variety (Ashby 1958), and learning in random networks (Beurle 1962) have had considerable impact on STSD scholars, an adequate translation and incorporation of these new concepts in early STSD models is problematic. In his commentary to the historical review by Trist (1981), Hackman (1981) has pointed to the elusive character of STSD's basic notions. According to Van der Zwaan (1975), in general the definition of concepts is poor. Also, the system-theoretical model has not been properly worked out. For instance, the vital concept of 'steady state' is not greatly elaborated. A main point of theoretical critique is that traditional STSD has not reached a satisfactory level of maturity. Conceptual

clarity as well as coherence is especially criticized. Unfortunately, there is some degree of absurdity, even of logical inconsistency, in specifying coupled but independently-based social and technical systems which have to be jointly optimized (Emery, F. 1959, 1963). The brilliant idea of integral design which lay behind this, initially could not be sufficiently worked out theoretically, because the 'aspect-system' as a logical construct was not known at the time.

Socio-technical design principles have been borrowed mainly from 'naturally occurring field experiments'. Although Cherns (1976, 1987) did try twice to summarize those principles, the resulting theory has never been very coherent. According to Kuipers and Rutte (1987) the principles have not been clearly attributed to different kinds of organizational structure (production, control, preparation), while design application order has been totally neglected. Also, the scope of traditional STSD theory has been judged as too narrow. In addition, conventional STSD is not as integral as it claims to be. According to Van der Zwaan (1975) traditional STSD has occupied itself almost exclusively with psychological needs, resulting in unacceptable reductionism with respect to the social aspect of the system. Having reviewed thirty years of STSD, Pasmore *et al.* (1982) concluded that the contribution of the conventional STSD paradigm to technological innovation is very limited. According to Hackman (1981), surprisingly limited attention is given to the systematic multi-level evaluation of change attempts. More recently, one of the best-designed outcome evaluation studies on autonomous group functioning (Wall *et al.* 1986) failed to show any significant long-term effects on work motivation and performance whatsoever.

Criticizing complacency in traditional STSD, Pava (1986) complains that 'methodologically, little has been developed beyond the conventional "nine step method" forged by the pioneering efforts of Emery (1959, 1977) and of Day and Canter (1956) based on early change projects' (Pava 1986: 202). Indeed Hill (1971), Cummings (1976) and Cummings and Srivastva (1977) have made no substantial additions, merely reproducing the working drafts of the Tavistock's analytical models (Foster 1967). Pasmore and Sherwood (1978) reprinted the same text, citing Emery and Trist as its authors.

The basic problem with conventional STSD method is the lack of an explicit design orientation. Analytic activities dominate design activities. Because in the last decade the complexity of organization design activities has multiplied, there is a need for a new participative STSD method that encounters the action planning stage in a more appropriate way. From a methodological point of view Van der Zwaan (1975) argued that, because of an ill-developed analytical model, in practice there is a real risk of

confusing system levels. Van der Zwaan found it difficult in conventional STSD paradigm to differentiate the analytical model from the action model. In a methodological critique of fifty-eight selected work experiments, Cummings *et al.* (1977) show that the majority of studies suffer from weaknesses concerning internal and external validity. Most selected studies score badly on minimum quality criteria of experimental design.

In the literature there seems to be only slow progress in system-theoretical, methodological and conceptual debates concerning what is generally known as core STSD. Probably one or more of the following circumstances are accountable for this:

- STSD key publications have been dispersed in heterogeneous volumes and in many international journals, while a number of conceptual papers have never reached these media at all. Prolonged difficulties in obtaining such documents have urged authors to copy older or non-original sources, resulting in inaccurate or incomplete discussion of the subject matter.
- STSD literature is very poorly organized with respect to the paradigmatic generations. Each author implicitly represents his or her own country with its idiosyncratic time schedule of STSD phases and local mixture of conceptual developments. STSD lacks a universal approach.
- STSD is mainly a strategy. Originally it was developed as a method, not as a theory. STSD method can produce a whole array of concrete, highly situation-specific end results which are not always reported as STSD-inspired endeavours.
- STSD has been strongly based on (a narrow version of) the open-systems concept. Early design principles lacked appropriate conceptual profundity. As stated earlier, part of the problem inevitably had to do with the immaturity of systems thinking in the 1950s and 1960s. It was not until the 1970s that more basic solutions were advanced. Paradoxically these new insights have not been picked up in STSD literature. During the same period, the STSD paradigm shifted gradually from an expert approach to a participative process. Because of this, further development of more specific and accurate structural design concepts faded, retreating more and more into the background.

It seems that after forty years the interest of the international academic world in STSD has largely vanished. But on a more local level, for instance in The Netherlands, the socio-technical inspiration is still very much alive. Although most problems concerning methodology and systems theory have been solved in the last two decades, international diffusion is hampered by the fact that a majority of studies are reported in Dutch.

## **DUTCH CONTRIBUTIONS TO STSD**

Although its visibility in the international literature is minimal, the contribution on the part of Dutch researchers to the conceptual renewal of STSD has been quite significant, as we shall illustrate.

With respect to system-theoretical aspects, there have been two major developments. First, at the time that Ackoff and Emery (1972) published 'On purposeful systems', De Sitter (1973) presented an up-to-date system-theoretical paradigm of social interaction in which there is a systematic and thorough definition of systems concepts. Second, In 't Veld (1978) developed an elaborate analytical model of a system in steady state with equifinality, which has made it possible to differentiate systematically between succeeding systems levels in an ordered way. Both contributions can be characterized as 'empty cartridge' approaches, constituting some neutral system-theoretical framework on which a modern STSD view can be more firmly based.

With respect to methodological aspects there has been one significant Dutch contribution. In an attempt to support the process of giving full scientific status to the action model, Van Strien (1975) proposed the 'regulative cycle of diagnostic and consultative thinking'. This cycle contains five phases: identification of the problem, diagnosis, action planning, intervention, and evaluation. The unique aspect here is not the action cycle as such, but the epistemological and methodological treatment of action research as an equal alternative to the traditional scientific method (Van Strien 1986). Central to this is the 'theory of practice'. According to Van Strien (1975) 'the view of science as a system of statements is making room for a view of science as a set of conceptual and methodological tools in approaching reality' (p. 601). Modern STSD interventions can be methodologically treated as theories of practice.

With respect to design aspects, in The Netherlands during the last decade the STSD paradigm has moved towards a management science approach, covering more relevant systems aspects (production, control, information), including different levels of aggregation (micro, meso and macro level in the organization and its relevant environment) and at the same time combining design content (integration of tasks in self-controlled organizational units) and process (training for self-design, organizational learning).

### **Dutch STSD paradigm**

Contemporary Dutch STSD can best be characterized as a mixture of up-to-date systems concepts and an integrated whole of various design aspects and management science techniques, applied in a participative

design context. The modern Dutch STSD variant covers all necessary ingredients: basic socio-technical systems theory, including level-independent concepts (Van Assen 1980; De Sitter 1982, 1989; Van Assen and Van Eijnatten 1983; Van Eijnatten and Otten 1985; De Sitter *et al.* 1986; Van Amelsvoort 1989); an elaborated action methodology (Van Strien 1986; Den Hertog and Van Assen 1988; Van Eijnatten and Hoevenaars 1989); tailor-made research instruments (Van Eijnatten, 1985, 1986, 1987a; Pot *et al.* 1989a,b); and dedicated participative design strategies (Buyse and Van Eijnatten 1987; Den Hertog and Danklaar 1989). Dutch STSD uses a multi-level strategy, carefully combining task design (quality of work) with organization design (quality of organization). Semi-autonomous functioning has been generalized to departments, product lines and business units. The journal *Gedrag en Organisatie* (Behaviour and Organization) published a special issue on Dutch STSDs in 1989. An English language monograph on the 'Dutch Variant' is also available (De Sitter *et al.* 1990).

## NEW STSD METHOD

### **An analytical model for more integral organizational (re)design**

In this chapter we will concentrate on the issue of a (re)design implementation logic. A multi-level model for more integral organizational (re)design is proposed, containing a mixture of (re)design ends, (re)design means and (re)design processes (see Figure 9.1). Central in the model is the so-called '(re)design interface' in which ends, means and processes are brought together to bring about the factual (re)design intervention. The model specifies three main entries to this (re)design interface: environment, knowledge and methodology.

- The environmental entry produces market requirements and functional claims to guide design ends for the (re)design intervention. These claims are normative in character.
- The knowledge entry specifies theories, practices and conceptual organizational paradigms to deliver design means for the (re)design intervention. These content theories are supportive in character.
- The methodology entry consists of action planning procedures and participative methods/techniques for (re)designing, in order to support the process of (re)design intervention.

Modern Dutch STSD method – here it is stressed again – is a mixture of content and process: it contains both rules and procedures based on structural paradigms arising from several key disciplines (including manage-

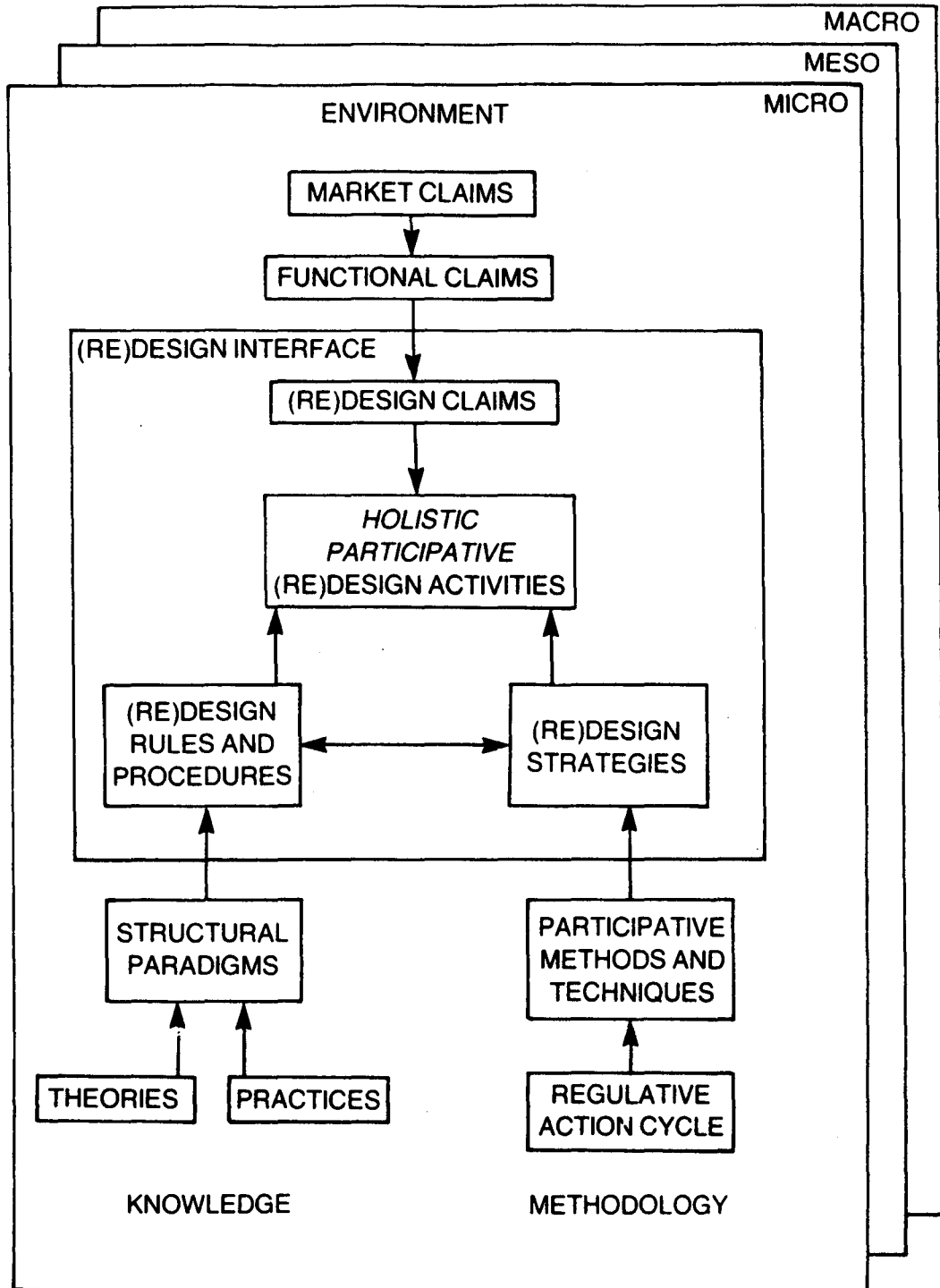


Figure 9.1 An analytical model for more integral organizational (re)design  
 Source: Van Eijnatten et al. (1988)



ment science, industrial engineering and accountancy), and (re)design strategies based on participative methods and techniques within a regulative action cycle framework.

What is really new in contemporary Dutch STSD method is the achievement of a proper balance of an up-to-date structural systems paradigm with a participative process paradigm, explicitly stressing both content and process on the same advanced level. The resulting holistic participative (re)design activities are guided by the normative multiple environmental claims, which have been analysed and given a concrete form.

The model stresses the multi-level quality of organization (re)design: the interface problem must be simultaneously dealt with at macro, meso and micro levels, in order to account for the actual complexity of the (re)design intervention.

Leaving aside the environmental and knowledge entries, we will continue by elaborating the methodological entry.

### **A tentative proposal for a more integral organizational (re)design method**

Because of earlier-mentioned deficiencies in the traditional STSD method, a new method for integral organizational (re)design is proposed. To guarantee a more explicit design orientation, the new STSD method follows the five methodological steps of Van Strien's regulative cycle. Each of those steps is divided into smaller portions such that the new method contains a total of sixteen steps (see figure 9.2). The new method not only emphasizes the micro level, but also incorporates the meso and macro level to guarantee an integrative approach. It is also explicitly participative in character: a (re)design team of organizational members is trained to do the self-design.

#### *Identification of the problem*

*1 Global strategic analysis* The first step comprises a global strategic analysis of the system on a macro level. At this stage it is important that the system boundaries are widely chosen, preferably on the level of what Kotler (1988) has called the 'strategic business unit' (p. 39). Basically, a strategic business unit is a single business or collection of related businesses that can be planned separately and, in principle, can stand alone from the rest of the company. It has its own competitors which it is trying to equal or surpass. For the selected strategic business unit a global analysis has to be done with respect to environmental demands, and the consequences of these for the (re)design of the system. It is important during this stage to start specifying the environmental demands in terms of market

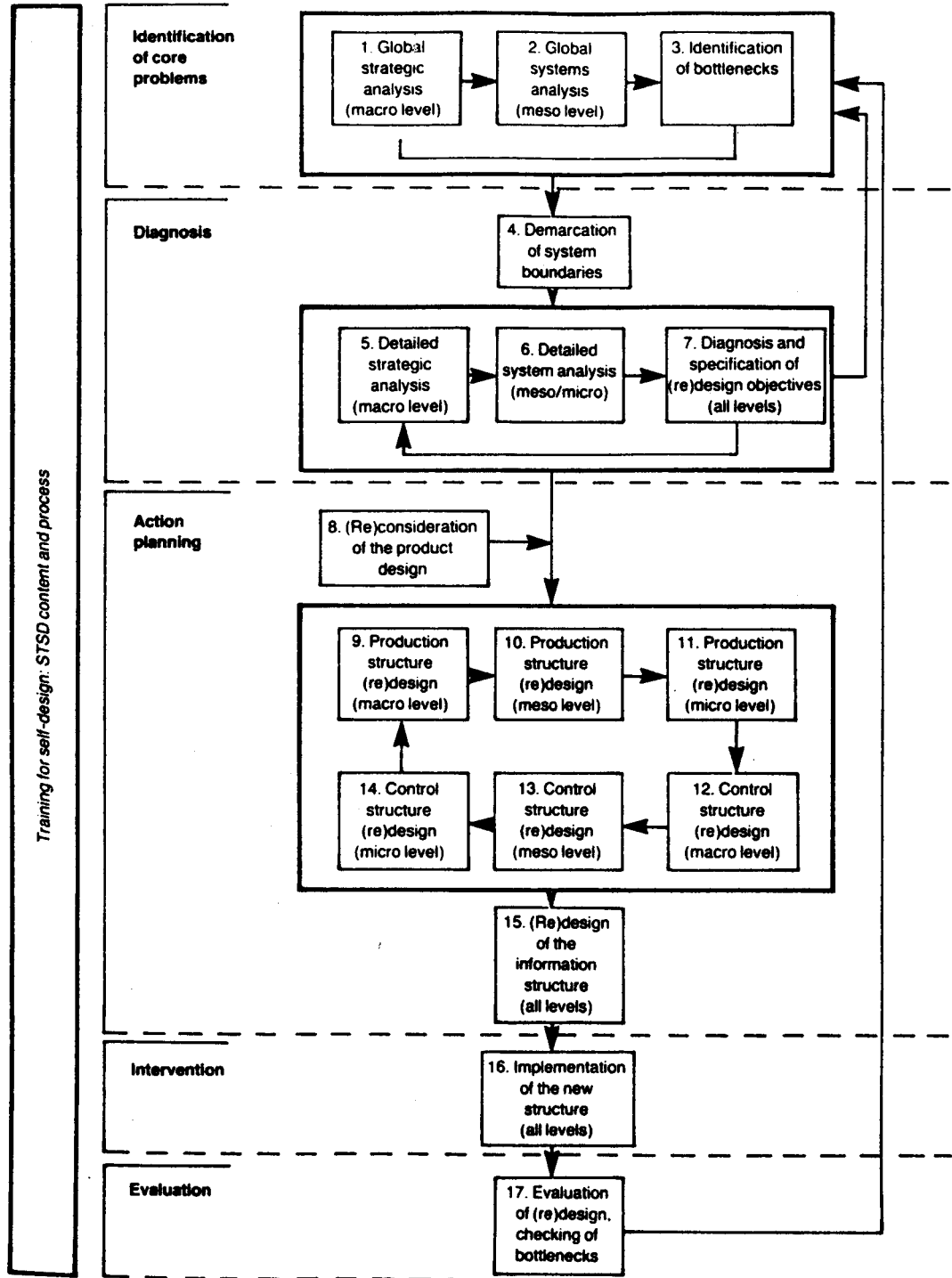


Figure 9.2 A tentative proposal for a more integral organizational (re)design method

claims with respect to controllability, flexibility and quality of work. In the succeeding phases of the regulative cycle these functional claims serve as design objectives.

*2 Global system analysis* The second step is a global system analysis of the business unit on a meso or departmental level, starting with a pure description and ending with an estimation of the current achievement in specified design objectives. The purpose of the description is to provide insiders as well as outsiders with a global picture of the system, taking in matters such as layout, organizational structure, main inputs, transformations and outputs. An estimation of the current achievement in design objectives can be made by analysing if and how much the system conforms to the requirements of the design objectives specified in the previous step.

*3 Identification of bottlenecks* Contrasting the design objectives of step 1 with the state of affairs in step 2 results in an inventory of bottlenecks. Herewith the first phase of the regulative cycle is completed: the problems are identified.

### *Diagnosis*

*4 Narrowing the system's boundaries* To start the diagnostic phase, the system's boundaries are demarcated. Accurately demarcating the boundaries is an important step. Too wide a boundary results in unnecessary extra work. Too narrow a boundary results in incorrect design choices. The boundaries should be chosen such that the (re)design can provide a solution for all bottlenecks. Often this will require that the system chosen originally has to be (re)designed entirely.

*5 Detailed strategic analysis* Step 1 is repeated in detail for the demarcated system. The parts of the organization which may have been deleted from the original system are now considered to be additional parts of the environment. Environmental demands and the design objectives belonging to them are to be recorded in as much detail as possible.

*6 Detailed system analysis* Now step 2 is repeated in detail for the demarcated system. A complete inventory has to be made of material and information inputs, transformations and outputs. It has to be established how materials and information flow through the organization. All decision tasks have to be specified within the context of regulation loops. An inventory has to be made of all norms and of all supportive tasks. With the help of all these data it has to be established who performs what tasks. Finally a

detailed description has to be made of layout, organizational structure and units, and product design.

*7 Diagnosis and specification of (re)design objectives* The data collected in step 6 are used to determine the exact causes of the bottlenecks specified in step 3. At this point the semi-autonomous (re)design team has detailed knowledge of the environmental demands (step 5) and of the causes of current problems. These insights into the system can be used to detail the (re)design objectives further. With this full description of the (re)design objectives the diagnostic phase is completed.

### *Action planning*

*8 Reconsideration of the product design* A good, efficiently constructed product is of vital importance. In this step an attempt is made to reduce the number of components of the product and to minimize the number of manufacturing steps, to prepare for easier making (design for production).

*9–11 Planning the (re)design of the production structure* The (re)design of the production structure has to be done on all levels, planned in a top-down sequence. To start the planning of the action process, first the macro level has to be (re)designed (step 9). Next the production structure on the meso level is prepared for (re)construction (step 10). Finally the micro level production organization is (re)structured (step 11). In general the (re)design team will parallelize on the macro level, segmentize on the meso level, and build in operational flexibility on the micro level.

*12–14 Planning the (re)design of the decision and control structure* The (re)design of the decision and control structure is also done on all levels, but in reverse order (bottom-up). Starting on the micro level (step 12), the planning of the (re)design is continued on the meso level (step 13). The (re)design of the decision and control structure is completed on the macro level (step 14). In general the (re)design team will allocate decision powers as close as possible to the point where the problems originate.

*15 Planning the (re)design of the information structure* The (re)design of the information structure should not be started before the planning of the new production and control structure has been satisfactorily finished. How this can be done is still the subject of study (Van Eijnatten and Loeffen 1990). With this step, the action planning phase is completed.

### *Intervention*

*16 Implementing the plans* This step has many facets. From a socio-technical point of view this step contains the actual building up of the planned production and decision (i.e. control) structures and information systems, in close co-operation with users and specialists.

### *Evaluation*

*17 Checking of bottlenecks* After implementing the new system, an evaluation has to take place in terms of the (re)design objectives. If discrepancies are found, adjustments have to be made by starting a new regulative cycle.

A training programme to master modern STSD concepts, rules and procedures supports the (re)design team in the same way as used to occur in the participative design tradition. Training of process and content matter is seen as an essential condition for effective self-(re)design and organizational learning (De Sitter *et al.* 1990).

## CASE ILLUSTRATION

To illustrate the first three phases of the method, a fictitious but as realistic as possible simulated model redesign is presented. The actual case (desk-chair production) is borrowed from a redesign exercise which arose in the context of an STSD training course (Van Amelsvoort and Vermeulen 1988). The case was originally developed by Van Amelsvoort and Vossen (1981). The stated problem is a cautious abstraction of a real-life project. The actual design solution was taken from a case study report of a student design team (Adams *et al.* 1988).

The redesign planning case concerns a small factory producing several kinds of chair in a rural production location employing some 130 workers, mainly local personnel. The original management team, members of the same family, had recently been replaced following amalgamation with a large office furniture manufacturer. The plant had been very unsuccessful, financially, in the past decade. The new management team wished to make a fresh start and called for an integral organizational renewal project. A company redesign team had been formed as a 'deep slice' (Emery and Emery 1974), containing members drawn from all levels of the manufacturing plant. The redesign team had been thoroughly trained for self-design by an authorized external STSD training agency.

A global strategic analysis (step 1), carried out with some help from the senior consultant of a training agency, revealed that the production

organization was confronted with rapidly changing product demands, such as customers' requirements for more product varieties, higher and more constant product quality, lower prices and earlier delivery times. Also the labour market had changed. More educated employees were presenting themselves, asking for more challenging jobs with 'whole' tasks, including all kinds of self-control and decentralized decision making. This multitude of environmental claims was operationalized by the redesign team as three basic functional requirements: higher flexibility in products and production process, higher controllability of the production process, and better quality of work. A flexible production process would enable the production departments to produce several product varieties, without taking too much time to change from one to another. A controllable production process would give the production department the capacity to control for variations in inputs, transformations and outputs. Quality of work would mean employees being offered work structures in which flexible allocation of individual tasks is possible, involving control of processes, and individual discretion.

The specification of the more concrete redesign parameters by the redesign team can be highlighted as follows. For our illustrative case a flexibility redesign parameter was, among other things, minimal throughput and delivery times for all product variants. A controllability redesign parameter included, a minimal number of hierarchical levels, and small units with appropriate decision facilities. A quality of work redesign parameter involved integration of non-decision and decision tasks, and loose co-ordination of people and machines.

After having translated the functional claims into more concrete redesign objectives for the organization, the redesign team continued with a global system analysis, which revealed a description of the existing design situation (step 2). The production process occurred in three shifts during a five-day cycle. Basic transformations were carried out in separate departments, involving sawing, bending, cleaning, welding, finishing, painting, varnishing, drying, assembling and packing. Some seventy-five workers were concerned with these basic transformations. Stocks of three days' work functioned as a buffer between the functional departments. Some fifty-five employees took charge of other functions: maintenance, planning and scheduling, buying, quality control, selling, marketing, developing new products and production methods, efficiency improvement, finance and administration, information services, personnel management, and physical distribution. Each staff member/department made decisions about only one aspect of the production organization. The organization chart showed six hierarchical layers, ranging from chief executive officer to the shop-floor workers.

The functioning of the production organization had been very

disappointing. At the time the market was expanding, sales fell by some 10 per cent. Market share dropped from 11 to 6 per cent; costs rose more than 30 per cent. About 10 per cent of the previous year's production showed quality deficiencies, while only 25 per cent of the production orders could be delivered within two weeks. Most client orders had been delivered late, some more than five weeks after the due date. Personnel figures also scored badly: absenteeism had reached the astronomical level of some 11 per cent of total working time, 5 per cent being considered normal for the industry. A couple of interviews with production personnel revealed that employees took no pride in the job they had to perform. Needless to say, the plant eventually got into serious trouble: year after year, production suffered more severe losses. An amalgamation offer could no longer be resisted.

Summarizing, the global system analysis carried out by the redesign team revealed serious drawbacks on all specified parameters. Principal bottlenecks (step 3) included over-long feedback loops, too many hierarchical levels, over-long throughput and delivery times, too close integration of people and machines, and complete separation of decision and non-decision tasks. The symptoms described were indeed preventing the realization of a desired future, put forward in the requirements document of the redesign team, which was very much welcomed by the new executive management team.

The diagnostic phase consisted of the following. First, a re-examination of the selection of the system boundaries (step 4) did not result in any alterations. The chair production plant as a whole was selected for reorganization purposes. A detailed strategic analysis (step 5) gave the redesign team some additional insights in structural and functional deficiencies, as perceived by customers, for instance. Additional information on the position of the firm in the office chair market revealed that contemporary profit chances in upholstered chairs were far better than for plastic desk chairs. Other discussions with former customers ultimately showed that the firm's image suffered most because of unreliable delivery times and the absolutely impractical standard delivery quantity of six chairs.

During the detailed system analysis (step 6) the causes of insufficient flexibility, controllability and quality of work were pinpointed. The product apparently was built up from some nineteen parts. This observation prompted a closer look at the appropriateness of the design for production. The factory layout also called for reconsideration. Control requirements had been needlessly enlarged by creating small functional departments in separate rooms. The prevailing organization of the technical process obscured the picture of order status and drastically increased order throughput times.

With respect to ineffective control, the following causes were detected:

missing or over-extended feedforward, feedback and boundary transaction loops; missing or outdated production norms; too great a distance between operative employees and staff members; no decision power on the shop-floor; and too complex a layout. All product varieties had the same inconveniently arranged material flow, and boundaries of units were judged illogical: dependent employees had been allocated to different groups, and independent employees had been allocated to the same group. The separation of decision and non-decision tasks had led to a situation in which manufacturing employees were dependent on staff members who worked only on the day shift. During evening and night shifts this situation became especially problematic, because quality and order scheduling problems had to be tackled by the uninformed supervisors. This bottleneck added to further quality problems and increased throughput times.

Ending the diagnostic phase (step 7) the redesign team concluded that the way in which the product and production process structure was originally designed called for some extra control requirements. Intelligent redesign should make it possible to reduce those requirements. Concerning process redesign, order flow could be simplified by logical grouping. Concerning product redesign, design for production could lessen the total number of parts, while abandoning the unsaleable plastic models could further reduce control requirements.

The redesign team also came up with a number of ideas concerning the means of control. These means would be reallocated in such a way that all kinds of disturbances could be intercepted and controlled as close to their source as possible. Actual means of control could be increased by introducing an information supply system on the shop-floor, or by allocating more decision power to lower organizational levels. The redesign team developed and accepted the idea that by better balancing of the means of control with respect to control requirements, a better functioning organization results.

The action planning phase started with a reconsideration of product design (step 8). Although the modular design was appropriate for all product variants, minor construction changes could simplify assembly considerably. Bolts and nuts could be replaced by a clever design change; this innovation resulted in a reduction of eight out of nineteen parts! The action planning for the production process structure at a macro (or plant) level (step 9) resulted in no changes at all. On this level the organization of the technical processes was judged appropriate. The actual reorganization started at a meso (or departmental) level (step 10). The redesign team divided the system into two main segments: a components department and an assembly and packaging department. Within the latter, the team created two parallel flows: one for wooden chairs and the other for upholstered



chairs. The reorganization of the production process structure was finished on a micro (or shop-floor) level (step 11) by tuning the individual tasks to the production means. Machines were grouped together in such a way that units were formed, combining several transformations, obviating the need for buffer stocks in the production of components. Individual tasks were grouped together in such a way that production units could function relatively autonomously. For instance one unit was planned to make black and grey frames, while another unit produced brown and white ones.

The planning of the decision and control structure redesign started on a micro (or shop-floor) level (step 12) by allocating operational flexibility to each process segment or unit. As much decision power as possible was allocated to this lowest organizational level, aimed at guaranteeing that workers within each segment would have the flexibility to solve as much production variance as possible. For example, for the 'black and grey unit' in the components department, this redesign measure resulted in 'whole tasks', where employees would not only produce black and grey frames, but would also control the amount of stock and decide when to replenish it. They would be equipped with simple repair tools in order to tackle small machine breakdowns, and would be made responsible for the quality of the frames. Clear targets were to be assigned to them with respect to the level of product quality and the quantity they had to reach. At the same time they would be set financial budgets, which should not be exceeded. All employees would receive tailor-made training.

The planning of the decision and control structure redesign on a meso (or department) level (step 13) resulted in an organization hierarchy with only four levels. The allocation of employees to staff functions was reduced, and separate staff departments were grouped together.

The planning of the decision and control structure redesign on a macro (or plant) level (step 14) resulted in allocating strategic decision power to the top level of the business unit. The executive management team should have one eye directed at the market and the other focused on the plant itself. It was ensured that the reorganization proposal should include a plan for up-to-date technical redesign of the information system (step 15), so that necessary information would reach those employees who had the decision power to act on that information.

The redesign plan was successfully implemented by the team in close collaboration with the workers involved (step 16).

In Table 9.1 some key attributes of the old and new structures are compared. It is predicted that the new system would function better in all sorts of ways (step 17). Evidence from similar real project evaluation studies is encouraging (Den Hertog *et al.* 1991).

**Table 9.1** A comparison of some key attributes of the old and new structures of the desk-chair firm.

<i>Key attributes</i>	<i>Old situation</i>	<i>New situation</i>
number of product parts	19	11
type of process flow organization (production structure)	one flow for all orders (complex flow)	partly parallelized and segmented flow (simple flow)
buffer stocks between process steps	yes, many between each step	no, hardly any
type of work organization	functional structure	product structure
number of personnel	75 direct 55 indirect	90 direct 40 indirect
allocation of decision tasks (control structure)	no decision tasks allocated at the shop-floor level	quality and quantity decision tasks at the shop-floor
number of hierarchical levels	6	4
supply of information (information structure)	no information supply to the shop-floor	own information system at the shop-floor

## DISCUSSION

The proposed method for modern STSD has been developed as a practical tool, which can be used in (re)design projects. As stated earlier, it is an intricate part of the Dutch STSD package, which also contains elaborated structural systems concepts, (re)design principles advocating more integration of aspects, and procedures supporting participative self-(re)design process.

At first sight the proposed method looks very much the same as its famous predecessors like the admired and abused 'nine-step method' (Foster 1967; Emery and Trist 1978). On closer inspection, however, there are some striking differences.

First, the proposed method for modern STSD clearly has an iterative character (see Figure 9.2). This is true for the cycle as a whole, as for the constituent phases. Therefore, in practice each project can have a unique intricate pattern of specific iterations of 'successive' steps and phases. In each stage techniques and instruments which are already available can be used and may improve the efficiency of the distinguished steps. We list some of them briefly for illustration purposes. System analysis (SA) can support the problem identification and diagnostic phase. A Dutch steady-state system model (In 't Veld 1978; Van Eijnatten 1987b) governs the

descriptive and evaluative process on all the levels of aggregation (macro, meso, micro). Socio-technical process analysis (STPA) and socio-technical task analysis (STTA) can be used for task analysis at the micro level during diagnosis and evaluation (Van Eijnatten 1985, 1986). Recently, alternative Dutch task analysis instrumentation has become available (Pot *et al.* 1989a,b). Stream Analysis (Porras 1987) may be of great help in identifying core problems during the diagnostic phase, as well as in planning the (re)design actions and tracking the interventions in the action planning and intervention phase. TIED analysis may be very useful in the action planning stage (Schumacher 1975, 1979, 1983; Van Amelsvoort 1987). This (re)design technique governs segmentation of production flows, while controlling for machine interaction, process interaction and interference. Group technology is a similar technique for planning the parallelization of factory/ manufacturing flows (Burbidge 1975, 1979; Aguren and Egren 1980). Production flow analysis (Burbidge 1975; De Witte 1980) can be used to identify routes of production flows in the planning phase.

Second, we want to stress the importance of technical (re)design of the production process. Technical analysis once again has become vital in modern STSD. Of course, the whole array of OD techniques are good supporters of the diagnostic, action planning and intervention stages in the regulative design-oriented cycle, from process consultation (Harvey and Brown 1988) to user participation and quality cycle techniques (Juran 1978; Dewar 1980). These techniques include pareto analysis, Ishikawa's 'fishbone', and brainstorming. Soft systems methodology (Checkland 1979a,b, 1990a,b) can be used by all parties to organize and manage the process in each stage of the regulative cycle.

Third the proposed method for modern STSD basically promotes controllable organizations and democratic work structures at the same time. Although for traditional socio-technologists there is something of a paradox in this statement, we cannot elaborate on this here. Suffice it to say that Dutch STSD is trying to achieve a proper balance between variety *increasing* measures, like segmentation of flows constituting 'whole tasks', and variety *decreasing* measures, like inputs selection by means of parallelization of process flow. The argument is discussed in more detail in De Sitter *et al.* (1990).

Fourth the proposed method for modern STSD basically supports a multi-level approach. The parallelization of flows is advocated on the next higher level to segmentation. A strategic analysis of the system at a macro level may reveal the environmental demands of the near future. In this context we acknowledge the network approach of the Search Conference (Emery, M. 1989) as a means of achieving desirable outcomes under turbulent field conditions. In Holland an STSD (re)design tradition is

gaining ground in which technological, social and organizational innovations go hand in hand. A series of more integral organizational renewal projects is being carried out along the theoretical and methodological lines of the approach to flexible productive systems (AFPS).

Fifth the proposed method for modern STSD is not necessarily linear in nature. The 'successive' steps do not prescribe a time order. They can also be used as a checklist to manage interconnections. The order of steps is indicative of available degrees of freedom for change. For instance, a change in production structure necessarily will urge forward changes in control and information structures, while a change in information structure is not expected to affect the production and control structure at all (see Figure 9.2). The steps stress dependencies in the (re)design process.

Finally, the proposed method for modern STSD is, of course, highly political in nature. Although it must be emphasized that different parties use it as a connecting and integrative device, insufficient control of that process can easily result in coalition formation. Also there will be some sort of paradoxical self-selection process among firms with respect to adoption. Because the method basically supports a democratic approach, organizations which want to adopt it will already feel sympathy for or will have invested in the type of change which modern STSD intends to accomplish.

In this chapter we have presented organizational (re)design methodology as explicitly advocating restructuring of construction at different levels of aggregation. The method to some extent supports 'manageable change and innovation', within the context of the integral organizational renewal of the total firm. The method is based on a socio-technical perspective which guarantees a better focus on the interactions between individual, group and organization in a highly automated work environment.

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