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From Complex Organizations with Simple Jobs to Simple Organizations with Complex Jobs

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Organization redesign has become widely accepted as a regular task for management, recently invigorated by the interest in Business Process Reengineering. In spite of that, it is still a neglected area in organization science. This paper emphasizes the importance of design theory and design-oriented research. The potential role of design theory is exemplified by the description of Integral Organizational Renewal (IOR), a design theory grounded in practical experience in the Netherlands. This approach can be viewed as a Dutch variant of Sociotechnical Systems Design. The essence of this approach lies in the transformation of complex organizations offering simple jobs into simple organizations offering complex jobs. IOR can both be regarded as an expert approach and as a route for self-design. The approach enables the members of the organization to develop and use their own design expertise. IOR is therefore not only a strategy for organization design, but for organization development as well. The paper points to opportunities to make organization research more relevant to organization practice.

KEY WORDS: organization design; systems theory; sociotechnical systems design; participation.

INTRODUCTION

This paper is concerned with the links between organization science and organization design. It explains a specific design theory that fits into a broader European tradition of organization redesign. This theory is a Dutch variant of sociotechnical systems design, referred to here as: Integral Organization Renewal (IOR). IOR theory has emerged during the last 20 years from intensive cooperation between consultants, organization researchers, professionals, and managers in industry and services. The main objective of IOR

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has been to develop a systematic approach to design which supports improvements in both the quality of work and what is called "the quality of the organization" (i.e., its ability to deal with a complex and continuously changing environment). Meanwhile, the theory has been applied by dozens of Dutch firms and is taught in more than ten institutions of higher education. Its development can be regarded as a continuous iteration between theory and practice and has resulted in a coherent set of design principles, design rules, and design sequences. As such, IOR can be regarded as a "grounded theory" (Glaser & Strauss, 1967), i.e., a theory using abstract concepts to describe and analyze a series of general phenomena, but based on practical experiences. As will be shown, IOR is based on a critical reception of the classical approach in sociotechnical systems design (cf. van Eijnatten, 1993). After a brief description of the basic principles of IOR, both from a design and from a development perspective, this paper offers some reflections on the implications for the development of organization science.

TWO OPTIONS FOR COPING WITH THE ENVIRONMENT

Organizations which are confronted with increasing uncertainty and complexity have to invest in organizational redesign in order to survive. They are facing a choice between two basic options (cf. Galbraith, 1974). The first option is to restore the fit with the external complexity by an increasing internal complexity. New organizational functions are created in this strategy to react adequately on the external developments (see Appendix A). This usually means the creation of more staff functions or the enlargement of staff-functions and/or the investment in vertical information systems. Staff is needed in this option in order to coordinate the actual work process which remains organized on Taylorist principles. One might call this the strategy of "complex organizations and simple jobs."

In the second option, by contrast, the organization tries to deal with the external complexity by reducing the internal control and coordination needs. This is done by the creation of self-containing units and lateral groups (Galbraith, 1974). An essential condition for this approach is that the (primary) work process itself is fundamentally tackled, by changing fragmented direct tasks in meaningful larger tasks and by re-integrating "thinking and doing" or "indirect" and "direct" tasks. This option might be called the strategy of "simple organizations and complex jobs." The option results in: less support (indirect) staff, less bureaucracy, and better jobs on the shop floor or office floor.

The development of the classical Sociotechnical Systems Design (STSD) Theory (Emery, 1959; Emery & Trist, 1960; Emery & Thorsrud, 1969; van Eijnatten, 1993) has been an important step in the development of organizational design theory along these lines. It has made clear that there exists an alternative for the process of continuously ongoing bureaucratization. Furthermore, the classical STSD theory has offered a systems framework with a high validity in the practice of organizational design on the shop floor level. However, there has been also a lot of criticism regarding the classical STSD approach. Pava (1986) states in this respect that STSD is ready itself for redesign, because in his perception there has been hardly any progress in the development of concepts and instruments and a stagnation in empirical field research. The classical STSD did not get beyond standard solutions like the semi-autonomous group and standard instruments, like the nine-step model and the variance matrix. Scandinavian writers (Sørensen, 1985; Gustavsen, 1992; Gustavsen & Engelstad, 1985) point to the lack of diffusion of STSD. In their view, the sociotechnical approach has been too strongly dominated by expert knowledge which is introduced from outside the organization. Because of this overdependency on external experts and external ideas, projects did not become self-propelling, nor did they work out as "self-selling" examples of best practice. Gustavsen and Engelstad (1985) therefore argue in favor of a process-oriented rather than a structure-oriented approach: the development of democratic dialogues in which members develop their own local theory.

The Dutch approach has developed in close interaction with debate and practice in Scandinavia. This has resulted in the adoption of a participative approach of design as outlined below. The Dutch approach, however, has also retained a strong expert component, which has particularly profitted from the work of Swedish practitioners in the Swedish automobile industry.

THE STSD TRADITION IN EUROPE

There exists a long tradition of work design and organization design in Europe, particularly in Northern and Western Europe. To a large extent, this tradition dates back to the 1960s, a period of enormous industrial growth accompanied by a rapid increase in the average training and education level of employees. This caused a gap between the capabilities and ambitions of workers on the one hand, and the monotonous and degraded work in mass manufacturing on the other. This gap became visible in high levels of personnel turnover and absenteeism, as well as in the decreasing quality of products and services (den Hertog, 1977; van Assen & den Hertog, 1984). The "machine bureaucracy" faltered and got stuck at the moment it was supposed to produce more output. Labor appeared to be a vulnerable spot in the complex structures that industrial engineering had produced. A number of large firms, including Philips, Olivetti, Volvo, SAAB, VW, and Renault, were looking for alternatives to the mechanistic work systems. An important source of inspiration was provided by the sociotechnical systems approach, which was particularly successful in Northern Europe (Emery & Thorsrud, 1969). STSD was accepted as a common framework by labor market parties as a way to improve both motivation and productivity and to give shape to industrial democracy on the shop floor. It is characteristic of the European tradition that the developments in firms and the cooperation of firms with social scientists from universities was strongly supported by the public authorities. Cooperation between social scientists, the trade unions, and the business community was encouraged by way of long-term development programs in Norway, Sweden, Germany, France, and The Netherlands (cf. Dankbaar, 1987; den Hertog & Schröder, 1989). A comparable development can be observed in Australia (Mathews, 1994).

This tradition, resulting from a period of boom, has survived the change in the economic tide in the 1980s and 1990s, but not without a clear shift in emphasis. The relevance of the quality of work is still recognized, but the need to improve productivity and flexibility of the organization is receiving more attention. The focus of these programs and projects has shifted and broadened from work design to organization design (cf. de Sitter, 1994). In the related theoretical research, the objective has become to find design principles that do not only lead to improvements in the quality of work, but also contribute clearly to an increase in organizational flexibility and product quality and to reduction of bureaucracy. Furthermore, organization redesign has been more explicitly recognized in these programs as a key to effective introduction of modern production technology (Agurèn, 1989). This development toward organization redesign was reinforced by closer interaction with the strong engineering traditions in these countries, particularly in such countries as Germany and Sweden.

The development of IOR in The Netherlands has to be viewed in this perspective. During the mid-1970s, The Netherlands had already proven to be fertile ground for experimentation in work design. The leading company in this field was Philips (van Beek, 1964; den Hertog, 1977, 1978b), where more than 50 experimental sites were set up at the time. However, the diffusion of these new practices to other plants and other firms was slow if not completely absent in the late 1970s. Analysis of the reasons for this lack of diffusion (den Hertog, 1978b; van Assen & den Hertog, 1984) at the time revealed a difficult paradox. On the one hand, the lack of diffusion could be explained by the weakness of the way in which the workers involved actually participated in the redesign process. The design process was, irrespective of all good intentions, in fact, dominated by design experts. General standard solutions were imposed on organizational members to solve local problems. Local contingencies and local knowledge were being disregarded. And even more important: solutions and problems were not owned by local players, but by experts from the outside. In this respect, the diffusion problem hardly differed from that described by Scandinavian writers (Gustavsen, 1992; Sørensen, 1985), and their recommendations for a further democratization of the organization were also supported in The Netherlands. However, at the same time it became clear that diffusion was also limited by the organizational environment in which the new work forms were embedded. It became apparent (van Assen & den Hertog, 1984) that the design of the product, the production technology, the firm's logistical and accounting systems, and the division between line and staff determined the degrees of freedom for the introduction of semi-autonomous groups. It was argued that these powerful parameters themselves would also have to be tackled in the design phase. The possibilities for new forms of work organization had to be "designed-in."

However, this observation made also evident that a mass of new expertise in each of the respective domains was needed to implement such integrated and preventive strategies. As a consequence, the tension between expertise and participation assumed a new shape. The question became relevant to what extent the designers of these higher level systems would be willing to include QWL-considerations in their work and share their expert power with workers and supervisors on the shop floor. At the same time, it became evident (Mulder, 1977; Hedberg, 1975) that participation in situations where one party has all the expertise and the other little or none tends to increase, rather than decrease the power distance between designers and users. The strategy chosen to deal with this paradox aims to empower system users by increasing their design expertise. The IOR-approach follows this route. The first condition in this perspective is that management becomes convinced of the economic benefits of the approach. In order to change the organization as a whole, urgent problems of the whole should be solved, rather than only social problems on the shop floor. The second condition is the availability of a common body of design knowledge: a shared set of well-elaborated design concepts, principles, rules, and design sequences, validated in practice. It was acknowledged that such a design theory would have to go far beyond standard solutions which would only be applicable to one single level of the organization (for example, the semi-autonomous production group, which had become the traditional "solution" for re-design at the shop floor level).

The mission to develop such a design theory was taken up by a network of organization researchers, consultants, and managers, who organized themselves in the Netherlands Institute for the Improvement of the Quality of Work and Organization (NKWO). The design theory that emerged from this effort built on the theoretical work of de Sitter (de Sitter, 1981, 1994; de Sitter *et al.*, 1986), traditional sociotechnical systems theory (Emery, 1959; Emery & Trist, 1960), the development work of the Swedish Employers Federation SAF (Agurèn & Edgren, 1980) and the design practice of a new consultancy bureau KOERS Consultants (van Ewijk-Hoevenaars *et al.*, 1995). The objective was to develop a framework for organization redesign which satisfied the following conditions:

- The design theory must embrace concepts and principles which are generally applicable irrespective of the specific nature of the organization.
- The design theory should focus on structural design as well as on the "learning" aspects of organizational development.
- The theory must open possibilities to customize the design for specific organizations.
- The theory must be easily applicable and manageable in actual practice.
- The design theory should be easily communicable and provide a language in which managers and workers from different functional areas can talk effectively about the same organizational problems and solutions.
- The theory must incorporate active involvement of management and empowerment of the workers concerned.
- The theory cannot be partial in approach, but should deal with the organization as a whole.

These efforts have resulted in the IOR approach. To date, more than 50 firms and public institutions have been engaged in major IOR projects in the Netherlands, not in the experimental sense of the 1970s, but as a real effort to turn the whole organization around. The range of firms engaging in IOR has been broad: from insurance firms like Aegon and Nationale Nederlanden, production plants of Philips' component division and of Van Nelle Tobacco to the tank maintenance workshop of the Dutch army.

A FOUNDATION IN SYSTEMS THEORY

In its efforts to develop a generally applicable theory, the IOR approach has introduced some important amendments to the traditional STSD approach. These are concerned with the original elaboration of the open systems character of sociotechnical systems, the conceptual differentiation between a social and a technical "system," and the ideal of joint optimization as a "best match" design principle (see also van der Zwaan, 1975).

Open Systems

The open systems approach says that a production system cannot be autonomous in its choice with respect to technology, industrial relations, social values, products, and services because it is at all sides tied to a time-dependent and changing technological, political, cultural, and economic environment. Traditional sociotechnical systems design has not always been able to deal with the implications of this approach in a satisfactory manner. For historical reasons, traditional STSD has stressed the importance of the human conditions which production systems should meet: the "Quality of Working Life" (QWL) (Davis & Cherns, 1975). A large part of its identity was derived from fulfilling a critical function in relation to Taylorist concepts, contending that the quality of work is important and should no longer be kept in disregard. An unconditional emphasis on QWL, however, cannot be reconciled with a truly "open" systems approach. The theoretical problem is to go beyond a plea for a reshuffling of priorities and to acquire insight into the manner in which organizational structures impede or foster the balance between a differentiated set of functions to be performed by the system.

This implies that, from a sociotechnical point of view, functional requirements with respect to customers, the physical environment, the labor market, suppliers of capital, workers, etc., should be regarded as equivalent. Sociotechnical systems design should be as good in shortening delivery times and in designing effective information systems as in improving jobs. An open systems model presupposes a comprehensive or integral rather than a partial problem definition. If it would focus only on QWL, for instance, sociotechnical systems design would simply join the range of already too numerous managerial specializations dealing with separate functional requirements, such as information science, production management, logistics, auditing, maintenance, marketing, quality control, and so on.

The Distinction Between the "Social" and the "Technical" System

In traditional STSD a sociotechnical system is defined as a combination of a social and a technical subsystem. Insight into their mutual interdependence is the designer's key to strike a balance between the two. This conventional definition of the social and technical "systems" as subsystems, however, contradicts the notion of a production system as an integral functional system. Conceived as a subsystem, the social subsystem would contain all human elements (and their attributes such as attitudes, values, and norms), and the technical subsystem would represent mostly human artifacts such as chairs, tables, telephones, PCs, machines, buildings, and so on. Clearly, very little can be said about the relationships between elements grouped in such a manner. The isolation of social and technical system elements into separate subsystems blocks the view of the functional relations between the two, which are at the heart of a real production system. In consequence, the concepts destroy the very object of analysis and impede rather than foster a comprehensive understanding of organizational dynamics.

Some have tried to save the notion of the two subsystems by arguing that one could differentiate between the social and technical aspects of all functional relations within a system. This would result in what could be called the social and technical "aspect systems." Closer investigation, however, makes clear that this does not make sense either. The social aspects of one or more functional relations by themselves can never make up a system. A (sub)system is always a complete set of relations between various elements that together perform a certain function. Such relations are always social as well as technical. One can also think of accounting, human resources management, or materials management as "aspect systems," i.e., as subsystems fulfilling specific subfunctions (filling in specific aspects) within the overall production system. Such aspect-systems, however, as they come into being in the form of subsets of interactions engaged in the production of a specific input–output function, always constitute a configuration of social as well as technical functions. Obviously, some aspect-systems have a higher social or technical "content" than others. The social aspects of human resources management are obvious and the quality of work could probably be enhanced by emphasizing social aspects in HRM. That remains a partial approach, however, with unclear implications for the functioning of the system as a whole.

Purely social or technical aspect-systems simply do not exist. The relations between social and technical aspects can therefore only be studied (and eventually "optimized") within complete (sub)systems. In other words, the desire to optimize the relations between social and technical aspects requires an integral approach of the system. The approach should focus on the manner in which a system's structure determines its capacity to select, develop, coordinate, reconcile, and balance a multitude of input–output functions with respect to a multitude of interaction partners within the system and in its environment, each of which implies social as well as technical dimensions.

Joint Optimization as a Partial Design Approach

Traditional STSD advocates "joint optimization" of the social and technical system as a design principle (Emery & Trist, 1960). As we have just noted, this "best-match" approach contradicts the two basic concepts of an open and integral systems approach. The openness of the system emphasizes the need for adaptive and innovative control and balanced coordination of a multitude of separate input–output transactions with the environment, where each transaction contains social as well as technical dimensions. The integral character of the system underlines the need for adaptive and innovative control and balanced coordination of the relationships between a multitude of functionally differentiated internal functions, where, again, each function contains social as well as normative and technical dimensions. Apart from this lack of clarity in the use of the systems approach, there is also a major problem in the methods envisaged to achieve the desired "optimum." The problem of compatibility of the social and technical subsystems (however defined) is treated as a matter of counting pluses and minuses attached to alternative partial designs of the separate systems (see, for example, Mumford & Weir, 1979). There is no consideration, however, of how the separate systems are supposed to fit together. It is logically impossible, however, to design a whole starting with the parts, but you can design (integral) parts starting from a vision of the whole.

The designers' goal should be to design an architecture sustaining and reinforcing the development of interactive relationships which support and reinforce each other with respect to all functional requirements such as flexibility, delivery time, throughput time, product quality, innovative capacity, pollution control, quality of work, and industrial relations. The conclusion of these fundamental theoretical considerations is therefore that IOR can only open new perspectives by fulfilling a truly comprehensive function with respect to the question of how sets of differentiated and purposive functions can be grouped and coupled into an organizational structure in such a manner that they mutually sustain and reinforce each other.

A BROAD OUTLINE OF IOR: BASIC CONCEPTS

The conceptual developments in the Netherlands as sketched above have resulted in a new paradigm for sociotechnical organization design, based on a number of primary considerations with respect to:

- The concept of Integral Design
- The concept of Controllability
- The twin concepts of Production Structure and Control Structure
- The concept of Structural Parameters

The Concept of Integral Design. A truly integral sociotechnical design is structural design: it should be based on insight into the interaction between aspect-systems (the logistic aspect-system, the quality aspect-system, the maintenance aspect-system, the personnel aspect-system, etc.) and subsystems (the sales subsystem, product design subsystem, planning subsystem, lathing, drilling, packaging, service subsystems, etc.). All system elements (individuals as well as tools and machines) involved in the differentiated sets of aspect-systems and subsystems are by definition tied and coupled in time as a function of the systems structure. It is, therefore, the specific architecture of a systems structure which should be viewed as the central object of sociotechnical theory and design. Sociotechnical theory explains how a specific architecture determines the opportunities for coordination, adaptation, and innovation of system-internal and external functions. Sociotechnical design is concerned with creating and using such opportunities by changing the architecture.

The Concept of Controllability. The second basic concept is the concept of controllability. Control does not refer here to specific goals or interests to be attained, but rather to shaping structural conditions for opportunities to formulate and implement goals. The basic sociotechnical question is therefore not to improve a systems' capacity to achieve a certain goal according to prescribed criteria, for example, the criterion of delivery time or product quality or QWL, but to improve a system's "controllability": the ability to achieve a range of objectives. As we do not know what the future will bring, we do not know the specific objects and problems to be controlled. Therefore, the designer's goal must be to improve a system's generic capacity to control. Moreover, the degree of controllability must satisfy criteria of effectiveness as well as efficiency. The degree of system controllability (Sc) can be conceived as a function of the ratio between opportunities and requirements for variation (Ashby, 1952):

$$Sc = \frac{\text{available opportunities for process variation}}{\text{variation required}}$$

Combining the notion of controllability with the notion of integral design, the conclusion must be that IOR should study the manner in which alternative architectures of structure influence a system's controllability. The specific architecture of a production system's structure fosters or restricts the opportunities for effective and efficient control of the required coordination between functionally differentiated processes, which may interfere with each other and may impede each other's completion. The core of sociotechnical inquiry is therefore the analysis and identification of structural parameters which together determine a system's interference probability and sensitivity with respect to a balanced production of internal and external functions in time. This endeavor requires a general conception of architecture as well as the identification of the main structural parameters (dimensions) which can serve to differentiate between architectures and—in further analysis—are to be related to the probabilities of disturbance (interference) and the sensitivity to disturbance (i.e., the capacity to reduce interference).

The Twin Concepts of Production Structure and Control Structure. In a purposive and therefore selective process, two basic functions are always involved (see Appendix B):

- control: the selection of relations to be performed;
- performance: the realization of selected relations.

From the point of view of design methodology, IOR therefore proposes to introduce a distinction between the structure of two basic aspect-systems:

- production structure: the grouping and coupling of performance functions.
- control structure: the allocation and coupling of control functions.

The Concept of Structural Parameters. Integral organizational renewal always implies change with respect to basic structural parameters. A designer should know how parameters are related to organizational deficiencies, and which parameters are in fact involved in various design questions and why. Parameters refer to the primary architectural dimensions of the production structure and the control structure. The following list of important structural parameters points to various distinctions, the majority of which have already been in use in managerial science, organizational sociology, and business administration for a long time. A substantial knowledge base is therefore available on the relations between different values for these parameters and the probabilities of disturbance (interference) and the sensitivity to disturbance (i.e., the capacity to reduce interference) of organizations.

1. Functional Concentration. Functional concentration refers to the grouping and coupling of performance functions with respect to orders or—in more general terms—with respect to input–output combinations or transformations. In principle, there are two extremes: all system transformations (order types) are potentially coupled to all subsystems (concentration), or each order type is produced in its own corresponding subsystem (deconcentration in parallel flows). This structural parameter is perhaps the most important one because high functional concentration limits very much the freedom of choice with respect to the remaining parameters and is responsible for deficiencies with respect to delivery times, quality, marketing, quality of working life, innovative capacity, etc. Functional concentration is still a dominant feature of most current production systems.

2. Performance Differentiation. Performance differentiation refers to the separation of the functions to prepare, to support and to make, into specialized subsystems.

3. Performance Specialization. Performance specialization refers to splitting up a performance function into a number of performance subfunctions and to allocating them to separate subsystems. According to the conventional production concept the number of such subsystems should be maximized with only capacity utilization as a restriction.

4. Separation of Performance and Control Functions. Separation refers here to the allocation of a performance and corresponding control function to different elements (individuals or machines) or subsystems.

5. Control Specialization. Allocation of the control of functional aspects to separate aspect-systems (quality, maintenance, logistics, personnel, etc.).

6. Control Differentiation. Splitting domains of control into separate control levels (strategic, structural, and operational).

7. Division of Control Functions. A control cycle always contains a "sensing" or "perceiving" function, a "judging" function, and an "action selection" function. Division of control refers to the allocation of these functions to separate elements (individuals and/or machines) or subsystems.

FURTHER ELABORATION OF THE IOR DESIGN APPROACH

The basic concepts summarized in the preceding section point to the possibility of integral (re)design of organizations by varying the main architectural parameters characterizing the production and control structure. The next step is to elaborate a practical design strategy incorporating these concepts. The design strategy of IOR is based on the use of a structured body of knowledge concerning the design of organizations in the context of a participative design process. Elaboration of the strategy therefore requires on the one hand the formulation of design principles, design strategies, and design sequence rules, in order to construct and structure a body of knowledge which can be used as a tool in system structuring; on the other hand, it requires the specification of a model for participation in design activities. This section provides a brief overview of the elaboration of design principles and design sequence rules. The next section discusses the models and modes of participation. Possible tensions between the use of a codified design theory and participation will be discussed in a subsequent section.

Design Principles and Design Strategies

Design principles refer to structural solutions with a rather generic bearing. In the IOR approach, these principles are primarily concerned with the problem of complexity. The complexity of a system is a function of the number of its elements, the number of their internal and external relations, and their variability in time. Conventional bureaucratic production systems tend to maximize on the structural parameters mentioned and are therefore complex. Increasing complexity is related to:

- increasing process variability,
- increasing probabilities of disturbance, and
- increasing sensitivity to disturbance,

all of which results in an increasing inability to deal quickly and adequately with changing demands made upon the organization, i.e., in reduced control.

The basic principles of integral design should therefore be:

- to reduce disturbance probabilities by a reduction of impending variety;
- to reduce disturbance sensitivity by an increase in control capacity.

The production structure determines the manner in which performance functions are related to order flows. Impending variety must always be dealt with by process variation. A good design of the production structure can limit the impact of impending variety, e.g., by directing "exotic" orders to specific parts of the organization. The degree to which performance functions are differentiated, split or coupled, limits or enhances the structural options for process variation. On the other hand, the utilization of such built-in options for process variation is—from the point of view of integral design—a function of the control structure. Control capacity can only be increased if opportunities for process variation are available.

The principle of controllability should therefore be applied to the design of both the production structure and the control structure, and it should be applied in this order. The design of the production structure aims to reduce the variation required. The design of the control structure ensures that options for process variation are utilized if required. Application of the principle of controllability to the production structure and control structure, respectively implies:

$$\text{Controllability production structure} = f\,\frac{\text{available means to vary performance functions}}{\text{variation required}}$$

$$\text{Controllability control structure} = f\,\frac{\text{control information available}}{\text{control information required}}$$

Together, the structural design measures in this respect should produce controllability at the level of individual tasks, which is called the quality of work:

$$\text{Quality of work} = f \frac{\text{control capacity built into the task}}{\text{control capacity required}}$$

The design principles provide structure to organizational solutions to the problem of complexity (and to the process of finding them). Design strategies refer to both the specific methods of analysis and the varying forms of application of the design principles. Functional deconcentration, for example, could be an important strategy for structural redesign in both an engineering plant, an automobile assembler, and an insurance company. The methods of analysis needed to find the right solution as well as the specific form of deconcentration to be applied, however, would be very different. The engineering plant would probably be restructured into parallel integrated flows of component families, which are defined by their degree of homogeneity in terms of processing technology. Redesign of conventional automobile assembly would require a re-sequencing of operations into functional homogeneous phase-segments and parallelization into separate but largely identical flows, whereas the insurance company would consider the integration of policy design, sales, and retributions into parallel market segments.

It is impossible to give a full account here of the design principles, strategies, and sequence rules as they are currently in use in sociotechnical consultancy in the Netherlands (de Sitter *et al.*, 1986, 1994; Kuipers & van Amelsvoort, 1990). The following overview must be understood as no more than a gathering of examples and comments.

Designing the Production Structure: Parallelization (Parameter 1). A good design improves both efficiency and effectiveness. Therefore, "variation required" should be kept as small as possible. From this it follows that the general design strategy is to reduce required variation and to increase options for process variation. Enlarging the opportunities for process variation is rather easy to understand: the importance of flexible automation and highly trained multiskilled personnel and integrated tasks is generally accepted. However, the reduction of required variation also needs attention. Required variation is triggered by two sources: external (demand) variation and system-internal local variation. External variation consists mainly of rapid changes in the demand for product mix and volumes. How can such demand variety be reduced without getting out of business? Parallelization is an important option. By the introduction of parallel flows the impact of demand variation on the need for internal variation can be considerably reduced. The effect of parallelization is always an exponential reduction of input complexity, which is an illustration of the importance of the first structural parameter, functional concentration.

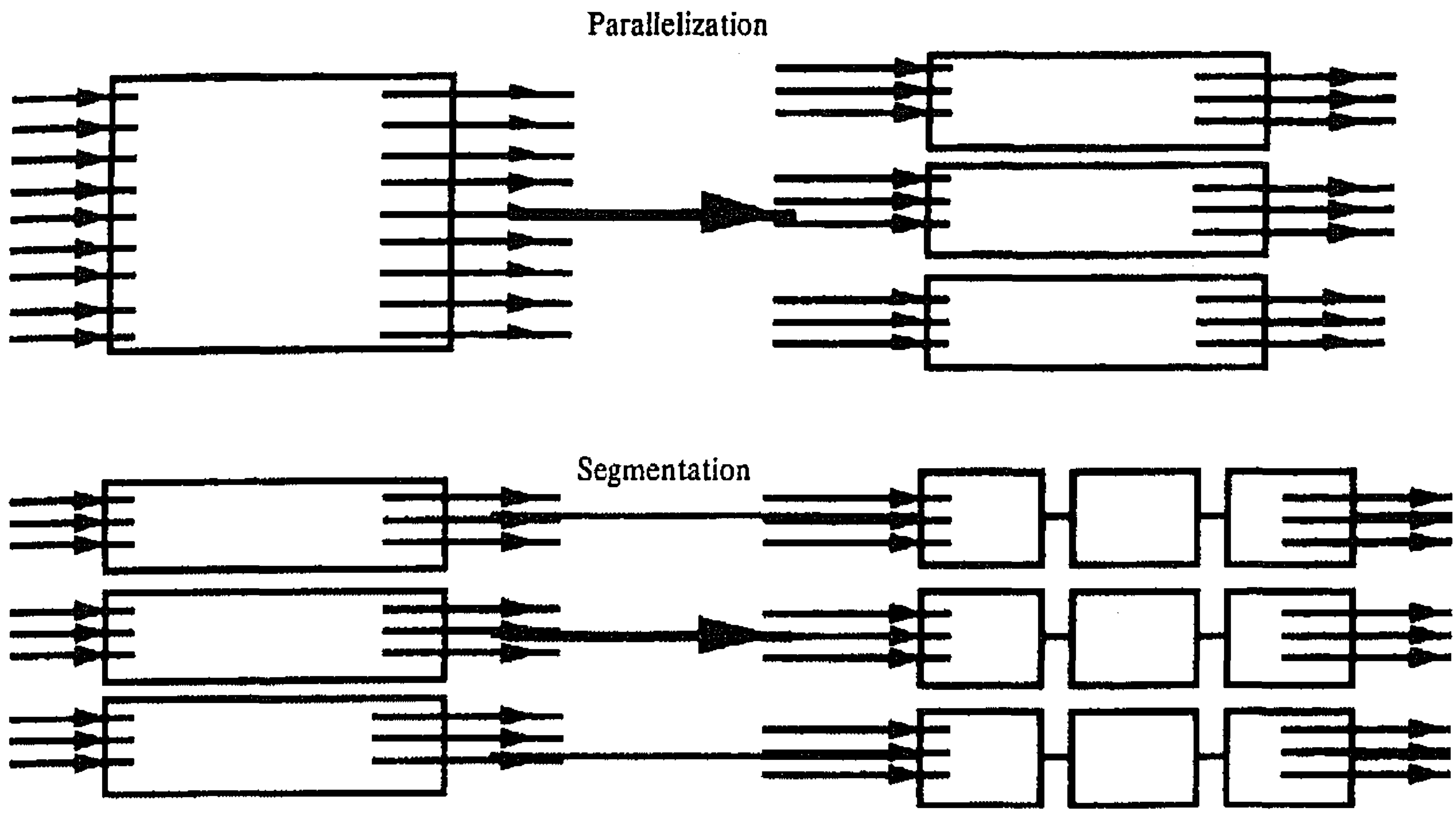

Fig. 1. Parallelization and segmentation.

Designing the Production Structure: Segmentation (Parameters 2 and 3). Again, variation is variation, but one can reduce its amplifying effects by structural design. Exponential amplification of internal variation sources is caused by the number of relations or interfaces between performance functions involved in the chain between input and output. In the prevailing functional structures of today, performance functions of the same technical type are grouped together into specialized departments. The number of interfaces between these specialized departments is necessarily high. Reduction of internal variation is mainly a matter of reduction of interfaces. By parallelization, external input variety is reduced by creating independent parallel flows, preferably corresponding to product market combinations. Segmentation of individual flows aims to reduce internal variety by selective clustering of performance functions into segments with a minimum of interfaces (Fig. 1). Segmentation requires in the first place clustering of performance operations with a maximum of mutual interdependence in direct production.

Segmentation of performance functions offers a starting point for a corresponding segmentation and/or integration of support and preparatory functions in the next step. The concluding step in the design strategy of the production structure is the internal structuring of segments. Reduction of required variety is the main goal in parallelization and segmentation. Now, design should be directed to reinforcing available means for process variation. On this micro level it is no longer feasible to limit the attention strictly to the performance functions. Instead, performance and control

Table I. Parallelization and Segmentation

Firm	Parallelization	Segmentation
Nationale Nederlanden General Insurance Division (1200 employees)	The old organization: based on insurance products (fire, motor, travel, and so on); the new organization: all insurance products are handled in regional teams serving a group of customers (insurance intermediaries).	Within each regional team, one subgroup is responsible for the acceptance of risks and another for the assessment of claims (the option is open to integrate these groups at a later stage).
St. Antonius Vesselheads (manufacturer of heads and specially formed parts for pressure vessels and pipelines, 140 employees)	The old organization: based on production functions like staining, welding, machining, metal cutting and assembly; The new organization: the functions are integrated in three units, each being responsible for a family of products: formed heads, hot and cold press products, and assembled products.	Both the preparatory work ("plate material supply") and the final work (finishing and shipping) for the three parallel flows are allocated to one department.

functions are simultaneously considered; in terms of performance differentiation and specialization (parameters 2 and 3), in terms of separation of control and performance functions (parameter 4), in terms of the degree of internal control specialization and differentiation (parameters 5 and 6), and in terms of the division between control functions (parameter 7).

Table I gives examples of both parallelization and segmentation in an industrial firm and a firm in the service sector. The IOR approach incorporates the traditional interest of sociotechnical design in semi-autonomous groups as the basic unit of work organization. This involves a strong interdependence between flexible multiskilled tasks within the group, flexible technical equipment, options for coordination, complete internal process control, participation in boundary control, and responsibility for operational and structural improvements and innovations. The options for creating such "complete-task groups" are heavily dependent on the right choices in the preceding strategies of parallelization and segmentation. Segmentation is therefore a very important and decisive operation in the process of integral sociotechnical design.

Designing the Control Structure: Unity of Time, Location, and Action (Parameters 4, 5, 6, 7). Less variety and fewer interfaces imply a reduction of required control. In consequence, experience shows that up to 80% of all control questions with respect to coping with complex variety and interference have already been solved by the preceding architectural (re)design of the production structure. Having redesigned the production structure, we now turn to the control structure. The control cycle is the building block of control structures. In its elementary form the control cycle consists of four interrelated functions:

sensing: perception of process states;
judging: evaluation per aspect;
judging: integrated evaluation of aspects;
action selection: choice of control activity.

These four functions form a control cycle in which the performance function is a starting and end point. The basic structure of the control cycle is independent of the control level: the operational level controlling operations on the basis of given step norms, the structuring level generating such norms on the basis of models with respect to production and control structures, given the organizational goals, and the strategic level, evaluating goals given environmental conditions.

A control structure can be defined as the allocation, selection, and coupling of control cycles. Only variety induces a need for control. The "control information required" as contained in the definition of the "controllability of the control structure" discussed above is therefore a function of impending variety. Reduction of variety has already been taken care of in the preceding design of the production structure. It implies reduced need for control. This is of course precisely the reason why the design of the production structure should precede the design of the control structure. "Control required" is the shared factor that links production structure to control structure. The design of the control structure should therefore be directed toward the remaining factor: reinforcing and improving the availability and use of control information through structuring the allocation, selection, and coupling of control cycles.

Availability of control information should of course be read as: availability of effective information. The effectiveness of control information is a function of:

- reliability: correspondence between facts and perceptions;
- actuality: time span between occurrence of variation and a corresponding control action;
- completeness: overview of all current conditions defining the situation;
- relevance: memory and experience, learning capacity.

Together, these four "requisites for effective information" obviously refer to the separation between time of occurrence and perception, between time of perception and action, and to the location of occurrence as a binding factor between the two. Separation should be reduced and "unity of time, place, and action" is the leading principle.

In the daily practice of a self-managing team in tobacco production, for example, this means that the team:

- gathers quality data during the process as well as quality data on finished products;
- diagnoses production problems on the basis of single parameters ("symptoms") and on sets of parameters ("syndromes"); and
- decides to interfere in the process itself or to call for external assistance (Roberts, 1993).

Designing the Control Structure: Bottom-up Allocation of Control Cycles (Parameter 4). In principle, everything can be controlled top-down, albeit at the cost of control efficiency and effectiveness. Only by allocating control cycles bottom up will it be possible to discriminate between cycles that could be allocated both to the micro level of individual workstations and to the meso level of whole-task groups or segments. This procedure is called "stepwise elimination." From the total set of cycles to be allocated, those that can be allocated to the micro level are eliminated. Next, from the remaining set, cycles are allocated to the meso levels of aggregation and so on, up to the global level. In order to reduce the complexity of this procedure, it is wise to start at the level of segments or whole-task groups. In this way, the range of control at the group or segment level is first determined. Subsequently, the procedure is repeated inside each whole-task group or segment, the micro level now being defined as a particular machine or workstation.

The options for allocation—keeping the design principle of "unity of time, place, and action" in mind—are determined by the preceding design of the production structure. Without parallelization and segmentation there would be no (whole-task) segments and there would be no deconcentration of preparatory, support, and manufacturing functions into conveniently arranged, surveyable independent flows. In such an architecture, very few control cycles could be allocated to the micro and meso aggregation levels and we would be forced to take the consequences in terms of raised volumes of requisite control information, and low degrees of flexibility, quality control, innovative capacity, and quality of work.

Building Control Capacity in Every Task (Parameters 1 to 7). An individual work process can be conceived as the smallest possible presentation of production organization. Therefore, the logic of control theory applies to all levels of aggregation and quality of work is just a micro presentation of the same problem: how to strike a balance between interference problems (variation) from different input sectors with which the worker is confronted, and his/her ability to control by utilization of control capacity the normative completion of a multitude of interaction cycles he/she is engaged in as a member of a group or social network. In this sense, quality of work is a function of the problems someone can meet in the course of work and the means at disposal to cope with them (de Sitter, 1970; Karasek, 1979).

Design Sequence Rules

The design sequence rules are an absolutely necessary tool in IOR, not only in order to improve efficiency and effectiveness in design, but also to structure the process of design in such a manner that it becomes clear to the participants why some questions come first and others later, and why managers should be involved in the solution of X and workers in the manufacturing division should be involved in the solution of Y. Again, it is impossible to give a full account of design-sequence rules. We have to restrict ourselves to a short overview of the most fundamental ones, which should always be observed.

Rule 1. Design the Production Structure First and Then Proceed with the Design of the Control Structure. Very often this rule is broken, with disastrous results. It is common practice, for example, to design new control structures for given production structures. The complexity of control is, however, determined by the complexity of the production structure. The results are of course disappointing: high investments in information technology, but no substantial improvements with respect to flexibility, delivery times, product quality, reduction of stock, and quality of work.

Rule 2a. Design the Production Structure Top-Down. Integral design requires starting from the whole at the macro level (identification of possible parallel flows), proceeding to the meso level (segmentation), and concluding with the elaboration of the structure of whole-task groups at the micro level.

Rule 2b. The Design of the Production Structure Precedes the Design of Process Technology. Process equipment presupposes couplings to input delivering elements and couplings to output receivers. Effective and efficient utilization of equipment therefore depends upon the specific architecture of the structure in which they are applied, because it is structure that determines these couplings. Moreover, application of technology implies the grouping and coupling of machines and instruments. The required repertoire of performance and control functions they should be able to execute, depends of course on their allocation within the overall system structure with respect to production order flows. Technical requirements in terms of repertoire flexibility, production volumes, and options for couplings between CAD, CAM, and other automation applications can only be specified after design and evaluation of the optimal system structure. Structural adaptation to equipment is therefore only justified if it appears impossible to meet the technical demands deduced from structural design.

Rule 3. Design the Control Structure Bottom-Up. The logic of this rule has already been discussed. One starts with the allocation of control cycles at the micro level of local control and proceeds to the allocation of control cycles to the meso level of interlocal and macro level of global control. The "stepwise elimination" procedure ensures:

- careful design of individual tasks,
- modular architecture of the control structure and therefore options to improve or change control structures per module (segment, whole-task group, production cell, FMS, etc.),
- flexible options for stepwise implementation of a redesigned control structure.

Rule 4. Design Control Cycles According to the Sequence: Allocation, Selection, and Coupling. Unity of time, place, and action is the leading principle. The location of sources of variation determines the allocation of corresponding control cycles. The scope of control activities is determined by the selection of the primary dimensions of the control range required in a given location. Couplings are derived from the allocated and selected ranges of control cycles with special attention given to the required lead time between the coupling of data to the local control of processing.

THE PARTICIPATIVE CHANGE STRATEGY

In our description of the IOR participative change strategy, we have to confine ourselves to the first main steps in the redesign process. The steps involving implementation and consolidation of redesign are obviously of paramount importance but cannot be covered here, since they show a considerable variety and require a full discussion of change management. The major projects carried out on the basis of the IOR approach have lasted 2 to 4 years and were shaped by the active involvement of a large number of employees. No wonder that there are no two projects which follow exactly the same course. It should be noted that in actual practice, of course, IOR is not the linear and standardized process as presented below. Within the broad framework of the strategy, there is always a need to customize the approach to the local contingencies. Still, in most projects the main lines as sketched here can be recognized (Fig. 2).

Step 1. Raising Awareness of the Need for Change. Firms won't set themselves in motion only because they are confronted with new and inspiring ideas. Before the first plan of action is written down, management, staff, workers, and the works council have to build up the belief in the new route for themselves. Intra-organizational barriers must be broken down and resources be made available. The phrase "readying the unready" charac-

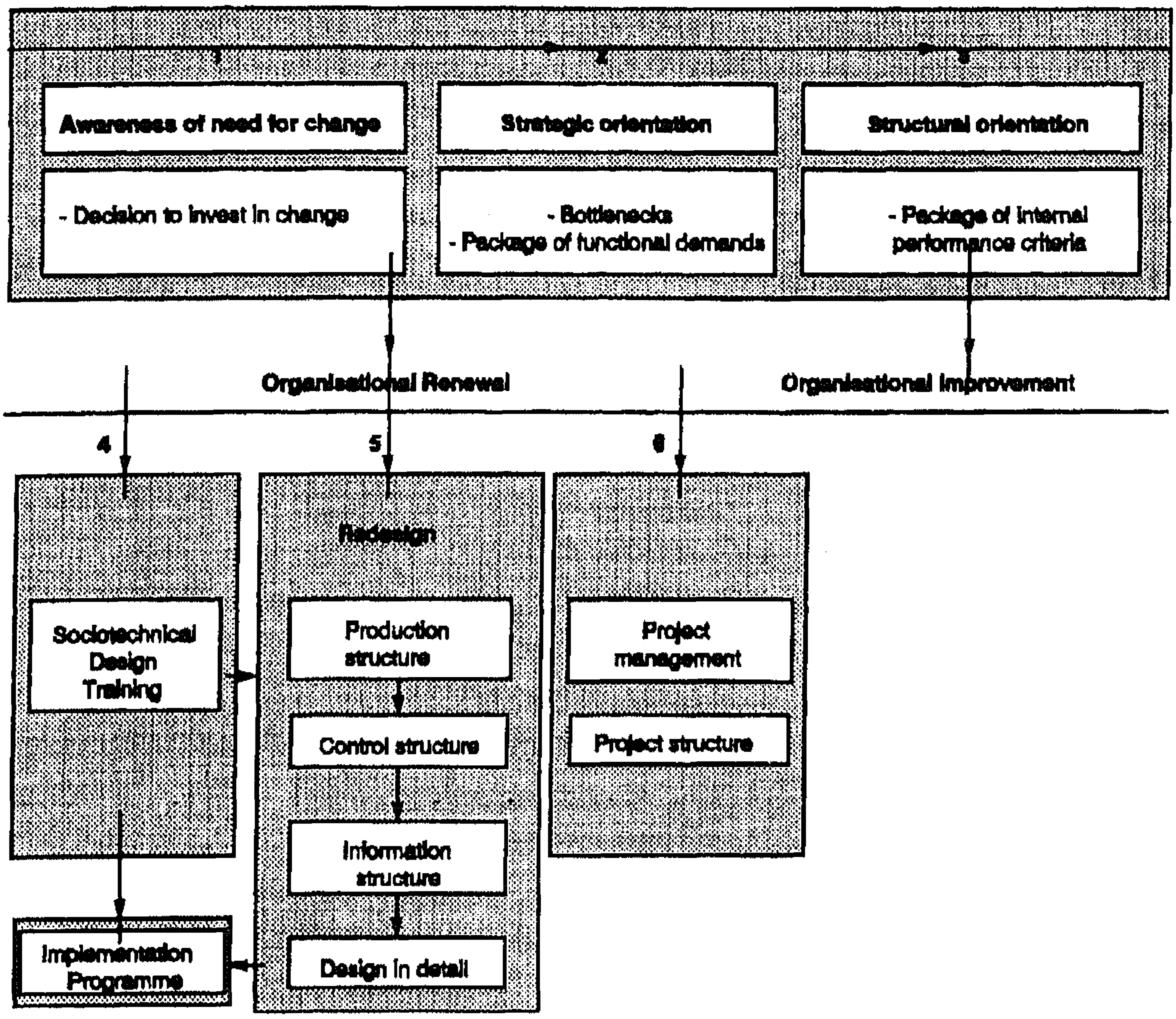

Fig. 2. The change trajectory.

terizes this often painstaking pre-phase. Top management plays a special role here. It has to act as a promoter of the new norms and values. IOR demands leadership in the real sense. In most projects, one of the top managers plays the central, or even "heroic," role in starting the motor of change and keeping it running. This implies also the assurance of the resources needed to carry out the redesign. Innovation costs time and money. It is no use to start an intensive change effort only to find out a year later that there is no money or no capacity to take the essential steps. The decision to invest in change is the first milestone of the project. The project can start.

Step 2: Strategic Orientation. The following step is a strategic exploration of the strengths and weaknesses of the firm to be compared with the threats and opportunities implied in its environment. The analysis is carried out by a group of about 20 persons. This group is composed of the management team and people from the various functions and sectors needed to obtain an overview of the problems and possibilities. The chairperson of the works council (a representative body elected by the workforce) is usually also a member of the group. Sometimes, firms already have experience with a strategic planning phase. Usually, just a small elite group from the firm has been involved in such an exercise. In such cases, firms are urged to repeat the whole process with a larger group and with more openness. Both the quality of the analysis and the involvement in the renewal process benefit from that. The main output of the strategic exploration phase is a document containing a list of external functional (performance) requirements, and an overview of discrepancies between current and required performance. This results in a quantified and specified summary of external performance criteria for the system to be redesigned.

Step 3: Structural Exploration. The strategic analysis points to discrepancies between required and actual external performance. Study is subsequently needed with respect to the question of how these may be related to the characteristics of the system's internal structure. A structural exploration must be carried out. This is done by a thorough inventory of all current problems in terms of disturbances of any kind. This requires training in how to "map" such shortcomings in a projection of the existing production and control structure. Training courses are available and have been adapted to organizational levels. Hundreds of problems may be listed. Next, the selected problems are divided into structural and nonstructural ones, and priorities are established by comparison with the document of external performance requirements.

The distinction between structural and nonstructural problems allows for starting up improvement activities that can and should be taken care of immediately and that do not require fundamental changes in structure. When there are acute problems of quality, the customer cannot be fobbed off with the announcement that the firm is in the middle of a renewal process. Furthermore, a great deal of problems can be solved without any structural changes. The immediate solution of some sometimes longstanding problems can be an important factor creating and enhancing support for the process of change. The output of the structural exploration is a document of internal performance criteria which is the main and crucial input for the following design phase.

Step 4: On-the-Job Training for Self-Design. The actual vehicle for renewal is an intensive training program. The basic idea is that the members of the organization have to learn to design themselves. They are an important source of expertise: the knowledge and experience gained in their own work situation. However, a participative approach and this expertise do not suffice to make an efficient design. In order to do so, one must learn to analyze one's own work organization and to make links with other functions and subsystems. It is essential for them to become familiar with analytical principles and design methods. The training is a type of on-the-job training: the own organization provides the content and the material. The prime objective of such training is to enable members of different organizational levels to take the design in their own hands. In this approach, the emphasis is placed on cognitive transfer. Its effects, however, go far beyond. The dynamics created in the organization are enormous. The training has a mobilizing character: it becomes clear to the members of the organization that their problems are being seriously dealt with and that their opinion is taken earnestly. Another important effect is that one learns to speak the same language: the plant manager is able to talk about his work situation in the same terms as the maintenance engineer. Finally, this training appears to be an adequate method to break through functional boundaries. Participants are part of a multidisciplinary team for a long period of time and learn to view the production and control process through the same glasses.

Step 5: Redesign. The document of internal performance criteria is the input of the design phase, which evolves from general to particular. As indicated, first the production structure is put under discussion. The design questions follow the "top-down sequence": macro (parallelization), meso (segmentation), and micro; the internal structuring of segments. Of course, the trajectory is iterative: one may move backward and forward in finding the right solution. Next, the control structure is dealt with. The direction of the design process is now reversed: bottom-up. At the start there is just one design group for the basic structure; as one proceeds, more design groups are actively involved in the process, thus increasing the need for a better match between the subdesigns. The design proposals are exchanged and discussed within the organization, the work consultation group, and the works council.

Project Structure. The project structure follows conventional lines consisting of a steering group, project groups, and work groups. The steering group is responsible for the definition of the final plan. In a number of cases, a separate and temporary project structure is established, which may be particularly important in greenfield projects, or in situations in which product and/or process technology are faced with radical changes. In such cases, one consciously distinguishes between old and new. When the emphasis is placed on redesign, where the switch from old to new is a gradual process, it may be wise to have the management team and steering group coincide.

We cannot discuss here the multivariegated practices of implementation and consolidation of the redesign. Obviously, it will seldom happen that a clear dividing line can be drawn between design on the one hand and implementation on the other. In practice, implementation will lead to new questions of design and will give rise to new feedback loops in a process of continuous specification.

The process of organizational renewal proposed here clearly takes up a considerable length of time. Much-publicized concepts like Lean Production and BPR appear to promise much quicker results. We would argue, however, that to a large extent these are only promises which cannot be backed up by hard results. Obviously, depending on the urgency of the situation, steps 1 and 2 can be done rather quickly also under IOR. The main goal of these steps is to achieve consensus. Under step 3, the distinction between structural (i.e., structure-related) and nonstructural problems serves to identify actions that can be undertaken immediately. These quick actions appear sometimes to be quite similar to actions undertaken under the banner of lean production and continuous improvement schemes. The following steps involving training and participation of a substantial number of employees in the actual redesign undoubtedly take time. However, it can be considered relatively low cost investment, if it creates a solid backing for the subsequent implementation of redesign, which we would argue will often be lacking in a similar top-down BPR exercise. Moreover, all projects show that knowledge on the actual processes in the organization is usually not available in one location inside the enterprise, let alone outside. A redesign, which is based on knowledge that is available basically in one place will be far from optimal if compared to a redesign based on the knowledge that is present throughout the workforce. A good design with a broad backing in the organization obviously can be implemented much quicker than an incomplete, imposed design. Interestingly, we have the impression that in the course of time, employees in the Netherlands at least have become much more accustomed to the idea of redesign, which has resulted in a greater openness toward training and a speeding up of redesign and implementation processes.

COMBINING AN EXPERT APPROACH WITH PARTICIPATION

As an applied design strategy, IOR aims at the successful implementation of organizational change. In the sociotechnical view (Dankbaar & den Hertog, 1990; Gustavsen & Engelstad, 1985), successful change cannot be an imposed one. This is an important difference with, for example, most proponents of Business Process Re-engineering (BPR). The latter tend to think that radical change can only come about swiftly if it is imposed from above (Hammer & Champy, 1993). IOR emphasizes that radical redesign can indeed be realized swiftly if necessary, but only if it has a solid basis in the organization. It is, therefore, crucial that the redesign is carried out by the organization members themselves in a participative manner. However, even if power and functional expertise would be equally distributed among organization members, participation by itself would not guarantee a choice for an optimal sociotechnical solution. Sociotechnical design, however participative it may be, has to rely on design expertise. It is therefore necessary to transfer some basic knowledge of sociotechnical concepts, methods of analysis, design principles, and strategies to the members of the organization.

There are various ways of using expert knowledge in a participative context and there is considerable debate about the relative importance of both kinds of knowledge in organizational (re)design. The approach presented in the preceding section has been developed in the Netherlands in consultancy and training work by several organizations. One can view this approach as the organization development side of IOR. This approach is not presented as *the* road to success, but as a pattern which has emerged from design projects in over a dozen firms and has proved to offer a serious perspective on systemwide and lasting change (see Table II). These projects resulted in a number of important lessons concerning the change process and the role of experts (Kuipers & van Amelsvoort, 1990; Dankbaar & den Hertog, 1990; van Ewijk-Hoevenaars *et al.*, 1995).

The first lesson is that redesign should offer realistic alternative structures at firm or plant level. It is useless, for example, to start with job design at the shop floor level. The degrees of freedom for job design are to a large extent determined by the technical and organizational structures and processes in which tasks and roles are embedded: the production hardware, the logistical systems, and the relation between line and staff. Without tackling these basic structures, job design experiments will fade away like sand castles at the seashore. For instance, substantial redesign of production work in a television assembly plant is impossible without an alternative solution to materials handling. The creation of self-regulating work groups in an engineering firm won't last if planning and control tasks are not shifted from the central support staff down to the production groups on the shop floor. Integration of thinking and doing demands, almost without exception, a smaller support staff and a decentralized but stronger production organization. In the IOR approach, it is essential that in the redesign of the production structure, degrees of freedom are created first, before the redesign of jobs and the design of complete-task groups at the shop floor level can be undertaken.

The second lesson refers to the participation of workers involved in the decision-making about the new organization. Involvement of the workers in redesign is an essential condition. The same holds for management and support staff. The redesign has to be "their redesign" and not a solution introduced by outside experts. However, participation is not a sufficient condition to set the organization in motion and to change its basic structures. Research in the engineering workshops of Philips concerning organ-

Table II. A Sample of IOR Projects

Firm before change	Implemented changes	Problems and effects
St. Antonius Vesselheads (140 employees, 1988–92). Manufacturer of heads and specially formed parts for pressure vessels and pipelines. Functional organization (job shop), both in staff services and in production. Sources: Roberts (1993); Bussemakers and den Hertog (1995).	Flow-oriented production (three parallel flows). Integration of staff services according to the flows. Segmentation. Decentralization of control task to self-managing teams. New team-based management accounting system.	Problems: Sharper demands (quality, timeliness, and delivery reliability) in the OEM market. Effects: shorter throughput times, less work in progress, lower inventories, quality improvement, lower down-times, higher productivity.
Zilverstad Silversmithing (70 employees, 1990–93). Manufacturer of premiums and corporate gifts, jewelry and souvenirs. Functional organization, centralized staff. Source: Roberts, den Hertog, and van den Oetelaar, 1995.	Flow-oriented production, parallelization according to product family (batch size). Integration of production and control task in the four self-managing teams.	Problems: Competition from the Far East urged the firm to look for new markets for high added-value products. The old organization was not fit to cope with the emerging complexity in terms of delivery and quality. Effects: Higher productivity, shorter delivery times, higher reliability of delivery, less inventory. 15% increase in turnover, while the silverware industry in the Netherlands faces 15% lower turnover in the same period. Lower absenteeism.
Van Nelle Tobacco (250 employees, 1986–88). Functional centralized staff, functionalized production. Source: Roberts (1993).	Introduction of business groups, parallellization according to product characteristics, segmentation of upstream production tasks, decentralization of staff, new team-based management accounting system.	Problems: inflexibility, high production costs, pigeon holing. Management had to realize a buy out and offer investors a new perspective. Effects: lower production costs, higher flexibility, shorter delivery times, less inventory, higher quality.
Philips Stadskanaal (1000 employees, 1986–93). Manufacturer of semiconductors and component for TV tubes. Functionalized staff and production. Sources: Bussemakers and den Hertog (1995); Haak (1994).	Introduction of business groups. Decentralization of staff to production units (operational group). Parallelization and segmentation in production according to product type.	Problems: The plant had to fight against closure. Low productivity, inflexibility, too long delivery times. Effects: The plant grows again. On the productivity list of Philips component division it rose from the bottom to the top. The plant received a quality award.

Table II. Continued

Firm before change	Implemented changes	Problems and effects
Philips Turnhout (160 employees, 1991–94). Manufacturer of small batches of high added-value speciality bulbs. Functionalized production. Source: Bussemakers and den Hertog (1995).	Integrated production teams. Introduction of flow-lines. Parallellization and segmentation on the basis of product characteristics. Closer linkages between development and production. Self-managing teams.	Problems: Rapidly growing market for new products. The plant was too slow for coping with product innovation. High inventory, long throughput times. Too large number of rejects. Effects: Faster introduction of new products in production. Higher quality and reliability of delivery.
AKZO-NOBEL, Fibers (200 employees, 1990–94). Business unit. Manufacturer of non-wovens. Worked with five function-oriented shifts. Source: Bussemakers and den Hertog, 1995.	Introduction of three self-managing groups (parallellization) according to product/market combinations. Decentralization of staff activities to the production teams.	Problems: This business unit was making a good profit, but the demands from the market (quality, price, variety in product types) were becoming increasingly tight. Effects: Higher flexibility, productivity, shorter throughput times. Despite the heavily increased competition the unit has kept its strong position.
Nationale Nederlanden, General insurances division. (2000 employees, 1991–94). Works for insurance intermediaries. Functional organization according to type of insurance. Centralized commercial function.	Split in two divisions: business and private insurances. Introduction of regional insurance teams working for their own set of intermediaries. The teams cover the whole range of insurance types. Decentralization of the commercial function to the teams. Introduction of knowledge management in order to secure functional knowledge.	Problems: The division was urged to defend its role as market leader. Change from a stable market into a demanding turbulent market. Effects: Higher productivity, higher service quality, reduction of managerial staff. Higher profits.

izational renewal and information systems design (den Hertog & Wester, 1979; den Hertog & Wielinga, 1992) shows that participative design makes no sense when the basic structural conditions for change in the workplace (i.e., an integral redesign) have not been fulfilled.

This brings us to the third lesson: the expert or design approach can be combined with the participative approach, if the change process is characterized as an educational program. The members of the organization have to learn how to redesign their own organization themselves. The redesign process demands a long involvement of many members of the organization. The basic structures of production and control are at stake. This means that the experience and knowledge of a broad range of disciplines and functions have to be involved: managers, product and process designers, planners, quality officers, supervisors, personnel officers, and operators. Most of them can oversee only a part or an aspect of the production system. They have been trained and conditioned in their careers to do so. They lack, in most organizations, the insight into interrelations, for example, between product quality and the quality of work, or between the production structure and logistics and delivery times. Besides, most of them speak only their own professional language. Out of these observations, the idea arose to compose a carefully tuned and integrated set of training courses which sustain and follow the course of the redesign process, enabling the members of the firm to understand the structural background of their problems and to redesign their organization themselves. An important aspect of this training process is that employees with different backgrounds acquire a common language to discuss organizational issues.

DISCUSSION

The approach of organizational renewal sketched out above raises some important theoretical as well as practical issues, all of which center around the notion of design. In this section, we will first discuss the place of a design theory like IOR in the social processes shaping organizations. We will then consider the general status of design approaches in the organizational sciences. We will finish with a brief discussion of IOR in relation to other modern approaches of organizational design.

Design Theory and Social Processes

Over the past decade, the application of formal design logics has been heavily criticized, even in the case of computer systems design (Winograd & Flores, 1986; Ehn, 1988). Referring to Simon (1969, p. 54), who says that "everybody designs who devises courses of action aimed at changing existing conditions into preferred ones," Ehn (1988) argues cogently that design is a social process in which two questions are crucial:

- What is the preferred situation?
- Preferred by whom?

Ehn criticizes Simon's view on organization design as the design of the artificial, arguing that the shaping of an organization is a social process involving human beings who may be prone to pursue sectional interests or to defend threatened identities and statuses. Is this criticism not also applicable to IOR, which also appears to take a very rational and even engineering kind of approach? In fact, the two questions put forward by Ehn are also useful to explain the role of IOR design theory in processes of organizational change and renewal.

What is the Preferred Situation? IOR offers the members of an organization a package of empty black boxes. The challenge for them is to define themselves:

- the content of the boxes, or the division of labor;
- the relationships between the boxes, or the control system; and
- the norms and values that prevail in the creation of the preferred situation.

This means that the members of the organization are being equipped with language tools, which enable them to develop their own local organizational theory (Gustavsen, 1996). This might seem like a paradox: the use of meta-concepts of a general nature in order to arrive at local solutions. However, one has to recognize that systemwide participatory change in complex organizations is in fact always a paradoxical process in which general and local knowledge as well as various interest positions (sometimes related to these knowledges) have to be mobilized.

Preferred by Whom? Essential in the IOR approach is the consensus within the organization about the tasks, roles, and responsibilities in the redesign process itself. Reaching this consensus is in fact the most critical step in each project. Obviously, consensus is by no means always natural or self-evident in enterprises. Consensus around redesign of an organization does not deny that there is bound to be a lack of consensus concerning many other issues, nor does it exclude conflicts of interest, which will turn up time and again during implementation processes. In some organizations, basic consensus can be achieved very early. They choose IOR and not some form of Business Process Re-engineering, because they agree on a participatory approach. In the preliminary phase of the project in the Dutch insurance company Nationale Nederlanden (den Hertog, 1995), members of the works council interviewed colleagues in other firms, who had gone through an IOR-process. On the basis of the information received, they decided to give a positive advice for IOR at Nationale Nederlanden, because the participatory potential of IOR seemed to them larger than that of other options. In other cases, however, it took considerably more time to reach this agreement. In still other cases, the process broke down half way, because of the lack of trust between the players involved. In most of such cases, it is not top management or the shop floor workers who are throwing up roadblocks, but the staff departments, which are defending their positions of power in the organization.

This means that IOR does not offer a guarantee for a successful participatory design. As in any other participatory scheme, concepts, procedures, and rules can be misused, for instance, to consolidate the status quo. However, IOR forces all players to make their choices explicit, not only choices about the "preferred situation," but also about the way the preferred situation is to be reached. Obviously, concepts can be misused and procedures can be misinterpreted. Managers can talk in a participative way, while acting in an opposite manner. Redesign processes can be undone by mergers and takeovers, or the firm can run out of resources. All these things happen, as in any other major organizational change program. Conceptual schemes are in this respect not more than tools for change. The learning remains in the doing.

Design Theory and Design-Oriented Research

Organization science is not only a descriptive and explanatory science but also a design discipline. Simon (1969) went even further by arguing that the ultimate orientation of disciplines like medicine and business administration is design. Simon found that this ultimate design orientation is seldom discussed in the mainstream of research and education in these disciplines. In order to be accepted, the design-oriented disciplines had to concentrate on description and explanation in order to acquire a scientific appearance. The real design issues were neglected, in Simon's view, because design was considered as being "intellectually soft, intuitive and cookbooky" (Simon, 1969, p. 57). A predominantly European stream of researchers has followed the track of Simon in propagating design-oriented research (cf. den Hertog, 1994; Ehn, 1988; Hopwood, 1983; Oehlke, 1993; Voss, 1988). IOR is part of that stream. Design-oriented research is concerned with investigating:

- the problems that cause firms to redesign structures and processes;
- design alternatives and methods of comparing them;
- the process of design: strategies, methods, and power relations; and
- the impacts of implementation.

Design-oriented research still has a long way to go. Managers are interested in off-the-shelf knowledge and tools, which organization science is only beginning to produce. For the time being, design theory will often be too esoteric for the practitioner and "too intuitive and cookbooky" for the editors of scientific journals. That also applies for the IOR-approach developed in the Netherlands. Only in the last 5 years have efforts begun to create a better scientific infrastructure at universities that allows for a critical analysis and description of redesign projects. The stream of empirical studies has grown as a result (for example, Roberts, 1993; Hoevenaars, 1991; van Ewijk-Hoevenaars *et al.*, 1995; Fruytier, 1994; Haak, 1994; den Hertog, 1995; Peters, 1995; van der Zwaan, 1994). The Dutch Ministries of Social Affairs, Education and Science, and Economic Affairs have contributed to a research program for this purpose.

Bridging the gap between organization science and design practice raises numerous methodological questions. One of the basic questions is the question of validation and testing. Organizational renewal programs as described above, are far more complex than can be deduced from a limited set of design concepts, design rules, and design sequences. In practice, they are composed of complex chains of discoveries, decisions, and actions (cf. Stacey, 1996), involving in each case dozens or hundreds of actors. Furthermore, each situation in which these concepts and rules are applied has its own unique features. That makes it hard to make a judgment about the validity of a design theory. There are always other factors which could explain the success or failure of a renewal process, apart from the ones taken into account by the design theory. Apart from the study of carefully collected case material, final judgment will always also be based on practical success. The problem is of course how to measure the latter. It becomes visible in at least two ways: in the interest shown by managements for a specific approach relative to other approaches and in the level of satisfaction shown by managements who have followed a specific approach. Concerning the first, we note that more and more managers appear disappointed in the application of business re-engineering approaches based on a purely technical rationality. Recently, the management of a large Dutch foods manufacturer came to the conclusion that the streamlining of the production system does require involvement and commitment throughout the organization. This led to the decision to stop an ongoing re-engineering process and to make a new start along the sociotechnical lines sketched above. Concerning the second, there needs to be evidence that the design works in practice. Managers are not as easily convinced as in the past by glossy presentations of consultants or guidelines from corporate headquarters. Managers do not decide to start sociotechnical redesign processes when they have not convinced themselves of the feasibility of the approach in other organizations. They have to see with their own eyes that the approach relates to their perception of their organizational problems and can be effectively put into practice. Works councils tend to act in the same way. Active involvement of works councils is important to create the right conditions for change. This involvement goes beyond the formal goal setting and planning of a change project. Early involvement in the selection of the right consultancy agency is one way to develop trustful relations between managers, worker representatives, and change agents. For example, the works council of the insurance company Nationale Nederlanden visited four other firms which were engaged in IOR before giving their approval to the redesign program proposed by management. The growing number of practical examples in well-respected firms has gradually contributed to the perception of IOR as a realistic organizational option. However, this cannot be considered proof of the superiority or even the validity of the IOR approach. The majority of Dutch firms is still opting for other strategies, be they cultural change programs or IT-dominated re-engineering programs.

Besides this general need for consolidation and codification, the Dutch IOR-approach is also facing another challenge. Up until now, IOR has developed as a local or rather as a regional theory. Although there are parallel developments in other European countries, IOR has not evolved within the framework of an international scientific forum. This local or maybe even provincial approach of redesign is a problem for most European approaches. It is, for instance, remarkable that very little of the massive research on work organization in Germany has ever penetrated the English literature (cf. Altmann *et al.*, 1992). A very positive development in this respect is the slow but steady growth of a design-oriented scientific community across national and disciplinary borders (Pornschlegel, 1993). Furthermore, in the last few years, some efforts have been undertaken to make a connection between the European design tradition and concepts in the Anglo-Saxon management literature (for example, Frackmann & Lehnkuhl, 1993; RKW, 1992; Dankbaar, 1993).

IOR and Other Design Approaches

On several occasions, we have noted above that there are some obvious parallels between IOR and other design-oriented approaches like Business Process Reengineering and to a lesser extent Lean Production. Together with the observation that IOR has developed in relative isolation, this raises the question whether these and other European sociotechnical approaches can be considered as European counterparts and indeed as functional equivalents of approaches developed in Japan and the United States. A complete answer to that question cannot be given here. There is a lack of evaluation research in this field. To date, there is an urgent need for studies which not only focus on the effects but also analyze the process of design and development. This makes it difficult to compare the changes as they are actually implemented in practice. We hope to have shown that IOR offers opportunities to base organizational (re)design on sound theoretical understanding and systematic, theory-driven analysis of organizational problems. Furthermore, IOR attempts to link the design process to the development process. We would argue that IOR is stronger in this respect than either BPR or Lean Production and therefore provides a better link to the organizational sciences. BPR is at its best where it combines a focus on the simplification of the primary process of the enterprise with a visionary understanding of the opportunities and options created by the new information and communication technologies. Clearly, such understanding could enhance the value of the awareness raising and strategic orientation steps of the redesign process. However, if they are not combined with a solid design and a proven development strategy, the results may be less spectacular than the visions. BPR does not appear to offer clear guidelines for the simplification of the primary process. It does not appear to have a view on the quality of labor remaining after automation and it is doubtful that implementation is more than the exercise of hierarchical power. Such statements remain tentative, however, as long as the empirical basis for comparison of different approaches is still lacking. In this respect, the need for design-oriented field research is underlined again, research on what the pioneers of sociotechnical theory have called "organizational choice" (Trist *et al.*, 1963). Lean Production, on the other hand, is not really a design-oriented approach, but a more or less coherent set of practices, which has emerged in the Japanese automobile industry over the past 40 years. It has not much to offer in terms of a design theory or an IT vision, but it does offer important insights in the still powerful effects of the methodical implementation and especially the continuous fine-tuning of mostly very traditional organizational designs.

IOR cannot pretend to have answers to all the questions and issues which have given rise to Lean Production and BPR. IOR is concentrated on actions to improve the flexibility of organizations faced by an increasingly complex environment. It is better at that than at continuous improvement or IT-driven redesign. It does offer theoretical insights and building blocks for the further development of a design theory, which is needed by all.

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APPENDIX A

Coping with External Contingencies by Investing in Extra Staff

A new staff member is introduced in a chemical production plant: the environmental official. As a first assignment, she is charged with the task of writing a strategic environmental plan and adjusting the existing procedures to current demands. In doing so, she must make an attempt to adapt these procedures and systems to the other systems and procedures that are used within the firm.

During the first week she meets all managers of the first and second echelons. Every manager conveys a separate message to her. The marketing manager points to the importance of the firm's image to the outside. The product developer wants more space for the development of environment-friendly products. The process technologist points out the need for new investments in basic processes. The production manager, finally, makes clear that he is very positive toward the environment, as long as he is not once again stuck with a whole new set of formal rules.

Then follow the staff members down the hall. In the first room is the safety expert, who proudly points at the row of handbooks containing rules and procedures. The safety expert has acquired a fixed position. The quality man next door is in a more difficult position. He has a similar row of standards and procedures, but quality is not "alive in the plant." At this moment, he works together with a business economist of a consultancy bureau to quantify the quality proceeds and costs. Perhaps that is the way to convince people. He cooperates with the automation department in order to achieve a better link of process data and economic data. In the room next to her own is the labor expert, who has only just arrived himself. He has a good relationship with the quality man. Formal procedures and information systems are needed to keep control of the process. But more must be done: "the culture must be reversed." In fact, what should be started is a training trajectory. They'd have to talk about that with the central training department.

APPENDIX B

Even Small Firms Can Suddenly Become Too Complex to Manage

Even small and medium-sized firms can be "strangled" by a sudden increase in internal complexity. That is exactly what happened at Zilverstad, a Dutch family-owned producer of premiums and corporate gifts, jewelry, and souvenirs (Roberts, 1993). Like many other silversmithing companies in the Netherlands in the late eighties, this firm, which employs about 70 people, faced severe competition from Asian countries. During that period, the Dutch turnover in this sector of industry diminished yearly about 15%. The two brothers who owned and managed the company had to find a new strategy to counter this development. They decided to change their product/market portfolio: more emphasis on customized high-quality products produced in small batches and more effort to enter the German market. This strategy proved to be successful even in the short term. Zilverstad managed to grow while the Dutch share of the market was declining. However, the price to be paid for this change was high. The complexity of the interrelations within the organization increased very rapidly. The primary process was running out of control. As the production executive stated (Roberts, 1993, p. 97): ". . . orders came into the factory and, at some time, came out again but what happened in between we didn't know. In the factory everything was milling about, and there were bottlenecks in manufacturing. This was mainly caused by our own pre-occupation with special customer orders, and therefore, with new and unknown products with all the quality and planning problems that went with it." The causes of the problem and possible remedies were recognized by the two owners during an introductory course on sociotechnical design organized by the Dutch Federation for small metal working firms. The brothers decided to start a sociotechnical redesign program in their firm. As a first step, a "deep slice" of employees participated in the design course. This group worked out a new set-up for the organization. The key of the new design was the breakdown of the functional organization ("functional deconcentration"). The primary process (or "the production structure") was organized in four parallel self-managing teams ("parallelization") on the basis of production and product characteristics. The configuration of indirect or control tasks (the "control structure") followed the redesign of the production flow. As much as possible, indirect tasks (or "control tasks" such as incoming inspection, job scheduling, and calculation) were allocated to these teams. The new control structure was supported by the introduction of IT systems. Due to this change, it was possible to reduce the number of interrelations within the firm and, thus, the complexity of the organization. Less than 18 months later, the economical effects became evident: delivery reliability went up from 40 to 85%, delivery times were reduced by 20%, and productivity improved by 20%.

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