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# From autonomous work groups to democratic dialogue and integral organizational renewal : 40 years of development and expansion of the socio-technical systems design paradigm

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# From Autonomous Work Groups to Democratic Dialogue and Integral Organizational Renewal: 40 Years of Development and Expansion of the Socio-Technical Systems Design Paradigm

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**Abstract**

This paper gives an outline of the Socio-Technical Systems Design Paradigm from its inception in 1951 until 1991. It documents four development trajectories, i.e. the Pioneering Phase, and the phases of Classical, Modern and Post-Modern Socio-Technical Systems Design. Placing emphasis on the highlights, these stages are described as anecdotes, and the geographical diffusion of Socio-Technical Systems Design. Special attention is given to the Dutch representatives and developments.

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## 1 Introduction

Since its inception in the fifties, the sociotechnical design paradigm of organizations has never left the socio-scientific and management literature. Socio-Technical Systems Design (STSD) plays an important role in giving shape to the plants, offices and government institutions that follow modern patterns.

Sociotechnical systems design is an applied science which is aimed at improving the functioning of both man and organization through adaptation or fundamental redesign of contents and organization of technology and human tasks. In the past four decades, many authors, with psychologists not being in the last place, contributed to the development of this broad-minded approach, which is basically a management approach.

In sociotechnical systems design, social and technical aspects are considered and fine-tuned to one another in their mutual connection. Such an orientation is nowadays referred to by the term 'integral'. To give an historic overview that does justice to the total range of ideas and elaborations in this area, one would have to go far beyond the available space and intentions (in terms of profundity) of this article. We have therefore opted for a selection of essentials.

In this article we lay out a broad outline of the history of sociotechnical systems design. Rather than striving for completeness, we chose to typify different phases in an anecdotical manner. In addition, we characterise the episodes by giving short descriptions, and we sketch the diffusion of sociotechnical systems design in terms of time and location. Special attention is given to the Dutch representatives and relevant developments.

**The author would like to extend special thanks to Fred Emery, Hans van Beinum, Friso den Hertog and Ulbo de Sitter for their useful suggestions and additions to earlier versions and variants of this monograph.**

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## 2 Socio-Technical Systems Design as Scientific Paradigm

Before we describe the actual development of Socio-Technical Systems Design (STSD) on the basis of a division based on phases, we first give a general characterization of methodological starting points and aspects regarding its content.

### 2.1 Methodological Starting Points

For a long period of time, STSD in its strive for integration - with the structure of the organization as object of study and integral (re)design as its objective - was (considered) an odd one out. Such a holistic, design-oriented science did not quite fit into the ossified academic disciplines developed at the universities. STSD was not only new as design theory in terms of its contents, it also implied a clearly different paradigm in terms of methodology. In order to obtain insight into the actual meaning of STSD, scientists and staff officials had to take a different attitude in various respects. Not only did they have to learn to think in terms of new schemes, they also had to change their work habits.

- The fundamentally different way of thinking implied a shift from the 'machine' approach to the 'system' approach (Eyzenga, 1975). The main characteristics of the *machine approach* are: the emphasis being placed on reduction (converting wholes into parts; disaggregation); the emphasis placed on analytical thinking (explaining the behaviour of entities from the addition into the behaviour of parts); as well as the emphasis being placed on mechanistic thinking (in terms of the uni-causal cause/result relationships). The object of the study is viewed here as a machine. The main characteristics of the *systems approach* include emphasis being placed on expansion (the parts are included in ever-expanding entities; aggregation); the emphasis on synthetic thinking (explaining behaviour from the role of the parts and how they function in the larger whole); and the emphasis on theleological thinking (determining and changing objectives, adaptation; cause is essential though not sufficient for a certain result). The object of the study is viewed here as an 'open system' which interacts with its environment.

- The fundamentally different way of working implied a shift from the use of a predictive model cycle to a regulatory cycle on the one hand, and a different attitude of the researcher on the other; from distant to co-influencing. The empirical or predictive cycle (De Groot, 1980) accentuates the testing of hypotheses that are derived from an *a priori* formulated theory by means of the following steps: observation, induction (generalising general connections from observed connections), deduction (formulating ideal-types/hypotheses), tests (verifying/ falsifying), evaluation. The regulatory or design cycle (Van Strien, 1986) stresses actual designing and, on the basis of that, developing a theory for practice through the following steps: problem definition, diagnosis, plan, action, evaluation. The role of the researcher is no longer distantly observant, but more involved and in fact co-influencing. The relevant process is referred to as 'action research'. It may be clear that many researchers have had difficulty with such a radical methodological changing paradigm. Illustrative of this is Hackman's lamentation: 'It may be that the only good way to comprehend a sociotechnical message is to

move from the library to the shop floor and then finally to understand'. Ah ha! That's what it means.' (Hackman, 1981, p. 76).

### 2.2 Brief Characteristics of Content

The contents of the sociotechnical approach can be characterised as a reaction to the unilateral emphasis placed in previous paradigms (Scientific Management: Taylor, 1911; Bureaucratic: Weber, 1947; Human Relations: Mayo, 1933) on either the technical or the social aspects of the organization. In the new perspective, both factors are integrated as being components of one single 'sociotechnical entity'. In an attempt to give a brief and concise typification of STSD, Van Beinum (1990a) lists nine characteristics of content of what he refers to as 'the new organizational paradigm', which he puts in contrast with the characteristics of the 'old paradigm': the Tayloristic bureaucracy (cf. Box 1).

*Box 1: Brief characterization of STSD*

"**The old paradigm**
* redundancy of parts
* external coordination and control
* autocracy
* fragmented socio-technical system
* technological imperative - man as extension of machine, a commodity
* organizational design based on total specification
* maximum task breakdown, narrow skills
* building block is one person - one task
* alienation

**The new paradigm**
* redundancy of functions
* internal coordination and control
* democracy
* joint optimization of the socio-technical system
* man is complementary to the machine and a resource to be developed
* organization design based on minimum critical specification
* optimum task grouping, multiple broad skills
* building block is a self-managing social system
* involvement and commitment"

Van Beinum (1990a), p.3

In his characterization he makes the following comparisons:

- *Redundancy of Functions versus Redundancy of Parts.* Rather than maximizing the labour division (overcapacity of persons having only one function within the organization), STSD suggests a minimal work division (overcapacity of functions in each person within the organization). Everybody is expected to be able to carry out different tasks, which leads to personnel being available for multiple jobs.

- *Internal versus External Coordination and Control.* Self-regulation rather than step-wise supervision is considered to be of paramount importance in the sociotechnical paradigm. Emphasis is being placed on small organization units with internal coordination and semi-autonomous control.
- *Democracy versus Autocracy.* The aim of STSD designers is direct participation of personnel in decision-making. The approach is based upon democracy in the workplace.
- *Joint Optimization versus Fragmentation.* STSD prefers to take an integral as opposed to a partial approach, which implies optimization of various aspects rather than maximizing the own job-specific aspect.
- *Man as Resource versus Commodity.* The sociotechnical paradigm considers the working man as being complementary to the machine, and not as its useful extension. People are the most valuable asset of an organization, which must invest in them.
- *Minimum Critical versus Total Specification.* STSD designers will prevent an organization from designing its structure in a detailed manner. They start with the idea that only the contours need to be determined; the remaining parts are filled in by the users according to their own insights and needs. The current situation is of course a condition relevant to the actual organization of work.
- *Maximum Task Breakdown versus Optimal Task Grouping (Narrow versus Broad Skills).* The sociotechnical paradigm strives for complex jobs in a simple organization rather than simple jobs in a complex organization. This means that personnel must have multiple skills.
- *Individual versus group.* In STSD, the smallest organizational unit is the group, not the individual. In this way it is possible for individuals to take control of the organization of work.
- *Alienation versus Involvement and Commitment.* Job erosion leads to alienation. Sociotechnically redesigned labour systems are characterised by 'whole tasks': It is meaningful work, thus promoting personnel commitment.

### 2.3 Milestones and Development Trajectories

The history of STSD is a sequence of major and minor discoveries, projects, conceptualizations and developments of methodologies. The literature about it is very fragmented. English handbooks are lacking, whereas a number of key publications have for a long period of time not gone beyond the stage of 'internal report'. All of this combined makes it a difficult task to give a reasonably valid outline of its historical development.
Other authors have recently made an attempt to record the history of the sociotechnical organization paradigm. Merrelyn Emery (1989), for example, distinguishes a number of important 'milestones':

- As a first relevant fact - basically not more than a pace-setter - she mentions Lewin's leadership experiments just before the Second World War (cf. Lippit & White, 1939). These laboratory studies pointed to three basic types of organizational structures: the autocracy (bureaucracy), the democracy, and the 'laissez-faire' type (structure-less variant).
- As a second relevant fact - the first factual milestone of STSD - Emery refers to the British mine studies (cf. Trist & Bamforth, 1951; Trist *et al.*, 1963). In these field studies, researchers

discovered an alternative form of work organization (the so-called 'semi-autonomous work group'), which they tried out on a limited scale.

- As a third relevant fact - the second factual milestone of STSD - Emery mentions the Norwegian 'Industrial Democracy Project' (cf. Emery, F. & Thorsrud, 1964/1969/1976). In this project, employers, employees and the government for the first time jointly carried out research into and improved the democratic quality/content of industrial sectors.
- As a fourth relevant fact - the third factual milestone of STSD - Merrelyn Emery (1989) refers to the development of the so-called 'Participative Design' methodology in Australia (cf. Emery, F. & Emery, M., 1974). Here, the employees themselves were given the opportunity to carry out the whole trajectory of sociotechnical analysis and redesign by means of 'participative design workshops' and 'search conferences'.
- In addition to Emery, Van Beinum (1990a) has proposed a fourth factual milestone in the development of STSD, namely 'large-scale and broadly based organizational change process with 'democratic dialogue' as the leading element on the conceptual as well as on the operational level' (cf. Gustavsen, 1985; 1988). This has been brought into practice on a national scale. In the long run, the Dutch approach to Integral Organisation Renewal (De Sitter *et al.*, 1990) may compete with the fourth 'milestone' classification.

The above-mentioned four milestones form sequential steps in a process of democratizing the workplace.

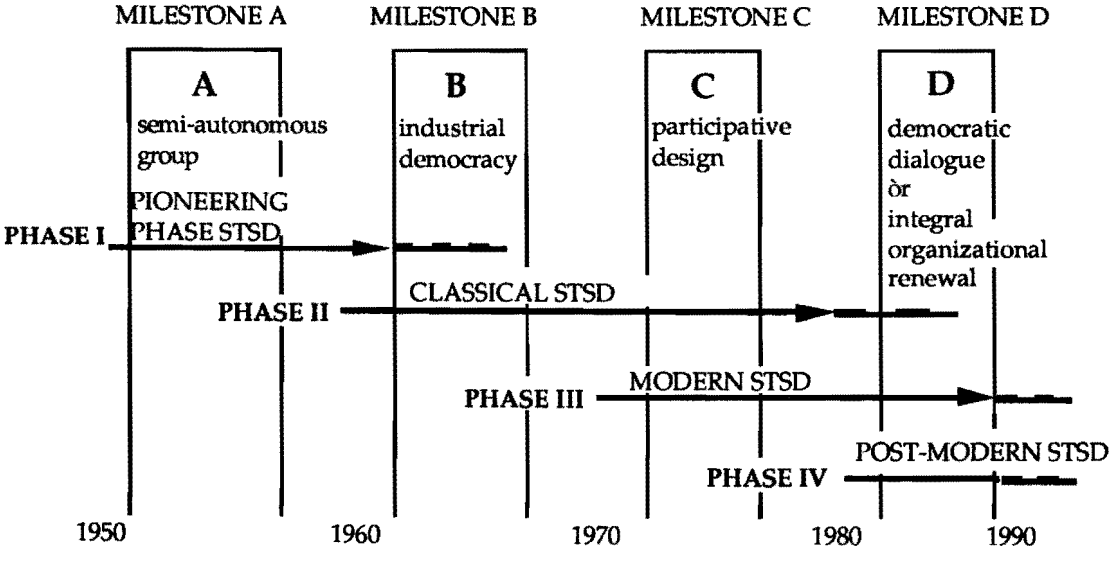


*Figure 1. The phases and milestones in the development of STSD.*
Adapted from: Emery, M. (1989); Van Beinum (1990a).

Based on a bibliometrical analysis of the literature (cf. Van Eijnatten, 1990a/b) and where possible corrected by changes in the actual sequence of events (Fred Emery, 1990 - personal correspondence), we have attempted to categorize the historical line of STSD into phases. The four development trajectories can be distinguished as follows:

- Phase I (1949 - 1967+): The period of the Socio-Technical Pioneering Work;
- Phase II (1959 - 1986+): The period of Classical STSD;
- Phase III (1972 - 1989+): The period of Modern STSD;
- Phase IV (1981 - xxxx): The period of Post-Modern STSD.

Figure 1 gives a representation of the phases thus distinguished, combined with the milestones previously mentioned. What immediately strikes the eye, is that the trajectories partly overlap in time. Sometimes, there almost exist parallel flows. Two main causes can be given for this. Firstly, from time to time the inventors/developers of the paradigm regroup to discuss new ideas, while the implementors/consultants continue to follow the course taken for some time. Secondly, the development of STSD is a-synchronous in the different countries and continents: One country is already in the next phase whereas the other has yet to start the previous one. It also happened (for example in the United States) that the entire development started off only after a number of years. This makes it difficult to link concrete end-dates to the various stages.

## 3 Highlights in the Development of Socio-Technical Systems Design

In order to typify the development of STSD, each phase will be described below by means of anecdotes. We will respectively discuss the discovery of the Semi-Autonomous Work Group (Phase I), the Industrial Democracy Project (Phase II), Participative Design (Phase III), and Democratic Dialogue or Integral Organizational Renewal (Phase IV).

### 3.1 The Success Story of the Pioneering Phase: the Discovery of the Semi-Autonomous Work Group

The cradle of STSD can be found in the postwar British coal mines. In the early fifties, a new, spontaneous form of work organization came into being which today is referred to as 'self-managing groups'. The turbulent British coal industry - which was continually plagued by labour conflicts and which was nationalized and further mechanized after the Second World War was not exactly a working area that was easily accessible to social scientists. Yet, Ken Bamforth, ex-miner and a new researcher of the Tavistock Institute of Human Relations in London, was given the opportunity to visit the mine he used to work in, the Elsecar mine in South Yorkshire, which was closed to many other researchers. During his visit he observed an unknown form of work organization in a new coal seam, called 'the Haighmoor'. Due to the short coal front, the usual mechanization, the so-called 'longwall' method, could not be applied in this seam. Thanks to the fact that he was a former colleague, the local management gave him permission to carry out descriptive research together with Eric Trist. However, it proved to be difficult to obtain the management's permission to publish their findings. After some commotion, the mine management eventually agreed to a strongly censored version.

In their now famous article - carefully included in an elaborate description of the mechanized coal mining process which was unravelled in small sub-tasks - Trist and Bamforth (1951) represented, in guarded terms, a unique underground alternative work organization that was built up of so-called 'composite work groups: small, relatively autonomous work groups consisting of eight miners, who

were responsible as a group for a full cycle in the process of coal extraction. This 'new' form of work organization much resembled the manual situation as it had existed before mechanization.
The work organization observed in Haighmoor proved that there were other, even better, ways of designing the work organization within the same mine. This was flatly opposed to the prevailing 'one best way of organizing' practice 'that fused Weber's description of bureaucracy with Frederic Taylor's concept of scientific management' (Trist, 1981, p. 9). It became a success story, the starting point of a new scientific paradigm: Socio-Technical Systems Design.

As Trist later recalled in his correspondence with Emery, the start of the sociotechnical paradigm did not exactly go without a hitch (see box 2). In fact, the pioneering phase came about in fits and starts.

*Box 2. An 'eye-witness' report of the difficult start of the sociotechnical paradigm*

"In the autumn of 1949, I went up to Elsecar Colliery in N.E. Division, Ken Bamforth's old pit, and found autonomous work groups in the Haighmoor seam. Improved roof control enabled them to mine it. (...) Teams of eight men interchanged tasks on shift and each shift took over where the last left off. (...)
The method, called the all-in method had been conceived by Reg Baker then Area General Manager No. 3 Area, N.E. Division, formerly manager at Elsecar. (...)
The project was an immense success - human-wise, productivity-wise and every otherwise. I began to study it with Ken (...). It was both moving and exiting to talk to the men about the value they placed on their experience in the newly formed autonomous groups. (...)
I read a paper with Ken on the 'all-in method' and its significance as a new paradigm (...) in the winter of 1950 (...).
I then asked Baker about publishing an expanded version of the paper in Human Relations. He had to task N.E. Division who refused. (...) They were frightened of the consequences of letting news about the 'all-in method' get out in the industry. They said it contained dynamite. (...) This is why the original Trist-Bamforth paper (...) was published simply as an analysis of the conventional longwall with only indirect references (which are nevertheless plentiful, the model provided by the ripping team) to there being something of another kind on the way. This something was suppressed. (...)"

Trist's private communication, 1977
Emery (1978), p.5-6

Real experiments with autonomous groups were carried out in the Bolsover mines in the East Midlands coal field (Shepherd, 1951; Wilson & Trist, 1951; Emery, 1952; Trist, 1953). During his sabbatical leave from Australia in 1952, Fred Emery visited this mine, where he found that autonomous groups had been introduced in seven locations. However, here too the National Coal Board was terrified of the consequences and cancelled a proposal for further diffusion. From January 1955 until March 1958, Trist c.s. performed a series of descriptive case studies and field experiments with semi-autonomous work groups in the mines of North-West Durham. The reason for this was the - 'discovery' of 'the working of a conventional, semi-mechanized, three-shift longwall cycle by a set of autonomous work groups' (Trist, 1981, p. 16). Trist reported enthusiastically that groups consisting of 40 to 50 miners worked here while exchanging their various tasks and also drawing up

the shift schedules themselves. Amongst one another they had worked out an adapted 'fair' rewarding system. Compared to an identical situation but with a traditional work organization, the output here was 25% higher, the costs lower, and absenteeism had been cut in half! A large number of reports were published pertaining to this Bolsover case (cf. Herbst, 1958; Higgin, 1957/1958; Murray, 1957a through g; Pollock, 1957/1958; Trist, 1956/1957). A collected description of these mine studies can be found in Trist *et al.* (1963).
Parallel to this, two field experiments were carried out from Tavistock in the textile industry (the Jubilee and Calico Mills in Ahmedabad, India; cf. Rice, 1953/1958/1963). Both in an automated and in a non-automated weaving mill a system of semi-autonomous groups was introduced, in the latter with lasting success (Miller, 1975). Trist (1977) reports that in the fifties autonomous groups were observed in both the London harbour and British retail trade, but efforts to study those all failed.
Yet another early sociotechnical reorganization is known in Scandinavia. In Sweden autonomous groups were introduced to the Stockholm telephone switchboard (cf. Westerlund, 1952).

The pioneering phase of STSD is characterized by conceptual ambiguity. Due to the lack of both time and resources at 'The Tavistock', it was difficult to develop its own concept in a systematic manner. The researchers from the very beginning were inspired in their observations by the emergence of systems thinking, which was initially propagated from biology, and later also from cybernetics. They enthusiastically adopted the new concepts and tried them out in actual practice.

- Thus, the generally known 'Gestalt' notion (Köhler, 1929), renamed the 'holistic system' (Angyal, 1941), makes it possible to look at the *whole* coal mining situation, i.e. at both social and technical aspects and their mutual connection.
- By means of the 'open system' notion (Koehler, 1938; Von Bertalanffy, 1950), attention is also directed towards the environment. Thus, the man-hostile and unpredictable work situation in mines can become explicitly involved in the research.
- The researchers place the concept of 'self-regulation' at the basis of the semi-autonomous group (Roux, 1914; Weiner, 1950; Von Bertalanffy, 1950; Sommerhoff, 1950). Self-regulation of *all* steps of the coal mining process is most effective in an unpredictable environment, and 'requisite variety' (Ashby, 1956a/b, 1958) - in other words, allround miners in the semi-autonomous group - are a prerequisite for that. This is exactly what Trist and Bamforth found in the Elsecar mine in South Yorkshire: small semi-autonomous work groups consisting of eight miners, each of them equally rewarded, who as a group were responsible for a full production cycle in the coal mining process. The ever-progressive labour division, which was so typical of the mechanization of the industry at the beginning of the twentieth century, was all of sudden rigorously broken down. Actual practice provided all the necessary ingredients for developing a new organization theory, but its exact concept was not elaborated upon until the early sixties.

The next phase in the development of STSD was heralded by Fred Emery's joining Tavistock in 1958 and the leaving of its director Wilson. As a result of increased tension, the sociotechnically-oriented researchers, under the guidance of Trist, were separated from the 'Human Relations'-oriented researchers which was led by Rice. The latter had had close connections with psycho-analysts since Tavistock was founded. Trist's HRC group (Human Resources Centre), which Emery

was also a part of, continued the developing of STSD, but Rice and his CASR group (Centre for Applied Social Research) also continued for some time to publish sociotechnically-oriented literature - mainly because of opportunity reasons ('profiling') - (cf. Menzies, 1960; Rice, 1963; Miller & Rice, 1967), which did not help in improving the mutual understanding between these two groups.
When Trist finally succeeded in obtaining financial support for sociotechnical concept development, Emery, supported by Herbst and Miller, turned his energies to the difficult task of tying up the numerous loose ends from the pioneering phase. Three documents (Tavistock 526-528; cf. Miller, 1959; Emery, 1959; Herbst, 1959) mark the transition from the pioneering phase to that of Classical STSD. At this point, the rupture with the Human Relations tradition is final (personal communication with Emery, 1990).

According to Emery (1959) the application of the open systems concept to the production organization leads to the distinction of a 'sociotechnical system'. A sociotechnical system consists of a social and a technical component. In other words: man and machines. This system considers the technical component as being the 'internal environment' of the organization. As Trist (1981) underlines in his review, the technical and social systems are independent of one another in the sense that the former follows the laws of natural sciences, and the latter those of social/human sciences. However, they are dependent upon one another in the sense that they need each other to fulfill the production function. There exists a connection of heterogeneity. According to Emery the economic aspect is not a separate third system as previously suggested by Rice (1958), but in fact may be viewed as a means to measure the effectiveness of the sociotechnical entity.

After 1959, Emery also continued to work on the formalization and methodological foundation of STSD as an open systems approach (cf. Emery, 1963a through d/1967). Jordan's message (1963) that man is supplementary to, and not an extension of machines, inspired him to elaborate the design principle of 'joint optimization'. The social and technical systems should no longer be maximized as separate entities, but instead optimized simultaneously. This is concerned with achieving the 'best match' between technical instrumentation and social work organization. In 1963 Emery speaks of 'the ideal of joint optimization of coupled, but independently based, social and technical systems'. In the early sixties, Emery also carried out pioneering work in the area of science theory and methodology. For example, he further developed Von Bertalanffy's (1950) 'open systems' concept, so that a definition of the process of 'active adaptation' was facilitated, and he based STSD on Sommerhoff's (1950) methodology of 'directive correlation' 'as a rigorous framework for conceptualism' (Emery, personal communication, 1990). The methodology of 'directive correlation' presented by Emery in 1963 belongs to the absolute core of the sociotechnical paradigm, and encompasses in brief the fundamentally symbiotic relationship between an open system and its environment. The way in which these continuously follow from one another, was and still is not fully understood by many people, and it has been Emery in particular who has pointed this out time and time again.
Because of their revealing character and despite their difficult accessibility, the epistemological and methodological documents mentioned above have been of essential relevance to anchor STSD as a scientific paradigm. A further treatment of this foundation goes beyond the scope of this article,

but there is one exception. The well-known environment typology can be viewed as being a direct result of this foundation process. On the basis of the study by Tolman & Brunswik (1935) and using Sommerhoff's (1950) 'directive correlation' methodology and Ashby's (1952) concept of 'joint environment', Emery & Trist (1963/1964/1965) developed an environment typology which is based on 'causal texture', consisting of four categories increasing in complexity and unpredictability. They make a distinction between: 1. placid, randomized environment; 2. placid, clustered environment; 3. disturbed-reactive environment; 4. turbulent field. This typology, a logical next step in sociotechnical conceptualization, stresses the increase in (changeable) demands affecting the organization from its environment, since organizations, being viewed as open systems, have a constant exchange relationship with their environment. Adaptations of the organizational structure to changes in that environment are crucial in order to survive. The above typology was later expanded only by the hyper-turbulent 'vortex' variant: 5. vortical environment (Crombie, 1972; McCann & Selsky, 1984; Babüroğlu, 1988).

### 3.2 Classical Socio-Technical Systems Design and the Demonstration of Industrial Democracy

One of the highlights in the period of Classical STSD was undoubtedly the Norwegian 'Industrial Democracy' (ID) programme, spanning the period between 1962 and 1969. After the mine studies, it was practically impossible in the United Kingdom to carry out action research. The 'Purfleet Power Station' project was an exception (cf. Emery & Marek, 1962). In the early sixties, a favourable climate for larger-scale experiments arose not in the United Kingdom, but in Norway. Employer and employee organizations formed a joint committee early in 1962 in order to study problems surrounding industrial democracy. Later, the government also joined this committee. Research in this area was initially subcontracted to the Trondheim Institute or Industrial Social Research (IFIM), which called in the Tavistock Institute. Eric Trist brought about the initial contacts, but from The Tavistock it was Fred Emery, together with Einar Thorsrud of the Norwegian Work Research Institutes (WRI) in Oslo, who gave actual shape and guidance to the ID project (cf. Thorsrud & Emery, 1964). The most important item of the research programme was formulated as 'a study of the roots of industrial democracy under the condition of personal participation in the work place' (Emery & Thorsrud, 1976, p. 10). The programme included sequential field experiments in which alternative forms of work organization (mainly concentrated around semi-autonomous work groups) were developed and tried out; subsequently, their effects on the participation of employees were examined at different levels within the organization.

The firms participating in these projects had been carefully selected by the experts of the 'Joint Committee' from the most important sectors in Norway: the metal, paper and chemical industries. This selection was based on a rudimentary diffusion theory (Emery *et al.*, 1958, see also section 3.3). After 1967 a minor project was still running in the shipping industry (cf. Roggema, 1968). The following is a brief description of the four main projects:

- The first project started in 1964 in Chistiana Spigerverk, a wire draw plant in Oslo (cf. Marek *et al.*, 1964; Emery *et al.*, 1970). Group work was introduced by the research team, but the rewarding system immediately posed all kinds of problems. The change process was not under control in this pilot project. Local unionists and management had too little involvement, and

therefore the project was cancelled when after more than a year the research team left the plant.

- The second project was started in February 1965 after careful orientation and extensive consultation with unions and management at the chemical pulp department of the Hunsfos paper mill located in Vennesla, Kristiansand (cf. Engelstad *et al.*, 1969; Engelstad, 1970). The change process was better controlled here: the introduction and formation of 'extended groups' was accompanied step-by-step by project and work groups composed of representatives of employees, bosses and management. However, the project really fell into its stride when the research team withdrew to the background and the (top) management committed itself in a more pronounced way. In 1966 the new work organization flourished and the effects of group work and multi-skilled personnel was proved convincingly, but early in 1967 the project got bogged down as a result of a crisis in the paper industry and the associated priority changes in management. In the seventies the Hunsfos employees themselves took over and began to breath new life into the project (cf. Elden, 1979).
- The Industrial Democracy programme has faced more setbacks. After an initial refusal of the management to join the programme as a result of political circumstances within the firm, the third ID project was initiated - more than two years after the first application - in December 1965 at NOBØ household appliances/metalware in its establishment in Hommelvik near Trondheim (cf. Engelstad, 1970; Thorsrud, 1972). Here too, an experiment with semi-autonomous groups took place, carefully embedded within the organization, and has now been elaborated upon for a new production line for electric radiator heaters. This project has become the actual demonstration project of the ID programme, which attracted many interested people from Norway and Sweden. Later, when a new plant had to be put into use in view of higher production, the employees succeeded in maintaining the new organization.
- The fourth ID project was initiated in 1967 - at the request of the firm itself - in the chemical concern Norsk Hydro, more specifically in the reorganization of the old and design of a new fertilizer plant in Heröya, Porsgrun (cf. Bregard *et al.*, 1968; Gulowsen, 1972/1974/1975). This project, in which Louis Davis also participated, was the umpteenth variant to the introduction of a group structure supported by a training programme and a rewarding system adapted to group work. It became a big success: The two plants with this sociotechnically based work organization functioned well until the late seventies.

The four demonstration projects described above received a lot of attention in the literature (cf. Emery & Thorsrud, 1969/1976; Engelstad, 1972; Gustavsen & Hunnius, 1981). Their aim was to indicate the practical feasibility of the new sociotechnical organization principles, but unfortunately these examples were seldom followed. In spite of the fact that the experiments were successful (cf. Gustavsen & Hunnius, 1981), they were largely limited to the department or the plant where they had been started. In their turn, the 'experimental gardens' became isolated from the rest of the organization, which even built up some kind of resistance against such a change. This phenomenon was referred to by Merrelyn Emery (1989) as 'paradoxical inhibition'. Although various diffusion programmes were set up, the programme stagnated in Norway around 1970.

Things were much different in its neighbouring country Sweden, where a cooperation project carried

by employers and unions similar to that in Norway was initiated. Because of its slow progress, the employers soon decided to start their own programme in more than 500 firms (cf. Jenkins, 1975). They also promoted a sociotechnical programme when new plants were built (cf. Agurén & Edgren, 1980). Apart from Saab-Scania, where parallel production groups were already formed in 1972, Volvo in particular has the reputation of developing a whole range of pioneering new forms of work organization, in which the one in Kalmar has become most well-known (cf. Agurén *et al.*, 1976/1984). For a more elaborate overview of the Volvo projects, see Auer & Riegler (1990).
In 1965, the Industrial Democracy programe was rehashed in the United Kingdom. The Norwegian example was 'copied', so to speak, at Avon Rubber, Shell and RTZ (personal communication with Emery, 1990). However, one important element was lacking here: a steering group which was composed of employers and employees. 'The Shell Philosophy program was an innovation but not a change in trajectory. It was developed because we could not get in the UK a sanctioning body of the union and employer leaders, as we had in Norway' (Emery, 1990).

The Norwegian ID programme and its variants are characteristic of the period of Classical STSD, in which the *expert approach* flourishes.

In giving shape to and working out the ID programme in Norway, a great deal of attention was given to a systematic elaboration of the project approach - amongst other things, because of its demonstration character (cf. box 3). This has led to important 'breakthroughs' in the development of methods and concepts.

*Box 3. The methodological approach of the Industrial Democracy programme in Norway*

"1. Establishment of a Joint Committee representing labour and management;
2. Choice of experimental company;
3. Systematic analysis of the company as a system and its environment;
4. Choice of experimental sites;
5. Establishing action committees;
6. Socio-technical analysis of experimental sites:
   a. description of variations in input and outputs and sources of variations;
   b. estimation of relative importance of different variations (matrix);
   c. description of formal organization;
   d. analysis of communications network;
   e. base-line measurement of (dis)satisfaction;
   f. analysis of wage and salary system;
7. Description of company policy;
8. Formulation of program for change, containing:
   a. multi-skilling of operators;
   b. developing measures of variations and data analysis methods for control by operators;
   c. attachment of local repair men;
   d. institutionalising of meetings;
   e. training of foremen;
   f. design and introduction of new bonus arrangement;
9. Institutionalisation of a continued learning and organizational change process;
10. Diffusion of results."

Emery & Thorsrud (1976); p. 150-154

In the ID project approach the whole process of change was defined and monitored in phases and steps. The starting point was a thorough sociotechnical analysis of the business situation found. The notions 'variance' and 'variance control' (cf. Engelstad, 1970; Hill, 1971) were highly important here. Based on Herbst's (1959) concept of 'disturbance control', this principle of 'signalling occurring disturbances and their control by the employees themselves as close to the source as possible' was brought into practice through projects. The application of this principle took place by means of the so-called 'variance control matrix', a table with specific disturbance sources as one input and (factual) disturbance controls as the other. This procedure was the first and most important formal sociotechnical method. This 'traditional variance analysis' technique was applied for the first time at the Hunsfos paper mill (cf. box 4).

A year later the technique was applied from the Tavistock at the Stanlow oil refinery of Shell-UK (cf. Foster, 1967; Emery *et al.*, 1967; Hill, 1971). Although the number of steps mentioned in the literature varies to some extent, this method is known as the 'nine-step method' (cf. Emery & Trist, 1978). It was originally developed for application in the processing industry, but was also later used for the analysis of discrete production situations and for mapping administrative processes. Emery was opposed to this.

*Box 4. A brief illustration of the original 'variance analysis' technique applied in the period 1965-1967 by Engelstad at Hunsfos*

"
1. Identifying key success criteria;
2. Drawing the layout of the system;
3. List the steps in the process in order;
4. Identify unit operations;
5. Identify variances;
6. Construct a variance matrix;
7. Identify key variances;
8. Construct key variance control table;
9. Suggest technical changes;
10. Suggest social system changes."

Engelstad *et al.* (1969)

The Norwegian ID programme was the first solid opportunity to test the usability of the sociotechnical basic principles developed by the HRC group at Tavistock in actual practice. These tryouts showed that a number of norms were still lacking at workplace level. Therefore, Emery and Thorsrud developed a series of job redesign principles to be used for the actual experiments with Industrial Democracy on the basis of the work of Louis Davis from the United States (cf. box 5). These so-called 'structural propositions for joint optimization' served as criteria for the assessment of the existing and newly created work situations. They were repeated in various publications afterwards (cf. Thorsrud, 1968; Emery & Thorsrud, 1976; Cummings, 1976; Cummings & Srivastva, 1977; Trist, 1981).

*Box 5. Detailed principles for the redesign of tasks*

"Individual level:
- optimum variety of tasks within the job;
- a meaningful pattern of tasks that gives to each job a semblance of a single overall task;
- optimum length of work cycle;
- some scope for setting production standards and a suitable feedback of knowledge of results;
- the inclusion in the job of auxiliary and preparatory tasks;
- tasks include some degree of care, skill, knowledge or effort that is worthly of respect in the community;
- the job should make some perceivable contribution to the utility of the product to the consumer.

Group level:
- providing for 'interlocking' tasks, job rotation or physical proximity;
  + where there is a necessary interdependence of jobs for technical or psychological reasons;
  + where the individual job entails a relatively high degree of stress;
  + where the individual jobs do not make an obvious perceivable contribution to the utility of the end product;
- where a number of jobs are linked together by interlocking tasks or job rotation they should as a group:
  + have some semblance of an overall task;
  + have some scope for setting standards and receiving knowledge of results;
  + have some control over the boundary tasks;

Over extended social and temporal units:
- providing for channels of communication so that the minimum requirements of the workers can be fed into the design of new jobs at an early stage;
- providing for channels of promotion to foreman rank which are sanctioned by the workers."

Adapted from:
Emery (1963d), p. 1-2; Emery & Thorsrud (1964), p. 103-105;
Emery & Thorsrud (1976), p. 15-17.

The 'technical variance' analysis method described above was introduced in combination with the design criteria in 1967 in (North) America when Louis Davis returned to his country and Eric Trist arrived at UCLA from Tavistock. Together they set up a sociotechnical curriculum. Many of the alumni started their own consultancy in (North) America. The first major design projects took place in the processing industry: in 1968 at Alcan aluminium in Arvida (Quebec, Canada; cf. Gagnon & Blutot, 1969; Chevalier, 1972; Archer, 1975), at Proctor & Gamble, in 1971 at the dog food plant of General Foods in Topeka (Kansis; cf. Ketchum, 1975/1982; Walton, 1972/1977), and at Corning Glass Works in Medfield (Massachusetts; cf. Beer & Huse, 1972).

The sociotechnical approach was renamed in the United States 'Quality of Working life'. In the seventies, this approach was used in a large number of (North) American companies as an application of participative redesign (cf. Davis & Cherns, 1975; Taylor, 1990).

### 3.3 Modern Socio-Technical Systems Design and the Expansion of Participative Design

When Fred Emery returned to Australia in 1969 after spending a period of ten years in Europe, he was swamped with applications for projects similar to those he had carried out in the United Kingdom and Norway. To some extent, he was forced to have firms set up and implement their own design projects. Inspired by the good experiences with a 'vertical project group' (top-down cross-section of the hierarchy) at Hunsfos, Emery developed the so-called 'vertical slice approach'. This approach implied the upgrading of 'Industrial Democracy' up to the level of the organization being an entity through the formation of 'self-managing design groups', consisting of employees, foremen and managers at various levels, who cooperated on the basis of equality.
Emery had learned a great deal from the negative ID diffusion experience in Norway, and attributed the disappointing results mainly to the expert approach used by the researchers. The projects had been insufficiently supported by the (persons directly concerned within) firms. Such an expert approach was no longer acceptable in view of the changed spirit of times (the students' rows in Paris were still fresh in everyone's memory).
Sociotechnical researchers like Emery began more and more to understand that an entirely new democratic system of value was hidden at the basis of the semi-autonomous work group in the UK and the principles for task redesign developed in Norway. Emery and Thorsrud (1969, p. 105) initially spoke of 'a limited number of general psychological requirements', but Emery (1977, p. 68) refer to 'a set of workable and relevant values (...), things (...) valued in work regardless of sex, nationality or race'. He summarizes these values as follows (p. 68):

1. "Freedom to participate in decisions directly affecting their work activity;
2. A chance to learn on the job, and go on learning;
3. Optimal variety;
4. Mutual support and respect of their work colleagues;
5. A socially meaningful task;
6. Leading to some desirable future."

Trist (1976) also talks about new values, which enable us to cope with the increasing complexities concerning the environment, such as self-actualization, self-expression, and 'capacity for joy'.
The technique developed by Emery in 1971, referred to as the 'deep slice' method of Participant Design, enables employees, (middle) management and union representatives to jointly take over the task and organization design from the start of the project. This was supposed to eliminate any resistance against change. The initial applications of this technique took place at the South Australian Meat Corporation SAMCOR (Yearling Hall), the Royal Australian Airforce, and Imperial Chemical Industries ICI. Even before the now well-known, 'little golden book' consisting of 14 pages was published (cf. Emery, F. & Emery, M., 1974/1975) the method had been 'exported' to India (cf. Nilakant & Rao, 1976), the Netherlands, and Norway. The long expected diffusion came about in Norway after all in 1972, because the firms assumed control of the development themselves, but not until the disappointed researchers had retired.

'Participative Design' (PD) is described by Merrelyn Emery as being 'an environment for conceptual and experiential learning about democratic learning organizations' (cf. Emery, M., 1989, p. 114). In the seventies, two such environments have been further elaborated upon: the Participative Design Workshop (Emery & Emery, 1975; Crombie, 1978; Williams, 1982), and the Search Conference (Emery & Emery, 1978; Williams, 1979; Emery, M., 1982; Crombie, 1985).

- The *'Participative Design' (PD) Workshop* is a meeting lasting anywhere from 1.5 to 3 days in which four to ten members selected from all layers of the organization ('deep slice') are brought together in order to map the working situation on the basis of equality and under the guidance of a so-called facilitator. The basis of its content which is at the core of this self- managing design group can be found in part I of the 'little golden book' (Emery & Emery, 1975). This part places the six psychological requirements mentioned above next to the 'genotypes' of the bureaucratic ('redundancy of parts') and the democratic ('redundancy of functions') structures, and gives a concise description of the advantages of the latter. The methodical basis which is at the core of the operation of the 'total design team', can be found in part II of the golden book. The different personnel functions are assessed on the basis of the six psychological job requirements, and the process flow is analyzed. Also, training requirements are derived from a so-called 'multi-skilling table', which evaluated skills per person for each (group) task. The aim of the PD workshop is to achieve structural organizational change by those involved. Its set-up is 'anti-expert-oriented', and is based on the assumption that 'the most adequate and effective designs come from those whose jobs are under review' (Emery & Emery, 1975). Emphasis is not placed on content, but on the participative process, in which the members of the organization create their own evolutionary learning process.

  A specific collective learning environment for Participative Design is the so-called 'Development of Human Resources' (DHR) Workshop (cf. Emery, M., 1988). This is a training programme given at a university for (recently composed) teams from various organizations. For an illustration of the content of such a workshop, see box 6. A PD workshop ahead of its time was the informal European network group which was composed in the early sixties by sociotechnical researchers from the very beginning. Apart from researchers from the UK and Norway, this group included Hans van Beinum and Mauk Mulder from the Netherlands.
- Continuing on from the PD workshop, Fred and Merrelyn Emery developed the so-called 'Search Conference'(cf. Emery & Emery, 1978; Williams, 1979; Emery, M., 1982; Crombie, 1985). This is a non-hierarchical, policy-preparing meeting based on the principle of 'redundancy of functions' involving a maximum of 35 persons, who cooperate two to three days in order to give shape to the future on the basis of equality. The sociotechnical search conference makes use of the indirect or 'broad front' approach, and is directed towards the joint development of 'desirable and probable future scenarios'. Special attention is given to the possibilities and limitations of the environment, with the history of the firm taken into account. This participative form of pro-active planning assumes that people are pragmatic and strive for meta-objectives (ideals); that they are willing to learn and wish to determine their own future. Its explicit objectives are: establishing policy, planning and learning in a non-dominant democratic structure. The very first search conference ahead of its time was held at Tavistock in 1959, when Emery and Trist listed the theories of Bion, Selznick and Asch.

*Box 6. The programme of a Development of Human Resources (DHR) Workshop*

| |
|---|
| "Plenary, Final briefing, expectations<br>Collection of data about changes in the extended social field |
| Small groups work on desirable and probable futures<br>Connections are made to democratic structures |
| Plenary. Briefing on concepts and tools |
| Mirror Design Groups. Two disparate groups work together<br>A + B analyse and redesign A's organization.<br>C + D do the same for C's |
| Plenary presentation and discussion of designs |
| Reverse mirror groups. A + B redesign B's; C + D redesign D's |
| Plenary reports as above |
| Team groups and/or plenary. Next steps. Strategy." |

Emery, M., 1989, p. 115

At the core of PD is an explicit diffusion strategy, which came about gradually, and which was recorded by Herbst (1976) and Emery, M. & Emery, F. (1978). The starting point of this strategy was the diffusion model developed by Emery *et al.* (1958) for an agricultural renewal programme in South-East Australia. Further diffusion took place after innovations had been successfully introduced with those farms that were respected most. Within the agricultural community, which was characterized by an aggregate structure with relatively homogeneous components, these model firms were considered as being a sufficiently large 'critical mass'. Thoralf Qvale (1976) has made a concise summary of the findings of Emery *et al.* (1958) (see box 7).

*Box 7. Results of the diffusion study of Emery et al., 1958*

"a. Diffusion of new principles must start within the existing structure, and in a way flow from one level of leaders to the next.
b. Generally, external scientific advisors will only influence the diffusion process through the leaders.
c. Oral and written communication is rarely enough to lead to change, except on the level of leaders.
d. Outside the level of leaders diffusion depends upon the force of the example. In order to be effective the demonstration must be such that everyone can see the similarity with his own condition.
e. A well-respected person or group must be behind the example."

Qvale (1976), p. 459

With the aim of explaining the (Norwegian) democracy experiments, Philip Herbst (1976) further

elaborated this diffusion theory. The characteristics of the diffusion process depend upon the structure of the *total* system. The network concept is put central in Herbst's theory. According to him (1976, p. 33) a network group can be described as being the reverse of an autonomous work group. It is a temporary organization of similar thinking people at *different* locations, who meet occasionally for consultation. Such a meeting is sometimes referred to in the literature as a 'flocking session' (cf. Davis & Cherns, 1975). Flocking is a phenomenon which involves different people with common interests coming together for a few days to intensely confer, without making new arrangements for another meeting. According to Herbst (1976) flocking by members of a network is likely to occur, and it supports a network's objective, namely maintaining 'long-term directive correlations'. The process consists mainly of stimulating one another in reaching a common, though not (fully) defined objective. The primary function is its common learning process. Emery, M. & Emery, F. (1978) base their PD paradigm on a open-system model, which in their view is applicable to the diffusion process (see Figure 2). The 'system' is composed here of the members of a PD workshop, search conference or network of firms, the 'environment' consists of 'the extended social field of directive correlations' (Emery & Trist, 1981). In other words, the changed society as a whole. The input function is called 'learning', the output function is called 'planning'. Both Merrelyn and Fred Emery state in general that the level of the environment complexity determines the form assumed by the learning and planning functions in practice.

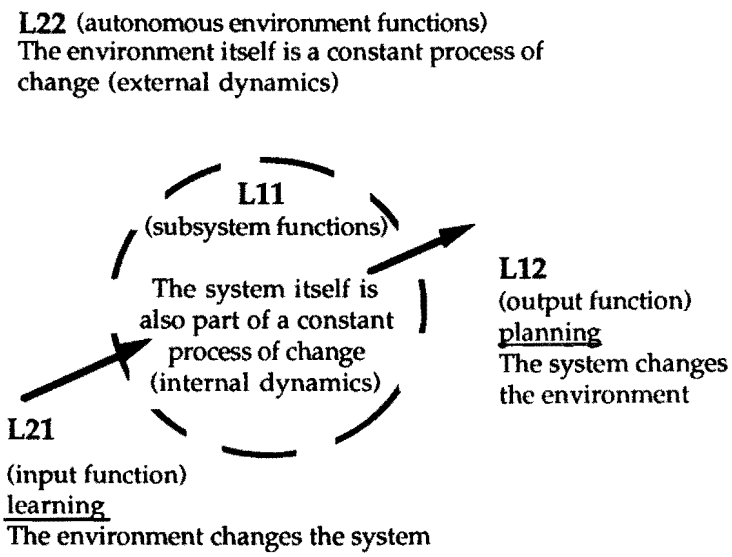


*Figure 2. An open-system model for diffusion*

Legend: - system = PD group or network, search conference;
- environment = societal institutions and firms;
- the indication 'L' stands for systematic coherence;
- the code '1' stands for system; code '2' stands for environment.

Adapted from: Emery, M. & Emery, F., 1978, p. 259/260; Emery, M., 1986, p. 416; Emery, M., 1989, p. 183.

In a competitive 'type III' environment ('disturbed, reactive', compare section 2.1) the learning function will assume the form of 'problem solving', and the planning function that of 'optimizing, using only technical and economic criteria'. In a turbulent 'type IV' environment (rapid, unpredictable changes, disturbed ecological chains) learning takes place through 'puzzling' (Angyal, 1965), and planning through the active and adaptive development of 'desirable future scenarios' (Emery, 1977).
Puzzling is a form of learning - in the literature it is also referred to as 'double loop learning' (cf. Argyris, 1970/1976; Argyris & Schön, 1978) - in which individuals try to discover the more fundamental key questions in a non-hierarchical, friendly ambience. They try to find trends in an excess of data, filtering 'the leading part' (Emery, 1967). Planning subsequently occurs step-wise plotting, evaluating and adapting a strategy consisting of jointly formulated 'desirable future scenarios'. According to Einar Thorsrud (1972) this type of policy- making is a form of active, adaptive planning, which is basically a continuous learning process. The actual motor behind PD is the pleasure experienced during this learning process. Rather than assuming an expectant attitude, one is willing to get to work. In the PD workshop, members start working as a group to adapt the working situation (in their own firm) all by themselves; in the search conference, participants develop future scenarios.
Another important item is that they do not necessarily aim for consensus: the aim is 'rationalization of conflict' rather than 'resolution' (cf. Emery, M. 1987). One tries to arrive at common starting points in a broad area. According to Merrelyn Emery (1989), the *process* of PD apply cross-culturally, in contrast with its *product* (actual design as a concrete result). This process is described as the creation of possibilities for open-ended self generative learning, 'learning to learn', of 'searching for ends instead of means'. PD is an evolutionary process which involves the democratization of the working situation. It is certainly not a 'T-group' training oriented towards personal relationships! It is a type of 'democratic planning', described by Roos (1974, p.218) as "Man's conscious and collective self-control of the development of a system".

The emphasis being placed on the diffusion process rather than on the changes regarding the content itself is a main characteristic of the period of modern STSD. In this context, one speaks of the difference with the previous phase as a 'figure-ground reversal' (cf. Herbst, 1976; Emery, M. & Emery, F., 1978; Emery, M., 1986). The 'figures' refer to our factual structures (the plants, offices, institutions), the 'ground' to our lifestyles and values. The object of change is reversed, a change in attitude is at stake now: learning to participate.
Max Elden (1979) has summarized the characteristics of PD step by step (see box 8).

PD as Modern STSD has not been as widespread (yet) as its classical predecessor. This is probably connected with the anti-expert character of the new approach, which puts consultancy agencies on a sidetrack. In the seventies, PD workshop projects were confined mainly to Scandinavia, India, Great Britain and the Netherlands. Only a minority of these projects have been documented in the literature.

*Box 8. Characteristics of the period of Modern STSD*

"1. A design team representative of (if not elected by) the employees: at the very least, employees agree to a change effort and union representatives usually are redesign team members.
2. Employees receive some training in work redesign concepts and techniques.
3. Participatory search processes initiate the change effort and are not necessarily limited to the design team.
4. The design team develops its own criteria and alternatives (little reliance on installing some pre-designed package).
5. All employees concerned participate at least in evaluating alternatives.
6. There is a high degree of participation in all phases of the redesign process (planning, developing alternatives, evaluating, etc.) which is focused and paced by the people affected (not primarily by management or change experts).
7. Outside experts have a share learning role that changes over time (from some teaching to learning with the participants and eventually to learning from them).
8. There is a supportive network of co-operative relations between design teams from different organisations who learn from each other's experience (they are not entirely dependent on experts for the necessary learning)."

Elden (1979a), p. 250-251; Elden (1979c), p. 373-374

- Even before the 'golden book' was published, 'off-site/do it yourself' workshops were regularly held in Norway as from 1972. Per Engelstad and Lars Ødegaard (1979) reported the monitoring of five of such consecutive year groups, each consisting of six teams from a total of 25 different firms (mass manufacturing, processing industry, batch industry and service sector). In 1975, Max Elden initiated a PD project in a bank (cf. Elden, 1974/1976/1977/1979b; Herbst, 1975; Herbst & Getz, 1977). In the shipping industry, the Work Research Institutes (WRI) in Oslo also performed several PD projects (cf. Roggema & Thorsrud, 1974; Rogne, 1974; Roggema & Hammarstrøm, 1975) Johansen (1975/1976/1979) reported on a PD project on the newly built merchant ship/trading vessel MS 'Balao'. New legislation in Norway provided support for the PD paradigm.
- The same holds for Sweden (cf. Qvale, 1975; Mills, 1978). Unions are allowed to negotiate with the management regarding all kinds of items. With the Industrial Democracy Act, which was adopted by Parliament in June 1976, Sweden led the way in Europe (cf. Gunzburg & Hammarström, 1979). As mentioned in section 2.3, the diffusion of Industrial Democracy projects in Sweden were successful. In 1975 the so-called Demos project started (cf. Sandberg, 1979). The project is concerned with democratic decision-making and (corporate) planning and is aimed at supporting the activities of unions at various levels (centrally and locally - from workplace analysis to negotiations). This project is backed by more fundamental research into the preconditions and limitations relative to democracy, planning and self-determination (Sandberg, 1976).
- In Denmark projects were performed between 1969 and 1973 which could fall under Modern STSD. Agersnap *et al.* (1974) report a number of experiments involving new kinds of cooperation in seven firms in the metal industry (N. Foss' Electric, Hilleroed; Højbjerg Machine Factory, Aarhus; Philips Radio, Copenhagen; Danfoss, unknown location; Haustrup, unknown location; Nordic Cable and Thread Manufacturers NKT, Glostrup; Scandinavian Airlines System, Copenhagen).

- Participative Design was also successful in India (cf. Nilakant & Rao, 1976). In the mid-seventies, the National Labour Institute (NLI) organized seven PD workshops throughout the country. In 1975 a classical Industrial Democracy project was initiated at Bharat Heavy Electricals Ltd. (BHEL) in Hardwar. In 1976, this project was extended with a three-day workshop organized by the BHEL in conjunction with Einar Thorsrud. Apart from a number of departments of this firm, representatives of the National Bank, the postal services and an insurance company participated in this workshop. As Nilakant and Rao (1976) illustrate, Emery and Emery's (1974) directions were closely followed, in terms of both the workshop's organization and the method applied (evaluation of psychological job requirements and the use of the multi-skilling table for outlining a training programme). Subsequently, PD workshops were held in the National Bank and the insurance company.
- Great Britain also gained a great deal of experience with PD. From the Tavistock, projects were carried out from 1974 until 1979 within the Job Satisfaction Research Programme, in conjunction with the Work Research Unit (WRU) of the Ministry of Employment. Researchers actually made use of the PD workshop at Associated Biscuits in Bermondsey. Supported by Margaret Butteriss and Archie MacKenzie of WRU, Mary Weir (1979) organized a PD workshop in Glasgow. Once again, Einar Thorsrud acted as introducing speaker for the teams coming from five Scottish firms (Scottish & New Castle Breweries Ltd., Edinburgh; Philips Ltd., Hamilton; Ladybird Ltd., Glasgow; Ailsa Trucks Ltd., unknown location; Tannoy Products Ltd., location unknown). The work of Enid Mumford is worth mentioning here. She applied the participative approach in a British supplier company, a bank, an engineering firm and an insurance company (cf. Mumford, 1979). Her explicit line of approach included the introduction of computer systems in office settings.
- In North-America and Canada, a careful application of Participative Design has only recently emerged (personal communication with Fred Emery, 1990).

### 3.4 Post-Modern STSD: Democratic Dialogue or Integral Organizational Renewal?

If there is a fourth, post-modern phase in the development of STSD at all, Scandinavia, and in particular Sweden, is without doubt the candidate to take the credit for this 'milestone'. We are referring here to the initiation of a "large-scale change process in a broadly based societal context with democratic dialogue as vanguard" (Gustavsen, 1985/1988/1989). Basically, it is a reaction to the Participative Design approach while placing emphasis on the formation of networks and the development of local theories. According to Gustavsen & Engelstad (1986) the 'Democratic Dialogue' (DD) approach assumes that all interested parties can and should participate. In order to promote DD, the authors mentioned above have defined the conditions in which a democratic dialogue may take place (cf. box 9).

A democratic dialogue can be given shape particularly at organized network meetings. Thus, conferences used as a platform for exchange are placed in a central position in this approach. The DD network philosophy should be placed against the background of years of experience with democratization of the working situation. More specifically, it is a reaction to the modest results of PD. In Scandinavia, PD was brought into practice at (some) large firms in the seventies, but it was

far from being a big success in small and medium-sized companies. This was attributed, amongst other things, to the lack of adequate mutual networks. Both in Norway and in Sweden an attempt was made to change this by means of DD.

*Box 9: Criteria for participation, public arena, and legitimacy*

"1. There must be a clear definition of arena(s) (...) It does (...) imply that the outcome of the conference is built primarily on what has emerged on the official arena.
2. Public issues are the only legitimate ones. This is a corollary to criterion (1).
3. Resource persons act only on the public scene. This is a further expression of criterion (1). Resource persons, such as researchers, (...) can only be used in public and not made accessible to 'off-the-record' consultations.
4. Analysis, problem solving, and decisions, have to build on what has emerged through the public proceedings. (...) For democratic processes to be possible, it must be clear to everybody what facts and other premises for decisions are relevant. (...) Again, the point is to avoid 'hidden' alternatives to which everybody does not have access.
Personal grievances and frustrations are topics which often tend to surface in
5. developmental efforts. They should, however, as far as possible, be kept out of the encounters. Democratic encounters provide a training ground in democratic competence, and are not therapeutic events. (...) However, personal grievances are not without significance (...) it is not easy to distinguish between their 'personal' and 'structural' sides (...) people should as far as possible turn towards the 'structural' side of the issues. In this way, a certain amount of training in democratic dialogue can take place before the more personal issues are allowed to enter the scene. (...)"

Gustavsen & Engelstad (1986), p. 109

In Norway, a national basis emerged for the development of local networks in 1982, when employers and employees jointly agree to support network-oriented activities both professionally and financially. On the basis of the regional experiences gained in this context, the so-called 'Development Organization' (DO) approach develops gradually (Engelstad, 1990). This is a more indirect approach to PD, with the aim of creating a suitable platform for mutual exchange - also for SMEs - and of improving the quality of the mutual dialogue. The DO approach is based on five pillars:

1. the strategy forum;
2. 'company-wide' conferences;
3. project groups beyond departments;
4. basic groups within departments;
5. sociotechnical changes in the daily work organization.

In particular, the first two pillars call for an additional elucidation. The strategy forum is not a steering group in the traditional sense, but the semi-open conditioning body of the network which is also accessible to invited external experts. In order to prevent to the best extent possible drop-outs as a result of employee turnover over years, the forum is composed of two members of each participating party. The strategy forum formulates general objectives, brings together (groups from) the participating cores in the organization network, stimulates fruitful discussions, and maintains contacts with the whole 'broad front' of activities.

With regard to the conferences, it can be said that these were initially largely built up in the same manner as those in the PD tradition. However, they became gradually more focused. Based on the experiences gained with projects in a specific line of business, so-called 'branch projects' (cf. for example the garage-owner project: Engelstad, 1990), the 'Dialogue Conference' (DC) method is developed, a type of PD workshop or search conference for network development. It starts from the assumption that the quality of the dialogue is an important vehicle for the change process. The DC method can be divided into three successive phases:

1. adoption in the branch network;
2. business development process;
3. expansion of the (supporting) network.

During phase 1, the demonstration conference takes place, the strategy forum is composed and regional promotion conferences are held. In phase 2, a 'whole- company' conference is organized, and a part-time expert is admitted to the firm as a 'scholarship holder', paid and supported by the national programme. In phase 3, a 'network development' conference is held to expand the number of participating firms and supporting institutions. The strategy forum acts as initiator and coordinator in all these activities.

The content of the conferences is largely left to the groups participating. However, the order of the sessions and composition of the groups are carefully planned in advance. Take for example the regional promotion conference. This conference is held under 'social island' conditions and lasts two full days. Some 30 to 55 participants from 4 to 7 firms take part, composed as 'vertical slice' groups varying in size from 5 to 10 persons. The plenary opening of the promotion conference is followed by four parallel sessions involving 10 persons at maximum and a plenary reporting session (Engelstad, 1990). In the *first* session, in terms of function homogeneous groups (executive personnel and management) from *different* firms discuss the experienced business environment and its future developments. In the *second* session, the homogeneous manager groups are divided over the groups with executive personnel. These heterogeneous groups discuss the improvements required in a product and in the working environment in each department. In the *third* session, homogeneous groups of executive personnel from *one single* firm are formed together with managers from *other* firms. These heterogeneous groups discuss what *radical other* organizational structures are needed in order to achieve better results. Finally, in the *fourth* session, only personnel from one single firm are brought together, in order to talk about the process of change rather than its structure. The starting point is that *each* individual employee should take part in such change *during* working time.

As previously pointed out, the rational, tripartite stimulation programmes in Scandinavia are highly important in realizing an infrastructure for a democratic dialogue. In Norway, this is the HABUT programme, which stands for 'The Basic Agreement's Enterprise Development Measures'. In Sweden, it is the LOM programme, established by the Swedish Work Environment Fund, and which means 'Leadership, Organization and Co-determination'. Of both programmes, LOM is the most extensive in terms of its content and size. Its most important characteristics are summarized in box 10.

*Box 10: Main features of the LOM programme*

"1. magnitude: more than 80 enterprises and public institutions and about 50 researchers from different institutions all operating within a loosely arranged common framework and forming networks of learning and diffusion. (...)

2. unit of change: a cluster of organizations collaborating with each other and with research. Broadly based approaches within and across organizations feed into processes of intra and interorganizational learning. The strategy is to link these clusters to other enterprises and clusters to form larger diffusion networks.

3. process of organizational change: based on and guided by the uniques of each local development. It rejects a general model for change and works with the notion of developing local theory, that is the local generation and continuous reconstruction of different patterns of work organization. Social research is in a support role to local action.

4. ongoing process: the actual existing experience is to form the base line for each project which therefore cannot be defined as a zero point but is defined in terms of an ongoing process. Participation in the programme commences with a project development conference in which representative vertical slices of the various enterprises jointly make decisions about the organization and direction of their local projects.

5. vanguard: the programme is founded on discourse-oriented democratic theory. Democratic dialogue which encompasses large networks of people forms the vanguard of the approach and determines the direction of local development.

6. infrastructure: the programme uses multi-level strategies which connect local developments to the various elements in the larger infrastructure of Swedisch society. Its points of anchorage in laws, agreements and bi- en tripartite structures and it linkage with the broader social and political structure, make the LOM programme 'reform oriented' rather than 'organization development oriented' (Gustavsen, 1989)."

Van Beinum (1990a), p. 16-17

The LOM programme acts as an umbrella under which separate, regional network programmes are performed. According to Gustavsen (1989) there are more than 100 firms and institutions taking part in this programme which was instituted in 1985.

However, whether or not the Democratic Dialogue as described above actually encompasses a subsequent qualitative leap forward in the development of STSD, or is just a further broadening, development and expansion of Participative Design, cannot, in the early nineties, be determined with certainty. According to Fred Emery (1990, personal communication) a real fourth phase would be characterized by the development of "organizational forms for the management of self-managing work groups". The Dutch approach to 'Integral Organizational Renewal' (IOR) would in such a case be more eligible for the designation of 'fourth phase milestone' (see also section 4.2).

# 4 Developments in the Netherlands

## 4.1 Classical Socio-Technical Systems Design

From the very beginning, the Netherlands has taken an important place in the history of STSD. From the outset, Dutch researchers have been involved in the development and application of the paradigm.
During the period of 1957-1959, Hans van Beinum was the first in the Netherlands to carry out a sociotechnical-tinged field experiment at the departments Transfers of the then Post Cheque and Giro Services (Pcgd) in the Hague under the guidance of Herman Hutte (Van Beinum, 1959/1961/1963 a/b). At the main Current Account department, which employed 1700 personnel, he examined the effects of the introduction of 'stable table groups', of another method of management ('business discussions'), and of delegating power. He did not find differences in productivity between experimental and control groups. However, Van Beinum did conclude that the experimental groups expressed clearly a more positive judgment about their working situation after the introduction of the organizational changes (Van Beinum, 1963b, p. 112). In the sixties, Van Beinum performed a number of other projects, both from the Tavistock (Van Beinum, 1965/1966/1968; Van Beinum & Bel, 1968) and in the Netherlands (Van Beinum *et al.*, 1968/1970). In this connection, it is imperative that we mention René van der Vlist, who - just like Van Beinum - did Tavistock research in Dublin, and subsequently carried out, under the guidance of Mauk Mulder and following Van Gils' tracks, a sociotechnical-coloured dissertation research in order to study the group performance of ship's complement/crew in Dutch offshore fishing (Van der Vlist, 1970). In a follow-up to this study, the effects of naval fishing was examined by Herman Kuipers (1969) through simulation, and reported in a dissertation (Kuipers, 1980).

A second clear representative of Classical STSD is Jacques Allegro. Under the supervision of Hans van Beinum, Allegro started a sociotechnical project subsidized by the Social Economic Council (SER) in 1969 at the cotton spinning mill Bamshoeve in Enschede, which was part of the Royal Dutch Textile Union until 1974. The aims of this project, which was carried out in four parts at the ring spinning mill of the textile company producing fine threads, were as follows:

> "To assist the company in acquiring the skills required to find new forms of task design, organizational structures and general business conditions itself, including - apart from technical points of view - also the material, social and psychological needs of its personnel, as well as their need for knowledge, in order to achieve more extensive commitment and job satisfaction, and if possible to better the performance of the organization."
>
> Allegro (1973a), p. 19

After an initial introduction and presentation, a sociotechnical systems analysis of one of the four production departments of the ring spinning mill takes place in the phase 2. This analysis, based on Van Beinum (1968), is a textbook example of a classical sociotechnical analysis, with much emphasis being placed on the variance control matrix (cf. Allegro, 1975, pp. 139-155). The 'expert'

suggestions for task redesign resulting from this (including a kind of semi-autonomous groups) were received by the spinners with suspicion, because for them, as a result of a variety of circumstances, there was little that actually changed, so that their expectations were not fulfilled; and because they thought they were in a situation analogous to a previous, unsuccessful task-restructuring project which had taken place at the daughter spinning mill Oosterveld, which was shut down shortly afterwards.

In action phase 3, the employees themselves were expected to develop an alternative ('group work') which was tried out on a limited scale, while the working conditions are improved simultaneously. However, this experiment also remained limited to a decreasing number of volunteers for a whole year, and in the end it did not fan out. Meanwhile, the interdisciplinary work group started to work on general improvements (personnel and organization policy/promotion policy). At this time, the project increasingly obtained the characteristics of an organization development programme (Allegro, 1973b, p. 194).

Quite unexpectedly, in 1972 the employees' interest in group work rapidly increases in phase 4, and even other departments shift to group work. At about the same time, the mother concern applied for a suspension of payment, but the Bamshoeve had a lucky escape and was continued from 1974 as an autonomous company, with a new sociotechnical work organization. Allegro gave little or no attention to an exploration of the relevant business environment in this project.

In the second half of the seventies, Allegro & De Vries (1979a/b) performed a sociotechnically-inspired experiment in the administrative sector, namely in the futuristic office environment of Centraal Beheer in Apeldoorn, at the 'Life' Department of this insurance company which was rapidly expanding at that time. In 1975, the project 'Improvement Organization Life' (VOL) was initiated here, subsidized by the Social Economic Council. Its aims were to enlarge employee participation in the work and humanization of the working situation (Glas, 1980). The immediate cause for this 'social experiment' carried out by Allegro and De Vries was the development and introduction of the 'Effective Life Insurance Information System' (ELVIS) initiated from technology. The project consisted of the re-introduction of work consultation in 25 groups at the life insurance department and the experimenting of a contract (client)-oriented approach. A preliminary try-out consisting of three contract control groups turned out to be a success. More emphasis was placed here than at the Bamshoeve, on the training of group supervisors as another way of monitoring. The researchers spoke of an integration of a task-structural and group-dynamic approach, of structure and culture. Nevertheless, this could not prevent the opposite tendency from taking place in 1978, when a division structure was introduced at Centraal Beheer causing it to go back to more transaction-oriented work. It appeared that the project was bogged down at the micro-level. The management, works council and unions had shown little interest in the project.

Coinciding with the above-mentioned projects, pioneering work was performed in the sixties and seventies at Philips in the area of Work Structuring (Van Beek, 1964; Does de Willebois, 1968; Den Hertog & Kerkhof, 1973; Den Hertog & Vossen, 1975). This work concerned itself mainly with curative redesign projects in various plants which were not influenced directly by, but show a strong resemblance to projects from the tradition of Classical STSD. In discussing a number of these Philips projects, Den Hertog (1977) concludes, among other things, that the numerous experiments remained limited to the department where they had been initiated and did not fan out to the rest of the

organization. There was a need for a new approach which would give more preventative attention to the design stage, and which would additionally involve more integral activities to restructure the *entire* organization. Philips subsequently chooses for organizational renewal (Den Hertog & Wester, 1979). A more detailed description of Work Structuring can be found in Van Assen & Den Hertog (1981/1984).

In 1966, a group of business sociologists from the Free University (VU) in Amsterdam under the guidance of Van Zuthem carried out research into developments in the Dutch relations relative to employee participation. A good example of this would be the research by Van Zuthem and Wynia (1967), which asked 636 employees from 42 separate industrial enterprises for their opinion regarding participation. Van Zuthem (1978, p. 43) defines participation as being a situation in which employees decide upon policy together with others (particularly the management and financiers) either directly or indirectly. According to Van Zuthem, the business democracy in the Netherlands can be typified as a control democracy rather than a co-determination democracy. 'The development of employee participation in our country is arranged largely in (national) acts (such as the 1971 Second Works Council Act), and not, as for example in the United Kingdom and Norway, through agreements between employers and employees' (Van Zuthem, 1978, p. 47). The VU research was concentrated upon the processes of institutionalization and of participation and their impact upon the division of power within the organization and between employers and employees. Under the guidance of Van Zuthem, Ramondt (1974) performed a secondary analysis of many of the previously mentioned (and other) Work Consultation and Work Structuring experiments from the perspective of business management and industrial relations. He concluded, among other things, that the management control the initiative and that the relevance of the experiments to the employees was systematically overrated. In addition, inadequate attention was given to describing the policy process in such projects. Ramondt observes that Work Consultation and Work Structuring should be viewed as being separate from other ways of promoting employees' interests such as that through Works Councils and unions.
Following up on that, Walravens (1977) carried out a series of field experiments with what he refers to as 'Industrial Democracy' with the same research group. These project were concerned with work consultation and task structuring at the Worsted and Ironing Spinning Mill Swagemakers-Bogaerts in Tilburg, and at the packaging firm Thomassen & Drijver-Verblifa in Oss. The total organization with all its policy levels and relevant environment were the express object of research here. These projects show a clear resemblance with the Norwegian ID projects described in section 3.2. Walravens opted for:

> "(...) a development and institutionalization of bottom-up participation, but in order to guarantee success and continuity, all levels are continuously involved in the changes. Characteristic (...) is the attention given to the relationships of the enterprise with the organizations or parts of organizations that are relevant to its functioning, such as works councils, unions, employers' organizations, (...) and the government".
>
> Walravens (1977), p. 247

Walravens actually carried out two projects and concluded that the success and permanence of the organizational change depended on the extent of responsibility which the employees have themselves. At the same time, however, he remarks that there existed little enthusiasm in Dutch firms in 1977 to experiment with enlarging participation.
The above-mentioned business sociological studies have contributed to the insight that the exclusive application of a micro-approach relative to humanization of work is too limited to achieve structural improvements in the area of Industrial Democracy. A critical note regarding these studies is that they particularly analyzed the *effects* of work consultation (from the legitimate recognition of participation), rather than the *conditions* which necessitate them (the operational problems relative to production control) (De Sitter, 1974a, p. 69).

Looking at the projects portrayed in this section, the Dutch contribution to Classical STSD can be described as being extensive. Remarkably, the same shortcomings of this 'expert-driven' approach have come to the fore, namely little acceptance, disappointing diffusion and hedging in of projects.

One Dutch contribution to the development of STSD which helped in the breaking of new ground was provided by Ulbo de Sitter. He was the first to formulate objections against the original paradigmatic elaboration of Classical STSD both in terms of content and methodology. The most important items of his fundamental criticism are briefly summarized in box 11.

*Box 11: A summary of the most relevant objections against the original foundations of Classical STSD*

" - the inadequacy of static structure concepts used;
- the logical contradiction of sociological value and psychological need postulates proclaimed into axioms, which exclude one another;
- the impossibility of the use of models which are partial in their cores at different aggregation levels, and as an extension, the impossibility to arrive at an integral
- approach;
the logical insolubility of a, once assumed to be unambiguous, relation between the
- form of behaviour and its function;
the impossibility to trace so-called 'operational disturbances' caused by processes obstructing each other, within a static, partial model."

Adapted from: De Sitter (1974a), p. 70-72
Source: Van Eijnatten (1985), p. 53

De Sitter's objections are concerned with, among other things, the outdated system-theoretical foundation of the paradigm and with its partial and static elaboration as socio-scientific approach in the aspect area of the quality of work. Van der Zwaan (1970/1971/1973) also points to the lack and insufficient specificity of the definitions used. These should, in his view, be determined by the exchange axiom of social systems. In view of the minimum availability of numerous 'Tavvi' documents in which Fred Emery in particular has performed much significant conceptual digging, one may wonder whether all this criticism is justified. It is my conclusion that, even after having read these development papers and considering the directive correlation methodology, the above-mentioned points of criticism do actually cut ice. Briefly summarized, the most relevant theoretical

and methodological objections, opened up by Van der Zwaan (1975) to the international forum, are as follows: insufficiently precise definition of basic concepts, inadequate attention for the system/environment relationship, the incorrect system-theoretical distinction between a social and technical *sub*system, the too strong reduction of the social system into a mainly psychological entity, and the inadequate separation of the analytical and the design models. The latter point focuses on the improper use of the Variance Control Matrix (cf. section 3.2.) for redesign purposes. As De Sitter *et al.* (1990) underline, an analysis of disturbance sources coupled to disturbance controllers is only useful to explain the operation of the *existing* architecture of the production system, but is absolutely unsuitable for giving shape to a *renewed* structure, since it is organized in a totally different manner.

The above-mentioned objections have instigated the development of a new theoretical framework. As an extension to the epistemological work of Luhmann (1968a/b) and Elias (1970), and taking into account the results of the Habermas/Luhmann (1971) debate, De Sitter, in cooperation with other business sociologists, produced a new theoretical foundation for Classical STSD from Eindhoven University of Technology in the mid-seventies (cf. De Sitter, 1974a/b; Van der Zwaan & Vermeulen, 1974; Van der Zwaan *et al.*, 1974; Smets & Van der Zwaan, 1975; De Sitter & Heij, 1975), which was adjusted in the early nineties regarding some minor points.
First, De Sitter broadly describes STSD as the study and explanation of the manner in which technical instrumentation and the division of work determine [system behaviour, capacity and functions] in their mutual connection and in relation to given environmental conditions, as well as the application of this knowledge in (re)designing production systems (De Sitter, 1974a, p. 76). Fifteen years later he replaces the part between brackets in the previous sentence by "the possibilities for the production of internal and external functions" (De Sitter, 1989, p. 232). For a graphic representation of the core variables from this complex definition and their relationships, see Figure 3.

*Technical instrumentation* is defined here as the technical equipment of people and means (in terms of capacity). *Work division* is defined as the grouping, allocation and coupling of executive and regulative functions. This is concerned with the separation of executive and regulative tasks on the one hand, and the splitting or division of executive and regulative tasks in sub-operations and subregulations respectively. De Sitter (1980/1981a) speaks of "the architecture of production control" and distinguishes four basic types of work division which he does not specify in more detail (p. 44/p. 119).
In the above description of STSD, De Sitter stresses that in particular, it is the nature of the *inter-dependence* between technical instrumentation and work division which influences the behaviour of the system, in terms of internal (directed towards purchase, preparation, manufacturing and sales) and external system functions (directed towards various 'markets'). Basically, De Sitter develops a process theory of change, which he designates with the term 'Model of Balance', in which the dynamics of cyclic interdependencies (both cause and result, compare the principle of the servo-controlled mechanism) is put central.

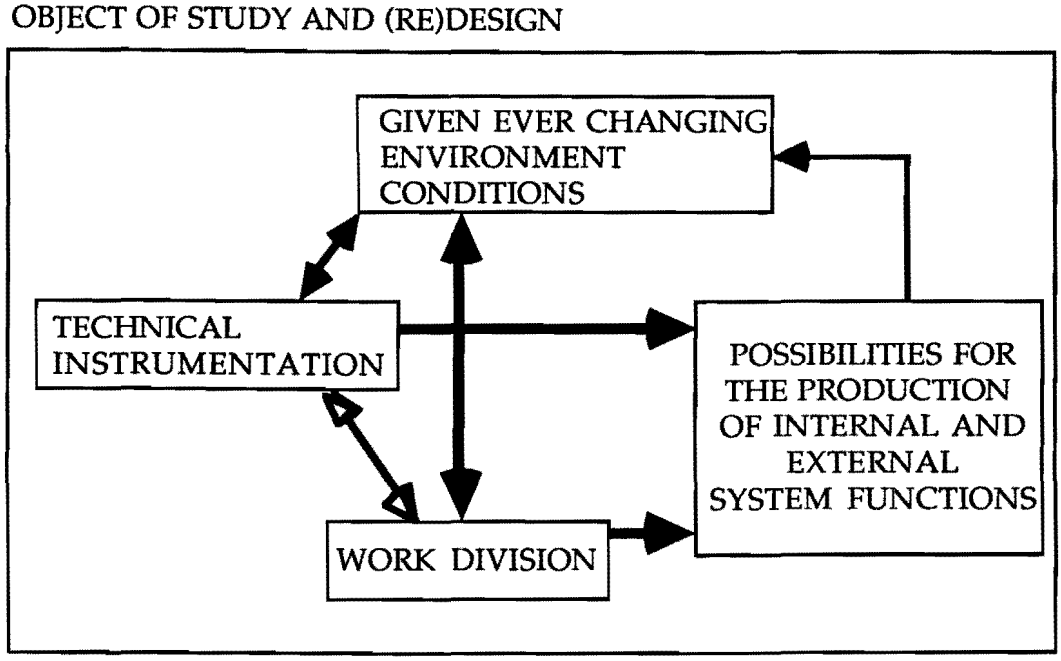


*Figure 3: STSD, a graphic representation*
*Legend:* ⟷ *interdependence*
⟶ *determining relationship*

Adapted from: Van Eijnatten (1985), p. 55

An explicit point of attention of the Model of Balance is the structure of the selective labour process. The quantitative aspect of the labour process is the volume of goods and services exchanged, the qualitative aspect is the continuity and development of work relationships (De Sitter, 1989a). The labour process is viewed as an intersection of various institutional and private exchange processes; needs and values are considered as being *changeable* social processes cultivated by society and brought into the work situation by individuals and groups. According to De Sitter, giving meaning is a function which is inherent in selective social processes which is closely connected to the regulation of the labour process: "What structural conditions must my labour process comply with in general, in order for me to solve changeable numbers and types of problems in time and participate in the process of giving meaning?" (De Sitter, 1978, p. 9).
Without regulative components in work, alienation occurs; but on the other hand, regulations provide involvement in work. Stress occurs when someone has problems and is unable to solve them. Using this model, which basically is applicable to all kinds of social systems, thus including firms, one is able to describe the dynamic process in a simple and economical manner, in which open system and environment follow from each other's change in a constant manner again and again, in different ways. As such, the model is a system-theoretical alternative to Emery's directive correlation methodology. In his elaboration, De Sitter concentrates primarily upon interaction conditions, upon conditions for structure. The operational problems in production control are the explicit point of departure.
Once again: De Sitter makes a conceptual contribution here which breaks new ground. In 1973, he

had already published a well-defined and coherent system concept framework, including the 'empty cartridge' concept of *'aspect-system'* unknown to Tavistock (cf. De Sitter, 1973). In the same article, a strongly condensed effort can also be found to fill the 'mould' of systems approach in terms of its content, by means of what is referred to as "a scheme of interaction strategy" (p. 138). De Sitter directs his theory towards social interaction in which he integrates segments of value, regulative and power theory. He calls the product "a theory of qualitative system dynamics" (p. 113). After 1973 this scheme was converted into a more verbal model (De Sitter, 1978). Central in the Balance Model is the so-called 'interference' phenomenon, an effect which occurs in a situation where one process operation is disturbed or even totally obstructed by another. De Sitter describes interference as follows:

> "(...) the chance that two or more interaction processes meet each other in the labour process, and as a result of their normative and/or material incompatibility, cause a disturbance which tends to affect the interaction possibilities which come into being through the labour process".
>
> De Sitter (1978), p. 15

The core of the new process model for Classical STSD is either preventing or curing interference and its diffusion in the system. This can be effected by means of regulation. Regulation can be broadly defined as keeping in balance processes fine-tuned to *different* functions in a system. The Balance Model uses the feedback loop as a basic model of the labour process. In the feedback loop, it is preferable not to separate and divide implementation (realizing connections) and regulation (selecting connections), but rather to integrate them (principle of minimal labour division).
The Balance Model, as well Classical STSD, departs from the so-called 'latitude premise', an assumption regarding control scope which is founded on the cybernetic 'Law of Requisite Variety' used as an axiom (Ashby, 1956a). This law roughly states that the external variability of the environment (turbulence) as input can be only compensated for or cancelled by a proportional internal variability of the open system (*un*programmed production control/latitude). De Sitter (1978) defines the variability of the input as control need, and the potential open systems variability as control possibilities. The balance between control need and control possibilities is defined as the quality of work.
A key concept in the Balance Model is 'control capacity'. According to De Sitter (1978), this concept does "not refer to authority but to control *possibilities* resulting from the objective nature of the labour process" (pp. 20/21). In 1980 he briefly defined control capacity as the problem-solving of disturbance reduction capability: "In actual practice the control capacity present manifests itself in the disturbance sensitivity of the process, thus in the extent to which a disturbance is reproduced without the possibility of reducing it through regulative action" (p. 69). According to Van Eijnatten (1985, p. 402) (internal) control capacity as a concept refers to a structure condition of the labour system in which it is possible to choose from alternative activities in order to achieve the production norms in different situations and under changing circumstances. A similar choice from possible situation leads to actual regulation (fulfilling a function). De Sitter states that latitude provides control capacity in order to reduce interference.
As pointed out earlier, in an objective sense there exists an adequate quality of work when the

control capacity is relatively high and fine-tuned to the existing control need (the complexity of the exchange relationship in terms of work orders, process specifications, time and work pressure). Karasek (1979) defines this combination as "the active work with social and technical learning opportunities". This American researcher made use of two sample surveys - the Quality of Employment Survey (USA, 1979, N=1016); and the Living Conditions Survey (Sweden, 1968/1974, N=2281) - to check the impact of work pressure (the amount of work, variance, and precision of assignments) and 'control capacity' (knowledge, skills, available technical resources and consultation possibilities) on absenteeism and dissatisfaction with work. He found that in the condition of combined high work pressure together with various control possibilities the scores regarding both dependent variables were *lowest*. De Sitter predicts - and this has been confirmed in a large number of cases in practice (cf. De Sitter, 1981a; AWV/NIA, 1990) - that the production result in this situation would also be optimal. Karasek (1990) demonstrated that there exists a negative relationship between 'job control' and health risk in a sample survey of 25% of all office staff in Sweden (4481 men and 3623 women).

Measuring instruments for control capacity (and latitude) have been developed in the course of time by De Sitter & Heij (1975), Egmond & Thissen (1975), Van Eijnatten (1985), Pot et al. (1989a/b) and De Sitter (1989c).

### 4.2. Modern STSD in the Netherlands

In the late seventies, the Dutch variant of STSD became increasingly broadened and in the late eighties developed into the approach of 'Integral Organizational Renewal' (IOR). Due to a stagnating economy combined with increasing competitiveness, attention was once again focused in and outside the Netherlands on the collapsed Tayloristic organization concept. The demand for unskilled labour posed more and more problems in relation to the qualitatively high supply of labour and changed opinions regarding the function of work in a welfare state. Markets became increasingly turbulent and called for more rapid reactions of the production organization. High wages and participation necessitated entrepreneurs to change their attitudes. It was high time for a new elan, fed by an emerging 'no nonsense' mentality. In the early eighties, new opportunities arose for the application of STSD, because the quality of work was no longer viewed as a social luxury, but as an essential foundation for a flexible production organization. De Sitter observes these developments, and places the production and work organization in a socio-economic perspective (De Sitter, 1980). He was the first to connect themes as the quality of working life, efficiency and effectiveness, as well as social binding and cooperation in a model. Following up on that he pleads for 'new factories and offices' based on modern STSD (De Sitter, 1981a). In these publications he stands up for more policy-based integration of the areas of attention of the quality of work (with stress and alienation as problems), the quality of the organization (with flexibility and controllability as bottlenecks), and the quality of the internal industrial relations (with employee turnover, absenteeism and labour conflicts as central issues). He points out that the issue of industrial democracy has traditionally been fragmented in the above-mentioned problem areas which are separate studied by psychologists, sociologists, economists and organization scientists. This has resulted in the well-known 'engineering, personnel and union-management approach',

having as respective orientations *isolated* improvement of the quality of the organization, work and industrial relations (cf. table 1).

*Table 1: Three types of partial analysis in the study of participation*

| type of approach | democratic 'idea' | object of reform | object of analysis | expected function | quality level |
|---|---|---|---|---|---|
| the engineering approach | participation in managerial functions | primary process regulation, boundary control between work units | production control structure | organizational performance | quality of organization |
| the personnel approach | integration of productive and regulative task functions | autonomy and discretion | task structure | work motivation | quality of work |
| the union-management approach | representation of collective interests | regulation of working conditions and the distribution of rewards | structures of collective representation, rules and procedures | stability of cooperation, effective conflict regulation | quality of labour relations |

De Sitter (1981b), p. 6

In the above description of STSD, De Sitter stresses that in particular, it is the nature of the *interdependence* between technical instrumentation and work division which influences the behaviour of the system, in terms of internal (directed towards purchase, preparation, manufacturing and sales) and external system functions (directed towards various 'markets'). Basically, De Sitter develops a process theory of change, which he designates with the term 'Model of Balance', in which the dynamics of cyclic interdependencies (both cause and result, compare the principle of the servo-controlled mechanism) is put central.

De Sitter very well recognizes the functional relevance of participation in decision-making as a vehicle for industrial democracy in order to have a synergetic effect on the above-mentioned problem areas. Thus, Modern STSD is a fact in the Netherlands. For an operational definition of participation, see box 12.

In 1981 the Dutch Institute for the Promotion of the Quality of Work and Organization (NKWO) was established. The objective of this foundation is to train business executives of all levels in sociotechnical principles, in order for them to take control of the redesign in their own firm (compare the approach of Participative Design in section 3.3). NKWO propagates Integral Organizational Renewal (IOR). According to De Sitter (1989a), an integral approach is a structure approach by definition. By 'structure' he means that part of a process which in relatively invariant in time (nature of the operations, norms). The core of an integral approach is "that on the basis of a strategic orientation external function demands are determined. (...) Problems in the

business management are evaluated in the light of the function demands ..." (De Sitter, 1989a, p. 36). He refers to settling those problems that can be solved independently of one another as 'improvement' (partial change in structure), and to settling interdependent problems as 'renewal' (integral change in structure). In De Sitter's view, renewal basically means the reordering of process functions with respect to order flows. De Sitter (1989a) typifies IOR as a fundamental shift from the old functional production concept to the new flow-oriented production concept.

*Box 12: Indicators of participation*

"a. the number of regulative functions performed;

b. the levels of regulation implied in a work role:
- internal regulation;
- external regulation;

c. effectiveness or influence:
- task complexity;
- substitutability;

d. symmetrical interdependence".

De Sitter (1981b), p. 8-12

Integral design is at the core of the IOR approach. A basic problem is the ability to control the production system as a whole; the objective of STSD is to improve this ability by means of changes in structure. The Balance Model discussed earlier acts as the core of IOR in terms of content; interference and control capacity are its central concepts.
The core of sociotechnical research consists of making an inventory of market demands and performance criteria (cf. Bolwijn *et al.*, 1986; Bolwijn, 1988; Bolwijn & Kumpe, 1989; Kumpe & Bolwijn, 1990), and, in its extension, the identification, analysis and introduction of structural parameters which together must reduce the chance of disturbance and sensitivity taking place (cf. box 13).

Performance and control are the basic functions here. Initially, De Sitter distinguished between two basic aspect-systems: the Production Structure (P) as grouping and coupling of executive functions (performance), and the Control Structure (C) as grouping and coupling of regulative functions (control). Later, these were expanded by the Information Structure (I) as technical elaboration of P and C. A whole series of design principles were formulated in the eighties (cf. box 14).
Giving shape to the production structure through parallelization and segmentation drew special attention. This is really concerned with a method to fundamentally change the organization of the technical processes, which is an explicit objective of the sociotechnical paradigm. The IOR approach pays a great deal of attention to the parallelization of order flows. For an elaborate study on the possibilities of Product Flow Analysis (Burbidge, 1975) as a technique for parallelization, see Hoevenaars (1991).

*Box 13: Structural parameters for sociotechnical analysis and design*

1. Functional (de)concentration: Grouping and coupling performance functions with respect to order flows (transformations). There are two extremes: all order types are potentially coupled to all sub-systems (concentration), or each order type is produced in its own corresponding sub-system (deconcentration in parallel flows).
2. Performance differentiation: Separating the preparation, supporting and manufacturing functions into specialised sub-systems.
3. Performance specialisation: Splitting up a performance function into a number of performance sub-functions and allocating them in separate sub-systems.
4. Separation of performance and control functions: Allocating a performance and corresponding control function to different elements or sub-systems.
5. Control specialisation: Allocating the control of functional aspects to separated aspect-systems (quality, maintenance, logistics, personnel, etc.).
6. Control differentiation: Splitting feedback loops into separate control levels (strategic, structural and operational).
7. Division of control functions in the feedback loop: Allocating 'sensing', 'judging' and 'action selection' functions to separate elements or sub-systems.

Adapted from: De Sitter (1989b), p. 234
De Sitter *et al.* (1990), p. 12

In addition, the formation of the control structure has also been elaborated upon in detail (cf. Landré, 1990; Van Amelsvoort, 1989/1991). Also, the exploration of the information aspect is given attention (cf. Van Eijnatten & Loeffen, 1990).
The IOR approach moreover distinguishes explicit design sequence rules (De Sitter *et al.*, 1986; De Sitter, 1989b; De Sitter *et al.*, 1990). Thus, the production structure should be given shape preceding the control structure and the design of process technology, and the design of control circles should be in the order of allocation, selection and coupling.

Apart from the content of the (re)design, the process of change also receives full attention. IOR suggests a renewal trajectory of two to four years (Den Hertog & Dankbaar, 1989; De Sitter *et al.*, 1990) including a strategic exploration, on-the-job-training and training for self-design, as well as project phasing and management. The IOR approach is internationally called the Dutch variant of (Post) Modern STSD. For the most relevant conceptual differences with the mainstream approach, see box 15.

*Box 14: A selection of design principles from the IOR approach*

| | Design strategy | Structure | Level | Parameter |
|---|---|---|---|---|
| a. | Parallelisation | P | macro | 1 |
| b. | Segmentation | P | meso | 2+3 |
| c. | Unity of time, place and action | B | micro | 4 t/m7 |
| d. | Bottom-up allocation of feedback loops | B | micro, meso | 4 |
| e. | Uncoupling of feedback loops in time | B | meso | 6 |
| f. | Building in feedback loops in each task | B | micro | 1 t/m7 |

Adapted from: De Sitter (1989b), p. 237-249
De Sitter *et al.* (1990), p. 13-19

Various teams are working on the development of (parts of) the IOR approach in the Netherlands:

- Until 1988, the research team 'Quality of Work and Organization' (KWO) at the University of Nijmegen worked on a follow-up to the Socio-Technical Task Analysis (STTA): the conceptualization and application of the Flexible Labour Systems Approach (BFA); cf. Van Eijnatten, 1987; Koopman-Iwema, 1986. This research was concerned with a practical approach that would give shape to the task structure at the micro-level (building in steering capacity, control capacity and latitude in labour tasks) on the basis of a design philosophy in which points of view showing insight into human nature are discussed in their mutual interaction with business administration as well as other aspects. It concentrated on a bottom-up approach and on the function demand 'quality of work '.
- The Group STSD at Eindhoven University of Technology worked on the conceptualization and application of the Flexible Firm Approach (BFB) until 1986; cf. De Sitter *et al.*, 1986. This project was concerned with a design paradigm involving the top-down redesign of the production structure and the bottom-up redesign of the control structure. This approach encompasses all levels, but emphasizes the macro- and meso-levels, using mainly 'controllability ' as function demand, and is directed specifically to the logistic aspect.
- From 1988 research teams at Eindhoven University of Technology have been working on the methodological elaboration of IOR (cf. Van Eijnatten & Hoevenaars, 1989), the integration of BFA and BFB into the Flexible Organizations Approach (BFO), cf. Van Eijnatten et al., 1988/1990; and on its documentation (Kuipers & Van Amelsfoort, 1990; Van Eijnatten 1990a/b; Van Eijnatten et al., 1991). Some essentials of the IOV approach have been reported in the literature under the denomination of 'the Approach to Flexible Productive Systems ' (AFPS).

*Box 15: The most relevant differences in terms of content between the mainstream approach and the Dutch variant of STSD*

SOME CONCEPTUAL DIFFERENCES

| | TRADITIONAL STSD | DUTCH STSD |
|---|---|---|
| definition of system components (aspect-systems) | social system (S)<br>technical system (T) | production structure (P)<br>control structure (C)<br>information structure (I) |
| main (re)design objective(s) | quality of work (partial improvements) | flexibility (integral renewal)<br>controllability<br>quality of work |
| (re)design scope/ aggregation level of intervention | work groups<br>micro | total organisation<br>micro-meso |
| basic concepts | open system<br>responsible autonomy<br>self-regulation | integral design<br>controllability<br>interference<br>control capacity |
| main (re)design principles | minimum critical specification<br>redundancy of functions<br>requisite variety<br>incompletion<br>human values | parallelisation of P<br>segmentation of P<br>unity of time, location and action (C)<br>uncoupled control cycles whenever possible (C)<br>control capacity built in every task |
| main (re)design strategies | reaching the 'best match' between technology and organisation (ideal of joint optimization) by using:<br>- search conference<br>- 9-step method (variance control)<br>- participant design | reduction of complexity by obtaining a balance between required variation and available opportunities for process variation, both brought back to acceptable minimum levels, advocating informed self-design:<br>- including all aspects<br>- at all levels<br>- with all parties |
| form of work organisation (self-regulating units) | semi-autonomous work group<br>discretionary coalitions | whole-task group<br>semi-autonomous work group<br>operational group<br>result-responsible unit<br>business unit |

De Sitter et al. (1990), p. 27

- NKWO/Koers has been working ever since its inception on the implementation and practical application of IOR and the development and implementation of a sociotechnical training programme for business executives (cf. the journal 'Richtingwijzer' and Ligteringen, 1989).
- Since its creation in 1988, the Dutch research stimulation network Technology, Work and Organization (TAO) has prompted research into IOR. The Maastricht Economic Research institute on Innovation and Technology (MERIT) coordinates these activities and has joined international networks (cf. Den Hertog, 1988a/b; Den Hertog & Schröder, 1989).

# 5 The Future of the Socio-Technical Systems Design Paradigm

The sociotechnical approach is now more than 40 years old. In the four decades of its existence, the paradigm has developed from a coincidental re-discovery of a flexible form of work organization in a British coal mine, into an integral alternative to Taylorism dating from the beginning of the Industrial Revolution. The open system and self-regulation are its key concepts. In the course of its existence, the sociotechnical approach has been rejuvenated and renewed time and time again:

- In the pioneering phase of Tavistock, the mine studies were globally founded in theoretical terms with a hybrid system of concepts, derived from the rapidly emerging revolutionary system thinking.
- In the period of Classical STSD these conceptualizations were expanded, adjusted in more detail in terms of content, made logically consistent, and founded in method(olog)ical terms.
- During the period of Modern STSD, models and methods were brought into line with developments in systems 'do-it-yourself' method.
- In the period of Post-Modern STSD, emphasis was increasingly placed on the formation of inter-organizational networks and integral production renewal.

However, despite these external metamorphoses, the ultimate objective of STSD never got lost: the integration of aspects was and still is of paramount importance. This integration thinking will continue to be prevalent in the future. In this context, Van Beinum (1990b) predicts a shift from sociotechnical to socio-ecological design. The organization *plus* its environment will be both object and objective of change. In Sweden, the LOM programme (cf. section 3.4) is a forerunner of such an approach. Also De Sitter (1990, personal communication) speaks of a similar development. He points to the ecological environment as a relevant new function demand for the integral design of production organizations.

Meanwhile, the complexity and unpredictability of the environment takes 'vortical' forms; the new Swedish Volvo plant of Uddevalla experiments with full parallelization of the production process of the Volvo 740 (Janse, 1989), in which autonomous workplace teams assemble a *complete* passenger car (learning time one year and a half, cycle time more than two hours, construction kit consisting of more than 1500 components and subassemblies); in the United States one is more and more willing to pass into a more integral and participative STSD approach; and from Japan comes the futuristic idea of 'Holonic Production Systems', i.e. decentralized adaptive assembly systems built up from autonomous cells, involving 'Human Integrated Manufacturing' (HIM), a concept in which man takes part in one or more holons, brings in the creativity and makes decisions, while the equipment provides the adaptive implementation (Sol, 1990). These and other developments will largely co-determine what new appearance STSD will evolve into in the nineties. But it's only the form that will change, not its function!

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