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(Eds.)

Aspects of
Integrated Company Renewal

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Zusammenfassung

Dieser Reader mit Beiträgen von Wissenschaftlern aus Dänemark, den USA, der Schweiz und Deutschland faßt Sichtweisen zur integrierten betrieblichen Erneuerung zusammen. Dabei geht es um so unterschiedliche Fragen wie die nach den Hindernissen und Hemmnissen des organisationalen Wandels, nach dessen Möglichkeiten und Potentialen, nach den Vergleichsmaßstäben für Arbeitsorganisation, aber auch nach der Bedeutung von DV-Systemen im Rahmen von betrieblichen Umgestaltungsprozessen. Ziel ist es aufzuzeigen, daß nicht eine einzelne Sichtweise oder eine einzelne Disziplin den entscheidenden Faktor für den Erfolg organisationalen Wandels ausmacht, sondern nur eine integrierte Sichtweise und Vorgehensweise den komplexen Anforderungen der Praxis gerecht werden kann.

Aspects of Integrated Company Renewal

Abstract

This reader with contributions by scientists from Denmark, United States, Switzerland and Germany comprises of several different perspectives on integrated company renewal. Questions are varying from what are hindering factors to organizational change, what is the potential of organizational change, how can different forms of work organization be compared and what can advanced computer systems mean to integrated company renewal. It is the message of this reader to explain that not a single point of view or just one field of knowledge is the crucial factor for success or failure of organizational change, but an integrated perspective and a concerted action to meet the complex needs of the real world.

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1 High Performance Manufacturing – the Need for Comprehensive Change

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1.1 Empirical Evidence of Superior Manufacturing Systems

In recent years much empirical evidence has been collected that in almost all industrial core sectors a huge productivity gap between entirely renewed and traditional companies has emerged. With respect to the most relevant indicators for international competition, such as productivity, lead time, work in progress, and agility for innovation, quantum leaps of economic performance can be observed among companies being busy in the same markets. It is well known since the appearance of the book "The machine that changed the world" that in the car industry, for instance, the assembly process of leading producers is twice as productive as in conventional companies, the time span needed for developing a new model is only two third, and, moreover this is achieved with roughly two thirds of the engineering effort only (Womack / Jones / Ross 1990, Clark / Fujimoto 1991). In mechanical engineering these differences appear to be even more dramatic: leading producers are about three times as productive as those operating on an average level, lead time comes down to only one third, and new products are developed in about half the time (Brödner / Schultetus 1992, Brödner 1993, cf. figure 1). In other sectors, like electrical engineering, measurement and control equipment as well as electronics, cases with similar results have been reported.

What are the reasons for these immense differences in economic performance? There happen to be some seemingly obvious, but rather short-cut explanations based on nationally or culturally specific features or conditions. No doubt that working processes are deeply rooted in the industrial culture in which they are performed and that culture-specific conditions contribute to this performance. This makes it difficult to transfer experiences from one industrial culture to another. No doubt again that more yearly working hours in an economy, e.g. 30% more in Japan as compared to Germany, are accountable for higher output or value added. But factors like these can only explain small fractions of the overall performance differences. Most strikingly, these enormous differences in economic performance can now be observed among companies in almost all developed industrial sectors and cultures. There mostly exists a small minority of vanguard firms operating far ahead of average competitors. This leads to the conclusion that there are a number of common features in basic structures and management styles producing the superior performance, although production processes show specific traits varying from country to country, since they are culturally embedded and adapted to the specific conditions of the environment.

From analysis of the success factors achieved by the leading pioneers a number of general guidelines for the necessary renewal of manufacturing processes can be derived. The crucial point is to unfold human productive and creative potentials, to comprehensively use human experience and knowledge, and to combine them with the performance of machines in a productive way. It is a whole bundle of mutually dependent and complementing structural innovations rather than isolated conventional measures of rationalisation that can bring about the necessary leaps of improvement (for more details see Brödner 1994).

Fig. 1: Economic performance indicators of Japanese and German machine tool manufactures

	1990	Japan			Average German Mechanical Engineering 1989	Germany			
		JA	JB	JC		GA	GB	GC	GD
Production value per employee	TDM	650	795	725	179	239	283	311	199
Value added per employee	TDM	336	517	249	95	119	132	149	113
Scope of production	%	52	65	34	51	50	47	48	57
Profit per production value	%	14	6	8	1,3	-2	2	5	2
Personal costs per production value	%	10	12	10	34	31	23	24	38
Inventories per production value	%	15	17	22	37	22	20	15	35
Plant & equipment per production value	%	19	12	31	16	13	37	26	29
Investments per production value	%	18	8	14	-	2	22	9	8

(Source: Company statements, VDMA, own calculations)

Systematic structuring and simplification of products and processes:
The consequent modularisation of products into configurable standard components is a necessary prerequisite to reduce the diversity of parts and subassemblies despite the broad variety of customer requirements. Through procedures of concurrent engineering, the needs of purchasing and manufacturing have to be taken into account on equal terms with those of marketing as early as possible. Product design, thus, creates already fostering conditions for less complex processes with considerably reduced diversity of means of production and much less frictions over organisational interfaces.

Object orientation rather than functional orientation:
All key processes of manufacturing (design, order management, production) should be structured in an object-oriented way, by splitting orders instead of dividing labor, according to the organisational principles of group technology. Multilevel hierarchies for coordination with their bureaucratic forms of decision making and high interface losses are replaced by the cooperation of work teams with holistic work tasks and much autonomy (figure 2).

Planning of results rather than planning of activities:
Within these new forms of work organisations with holistic work tasks, skilled group work with a wide scope of action is emerging where workers control their work within wide-meshed planning prescriptions. The result of work (quality, due dates), i.e., what is to be done rather

Fig. 2: Integrated group manufacturing

O: Order Management Island   P: Production Island
D: Design Island   A: Assembly Island
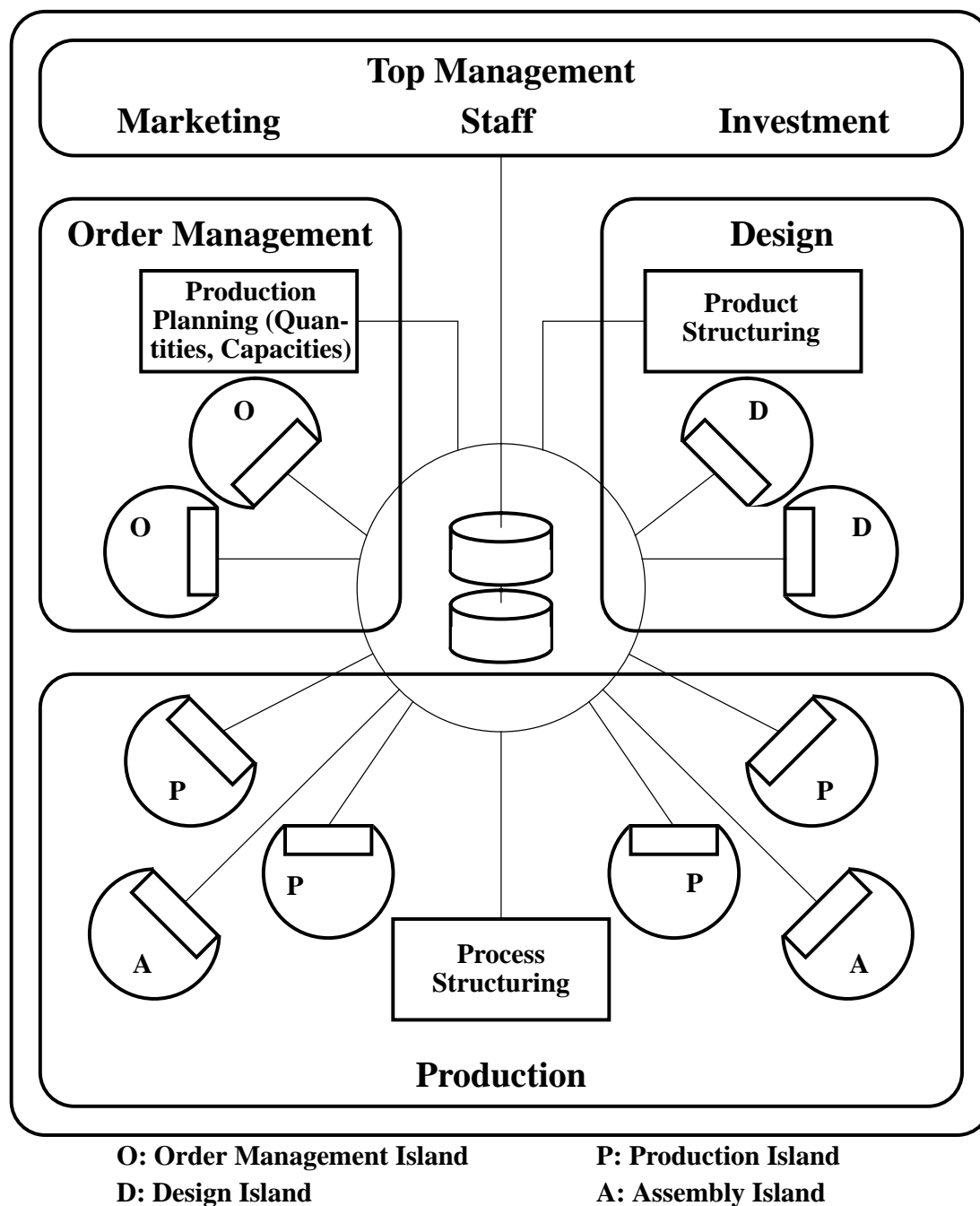
than specific acitivities and operations, i.e., how it is to be done, are subject to central planning and control. Instead of merely executing prescribed operations, the workers are expected to solve complete tasks cooperatively and to codesign the work procedures. Thus, professional, methodical, and social competences are comprehensively used that at the same time will maintain and develop through work.

Computers as tools rather than as means of automation:
In connection with these new forms of work, the functionality and user interfaces of computer systems must be designed in such a way that they support, not replace, the skilled work of the

factory's experts. They must be appropriately designed as tools for effective and efficient use to solve individual tasks and as media for cooperation in and between companies. Commonly used data should be provided by a data base with agreed data definitions and process views based on the new forms of organisation. This data base serves as the organisation's external memory (see H. Paul's paper).

Comprehending human resources development as investment rather than mere adaptation:
The creation of "human capital" through systematic human resources development is at least as significant for the efficiency of new manufacturing systems as the procurement with machinery. It should aim at developing sufficient competence to act, including social skills and the ability to codesign work and technology which goes beyond necessary professional and methodological skills (see E. Lüders' paper).

Management by participation rather than command and control:
Participation should be the general principle of managing and decision-making. This principle guarantees that all relevant actors are actively involved, that their different perspectives and interests are taken into account, that objectives and procedures for future acting are accepted, and that distributed and specialized knowledge and experience are used for continuous improvement. This calls for high social competence in building consensus and establishing agreed goals (see U. Pekruhl's paper).

It goes without saying that other social conditions have to be adapted such that the new production systems can produce their potential performance. In particular, the wage system has to appropriately assess the development of skills, competence and knowledge as well as the customer-oriented performance in terms of quality, due dates, and agility, while new controlling systems have to mirror the companies objectives in order to provide appropriate figures for self-regulation of working units.

1.2 The Nature of Change

The empirical findings summarized in the previous section point to the fact that there is a radical change in basic principles and procedures of manufacturing going on. Despite its impressive successes in the past, the Taylor model of manufacturing now obviously is getting inadequate. So far self-evident rules and principles of rationalisation have become questionable. A fundamental shift in perspective appears to be necessary.

Taylor's basic approach was to separate conception from implementation, to derive precise prescriptions of how to produce and of how long it should take to produce from objectified, explicit knowledge about production. With this conception of the scientificly determined "one best way" to produce he was deeply rooted in the rationalistic tradition of the West. This tradition is built on the far reaching assumption that the world surrounding us is, at least in principle, fully comprehendable and describable in objective terms or by propositional knowledge, and that, accordingly, human behavior can be explained by the functioning of machines. Consequently, this perspective envisages the total describability and controllability of production processes by means of data and algorithms, and, ultimately, the replacement of humans by machines. In the eighties, we experienced the so far last big attempt of this kind, the implementation of knowledge-based and computer-integrated manufacturing systems (CIM). Computer artifacts were designed to increasingly replace the knowledge – and supposedly also the experience and skills – of human experts, the dead dominated the living.

This approach was, without doubt, very successful under specific historical circumstances. As long as there existed stable and transparent markets for mass products, as long as the products as well as the processes to produce them were simple and only few changes occurred over time, the rationalisation potentials inherent in the Tayloristic production system could be exploited to a large extent. The clumsiness of its production structures brought it into trouble, however, as soon as market conditions required more flexibility. In a hardly comprehendable, highly dynamic environment, with complex products and processes that are subject to various rapid changes as well, only living and learning systems can survive. They are crucially dependent on human skills, experience and knowledge, in particular on the ability to learn and the competence to act under uncertainty.

Conventional organisational structures in manufacturing based on horizontal and vertical division of labor are inappropriate to develop and comprehensively use these skills and competences. The Taylor model, in effect, was based on simplified working tasks with low skill requirements tied together and made effective by a complex organisation. Production knowledge and competence should not be relying on the skills and experiences of the workers but rather be embodied in the organisation, in the form of formal procedures, detailed instructions and propositional knowledge being developed and maintained by a professional elite. Growing flexibility requirements to adapt to a changing environment as well as more demanding functional specifications for products and processes led to further differentiation of functions and more coordination effort and, hence, resulted in an even more complex, bureaucratic and inert organisation. This trend could only be broken by a fundamental shift of perspective in organising work: By bringing together various related tasks, by reintegrating conception with implementation, and by introducing teamwork with direct task-related communication, complex jobs are created in a simplified organisation. Flexibility then is a result of continuous learning of skilled and competent workers, work no longer is the mere execution of prescribed routines but the unity of producing, reflecting, improving and learning.

Thus, a much more flexible manufacturing system emerges that avoids the rigidity of the Taylor model. In contrast to the rigid functional specialisation of work and the inert coordination and control hierarchy, the renewed system consists of adaptable, rather autonomous and holistic working units cooperating and communicating with each other under shared objectives. They can, being based on continuous improvement of performance and competence, easily take over new tasks and form new links according to market requirements. These organisational principles facilitate the implementation of an adaptable, "learning" organisation (Senge 1990). Productivity then no longer is a pure quantative economic indicator, but rather a mental attitude as a new quality, the deliberate improvement of everything that exists.

It follows from these reflections that the company as the essentially acting unit is in the focus of change. With this respect, it is very important to understand the interplay between the grown structures of manufacturing systems and their environment and, in particular, the conditions, under which they can adapt to changing requirements. In situations where the flexibility requirements of the environment go beyond the capacity of the manufacturing system to adapt, its internal structure has to be qualitatively changed. Therefore, successful renewal must be based on a sound critique and assessment of the Taylor model of manufacturing recognising its specific strengths and weaknesses as well as its operational conditions. Those who miss to gain an understanding of the past are condemned to repeat it and to reproduce its failures.

1.3   Resistance to Change

According to these considerations one has to realize that the Taylor model of manufacturing is bound to fail under the new market requirements due to the same features that made it so strong and successful under past conditions. Therefore, a radical change of perspective for design of work and technology for efficient manufacturing processes is inevitable. The small minority of pioneer companies having successfully mastered this social innovation already proves that it can be done and that it creates extraordinary benefits both in economic and in social terms. Nevertheless, the vast majority of firms appears to be reluctant to change. While the rhetoric has altered, practice more or less remains the same (Kleinschmidt / Pekruhl 1994). This resistance has systematic reasons which deserve some further explanation.
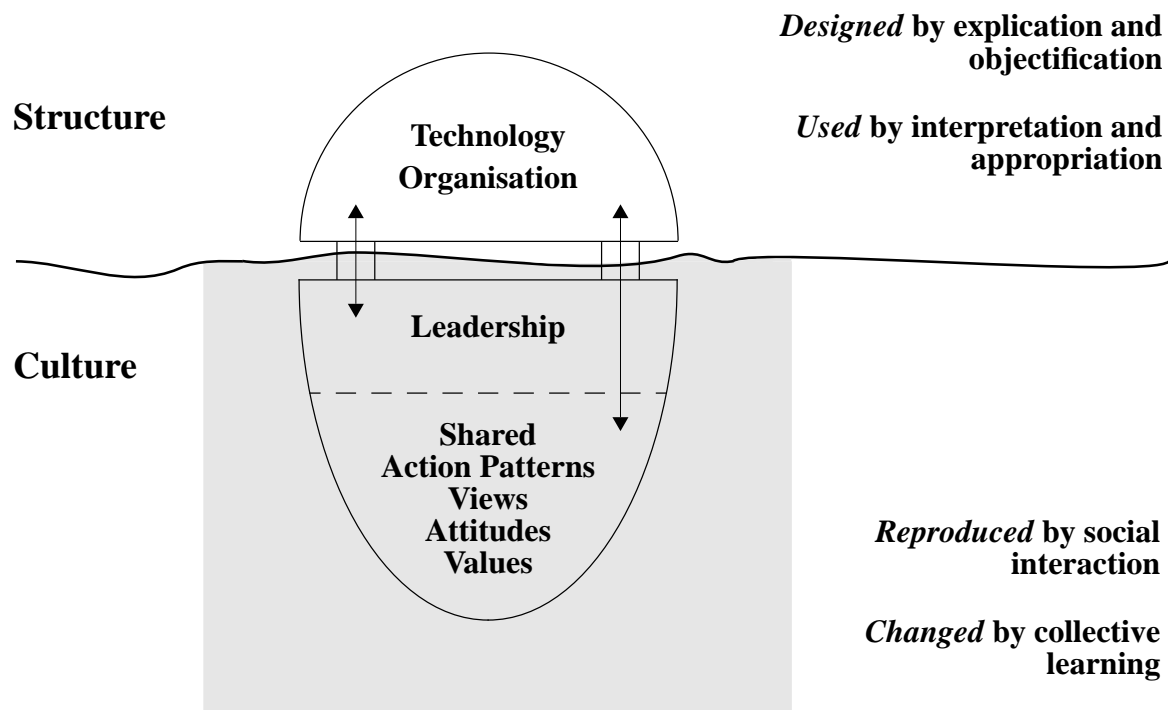
There are, at first, the existing computer systems. They have been designed according to the old principles of work organisation, and, therefore, it is necessary to adapt or redesign their functions and procedures of human-computer interaction as appropriate tools for the new working tasks and media for cooperation within the new organisation. Being embedded into the existing organisation, this is not an easy reengineering problem to be solved. Participatory design of the shared data model proves to be an adequate way to bridge the gap between organisational development and systems reengineering (Adler / Winograd 1992, Davenport 1994, Ehn 1988).

Another, even harder moment of inertia lies in the social system of the firm, however. Any position in the organisation is connected with specificly defined social and power relations, with income, status and career opportunities. Substantial changes in these patterns will give rise to uncertain expectations and, thus, create resistance. But there are even more deeply rooted reasons for this social inertia.

The usual organisational schemes, job descriptions and instructions only provide the formal, explicit description of the organisation's structures and procedures. They denote abstract tasks and functions that humans have to perform, not the reality of work itself. Real individuals, in order to be able to sensibly act within these structures and procedures, do need more. They need a common background knowledge and shared understanding of the work and its context, which brings them into the position to appropriately interpret and assess given situations, facts, data, and orders for purposeful coordinated action. Moreover, their acting is substantially codetermined by various interests, customs and wishes, by well established acting routines and by patterns of communication and conflict resolution.

Both factors taken together, the normally unquestioned, but omnipresent background knowledge, the shared assumptions and perspectives being self-evident to all actors as well as their habitualised patterns of acting, constitute the formative context as an indispensible condition for meaningful acting of the members of the firm's social system. It gives meaning to its everyday practices and routines, defines acceptable and unacceptable behavior, and determines relevant problems and appropriate solutions. It normally remains unconscious to the actors, because it is taken for granted and because it is formed without their deliberate action just within the process of social interaction itself. This makes it a double-edged attribute of organisations that proves to be highly resistant to change but has to change appropriately, nevertheless, in order to make the new organisation work (Adler 1992; see U. Pekruhl's paper; figure 3).

Fig. 3:   Factory as social system

Designed **by explication and
objectification**

Structure

Technology
Organisation

Used **by interpretation and
appropriation**

Leadership

Culture

**Shared
Action Patterns
Views
Attitudes
Values**

Reproduced **by social
interaction**

Changed **by collective
learning**

The neglect of this institutional ("second order") learning process accounts for the fact that change programs typically do not produce change (Beer / Eisenstat / Spector 1990), that organisational structures and working procedures cannot be altered unless the formative context has also been triggered to change. In the process of renewal the formal structures and procedures of the organisation, in particular the working tasks, cooperative links, technical means, and qualifications, can be deliberately designed, while the formative context can only change through "self-organisation" within a collective learning process. This learning process is not controllable in a strong sense, but it can, of course, be triggered and influenced by conducive conditions. This has to be initiated as early as possible and interlinked with the bargaining on the objectives and frame conditions for shaping the new organisation. In other words: The design perspective of shaping the new structures of manufacturing has to be combined with the process perspective to develop the new culture by collective learning. Participation is a practically proven means to achieve this effectively.

1.4   Participation as Appropriate Means for Mastering the Factory Renewal

From what has been said so far, it is quite clear that the necessary radical change of the structure and culture of manufacturing cannot be achieved without far reaching social innovations and collective learning processes. Unusual tasks call for unusual means. Direct participation is such a social innovation that turns out to be a promising approach to manage the change and to keep the renewed factory running efficiently. At the same time, it can considerably improve the quality of work. What can be learned from cases of successful renewal is that direct participation is a necessary, but surely not sufficient, condition for success. Paricipation, in whatever

precise form it may be accomplished, cannot guarantee, of course, the intended outcome, but it is, for a number of well comprehendable reasons, a necessary prerequisite; trying without will almost certainly end in failure.

Direct participation means that management provides opportunities for employees, either as individuals or as members of a group, to get involved in affairs of design of work and technology, i.e. determining work tasks, work organisation and working conditions, at work place level. This involvement may consist of regular consultations or delegation of responsibility and authority for decision-making on these issues. Direct participation, thus, excludes various forms of indirect or representative participation through shop stewards, works councils, trade unions or collective bargaining. It also excludes financial participation and profit-sharing. The various legal regulations and collective bargaining agreements for indirect participation form important boundary conditions that have to be taken into account in the change process, but they are, as a given frame, not considered here.

Two main forms of direct participation can be distinguished. With consultative participation, on one hand, employees are enabled and encouraged to articulate their views, while it is up to the management to decide what actions are to be taken; quality circles may serve as an example for this form. Employees are, according to this consultive approach, empowered to recommend rather than implement solutions to work-related problems they are concerned about. Delegative participation, on the other hand, also transfer the responsibility and authority for work-related decision-making to the employees. They are then granted with the autonomy to establish work schedules and to control their own work tasks and methods, to be self-managing within agreed objectives and boundary conditions. Semi-autonomous working groups are good examples for this form (European Foundation 1994).

Direct participation has a number of roots reaching back quite a long time in industrial development. From the beginning, it has been, as part of theoretical and practical criticism of Tayloristic work organisation, associated with the socially compatible design of work and technology, with the improvement of quality of working life, and with industrial democracy. There is at the same time, however, a strong economic rationale in the conception of direct participation making it an appropriate approach to overcome the weakness of the Taylor model of manufacturing.

First, the complexity of products, processes and market relations makes it necessary to take into account and actually use the knowledge, skills and expertise of various product and production experts distributed over the factory. In order to find a good solution to complicated problems of product design and process engineering their various views and perspectives have to be related to each other. Since these different knowledge domains and perspectives are, due to the interaction within the firm's social system, necessarily connected with social interests of the actors, they have to be considered as well such that each actor feels being taken seriously. This can most adequately and effectively be done by having all actors involved and letting them know the whole spectrum of views.

Second, social systems like a firm's social web can only change through an interactive, collective learning process. This second order learning process is, of course, being accomplished through the individual learning of the persons participating, it can, however, produce a coherent result of coordinated action patterns only if the individual's learning is triggered by and embedded in the context of shared objectives and social interaction. It is the basis to form a

common understanding and shared view of the manufacturing process that makes cooperation and communication more efficient. Such collective learning processes again call for a participatory setting.

Third, participation is an important factor of motivation. Social acknowledgement by the colleagues at work has proven to be a powerful reward being as effective as remuneration. This only works, however, if it is perceived as being fair assessment, taking into account all circumstances under which work has been performed. Management by participation provides such situations where the conditions for doing the work are transparent to all actors involved.

Fourth, participation can, to a large extent, reduce the efforts for coordination and control through the hierarchy. Work is now directly coordinated within the group and underlies direct social control among the group members. This is one important source of productivity gain without loss of flexibility.

These are the main reasons why direct participation is a powerful form of managing complex manufacturing processes in a turbulent environment. There are, of course, a number of boundary conditions and requirements that have to be met in order to make direct participation working successfully. The employees involved need, for being able to make meaningful contributions, a rather complete picture of the firm's situation. Therefore, comprehensive information on the product and production strategies envisaged, on the market situation as well as on the economic performance is a crucial requirement for participation. This kind of information has to be given regularly so that changes over time can be recognised and assessed. This assessment must be based on reflections about past actions in order to make good choices for future actions.

A further necessary prerequisite for effective management by participation is the agreement on appropriate operational objectives for the different working groups. Under the changed manufacturing structure, it is one of the most important management tasks to break down the firm's overall strategic goals into transparent operational objectives for the different units or sections of the manufacturing process. The meaning of these objectives has to be discussed as part of the participatory procedures with the employees in order to have them shared, eventually modified and accepted.

Direct participation requires a relatively high level of trust in the firm's social relations and it challenges the social competence of all actors involved. This social skill is needed for forming consensus integrating various perspectives in the light of the agreed objectives and for a productive way of conflict resolution avoiding blockings. This basicly means for each actor participating to be prepared to accept other people's views and, by shifting perspective, to help constructing a shared problem solution that relies on his own competence and perspective, but also takes into account others' expectations. All this will only work if there is sufficient commitment to the agreed objectives and if there is coherence in the persons' acting on which trust can develop.

These considerations make it quite obvious that direct participation is a social process which can be characterised, due to the mutual contingency of the actors involved, by an open development neither completely foreseeable nor controllable. It can be, at any time, subject to positive feedback reinforcing its successful social interactions as well as to failure or break down. This exactly makes it suspicious, of course, for all Tayloristic thinkers, but, considering the

rigidities of the Taylor model, it still appears as a promising and proven approach to overcome its weaknesses and to cope with complex and dynamic situations.

In front of the severe difficulties of Tayloristic manufacturing processes, direct participation can have two important functions: it can help mastering the difficult fundamental change to non-Tayloristic forms of manufacturing and it can, as a basic feature of the renewed manufacturing system itself, be an effective management practice suited to cope with complexity and dynamics and forming a source of productivity, flexibility and innovation.

1.5 Practice and Experience with Direct Participation

Despite the long debate on worker involvement and participation and despite the rather positive experiments that have been made over the last decades, there is only little practice in Europe's industries. As compared to Japan, where culture-specific forms of team work, consultation and consensus formation are normal and wide-spread management practices, as well as compared to the USA, where self-managing teams, worker empowerment and participatory management practices seem to disseminate rapidly in various industries more recently, European managerial practices are still more or less following the old tracks of hierarchical coordination and control. Although there is a tiny, but growing minority of pioneering firms with outstanding results, Europe's industries are obviously falling behind in coping with change, due to a lack of social innovations such as semi-autonomous working groups and management by participation. A brand new investigation carried out be the European Foundation for the Improvement of Living and Working Conditions in Dublin reveals a number of interesting results with this respect.

First, in Japan more than 90% of the employees in large manufacturing companies with 1000 employees or more are working in groups. This kind of group work has until recently been characterised by job rotation in an otherwise rather conventional work environment, by processes of continuous improvement and comprehensive work assessment as basis for remuneration. Over the last years, however, a clear trend emerges to expand the autonomy and self-managing responsibilities of the groups.

Second, in the USA recent investigations report on large and widely spread efforts of "company transformation" to make them more agile and reactive to market requirements. This multi-level approach to industrial renewal provides, among other things, worker empowerment by the implementation of self-managing teams, of information and communication schemes for the employees, and of concurrent engineering teams. Although it is hard to really catch the quantative dimensions, this appears to be a strong movement with high dynamics.

Third, there is much evidence confirming the fact that the most advanced and comprehensive applications of direct participation are driven by the motive to reconstruct the entire production process to meet exactly the requirements discussed in this paper. More consultative forms of participation, like Quality Circles, turn out to be of limited effect, though, as they mostly are successful in the beginning (when everybody is quite enthusiastic), but start to wane over time as an alien element in the otherwise unchanged organisation (when frustration grows over ideas not being realised). Group work, in contrast, is more likely to produce much more stable, long-term effects with both respects, social compatibility and economic performance, since it deeply cuts into traditional forms of work organisation and actually changes every day work.

1.6 Conclusion

The theoretical arguments as well as the empirical results summerised in this paper emphasise a few lessons to be learned. First of all and most important: The shift to human-centered high performance manufacturing systems is an economic necessity and direct participation is a key issue to comprehensive renewal. Despite all differences in appearances and practice in various industrial cultures, it has proven to be an appropriate means to master the necessary fundamental change in manufacturing. The full economic potential of the renewed manufacturing system can only be realised, however, if direct participation is integrated in an overall conception of the new manufacturing system. In cases of successful renewal, direct participation has often been introduced in a participatory way, thus linking the system's structural design with the process of implementation as a cultural change.

Moreover, it is important to realise that the renewed manufacturing systems own a new quality with respect to flexibility and agility. They do not reproduce just another "frozen" and, hence, rigid internal structure, but rather develop the ability to permanently adapt to a changing environment. This ability is mainly based on the new quality of work as a unity of producing, learning and improving and on participatory management as a permanent feature leaving a wide scope for acting within the bounds of common goals.

As the focus of these considerations is on the companies as the essential acting units that must change themselves in order to survive, it appears necessary to additionally shed some light, when concluding at the end, to important environmental aspects that have to be adjusted in order to support the change process or create fostering conditions. Since much of the production-related technology has been designed to imitate and replace human capabilities along the lines of Tayloristic thinking, it has to be reengineered or adapted to fit into the new organisation and to serve as supportive tools for human expert workers. Education and training systems have to put additional emphasis on the development of social skills, of learning and designing abilities as basic competences for productive work. And the social partners must adapt their perspectives to the new manufacturing principles and learn to cope with direct participation.

Since most of European industries are obviously falling behind in the global context with respect to these social innovations, there is an urgent need for action on all levels, in particular on the level of companies, industrial relations, and political schemes. All relevant actors should focus their attention on strengthening the awareness of the underlying problems of manufacturing and of the potentials offered by the new organisation and management principles, on stimulating the exchange of experience and learning from cases of best practice, on supportive actions in the areas of R&D, industrial relations or education and training in order to encourage the social innovation of direct participation.

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References

Adler, P.S., 1992: Technology and the Future of Work, New York Oxford: Oxford University Press

Adler, P.S. / Winograd, T.A. (Eds.), 1992: Usability: Turning Technologies into Tools, New York: Oxford University Press

Beer, M. / Eisenstat, R.A. / Spector, B., 1990: Why Change Programs Don't Produce Change, Harvard Business Rev. 11/12, 158-166

Brödner, P., 1994: Design of Work and Technology, in: Salvendy, G. / Karwowski, W. (Eds.): Design of Work and Development of Personnel in Advanced Manufacturing, New York: Wiley

Brödner, P., 1993: Mechanical Engineering. The Future of Industry in Europe (FINE), MONITOR-FAST Occasional Paper No. 369, Brussels: CEC

Brödner, P. / Schultetus, W., 1992: Erfolgsfaktoren des japanischen Werkzeugmaschinenbaus, Eschborn: RKW

Clark, K.B. / Fujimoto, T., 1991: Product Development Performance: Strategy, Management, and Organisation in the World Auto Industry, Boston: Harvard Business School Press

Davenport, T.H., 1994: Saving IT's Soul: Human-Centered Information Management, Harvard Business Review 72, March-April, 119-131

Ehn, P., 1988: Work Oriented Design of Computer Artifacts, Stockholm: Arbetslivscentrum

European Foundation for the Improvement of Living and Working Conditions (Ed.) 1994: Conceptualising Direct Participation in Organisational Change – The EPOC Projekt, Dublin: EF

Kleinschmidt, M. / Pekruhl, U., 1994: Kooperative Arbeitsstrukturen und Gruppenarbeit in Deutschland, IAT Strukturberichterstattung 01, Gelsenkirchen: IAT

Senge, P.M., 1990: The Fifth Discipline. The Art and Practice of the Learning Organization, New York: Doubleday

Womack, J.P. / Jones, D.T. / Roos, D., 1990: The Machine that Changed the World, New York: Rawson Ass., Maxwell MacMillan Int.

2 Integral Analysis and Evaluation of Enterprises as a Precondition for Optimal Sociotechnical System Design

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2.1 Introduction

Effectiveness, efficiency and high quality of working conditions and working results are main effects of the sociotechnical optimization of companies (Emery 1959). Sociotechnical aims toward the joint optimization of the utilization and the development of the employees' qualifications, the implementation of advanced technology as well as the design of the work organization (people-technology-organization approach). The allocation of functions between human and machine has a crucial importance (Grote / Weik / Wäfler / Zölch 1995). Sociotechnically optimized, what we call work-oriented, enterprises are characterized by decentralization at the level of the enterprise, functional integration at the level of organizational units, work in self-regulated groups and qualified work at the level of individual work tasks (Figure 1, Ulich 1994).
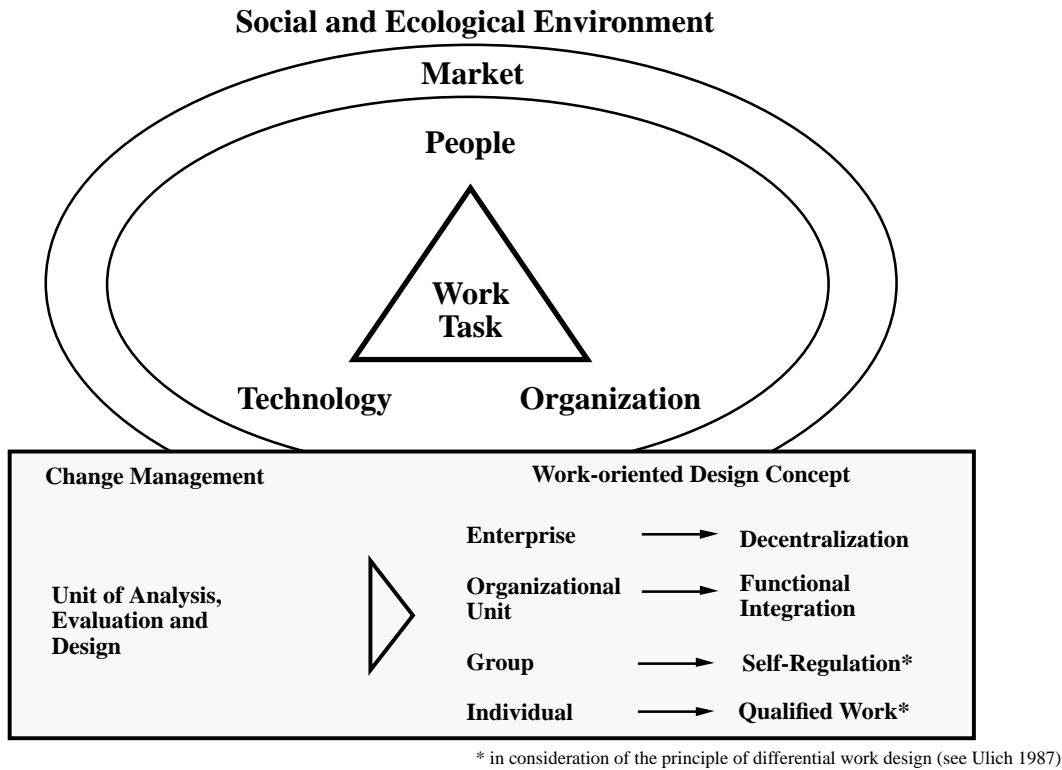
2.2 Results of the GRIPS-Project

In the research project "Design of Computer Aided Integrated Manufacturing Systems" (orig. German „Gestaltung rechnerunterstützter integrierter Produktionssysteme (GRIPS)") sociotechnical concepts for the design of computer aided integrated manufacturing systems have been developed and empirically examined. The project consisted of three phases.

The first phase was completed in the form of a written survey in the machine building, electronic, metal-working and the processing industries (N=917). Its main goal was to gain data on the use and integration of computer aided manufacturing functions, the aims associated therewith and the problems that were encountered during implementation. The results of this study show that there is a high level of implementation of computer aided integrated manufacturing functions. In general, the aim which is associated with the implementation of such technologies is to manufacture with more flexibility and economic efficiency. At the time of the survey however, most of the companies of the sample had not attained their goals (see Kirsch / Strohm / Ulich 1996). The problems which were connected with the implementation of the technical systems offer one explanation for this fact. Technical shortcomings, problems with the qualification of the employees, the work organization and the acceptance / motivation of the employees were named most frequently. With regard to the technical shortcomings, problems with network integration, software bugs flexibility as well as reliability of systems were the most common (see Kuark 1996).

In the second GRIPS project phase, 60 companies were selected for detailed case studies with the aid of document analyses, company tours and expert interviews. Questions concerning manufacturing conditions, work and organizational structures, implemented and planned use of computers and their technical integration, the structure and development of employees' qualification, as well as innovation strategies were pursued.

Fig. 4: The People-Technology-Organization-Approach (Ulich 1997)

Social and Ecological Environment

Market

People

Work
Task

Technology   Organization

Change Management	Work-oriented Design Concept	
Unit of Analysis, Evaluation and Design	Enterprise	Decentralization
	Organizational Unit	Functional Integration
	Group	Self-Regulation*
	Individual	Qualified Work*

* in consideration of the principle of differential work design (see Ulich 1987)

With regard to the work organization of the companies we found – despite the quite high degree of computer support – that 63 % of our sample have rather centralized enterprise structures, and that most practice more or less functional specialization on the level of the organizational unit (see Table 1). 53 % of the companies have forms of work groups in their manufacturing or assembly units. However, the most of these groups are more or less controlled centrally. 86 % of the tasks of workers in manufacturing units cannot be described as complete and challenging. We were able to identify only two companies which can be considered to be work-oriented and two others which are classified as rather work-oriented. The majority of the companies were found to have rather technically-oriented production processes and structures (Strohm et al. 1993).

We contend that the high degree of technical orientation is the main reason for the low attainment of the companies goals that were associated with the implementation of computer aided integrated manufacturing systems. This interpretation is supported by the fact that the companies spent an average of 71 % of their budgets for hard- and software and only 4 % for training measures for employees' in projects on the implementation of systems for production planning and control (Strohm 1996). Thus, training and education was not treated as a strategic investment in these projects, but as a cost factor which had to be minimized.

As expected, we found some empirical indications for the positive correlation between sociotechnical optimization and economic efficiency. The attainment of some of the goals which were associated with the implementation of computer aided integrated manufacturing systems correlate positively with features of sociotechnical optimization (see Kirsch / Strohm / Ulich 1996). Moreover, the two work-oriented companies in our sample attained various positive economic effects by changing in the direction of work-orientation.

Table 1: Degree of Functional Integration in Manufacturing Departments (n=53–59)

Participation of manufacturing departments at the...	
Design of new products	17%
Make- or buy-decisions	26%
Planning of the production program	18%
Planning of the capacities	13%
Complete integration into the manufacturing departments	
Definition of the operation plans	12%
Definition of the machining sequence	25%
NC-Programming	45%
Final control of the product quality	39%

In one of these companies a technical-organizational change has been realized, where e.g. a new system for production planning and control, new CAM components and functional integrated manufacturing islands have been implemented. The operators in these manufacturing islands complete challenging tasks which include e.g. parts of the technical planning, parts of the production control, the NC-programming and the quality control.

The company attained the following results through this redesign:

- ❒ Reduction of cycle time for 50%.
- ❒ Increased accuracy of meeting delivery time from 70-80% to 98-100%.
- ❒ Reduction of preprocessed parts on stock by 30-35%.
- ❒ Considerable improvement of product quality.

The costs for the technical investments were much higher than the costs for the organizational change and the training measures. In the company however, about 70% of the effects are attributed to the organizational and training measures and only about 30% of the effects are attributed to the technical investments.

The second work-oriented company of the sample of GRIPS II explicitly state in their own corporate image that they do not intend to insult their employees by not offering them enough challenges in their work. They completed a change process which was characterized by the following features:

- ❒ Demand-oriented production
- ❒ Flat hierarchies
- ❒ Cells for production planning
- ❒ Cells for manufacturing and assembly
- ❒ Introduction of a group bonus component
- ❒ Conscious development of the enterprise culture.

The company could attain e.g. the following effects by this changes:

❐ Reduction of cycle time for 50 %
❐ Increase of production output for 20 %
❐ Reduction of time for introduction new products for 60 %
❐ Increase of turnover per employee for 100 %.

The results of GRIPS I and II exemplify that to the approach humane flexibility and efficiency many companies must proceed a change from technically-oriented towards work-oriented production processes and structures. Therefore, redesign measures in accordance with the following principles are crucial (Ulich 1994):

❐ Organizational design prior to automation
❐ Education and training as a strategic investment
❐ Functional integration
❐ Local self-regulation.

2.3 MTO Analysis as a Starting Point for Sociotechnical Optimization

In the third phase of the GRIPS-Project a procedure was developed for integral analysis and evaluation of industrial enterprises in terms of people, technology and organization.[1] MTO analysis has since been carried out successfully in more than 20 firms.

In the MTO analysis procedure a "top-down" approach is utilized because findings of the analyses at lower levels of the enterprise build on the knowledge extracted from the analyses of the upper levels. Table 2 presents the seven steps involved in MTO analysis, the objects of analysis as well as the methods used (see Strohm / Ulich 1997a, Strohm / Ulich 1997b).

Experience has shown that MTO analysis and evaluation produces a comprehensive profile of the strengths and weaknesses of an enterprise and allows the formulation of well-founded design criteria for integral restructuring, in the sense of sociotechnical optimization. Moreover, the use of the MTO analysis is particularly appropriate when an enterprise requires development and realization of design concepts that are oriented toward the future. Specifically the risk that technical-organizational innovations will be inadequate can be reduced. Costly and time-intensive mistakes during the realization phases of change processes that are traced back to insufficient consideration in the conceptional phase, can be avoided.

In the following section the steps 2) Analysis of order processing along the value-add chain, 3) Analysis of work systems and 7) Analysis of socio-technical history are described in more detail.

The optimization of order processing and work systems is crucial for the design of work in self-regulated groups and the design of qualified work tasks on the individual level. This means that the design of these processes and structures are very important preconditions for humane and efficient work design. Knowledge of a company's sociotechnical history is very important for the design of a well-founded change process.

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[1] With regard to literature references, we will use the acronym MTO, the original German-language abbreviation for „Mensch-Technik-Organisation".

Table 2: Steps, Objects and Methods of MTO Analysis

Steps		Objects of analysis	Methods
1.	**Analysis at the level of the enterprise**	Analysis of the enterprise's goals, strategy, products and production requirements, personnel structure, use of technology, quality management, reward system, working hours model, etc.	Document analyses, expert interviews
2.	**Analysis of order processing along the value-add chain**	Analysis of order processing of 2 to 5 typical and completed orders	Document analyses, company tours, expert interviews, group interviews
3.	**Analysis of work systems**	Analysis of inputs, transformation processes, outputs, social and technical components, technical-organizational design, fluctuations and disturbances, etc.	Document analysis, expert interviews, group interviews
4.	**Analysis of work groups**	Analysis of possibility for collective regulation of work environment, work tasks, working hours, qualifying, achievement, quality, internal and external coordination	Document analysis, observational interviews, group interviews
5.	**Objective work analysis of specified key tasks**	Analysis of work units, task processes, communication and cooperation requirements, division of functions and interaction between person and machine, mental work load, etc.	Observation of whole work shifts, observational interviews, expert interviews
6.	**Subjective work analyses**	Analysis of employees' expectations regarding work and employees' perceptions of the work situation	Written questionnaire with scaling methods
7.	**Analysis of socio-technical history**	Analysis of strategies, proceedings and milestones of the technical organizational development of the enterprise	Document analysis, expert interviews

2.3.1 Analysis and Evaluation of Order Processing

With the knowledge gained from analysis at the level of the enterprise of the products and production requirements of the organization, the second investigative step – targeted analysis of representative examples of order processing – can be carried out. Here 2 to 5 typical and complete examples of order processing are analyzed in terms of work process and completion time, whereby, for example, time planned for order completion can be compared to actual time required. In order to analyze the order processing, assessment will require a time period of a half-day to a full day for one order. Evaluation of the order processing is undertaken using the following criteria (see Schüpbach / Strohm / Troxler / Ulich 1997):

(1) *Number of Interfaces*
    The number of internal and external interfaces within the total order processing

(2) *Quality of Interfaces*
The degree to which the information and partial results, which are exchanged at the interfaces fulfill defined quality standards

(3) *Necessary and Unnecessary Redundancies*
The degree to which redundancies within the order processing are necessary or unnecessary

(4) *Quality of Planning*
The degree to which order processing is planned realistically, carefully and with sufficient degrees of freedom for the regulation of fluctuations and disturbances

(5) *Functional Integration*
The degree to which the order processing is characterized by self-contained partial processes

We contend that a functionally integrated form of order processing, characterized by a few, high-quality interfaces as well as specific redundancies and high-quality planning are good predictors of efficiency in terms of fast production of high-quality products. The analysis of the order processing, from making a bid to the finished product itself, also serves to identify the work systems which are analyzed in the next step.

2.3.2 Analysis and Evaluation of Work Systems

Step 3 in MTO analysis investigates work systems with regard to inputs, transformation steps, outputs and technical-organizational design, as well as the fluctuations, disturbances and main problems associated with them. The evaluation of work systems is made according to the following criteria (Strohm 1997a).

(1) *Independence of the Organizational Unit*
This criterion concerns the degree to which an organizational unit performs whole tasks, or complete primary tasks, so that it is in a position to register fluctuations and disturbances where they arise and to counterbalance them itself.

(2) *Relatedness of Tasks Within the Organizational Unit*
This criterion examines the various part tasks within an organizational unit as to their relatedness in terms of content.

(3) *Unity of Product and Organization*
Using this criterion, the degree to which resulting products can be assigned to the organizational unit in terms of both quality and quantity is assessed.

(4) *Polyvalence of the Employees*
This criterion examines the extent to which employees within an organizational unit are qualified to fulfill or perform various part tasks so that they lend mutual support to one another and may stand in for others.

Fig. 5: Evaluation of a design department
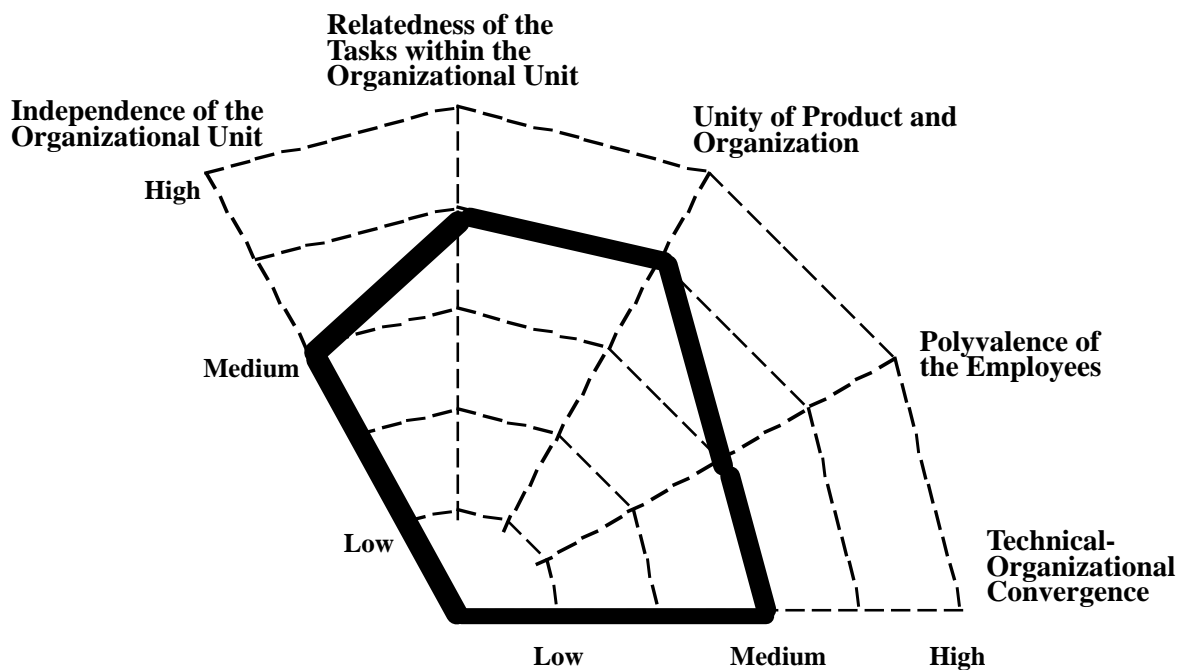
(5) *Technical-Organizational Convergence*
      This criterion assesses the degree to which there is an optimal fit between technolog-
      ical and organizational requirements and conditions.

Figure 2 shows evaluation of a design department according to these five criteria.

2.3.3   Analysis and evaluation of the sociotechnical history of the enterprise

MTO analysis is an aid for articulating and realizing suggestions for work design that optimize
the development of employees' qualifications, the utilization of advanced technology and the
design of the organization. Keeping in mind that this entails triggering and carrying out change
processes which evolve with time, the persons contracted with redesign should have knowl-
edge of the sociotechnical history of the enterprise. During restructuring and change, such
knowledge of a company's historical development allows the experiences of the past to be
used and prevents unnecessary repetition of mistakes. In step seven, therefore, – once analysis
of work structures and processes has produced a sufficient base – the question is addressed as
to how technical-organizational structures and processes within the enterprise arose. Not only
will the sociotechnical history of the enterprise be submitted to a general analysis, but specifi-
cally, historically significant milestones in the development of the enterprise are examined.
Criteria for the evaluation of important milestones are illustrated by example in Figure 3.
Experience has demonstrated that this form of study and reflection contributes greatly to inte-
gral planning and concept design regarding future measures (Strohm 1997b; Kuark 1996).

Fig. 6: Evaluation of a project for implementing a system for production planning and control (Strohm 1997b)

		Low				High
PLANNING	*Planned sociotechnical optimization*	■	■	■	□	□
REALI-ZATION	*Task appropriateness of project organization*	■	■	□	□	□
	Task appropriateness of project process	■	■	□	□	□
	Involvement of employees	■	□	□	□	□
	Training of employees	■	□	□	□	□
RESULT	*Realized sociotechnical optimization*	■	□	□	□	□

Low   High

2.4 Conclusions

The paper has presented results of the GRIPS-Project as well as the MTO analysis in its steps and procedures and its evaluation criteria. Experience has shown that with use of the MTO analysis, basic restructuring projects can be initiated and supported. In sum, the advantages yielded by MTO analysis include the following:

1. Detailed evaluation emphasizing strengths and weaknesses of the company

2. A basis for well-conceived derivation of integral design concepts

3. Launching of a process of change which emphasizes involvement

4. Building up trust in relationsships with employees at all levels

5. Important knowledge relevant to the time plan for the phases of design and realization

6. Data base and methodological support for design efforts

7. Data base for the controlling of the effects of the redesign.

References

Emery, F.E. (1959). Characteristics of Sociotechnical Systems. London: Tavistock document no. 527.

Grote, G. / Weik, S. / Wäfler, T. / Zölch, M. (1995). Criteria for the complementary allocation of functions in automated work systems and their use in simultaneous engineering projects. International Journal of Industrial Ergonomics 16, pp. 367-382.

Kirsch, C. / Strohm, O. / Ulich, E. (1996). Design concepts of computer-aided integrated manufacturing systems: Work-psychological concepts and empirical findings. International Journal of Industrial Ergonomics 17, pp. 11-19.

Kuark, J.K. (1996). Factors in the Organizational and Technical Developemnt of CIM Strategies and CIM Systems. Diss ETH No. 11906. Zürich: IfAP.

Schüpbach, H. / Strohm, O. / Troxler, P. / Ulich E. (1997). Analyse und Bewertung von Auftragsdurchläufen. In O. Strohm / E. Ulich (Hrsg.), Unternehmen arbeitspsychologisch bewerten. Schriftenreihe Mensch-Tech-nik-Organisation, Band 10 (S. 107-134). Zürich: vdf Hochschulverlag der Fachvereine.

Strohm, O. (1996). Produktionsplanung und -steuerung im Industrieunternehmen aus arbeitspsychologischer Perspektive. Arbeitsorientierte versus technikorientierte Gestaltungskonzepte. Schriftenreihe Mensch-Technik-Organisation (Hrsg. E. Ulich), Band 15. Zürich: Verlag der Fachvereine / Stuttgart: Teubner.

Strohm, O. (1997a). Analyse und Bewertung von Arbeitssystemen. In O. Strohm / E. Ulich (Hrsg.), Unternehmen arbeitspsychologisch bewerten. Schriftenreihe Mensch-Technik-Organisation (Hrsg. E. Ulich), Band 10 (S. 135-165). Zürich: vdf Hochschulverlag.

Strohm, O. (1997b). Analyse und Bewertung der soziotechnischen Geschichte. In O. Strohm / E. Ulich (Hrsg.), Unternehmen arbeitspsychologisch bewerten. Schriftenreihe Mensch-Technik-Organisation (Hrsg. E. Ulich), Band 10 (S. 299-320). Zürich: vdf Hochschulverlag.

Strohm, O. / Kirsch, C. / Kuark, J.K. / Leder, L. / Louis, E. / Pardo, O. / Schilling, A. / Ulich, E. (1993). Computer Aided Manufacturing Systems: Work Psychological Aspects. In A. Bürgi-Schmelz et al. (Eds.), Computer science, communications and society: A technical and cultural challenge. Conference Proceedings, Neuchâtel, Switzerland, 22-24 September 1993 (pp. 221-238). Lausanne: Beck.

Strohm, O. / Ulich, E. (1997a). Unternehmen arbeitspsychologisch bewerten. Ein Mehr-Ebenen-Ansatz unter besonderer Berücksichtigung von Mensch, Technik, Organisation. Schriftenreihe Mensch-Technik-Organisation (Hrsg. E. Ulich), Band 10. Zürich: vdf Hochschulverlag.

Strohm, O. / Ulich, E. (1997b). Integral Analysis and Evaluation of Enterprises. A Multilevel-Approach in terms of People, Technology and Organization. Human Factors and Ergonomics in Manufacruting.

Ulich, E. (1987). Individual differences in human-computer interaction: concepts and research findings. In G. Salvendy (Ed.) Cognitive Engineering in the Design of Human-Computer-Interaction and Expert Systems (pp 29-36). Amsterdam: Elsevier.

Ulich, E. (1994). Arbeitspsychologie (3. Aufl.). Zürich: vdf Hochschulverlag, Stuttgart: Schäffer Poeschel.

Ulich, E. (1997). Mensch-Technik-Organisation-Ansatz: Eine europäisches Produktionskonzept. In O. Strohm / E. Ulich (Hrsg.), Unternehmen arbeitspsychologisch bewerten. Ein Mehr-Ebenen-Ansatz unter besonderer Berücksichtigung von Mensch, Technik, Organisation. Schriftenreihe Mensch-Technik-Organisation (Hrsg. E. Ulich), Band 10 (S. 5-17). Zürich: vdf Hochschulverlag.

3   Fighting Simple Repetitive Work – a New Leaver to Get Rid of Taylorism

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3.1   The Core of the Problem

The main offender in regard to one-sided strain is the extreme distribution of work which is one of the main characteristics of so-called Tayloristic work organisation. The concept of Taylorism is that the divided work provides so short work sequences for the individual operator that he / she will very quickly be able to reach a high level of efficiency in the work. A derived advantage of this will be that the production will not be so sensitive towards changes in the workforce. Furthermore, this organisation form is characterised by the fact that it established a sharp division between the people who plan, prepare and control the implementation of a task and the people who in fact carry out the work.

Taylorism has turned out to be an efficient organisation form when certain conditions are present. The most important of these is that the enterprise is directed towards a market for mass consumption of standardised products or services. Furthermore, it is important to recall the specific problem situation which Taylorism was developed to handle. At the beginning of the century, when the engineer Frederick W. Taylor was responsible for the introduction of assembly line production at Ford's car factories, one of the problems which needed to be solved was how it was made possible to carry out a rational industrial production with a workforce which consisted of new immigrants from a large number of countries. Often, they were neither able to communicate with each other nor able to understand oral instructions from the supervisor. Furthermore, all of their previous work experience had been derived from work in the agricultural sector, and finally a large number of them were illiterate.

If we look at the demands and preconditions which are made today on the market and the labour market respectively, it should be obvious that distinctive changes have taken place. As regards the labour market it is very clear that a Tayloristic work organisation to a very high degree prevents a sensible use of the majority of the qualifications which today's workforce possesses, and to a wide extent this causes motivation problems at the workplace which results in increased expenses for a high staff turnover, absence, other interruptions in the production and quality problems.

As regards the market, huge changes have taken place during the last 5 to 10 years which, in reality, have prevented mass production in many lines of business. The way in which this has affected the individual enterprises may be described through a statement from a sales manager in a Danish clothing enterprise:

> "…More and more often, I feel squeezed between the customers and the production manager. The customers expect that when we accept orders for a very small number of units, they will receive them next week. They also believe that they can influence the design, e.g. if they would like an extra pocket somewhere, a new colour, etc.

If we accept such orders – and the market may have / has changed so that we have to – then I can be sure that I will get into trouble when I return to the factory. The production manager will tell me that it is either impossible or at the outside that it is extremely expensive to produce such small quantities and with such short notice. It will ruin the production plan for the entire factory, and if he accepts, it will ruin the efficiency. This means that a lot of sales people are afraid to direct their efforts towards this segment of the market even though it is becoming increasingly dominant…" (sales manager at a clothing enterprise).

Such experiences are typical, not just within the clothing industry. Today, the Tayloristic work organisation, which provided efficiency and competitiveness until the 1980s, stands in the way of many enterprises' need for flexibility and thus for their ability to quickly directly their efforts towards the most attractive part of the market.

It is this weakness in Taylorism which provides an opening for developing the workplaces away from the divided, one-sided repetitive work. Through a number of projects, it has been demonstrated how this form of market orientation through changes in the organisation can lead to improvement in the earnings of the enterprises as well as in the psychical and physical working conditions.

However, experience also shows that even with such exemplary demonstration cases, it can be very difficult to start a development in the working life as such. One of the main reasons is that even if an enterprise realises that the work is organised in an inexpedient way in relation to production and market potential, there is a high degree of inertia in the system which counteracts the generally desirable renewal process. The system at the enterprise has so to speak been balanced through decades of development within a Tayloristic production paradigm. Elements such as machines, layout, buildings, enterprise culture, planning systems (such as computer software), enterprise strategy, customer portfolio, network of suppliers, etc. have been adapted to each other in a way so that an upgrading of a single element to support a flexible strategy will not provide any result. It may be compared to an organism where an interruption of an established equilibrium is counteracted by a coordinated reaction from the individual parts of the system. The same thing takes place in connection with attempts to get drug addicts off drugs.

3.2   Tayloristic Blindness

A large number of the factors which pull the development of individual elements back towards the Tayloristic equilibrium are so common and obvious that we have become blind to them. The first step must therefore be to acknowledge where the barriers are, and in the following I will discuss the concealed Taylorism which is built into machines and equipment as well as into the qualifications of the employees.

In the following, I will make use of the clothing industry as an illustration of the massive invisible Taylorism in which the majority of us find ourselves in our daily work situation. This industry is especially well suited as a model example because it has been Taylorized to an extreme extent. The cycle time is often as low as a few seconds which means that a seamstress can start over on the same operation with exactly the same movement pattern several thousand times during one and the same working day.

At the same time, the industry may serve as a good example because it is considered to be very difficult to implement improvements within this industry because the wage percentage of a product's price is very high and survival for the enterprises has therefore been regarded as being completely dependent on maximum productivity.

This schism between a traditional efficiency measure in the form of "minutes per product" on one side and the strain on the machinists on the other has been expressed like this:

> "…The cycle time has become short, damned short. It is bad. We have to make them move around more. It damages their muscles to sit with the same operation all the time. We know what happens to them, and we do not want to have our name associated with that. It is not nice to meet someone in the street who has been ruined here – but on the other side, it takes too long to have more operations…" (manager of Danish clothing enterprise)

Here, I will quickly go to the main conclusion of a broadly founded pilot project which was carried through in the period 1987-1990. The project was initiated with financial support from both trade union and employers' association and it was carried through under the management of DTI Human Resources Development. An improvement of the enterprises' financial situation and the seamstresses' job quality has bee a precondition. The emphasis of the project has been on work organisational development of two demonstration enterprises carried out parallel with development and arranging of test courses for those seamstresses who participated in the project groups. From the conclusion I can mention:

> "Enterprises which have become capable of handling many small orders at the same time, deliver quickly and guarantee a high quality have in return obtained a higher degree of competitiveness on the segment of the market where quick response to changed customer demands is more important than a low price."

> "Group oriented production gives the possibility of achieving more flexibility through an increased participation of the seamstresses in the responsibility of carrying through the production in the best possible way."[1]

For many who work with workplace development today, such conclusions seem almost banal. With the results which we have from this project and from a number of projects carried through in other lines of business, it is especially surprising that a change in work organisation has not become a far more widespread tool in the renewal process of the workplaces and hereby an effective tool against the divided work. Here, we are back at the barriers which prevent renewal. In the following I will mention those barriers which are most important to be aware of in a renewal project:

✗ traditional thinking
✗ qualifications
✗ management strategy
✗ wage systems
✗ machines / layout

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[1] *Palle Banke: Gruppeorganisering. Fleksibel produktion i den syende industri* (Group organization. Flexible production in the sewing industry). Danish Technological Institute, 1991. The quotations are from this publication.

3.2.1 Traditional thinking

Group organisation has turned out to be perhaps the most effective way of avoiding monotonous work. Firstly, the group gives the members the possibility for managing the change in the work themselves, and secondly, the group organisation gives a possibility for giving back some tasks to the operators in an effective way; tasks which are necessary for the direct work performance, but which through Taylorization have been pulled away from the operator jobs. Here, you often meet lacking ability, and perhaps also lacking motivation, with the management to think freely and creatively. An automatic reaction you often get the first time this form of organisation development is mentioned is that is, with guarantee, will end in chaos and anarchy. This viewpoint has its basis in negative experiences which the management can inform about in the form of lacking interest and sense of responsibility to other persons in the enterprise. Truly, a genuine catch 22.

If group organisation is suggested, managers imagine that every little detail will end in long discussions – and the employees often have the same fear. But naturally, a group organised system can be just as regulated as other organisation forms; and the weaknesses which are feared can be prevented through the establishment of structures, definition of roles, and working procedures.

Experience shows that the best technique to beat the traditional way of thinking is to confront the "doubting" managers – and for that matter also the operators – with experiences form workplaces where this form of delegation of responsibilities and employee involvement have been carried through. The best form is to visit such enterprises, but also video descriptions of processes or guests from such enterprises have turned out to be effective.

3.2.2 Qualifications

When a clothing enterprise works according to an assembly line principle with a sharp division into sub-operations, it has the result that you "educate" the employees to become cuff seamstresses, pocket seamstresses, button holders, etc. Just how far this line of business has gone in this direction is most clearly seen when enterprises advertise for new employees for the work room. It appears from the example from a job centre in Nottingham that both specific operation and machine type are included as selection criteria.

It is evident that such a division of qualifications here and now is an ultimate barrier against the introduction of "broader" jobs. Thus, an educational effort is necessary if the individual enterprises are going to have a real choice of work organisation form.

3.2.3 Management strategy

As mentioned earlier, the present organisation form was introduced to solve a certain kind of task. Regarding Danish industry's possibilities for obtaining competitiveness, it can be said that the maintaining of Taylorism forces industry to compete in a way which gives countries with low wages great advantages. This organisation form forces enterprises to direct their business towards the market for mass production which, unfortunately, is also the area where the price of the product plays the biggest role, and where competition from countries with a wage level which is often only a tenth of the Danish level naturally is a problem.

A change of the job contents towards more "broad" jobs for the operators will often have the result that the productivity measured solely as the number of produced units becomes lower. However, this is under the precondition that, with mass production, you will still be able to achieve very large homogeneous production orders; something which the recent development has shown is no longer possible.

However, an increased ability to direct a production towards a specific market quickly implies that the work, which the operators are performing, adds a far greater value to the product than the case is in connection with assembly line work. But this increased value is an expense which the enterprise needs to have covered, and this can only happen through a revision of the strategy concerning which products and market segments the enterprise is directed at. The success of group organisation thereby becomes dependent on the enterprise changing its sales strategy as they are going away from Taylorism.

3.2.4   Wage systems

The traditional way of paying the employees in the manufacturing industry is one of the most serious hindrances for a new work organisation form. Piecework or similar systems often lead to suboptimisation of the activities and assessments which both management and employees make in an enterprise. This can probably be seen most clearly in the following interview clip:

> "…The piecework system has previously had a very positive effect for the business. It has helped avoid laziness and inexpedient planning. But over the past ten years, the development has turned. Today, the piecework system prevents the businesses from achieving their goals. But people – including the seamstresses – are afraid of letting go of what they know…" (manager of clothing enterprise)

3.2.5   Machines / Layout

Within the area of machine development the clothing industry is one of the most perfect examples of how work organisation has been kept in mind in the construction of equipment and machines. In catalogues from the big machine suppliers you will see that the machines are arranged according to which specific operation they can perform, for example buttonholes, etc. For many years, suppliers of sewing machines have concentrated on producing machines for specific operations. In a sense, that fits fine with Tayloristic work organisation. But at the same time the possibilities of enterprises which invest in this equipment become limited concerning later development of the jobs.

Throughout the entire golden age of Taylorization, which in the Danish clothing industry lasted from the mid 1950's till the end of the 1980's, the machine suppliers concentrated the development around machines which can make a large number of stitches per minute, often on a very narrow operation type and naturally with an acceptable quality. Today, this form of equipment is widely used in the industry. It is evident that this in itself is a barrier against a change of the jobs. When it for example takes two different machines to sew one buttonhole, it is almost too easy for a production manager to divide this operation between two operators. Or perhaps one should rather say that is too difficult to think alternatively in Tayloristic work organisation.

The main trend with machine suppliers is still to develop equipment and systems which can help businesses solve current problems – naturally, one has to say. At the same time, when one

looks at analyses with a more general approach, it is evident that the main problem regarding the survival of the businesses is the Tayloristic work organisation; and when the machine developers continually offer new solutions to the problems which keep occurring in this production form, they are actually doing the buyers a disservice. An example of this can be computer based production follow-up systems with terminals at each seamstress. E.g. a system which, on a continuous basis, gives the production manager an updated picture of how far a given order has come in the production. Thereby, it becomes possible to overview the increased number of models and small orders which today cause problems for many manufacturing industries. But since the system is based on the traditional rigidity in organisation and qualifications, it is very little the production manager is able to do about the problems in a profitable manner. In the same way, internal transport systems have been developed the purpose of which is to maximise the direct sewing time for the operator and at the same time make it possible to handle greater variations in products and processes.

In relation to the efforts to phase out the repetitive work, it is necessary to establish a deeper understanding in the individual businesses for the way in which arrangements regarding work organisation are made indirectly when purchasing new machines. In the project regarding development of a sewing machine on the basis of the needs which qualified seamstresses in a group have, an effort is being done to make it possible for the seamstresses to take over programming and maintenance, functions which, in a traditional work room, would have been taken care of by specialists.

Lately, positive signs have indicated that machine suppliers very well can participate in development work which takes its basis in a wish of having another form of organisation than Taylorism. Thus, in an EU-supported project within the technology development programme BRITE / EURAM, a project is carried out with the purpose of developing a flexible sewing machine which is going to support qualified seamstresses who work in a production group. The project is headed by the Danish Technological Institute. The other participants are an Italian manufacturer of sewing machines, Rimoldi, and Italian and Danish clothing manufacturers which are going to assist with requirement specification and testing.[2]

3.3   Conclusion

As regards methods for limiting repetitive work, it is obvious that a lot can be gained through a change of work organisation. It is probably the only way to limit this type of work-related strain.

But at the same time it is important to be aware of the fact that in the form which work and production have today is a large number of hidden barriers against such an effort. If a renewal process is to have lasting results, all the individual parts which make up a workplace must be considered. Here, I am referring to both internal conditions at the workplace and the external relations.

At most workplaces there is a natural need for changing the work organisation. The efficiency one imagines to obtain through Tayloristic work organisation is, in most cases, greatly overestimated. Still, it seems as if the inertia in the present system is so great that it is difficult to ini-

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[2]   A more detailed description of the project can be found in *Design of Human Centred Technology in the Clothing Industry: TA-approach to the Sewing Machine Technology.* Paper presented at ECTA III, Copenhagen, 4-7, November 1992

tiate and maintain a development. If such a process is to be supported, there is a need for establishing model examples which partly can be used to convince doubters that real alternatives do exist and partly can be used for a more concrete contribution to action guidance for actors in renewal processes at the individual workplace.

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References

Banke, Palle, 1991: Gruppeorganisering. Fleksibel produktion i den syende industri (Group organization. Flexible production in the sewing industry). Taastrup: Danish Technological Institute.

Banke, Palle, 1992: Design of Human Centred Technology in the Clothing Industry: TA-approach to the Sewing Machine Technology. Paper presented at ECTA III, Copenhagen, 4-7, November 1992.

4   Firms must Learn to Change their Culture

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New forms of work organisation and new production systems that mark a decisive break with the Taylorian principles of bureaucracy and division of labour are the foundation on which the competitiveness of modern firms is built.

This statement is now hardly a controversial one. All over the world, methods of adapting firms' structures to the new requirements are being developed and propagated. Lean production, total quality management, assembly platforms, people-centred production systems, kaizen (constant improvement), group work, quality circles, business re-engineering: all these approaches differ somewhat in their thrust and specific focus of attention, but they do have a common goal, namely the restructuring of the firm, and in particular the fostering of close cooperation among the workforce and the involvement of individual workers in decision-making at plant level. The number of articles devoted to this subject in the popular and academic management press has increased exponentially in recent years, and the same applies to conferences and seminars on the topic. A review of the literature in this area (Fröhlich / Pekruhl 1996), in which all the important empirical studies carried out in EU member states, the USA and Japan were evaluated, confirms the economic superiority of new production systems while at the same time establishing that these systems have considerable potential in respect of the humanisation of working life. However, the same study also makes it clear that half measures do not usually achieve the desired results. Merely altering organisational structures "a bit", by introducing a quality circle here and a little group work there, seldom has the hoped-for effects on productivity, flexibility or product quality. Rather, "systematic change in all parts of the company organisation" is a precondition for the successful implementation of new production systems: this is the principal message of a study of the 1000 largest US companies. This finding is supported by numerous case studies.

The new production systems have obvious advantages; what is more, the ways in which they function have now been adequately researched and described, and most firms must by now be familiar with them. Nevertheless, they are not widely diffused yet. In a survey of German employees (Kleinschmidt / Pekruhl 1994), only 7% claimed to be working in a system that could be described as group work. In fact, less than 2% of employees actually work in semi-autonomous work groups in which participation and individual autonomy are the key organisational principles. Thus fundamental changes in the organisation of production that represent a real break with Taylorian principles are seldom found in firms. As far as can be judged from inadequate data, the situation is not significantly different in other European countries. How can this state of affairs be explained?

4.1   Hypothesis

The fact that new production methods are not diffused more widely is not mainly the result of inadequate knowledge or understanding on the part of firms or of the unsuitability of the new methods; rather, it is above all the consequence of deeply entrenched patterns of perception and received notions of how to think and act that shape the thinking and behaviour of individ-

uals in firms. The capacity of existing company cultures to block radical change is the main problem in any fundamental restructuring of company organisation.

It is true that enormous practical efforts and considerable expertise in the implementation of organisational projects are also required in order to draw up detailed proposals for the restructuring of a company and to adapt them to the situation in individual establishments. This may deter many firms. However, there is no shortage of knowledge about the instruments required to plan and implement such a project successfully. On the other hand, the methods by which company culture might be adapted to the requirements of new production systems have been relatively little investigated, even less extensively tested and are almost totally unknown in firms.

The purpose of this paper is to present a method by means of which this cultural change might be effected. However, it is necessary first to make clear what we mean by company culture and how it can block organisational change.

4.2   Cultural barriers to change within the firm

In general terms, company culture or, more precisely, the organisational culture within a company, might be defined as "the way we do things here". This way of doing things is shaped by custom and practice, values and attitudes that are not queried each day but lay down, as it were, a frame of reference that guides the thoughts and actions of the workforce. This frame of reference has been tried and tested over many years and therefore provides a secure basis for everyday actions. Thus culture is a complex of unquestioned basic assumptions that shape the perceptions, the thinking and the feelings of members of the organisation when they find themselves faced with certain recurring situations. The historical embeddedness of organisational culture and the fact that this culture provides members of the organisation with a secure basis for their actions makes it extremely resistant to any short-term change. The culture in a Taylorian-bureaucratic firm is of course adapted to that form of organisation. The workforce will have come to terms with the situation within the firm and know how they should behave in general terms in order to meet the requirements of the organisation. When new production systems are to be introduced, this culture is not only put to the test but is also called into question.

If they are implemented rigorously, new production systems mark an almost complete break with the traditional basic principles of bureaucratic organisations. While it is true that the bureaucratic decision-making pyramid is not turned upside down in favour of grass-roots democracy, the one-way flow of decisions from top to bottom is replaced by a system in which decisions taken at all levels of the hierarchy mutually influence each other. Typical elements of bureaucratic organisations such as standardisation and formalisation are replaced by the continuous improvement of both products and processes. The division of the organisation into functional units gives way to a task-based mode of work organisation and close communication and interaction between the various organisational units. The hitherto familiar principles of command and execution, of a hierarchical command structure, central planning and information flows converging at central level are abandoned, at least in part. A system based on spheres of competence and central control is replaced by a system of individual responsibilities, orders give way to discussion processes and the need to obtain authorisation for many measures is abandoned. The traditional bureaucratic organisation is literally taken to pieces and reassembled in a completely different way.

From the cultural standpoint this means that virtually everything that used to be self-evident suddenly no longer applies. Carefully nurtured departmental rivalry ("sales and production as natural enemies") is supposed to be abandoned forthwith. The tried and tested motto that "interfering only creates trouble" is suddenly completely reversed. The familiar and culturally rooted bureaucratic principle that "things have always been like that" is replaced by the notion of continuous improvement. Communication is no longer to be regarded as "unnecessary blather" but rather as a precondition for efficient management. The famous sign "§ 1: The boss is always right" that hangs in many offices and workshops is far from being a mere joke, but reflects the lesson, learnt over many years, that if they want to progress within the organisation, individual employees have to agree with the boss, at least in discussions. In this respect as well, all members of the organisation, including the boss himself of course, have to change their ideas. Countless other examples could be cited here, but this should be sufficient to make the problem clear.

The necessary changes in attitude and culture could perhaps be successfully implemented if the new organisational structures could be put in place overnight. It would then become apparent that the old behaviour patterns were obsolete and a new culture, suited to the changed structures, could gradually develop. And yet it is the old culture that is the biggest obstacle to the successful establishment of new structures. Firstly, there is the overt or covert resistance of those who cannot accept the new ideas because they contradict their "life experience", i.e. the old cultural assumptions. However, even those actors who have a receptive attitude towards the new ideas have difficulties. These members of the organisation are able rationally to accept such a process of structural change (i.e. they understand the arguments in favour of change), indeed they are actively in favour of it (it would be good if it were to work properly), but serious doubts remain (it cannot work because people and organisation just aren't like that). These doubts may cause them to offer only half-hearted support to the whole project: in order to leave their options open in the case that it should become necessary to beat a hasty retreat back to the old ways. Doubts lead to uncertainty and thus to hesitancy in critical phases of the restructuring process. Moreover, actors in the firm will tend to interpret all the difficulties that inevitably crop up during the process by reference to their established cultural assumptions, and may indeed be justified in doing so, since in this phase of the changeover old cultures continue to exert influence. As a result, every difficulty that emerges serves to strengthen the doubts, which sets in motion a self-reinforcing process. In general terms, the problem can be summarised thus: new patterns of behaviour develop when the new structures function successfully over relatively long periods of time, but the emergence of such patterns is hindered or even prevented altogether by the longevity of the old culture.

4.3   Working together to change the culture: organisational learning

On the basis of its experience to date with company restructuring projects, the Production Systems Department of the IAT has developed a method of facilitating simultaneous change in both company structures and organisational culture. However, this method has not yet been evaluated, i.e. it has not yet been examined to ascertain whether it works in practice. The method is currently being used in a major, "real-life" restructuring project that is at the moment in its preliminary phase. In the course of the project, the method of which only the basic elements are currently available, will be further developed, given concrete form and a precise specification and tested for its usability.

The starting point, and at the same time the particularity, of this method is that its primary objective is to bring about change in organisational culture; in other words, it makes culture itself the focus of change. Although it is true that many articles refer to the role of company culture in processes of change, it is generally assumed that the problem, once it has been revealed, can be solved "somehow or other" and "incidentally". On the basis of our own experience, we would like explicitly to refuse that notion. All our investigations and projects have shown that mere awareness of organisational culture as a topic is not sufficient to overcome the problems that commonly arise. We have been encouraged in our views not at least by the theory of organisational learning, which in recent years has become increasingly prominent in (certain sections) of the debates on organisation theory and practice. We have also absorbed certain ideas that have played a role in the organisational culture debate on the possibility of selective change in company cultures. And a third source of inspiration for our reflections has been the socio-technical approach and the ideas on participatory organisational development derived from it.

Our approach is divided into four sequential components that are first listed and then further examined below.

1. Rational target setting: the members of the organisation (or those sections of the organisation involved) agree on the changes to be made to organisational structures, develop a model of the new organisation and establish a goal to be achieved together.

2. Cultural analysis: the dominant, culturally rooted patterns of behaviour in the organisation (or section of the organisation) are uncovered and made available for discussion.

3. The development of new behaviour patterns: discussion of which of these behaviour patterns will be helpful in achieving the agreed objectives and which will be a hindrance and must therefore be changed. Debate among members of the organisation as to the values that should govern behaviour in the future, so that the agreed target can be attained.

4. Implementation of the new behaviour patterns as "trail models" that could, if successfully implemented, form the basis for a new organisational culture:

    ❐ adaptation of structures,
    ❐ creation of free spaces,
    ❐ search for "agents of change",
    ❐ continuous feedback processes.

1. The process of rational target setting…
…accords essentially with the socio-technical approach to participatory organisational development: all the actors in the organisation (or sections of it) start by agreeing the objectives that are to be achieved as a result of their joint actions within the organisation. In reaching agreement, the actors must of course remain within a framework imposed from outside. "Outside" may be the environment in which the organisation functions (the market, the technologies, the social relations of production) or, in the case of sections of an organisation, an objective being pursued at the level of the organisation as a whole. However, this framework is not rigid and may be more accurately described as a "decision-making corridor" (Ortmann 1995) that

allows a wide range of different solutions to be adopted. The main difference between the various possible solutions lies in the particular combination of goals laid down by the organisation and its members that can be achieved simultaneously with each one. This decision-making corridor makes it possible to adapt the objectives of the organisation, at least in part, to the interests of individual actors and thus to obtain widespread acceptance for the overall target. After that target has been set, the existing structures and procedures within the organisation are analysed and then examined to ascertain the extent to which they can contribute to the achievement of the target. The final stage is to devise, again jointly, better procedures and structures, initially in broad outline and then in greater detail.

In practical terms, this means that project groups will be set up within the firm to deal with all the fundamental issues arising out of the reorganisation. These project groups should be made up of representatives of all levels of the hierarchy and all the various functions in order to ensure that all the relevant groups take part. If one of these groups is too big, then representatives can be appointed. In this case, the details of the discussions and the results achieved should be continuously fed back to the group not directly involved. Efficient and result-oriented discussion in the project groups can be assisted by various facilitating techniques that can be adopted by the chair, with the aid of which even those unused to discussion can be given an opportunity to participate.

2. If culture is to be deliberately changed, …

…it must be the subject of deliberation. In other words, the actors must recognise and understand the cultural models that govern their everyday perceptions, thinking and behaviour. Thus analysis of the existing organisational culture is the first step towards reviewing and if necessary changing it. To this end, "participants in the organisation (must) place themselves in the position of observers, i.e. put themselves on a higher cognitive level in order to reflect upon, evaluate and change the theory on which their actions to date have been based" (Türk 1989), they must adopt the bird's-eye view of the observer in order to be able to detect patterns of behaviour. This is easier said than done, since it is in the very nature of culture that it cannot be easily be reduced to a set of abstract concepts. This means that simple surveys of organisation members must be ruled out from the start. Rather, culture has to be brought to the surface, and even if it is not labelled as such, its effects must be described.

Culturally determined patterns of behaviour should be disclosed by a combination of participant observation and action research. The basic assumption underlying this procedure is that culture cannot be disclosed simply by asking questions. In this process, it is revealed above all through observation of actual behaviour and analysis of the verbal statements made by organisation members in a variety of different situations. The underlying patterns of behaviour can then be deduced and explained on the basis of these observations. The results of this procedure are then presented to organisation members and examined, corrected and added to in collaboration with them. The procedure has the merit of being relatively simple to put into practice, and the inclusion of actual behaviour means any statements made can be backed up by solid evidence.

A second approach aims to establish dialogue within the group. Everyday patterns of behaviour are brought to the surface in discussions with other group members and identified as cultural artefacts. Such dialogue makes it possible, by means of what Giddens (1992) calls "discursive consciousness", to reflect upon patterns of behaviour and bring them to the surface. If it is to have a successful outcome, such dialogue must be free of hierarchical boundaries:

In order to bring about cultural change in a "real-life" situation, we propose what is virtually a combination of these two methods: observers using action research methods describe the organisational culture they perceive or suspect exists, while the group of actors in question discuss their own behavioural patterns. By comparing and jointly discussing these two sets of perceptions, a composite picture can be assembled that provides a sufficiently accurate description of reality.

In practice, the analysis of organisational culture by action researchers is a three-stage process. Firstly, data and documents as well as everyday activities within the organisation are analysed in order to determine their cultural content. Attention would be paid, for example, to the tone of written arrangements between actors, to any outward signs of a corporate identity (colour combinations, logos etc.), to the use made of notice boards, to the general level of cleanliness and tidiness and so on. This list could be extended considerably. In essence, it includes things that consultants normally regard as personal "impressions" but that also strongly influence their conduct within the firm. The objective here, however, is to record these impressions in order to make them accessible to others for discussion. In interviews or conversations with individuals and in group discussions, attention should be paid to the cultural content of the discussion or description of "facts", while at the same time certain relevant aspects of organisation culture should be deliberately addressed. In group situations, attention should also be paid to the interaction between the actors. The hypotheses about the organisational culture made by the action researcher on the basis of his or her observations are included in the minutes of the discussion. In the final stage, all the action researchers who have become acquainted with a particular establishment in one way or another discuss their hypotheses and analyses and try to piece together and interpret what seems to them to be a coherent overall picture. If contradictory views emerge, attempts should be made to find the reasons for the contradictions.

As a result of this process, the various groups of actors within the organisation are in a position to consider their collective behaviour patterns in group discussions, and the results of their deliberations are compared with the consultants' own impressions. This final phase is certainly the decisive one, since it forms the basis for the collective implementation of cultural change. Most of the methodological procedures for these group discussions, together with those to be adopted by the chair, have still to be developed; the experiences of American researchers working in the sphere of organisational learning will be of assistance in this process.

3. In the terminology of organisational learning theory, …
the development of new behaviour patterns is a question of "double-loop learning". Organisational learning means that the stores of knowledge in an organisation are changed when it becomes clear that the patterns of perception and behaviour deriving from them are hindering achievement of the organisation's goal. One of these stores of knowledge is a company's organisational culture.

Argyris and Schön (1978) use the term "single-loop leaning" to describe situations in which these stores of knowledge are modified in the course of everyday activity, i.e. when they are either optimised or adapted to changing environmental conditions. In such cases, "basic attitudes, frames of reference and norms (…) remain unchanged (Türk). Cultural change, on the other hand, is achieved through double-loop learning. In this case, various possibilities for action are compared from a higher logical level in order to produce a modified frame of reference. Thus double-loop leaning is the discursive process of developing a new framework for action or a new organisational culture.

Thus as far as organisational culture is concerned, it involves the discursive investigation and reformulation of culturally rooted patterns of perception and behaviour and the values, symbols, models, etc. associated with them. However, in organisational learning theory, and as far as the concept of organisational culture as we understand it is concerned, the discourse of organisation members is not only a normative requirement but also a precondition for the successful implementation of change.

However, when it comes to the question of how this collective learning process actually manifests itself in practice, views remain somewhat unspecific. It is stressed that communication is of fundamental importance to the process and that group learning processes are also an essential element. Indeed, in the light of what has been said so far, this is actually self-evident. What needs to be investigated is the extent to which similar, or indeed the same techniques for facilitating discussion can be used, as happens in the examination and reformulation of "hard" organisational structures in the participatory approach to organisational development; it would also be conceivable to have these two processes running simultaneously. However, account should be taken of the fact that "learning processes of this kind (…) generally (turn out to be) extremely antagonistic, because individual members of the organisation are being expected to abandon their "theory-in-use" (…) Simply fighting it out and then taking out a vote at the end would not constitute a real learning process" (Türk 1989). Micro-political aspects of power and strategy in organisations also play a role in this context and have to be taken into account in learning discourses. Finally, and this is something that should not be forgotten, it is also a question here of power and control, of whose values and ideas - whose "ideology" - can or should exert influence over members of the organisation.

4. Implementation of the new behaviour patterns…
…is the final stage in the process of change. As has already been stressed several times, culturally determined patterns of behaviour that have proved to be successful over many years are very difficult to "unlearn". The desired changes will not be brought about by relying solely on causal / intellectual arguments. By way of conclusion, we shall offer a few ideas as to how the implementation of new behaviour patterns and the transfer of these provisional values into a new organisational culture might at least be encouraged.

Firstly, the organisation's formal structures and procedures must be changed in such a way that the new models can actually lead to successful behaviour on the part of the actors. After what has been said already, this may seem self-evident or even trivial. However, the opposite can often be observed in practice; this applies particularly to "cultural preparations" for the introduction of participatory management. Values such as "responsibility" or "participation" are intended to shape employees' behaviour; in the reality of the workplace, however, they are neither given the tools required to make the necessary changes nor suitably rewarded for appropriate behaviour, whether because formal mechanisms such as the payment system are not appropriate or because there remains a gap between "word and deed" in management behaviour. To stick to the conceptual terminology already employed above, rational target setting must be reflected within a reasonable time in actual changes in formal structures and procedures.

Pawlowsky suggests that so-called "innovation havens" should be set up in firms, in which new patterns of behaviour can be tested. "These (innovation havens) function almost as experimental behaviour theories which, if they prove themselves, become models and thus help to bring about a change in conventional theories of behaviour". The advantage of such experi-

ments is immediately obvious: new concepts can be tested in peace, largely undisturbed by any possible negative attitudes in an environment hostile to innovation; news of successful experiments can then be disseminated throughout the firm by protagonists of the model. In this way, scepticism can be softened and receptiveness to experiments increased. One major problem, however, is what is often described as the "hothouse nature" of such "innovation havens": experiments flourish precisely because they are sheltered from the hostile environment, are well resourced and attract special attention because of their unusual nature and because many of the actors involved in them have personal qualities that make them particularly receptive to experiments. Under such circumstances, the transfer of the model to the rest of the organisation fails, often because expectations were raised far too high by the positive experiences with the model. Nevertheless, allowing for the known risks, the notion of such sheltered "innovation havens" may be extremely useful in circumstances when completely unknown territory is to be explored

Another suggestion would be deliberately to exploit the role of "change agents", i.e. to support those actors who, for particular personal reasons, become protagonists of cultural change. At first sight, this seems to contradict the notion of the discursive development of new common behaviour patterns. Nevertheless, for all the discursiveness, even new values jointly decided upon are received very differently by individual actors and will accord to a greater or lesser extent with their personal intentions and cultural assumptions. A strong personal conviction on the part of certain group members that the new way is the right way can have a considerable catalytic effect and help to stabilise the process, particularly in problem situations. Even "individuals with authority" (authority in the sense of recognised professional ability and personal integrity) from outside the group can exert influence over the group in a similar way. However, this experience, which has been noted mainly by management consultants, needs more systematic appraisal.

In conclusion, it should be noted that a successful, deliberately initiated change in organisational culture requires, on the one hand, constant monitoring and attention in order to prevent the old cultural behaviour patterns - still subliminally present - from creeping in again "behind the actors' backs". On the other hand, this process of change can hardly come to a halt, since once it has become clear that its own collective patterns of behaviour can be consciously influenced, then the "art and practice of a learning organisation" (Senge 1990) must be developed.

References:

Argyris, C. / D.A. Schön (1978): Organizational Learning: A Theory of Action Perspective, Reading

Giddens, A. (1992): Die Konstitution der Gesellschaft: Grundzüge einer Theorie der Strukturierung, Campus Verlag, Frankfurt / Main; New York

Ortmann, G. (1995): Formen der Produktion, Organisation und Rekursivität, Westdeutscher Verlag GmbH, Opladen

Türk, K. (1989): Neuere Entwicklungen in der Organisationsforschung; Ein Trend Report, Ferdinand Enke Verlag, Stuttgart

Fröhlich, D. / U. Pekruhl (1996): Direct Participation and Organisational Change: Fashionable but Misunderstood? Dublin

Kleinschmidt, M. / U. Pekruhl (1994): Kooperative Arbeitsstrukturen und Gruppenarbeit in Deutschland, Gelsenkirchen

Senge, P. (1990): The Fifth Discipline: The Art and Pratice of Organisational Learning

5 Competencies for Participative Work Design

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Employees participation has been identified as a main criteria for a successful implementation of new production systems. However, participation on workplace level does not only require appropriate formal structures. The initial thesis of this contribution is that it is not sufficient to just give the employees the opportunity to design their work. Because work design is a very complex task, employees involved need additional qualifications.

In order to put this thesis in concrete terms it will be illustrated that there is a gap between design tasks within participative processes and the dominant type of work tasks in tayloristic organisations. This gap characterises the demand for qualification. An approach to bridge the gap will be presented in the second part. This approach is based on a conception for the design of work-related learning processes, the so-called Task-oriented Training methodology. Finally it will be described how this theoretical framework can be transferred into a basic practical training for participative work design.

5.1 The gap between the requirements of a design tasks and the dominant type of work tasks

Design tasks require a detailed analysis of the problems of the existing work situation and the development of an alternative work structure. Moreover, it is necessary to cooperate in a team and to present the results to the management.

To work on these tasks the employees need knowledge of appropriate analysis instruments, knowledge of design principles and new production concepts. They need abilities in problem solving, creativity and social skills for working together in the team. They must know presentation techniques and, above all, an insight into the logic of the production process is necessary (figure 1).

Tayloristic organisations are characterised by centralisation, hierarchical structures and a strong division of labour. Within this kind of organisation the work tasks oft the largest part of the employees can be characterised by the following features (Oesterreich / Volpert 1986; Volpert 1992).

1. Limited scope of action
Work tasks neither require self reliant action, planning and decision making about goals, nor the means of attaining them. They do not usually demand creativity, nor is the ability to solve problems and reach decisions or make use of professional knowledge necessary.

2. Limited variability
Work tasks do not offer possibilities to gain experience with variable situations and different problems. They do not demand flexibility nor the ability to react to changing conditions.

Fig. 1:   Requirements of a design task

Fig. 1: Requirements of a design task
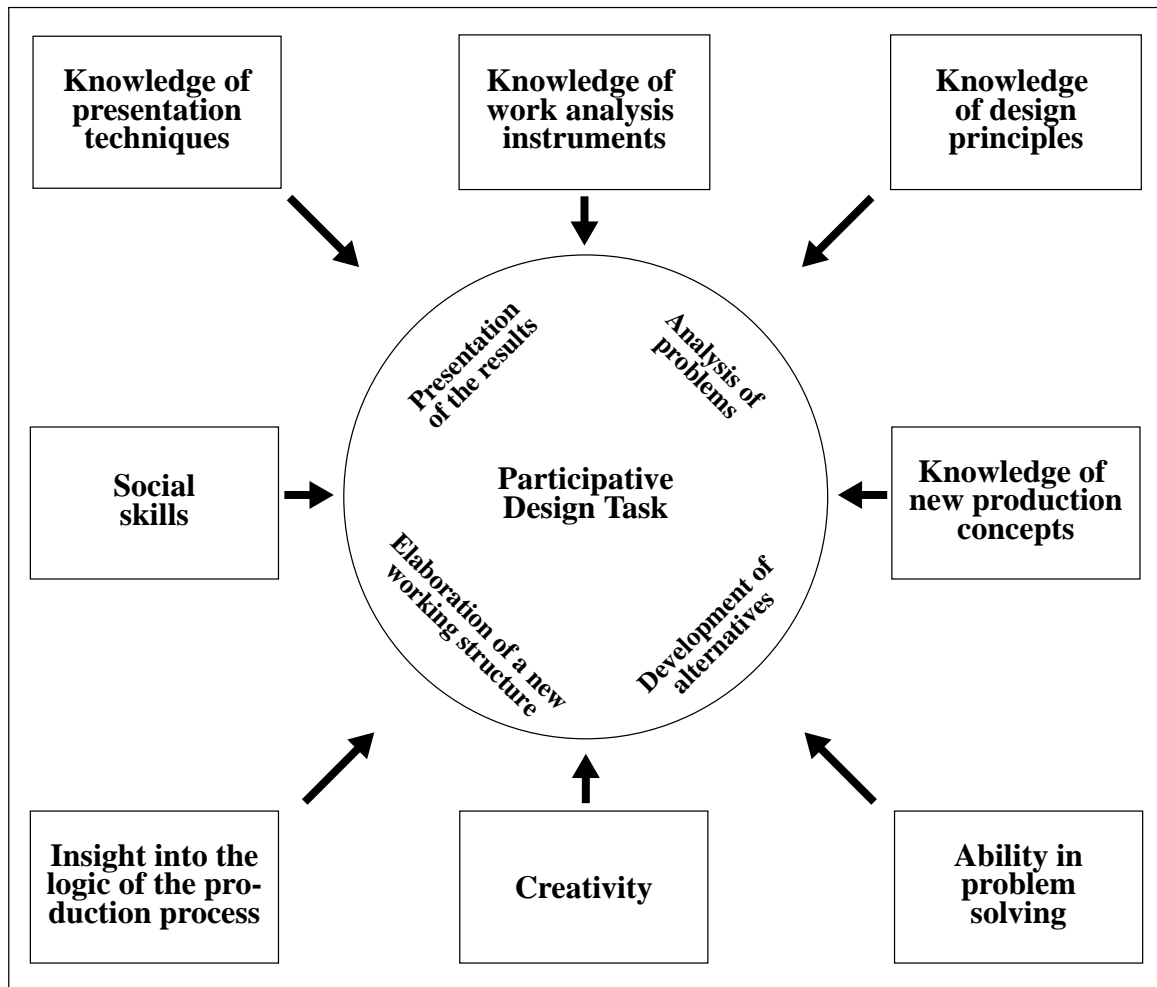
3. Limited communication and direct co-operation

With formalised working procedures and information flows, communication and direct co-operation is unnecessary. Work tasks do not require social skills.

4. No insight into the overall production process

The strong division of work and highly specialised tasks involved prevent employees from gaining an insight into the overall working context.

These are general characteristics of the dominant type of work tasks within tayloristic organisations. There is a large amount of empirical evidence verifying the impact of those working conditions on the worker's personality development in general and the development of competency in particular.

Instead of listing such empirical results an early source from the 18th century is cited to illustrate the impact of work on the human mind.

> "…In the progression of the division of labour, the employment of the far greater
> part of those who live by labour, that is, of the great body of the people, comes to
> be confined to a few very simple operations; frequently to one or two. But the

understandings of the greater part of men are necessarily formed by their ordinary employments. The man whose whole life is spent in performing a few simple operations, of which the effects too are, perhaps, always the same, or very nearly the same, has no occasion to exert his understanding, or to exercise his invention in finding out expedients for removing difficulties which never occur. He naturally loses, therefore, the habit of such exertion, and generally becomes as stupid and ignorant as it is possible for a human creature to become…" (Smith 1979: 781).

These drastical words have been written in 1776 by Adam Smith in his "Inquiry into the Nature and Causes of the Wealth of Nations". In the 20th century his view has been stated more precisely but was confirmed at the core. It is generally recognised that the working conditions have an essential impact on the chances of the individuals for personality development. Work tasks with a large scope of action provide opportunities to develop one's abilities. Work tasks with a small scope of action on the other hand go along with a process of deskilling.

In summary: for the majority of the employees the requirements of participative work design are new requirements. Most of the employees had no or very few opportunities to develop the necessary competencies within their work. That is because the strong division of labour turns out to be a considerable hindrance for participation. The less employees had been involved in work design in the past, the lower their scope of action, the more important it will be to qualify them. In a word, training for participative work design can be characterised as training to reject the consequences of taylorism.

5.2 An approach to bridge the gap

An appropriate framework to bridge the gap between the requirements of design tasks and tayloristic work tasks is the so-called "Task-oriented Training Methodology" (Weyerich 1992). This approach was developed at the Technical University of Berlin, based on the psychological theory of Action Regulation (Volpert 1989). It offers general principles for the structuring of work-related learning processes, which have been specified in a number of trainings for complex work tasks. After a short description of the approach it will be shown that it can not only be applied on the learning of complex work tasks but as well on the learning of the participative design of work tasks.

The basic assumption of the Task-oriented Training Methodology is that work-related training should be structured through simple but holistic versions of the task that should be mastered at the end of the training. The conception can briefly be described in terms of four central features.

1. Learning by doing
Training should be carried out through practical exercises. As far as possible "lectures" of the trainers should be avoided. The practical exercises, however, should not take place in an undirected manner of trial and error. This is expressed in the second feature.

2. Learning through true-to-life learning tasks
The learning process should be initiated and structured through true-to life tasks. Such tasks are called learning tasks. Learning tasks represent a rough and general frame of the activity to be learned. They include the essential characteristics of the activity. Theoretical knowledge and practical skills are integrated and will develop within the carrying out of the learning

tasks. Also the so-called key abilities like decision-making, planning abilities and social skills are components of the learning tasks.

3. Promoting self-reliant action
The learning process should be aligned to a high final self reliance of the learners. For this purpose it is necessary to develop appropriate learning material. This material must support the self-reliant working on the learning tasks.

4. Experience-related deepening of knowledge
Contrary to traditional knowledge centred instructions there is no theoretical prephase. Instead, the necessary knowledge is developed within the context of the practical exercises. After each exercise the experiences of the trainees and possible problems are discussed together and the trainer emphasises important aspects. This is called experience-related deepening of knowledge: the knowledge is deepened after the practical exercises when the trainees already have some experience. This has proved to be especially motivating, because the trainees then see why they need the knowledge and in which context they can use it.

On the basis of the Task-Oriented Training Methodology several trainings have been developed. For instance a training for CNC-machine operators (Krogoll et al. 1988), training on the use of computer programs (Rieder / Oesterreich 1996), and a training for working groups in so-called "production islands" (Schilling 1994).

Experiences with these trainings suggested that the theoretical framework might as well be a sensible basis for the development of a training for participative work design. The most important question to be answered in this context is: How can learning tasks be constructed which are less complex than a real design task and yet include the essential features of the real task.

5.3   Task-oriented training for participative work design

In order to organise a basic task-oriented training for participative work design the author developed a workshop conception of two days. According to the theoretical framework the training consists of three elements (figure 2):
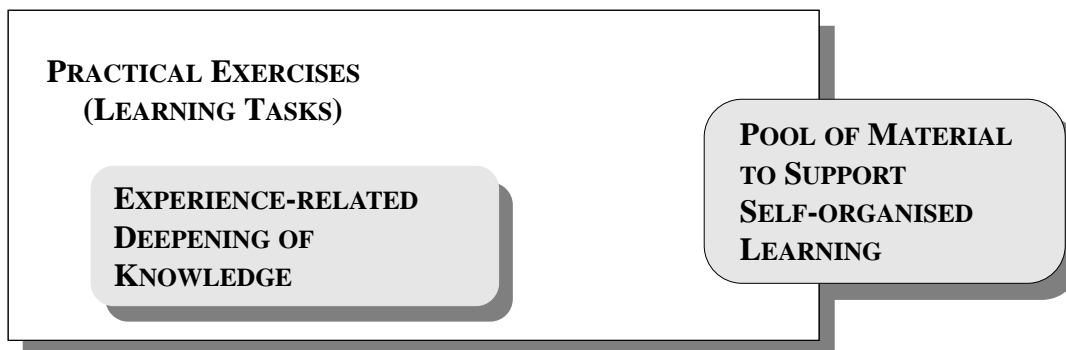
- ❏ practical exercises and learning tasks,
- ❏ knowledge acquisition and deepening that is embedded in the practical exercises,
- ❏ a pool of learning material to support self-organised learning during the practical exercises.

The practical exercises are integrated in a production game that allows the construction of appropriate learning tasks. In this game a plant is simulated in which simple products are made out of paper, cardboard and glue.

In the first part of the game a typical traditional production with a strong division of labour is simulated. In this part the trainees act as workers of the plant; each of the trainees has to carry out a certain task.

In the course of the first part problems arise which are typical for a tayloristic production and well known by the trainees. For example there will be problems with the supply and the transport of material, quality problems will occur and there will be pressure of time at some work

Fig. 2:   Training for participative work design – three elements

PRACTICAL EXERCISES
   (LEARNING TASKS)

EXPERIENCE-RELATED
DEEPENING OF
KNOWLEDGE

POOL OF MATERIAL
TO SUPPORT
SELF-ORGANISED
LEARNING

places. In this sense the game is quite realistic and true to life. Altogether the purpose of this part is to build up a shared basis of experience which allows the trainees to work together on the following parts.

In the second part the plant is to be redesigned and groupwork is to be introduced in order to improve the production process and gain a higher level of quality. At the same time the working conditions of the workers should be improved. The process of redesign should be a participative one. In this part of the game the trainees will redesign the production process and organise group work. It is subdivided into several tasks.

The first task is to analyse the working conditions of the tayloristic structure and to assess the problems the trainees have experienced. The objective of the second task is the development of goals for the redesign of the work. Within the third task the new work organisation is elaborated. The trainees work together on these tasks in small groups.
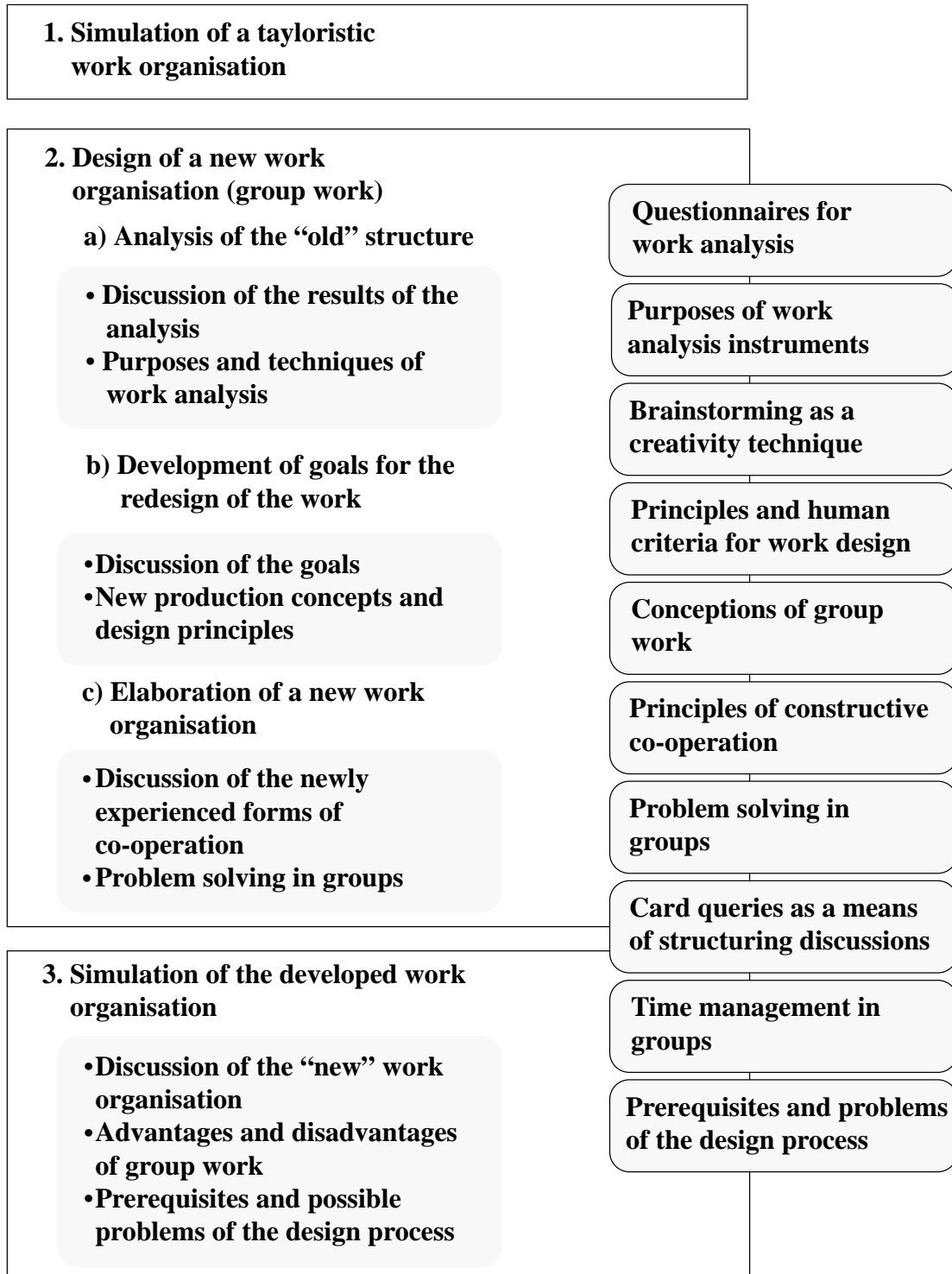
In the third part of the production game the work organisations which were designed by the trainees are simulated. Afterwards the experience the trainees had with these new work structures are evaluated (figure 3).

For each of the tasks learning material was developed to support the self-reliant working of the trainees. The learning material includes on the one hand suggestions on how to work on the tasks. For example brainstorming as a creativity technique and certain techniques for problem solving in groups are introduced. On the other hand there is material concerning certain relevant subjects, for example "conceptions of group work" and "human criteria for work design" are briefly presented.

The learning material consists of short texts describing the main principles or the central ideas of certain subjects. The material is meant to provide stimulating impulses without dictating the trainees in detail how to work on the task.

After having finished a task the experiences of the trainees and the problems they had are discussed. In the course of these discussions it is possible to deepen the knowledge. The trainers give additional comments and explanations on important aspects of the tasks. On the basis of

Fig. 3:   Training for participative work design – a production game

1. Simulation of a tayloristic work organisation	
2. Design of a new work organisation (group work)	**Questionnaires for work analysis**
a) Analysis of the "old" structure	**Purposes of work analysis instruments**
• **Discussion of the results of the analysis**	**Brainstorming as a creativity technique**
• **Purposes and techniques of work analysis**	
b) Development of goals for the redesign of the work	**Principles and human criteria for work design**
•**Discussion of the goals**	**Conceptions of group work**
•**New production concepts and design principles**	
c) Elaboration of a new work organisation	**Principles of constructive co-operation**
•**Discussion of the newly experienced forms of co-operation**	**Problem solving in groups**
•**Problem solving in groups**	**Card queries as a means of structuring discussions**
3. Simulation of the developed work organisation	**Time management in groups**
•**Discussion of the "new" work organisation**	**Prerequisites and problems of the design process**
•**Advantages and disadvantages of group work**	
•**Prerequisites and possible problems of the design process**	

their practical experience it is easy for the trainees to understand such additional theoretical comments.

For example after having finished a task it is quite easy to discuss problems of co-operative work because the trainees have usually just experienced it. On this background the techniques

which are described in the pool of learning material can be explained in detail and the purpose and the advantage of the techniques become very clear to the trainees.

It was already mentioned that playing a production game in a two-day-workshop can only be a basic training for participative work design. Certainly the special advantage of the game is that the overall context of the process is preserved and important phases can be practically tried out in a way that is simplified but nevertheless true-to-life.

First experiences with the training conception were very promising. After the workshops the trainees were asked to judge the learning process. The majority of the trainees expressed that they gained quite a lot of understanding of what participative work design at the core is and how complex the process is. Of special importance was that they could see each detail of the training in its context. They saw this to be very motivating. Concerning the transfer of the training effects it is important to mention that already during the workshop the trainees had many ideas for redesigning their own work places.

These results allow the following concluding remark: In the literature dealing with participation it is often emphasised that employees being involved in work design have to be qualified for this task. However this has not led to a corresponding amount of elaborated and well documented training conceptions. In this context the further adaptation of the Task-oriented Training Methodology will help to reduce this deficiency.

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References

Krogoll, Tilmann / Pohl, Wolfgang / Wanner, Claudia, 1988: CNC-Grundlagenausbildung mit dem Konzept CLAUS. Didaktik und Methoden. Frankfurt am Main: Campus.

Rieder, Kerstin / Oesterreich, Rainer, 1996: Ein aufgabenbezogenes Konzept zur Gestaltung von Qualifizierungsprozessen im EDV-Bereich. Zeitschrift für Berufs- und Wirtschaftspädagogik,92, 31-45.

Oesterreich, Rainer / Volpert, Walter, 1986: Task analysis for work design on the basis of action regulation theory. Economic and Industrial Democracy, 7, 503-527.

Schilling, Michael, 1994: Aufgabenorientierte Qualifizierung bei der Einführung qualifizierter Gruppenarbeit: Die lehrende und lernende Arbeitsgruppe. In: Krogoll, T. (Ed.): Betriebliche Weiterbildung und Erfahrungswissen von Facharbeitern. Stuttgart: IRB, 73-85.

Smith, Adam, 1979: An inquiry into the nature and causes of the wealth of nations. Oxford: Clarendon Press.

Volpert, Walter, 1989: Work and personality development from the viewpoint of action regulation theory. In Leymann, H. / Kornbluth, H. (Eds.): Socialisation and learning at work. Aldershot: Avebury, 215-232.

Volpert, Walter, 1992: Work design for human development. In: Floyd, C. / Züllighofen, H. / Budde, R. / Keil-Slawik, R. (Eds.): Software development and reality construction. Berlin: Springer, 336-349.

Weyerich, Astrid, 1992: Aufgabenbezogene Gestaltung von Qualifizierungsprozessen vor dem Hintergrund der Erfahrungen des AQUA-Projekts. IfHA-Berichte Nr. 30. Berlin: Technische Universität.

6 Mirroring the Organizational Structure: Data Modelling

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6.1 Introduction

Not so rarely it occurs that practitioners *and* scientists think of company renewal, change of work organization and introduction of new elaborated computer systems as autonomous fields that are independent from each other and that can be dealt with in such a way. But they are not, they are dependent.

It is the other way round: you cannot renew a company without changing the work processes and the organization of work by just introducing new software, you cannot work in a renewed company with a new organization of work using the old computer applications. This contribution will explain why company renewal and computer technology are highly interrelated and will describe the importance of data modelling for successful organizational change.

You will see that data models can work as collective, external memories of organizations. And that each organization has a data model: no matter if consciously or not, no matter if it can be explicated by the members of the organization or not. Data modelling as a process of analysis and reshape of a company's data model has to be an integrated element of company renewal. This has to be done cooperatively, evolutionarily, by direct participation and by using "natural language" methods and techniques. You will agree that organizations benefit enormously from well-designed, well-organized and maintained data models and that data modelling is as important as finding the new organizational structure and developing the organization's workflows.

6.2 A Question of Misunderstanding: *Data* versus *Information*

Before we can go into any details about why and how to shape a data model, it is important to understand that data and information are different. Many people do not distinguish between data and information or mix them up. For them a computer provides the user with information: wrong – a computer is providing the user with nothing but data. For them a good computer application produces as much data as possible and that this amount of data equals to the amount of information: wrong – a lot of data does not mean a lot of information (see figure 1), sometimes one single bit is enough.

Depending on the current context of a situation, *data* are interpreted by human beings; by this act of interpretation *data* become *information*. For a human being who cannot find a link between the current context and the data presented to him, data will remain data – it is of no information for him. E.g. the figures of the Wall Street are nothing but data to me as long as I am unable to interpret them.

This difference makes sense not only for individuals – much more is it true for groups. Each individual group has to find its own set of rules for interpretation, rules that are shared by all members of the group. The shared rules comprise things like language, characters, writings, icons, signals, but also more task-specific elements such as what an order means and how a

**Fig. 1:   A lot of data does not mean a lot of information**

certain activity has to be performed. Executing tasks cooperatively and exchanging information requires agreements, in particular also agreements about the common interpretation of data and their structures. Rather simple examples are technical drawings: it is quite obvious how important the scale of the drawings and the measures – e.g. centimetres or inches – can become.

Invoices are good examples to make the complexity of data modelling and the relations to the processes of the organization lucid. From the point of view of data modelling, invoices consist e.g. of article name, article id, amount of article, price per article, taxes per article and the total. But the data model of an invoice is not complete without the required data about customer, payment, way of delivery – and the indication whether the articles have been delivered, the invoice has been paid. There has also to be an indicator in case the customer sends back the articles or some of them.

Whenever it is tried to write down and define all the elements of a technical drawing, of an invoice or any other "things" of importance in an organization, it is impossible to do this correctly and completely without the knowledge about the processes and structures of the organization. Knowledge about the workflows is absolutely needed.

Therefore, a data model consists of agreements about the common interpretation of data and the data's structures are creating the data model: a framework where meaning is assigned to data and data are linked according to the structure of workflows. A data model does not depend on a computer system or computer application: even without any computer there is a data model. Every organization has a data model – no matter if it can be written down or not

Fig. 2: The early days of data processing
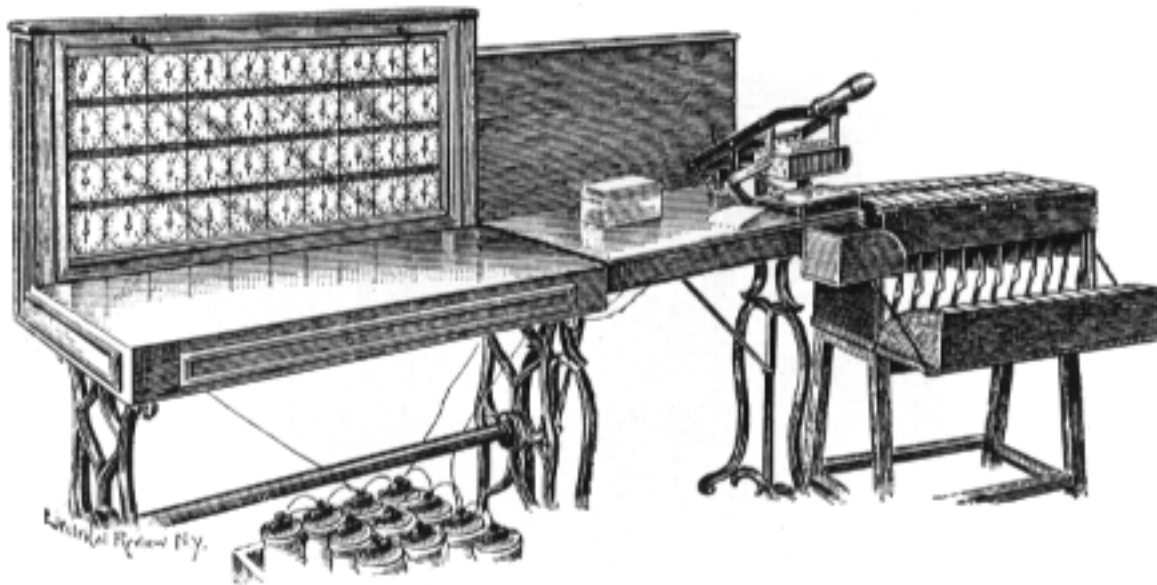
The Hollerith Electric Tabulating System.

by the members of the organization, no matter if anybody is responsible for the maintenance of the organization's model or not.

6.3 A Question of Unawareness: about Organizations and Data Models

An organization and its data model are highly interrelated. Like a skeleton the data model reaches every branch of an organization, the branches of an organization are linked together by the data model. A data model can be regarded as the collective, external memory of an organization – memorizing how data become information, how to act under certain conditions, echoing the structure of processes and the links between cooperating groups, mirroring the dynamics of the organization's development.

There are only a few organizations that are aware of this memory and that treat this memory in an adequate way. As a consequence, an increasing number of organizations are facing a problem concerning their data model: usually data models are growing over the years without any surveillance or monitoring and they are only seldom subject to explicit design activities.

As a result of this inattentiveness data models become bigger and bigger over the years, they become extra complex, highly redundant and contradictory. Changes in the structure of the organization, e.g. the discontinuation of branches and the omission of processes, do not necessarily lead to smaller or less complex models – in most cases data are still collected although it does not mean information for anybody any longer.

While certain problems of the organizations have their roots in the inadequate treatment of the data model – sometimes no treatment at all – computers and computer applications are sold as solutions for inadequate data models and resulting problems. But: computers do not tidy things up, they count on all affairs being in order...

Thinking of computer systems as solutions for organizational problems very often can be found in combination with the misunderstanding that data models are limited to computers. They are not: they are an important part of the implementation of computer applications and the design of databases, but data models exist also "outside" the computer. Data models cover any activity within a company, while computer applications mirror only a smaller or larger subset of the organization-wide data model – just that subset that is supported by computer applications.

6.4 Data Modelling: an Integrated Element of Company Renewal

How can an organization with an inadequate data model and the problems that come along with it get out of this situation? How can the organization solve its problems? First of all, the organization has to understand that its problems are organizational problems – therefore, technical means like computers and computer applications can be only a part of the solution, along with organizational solutions like the redesign of processes and structures of the organization.

Very often the management skips the process of company renewal and starts with hiring external experts for the analysis of the current data model and its re-creation. But this task is not the task for external (computer application) experts: it is the task of the experts being responsible for the work processes of the organization and the required information for each sub-task. It is the task of those who have been working for that particular company for years and who know each and every part of the production process, each and every task that has to be performed. The members of the organization – from workers over foremen up to the management – are the most qualified people that can be found for data modelling and, in general, for company renewal.

Concerning the data model the core idea is to take the chance of an organization-wide restructuring and make the well-aimed, well-planned design of the data model an integrated element of the change process. Before a new data model can be created participatively, an analysis of the old data model is needed, e.g. contradictions have to be detected and dissolved and redundant elements have to be spotted. This crucial process of data modelling is then followed by the adaptation and development of the information technical infrastructure. The training and qualifying of the members of the organization, the introduction and the establishing of the new structures, processes, ways and methods are the following stages of company renewal.

Although training, introduction and establishing sound like the final steps of company renewal, they are not: they are the final steps in the circle of company renewal. Company renewal is no once-in-a-lifetime process, company renewal is a permanent task for an organization in a turbulent sphere like today's market. Therefore, the ability for renewal is a basic qualification for an organization (Fröhlich / Pekruhl, 1996). In the following, we will not focus on this more general aspect, but on the special task of data modelling and its methods and techniques.

6.5   Methods for Integrated Data Modelling: Lessons Learned

Data modelling has to be done participatively because the special knowledge of the people working in that particular organization is the prerequisite for an adequate data model. Although the aim and subject of the task is the data model it might be difficult to start with talks about and presentation of data models. The members of the organization are the most qualified experts for designing the data model, but yet there might be no one in the organization who has ever seen a data model before. A special qualification is required to be able to discuss elements of a data model, to describe and to compare data models, e.g. the ability to think and talk about "invisible" and abstract things or the knowledge of a very special notation for data objects. This causes an imbalance between application experts and members of the organization which is unfavourable for the members.

In order to strengthen the position of the members of the organization, it might be easier and more productive to start with processes of the organization instead of data models. By doing so less special knowledge, e.g. no abstract special notation, is required and the organization-specific knowledge is the focus of interest. There is still an imbalance, but the imbalance is favourable for the members of the organization.

It is much easier for the people to talk about their fields of activities and to give job descriptions than to discuss data objects. Discussions about the processes of the organization can be used as a "warming up", for building up a communicative competence. Because it is relatively easy for them to describe the things they do at their jobs, this phase of data modelling can stimulate a "culture of work" for the project. The major benefit of this procedure: there will be much fewer problems during the subsequent phases of the data modelling process.

There are more reasons for beginning data modelling with discussing about the organization's processes. Descriptions of the organization's structure and its processes are findings of company renewal. Therefore, it is very productive to start data modelling with those results. In addition data modelling will verify the findings of the earlier stages, not only the people's understanding of the findings, but it will also scan for missing, redundant and contradictory elements.

During data modelling no methods should be used which increase or reawake gaps between the external experts and the members of the organization. It is of great importance to continue to communicate and not to focus on artificial and formal languages or abstract methods. A concentration on participation-oriented methods and the strengthening of evolutionary concepts is more important than a formal correctness of the notation.

The aim of the process is an adequate and efficient data model mirroring the organizational structure and its processes. Again, formal correctness in the sense of mathematical-technical notation is less important in the crucial initial phases than the mapping between organization and data model. Natural language and the terms and expressions used in an organization are representing a rich knowledge for data modelling. In the following we will focus on this "knowledge base".

6.6   The Natural Language Approach for Data Modelling

Every company has a specific language: certain terms and phrases that are of very little use for others, but say very much to the members of the organization. Sometimes the terms are refer-

ring to explicit code lists, e.g. at police stations or at fire brigades, but in most cases those "company slangs" are natural languages that comprise a lot of information about the organization and its processes. This knowledge is a powerful basis for data modelling.

The terms, expressions, phrases, metaphors etc. used in an organization can give answers to questions like why and how does the organization work, what are the objects people work with, what are the processes people are involved in, which processes do work and which do not. The analyses of these very precise languages – languages with little redundancy and less contradictions than usually expected – are an efficient, cooperation-oriented approach focusing on the experts for the tasks (workers, employees), not on plans and ideals other people might have, e.g. managers.

There are several approaches which deal with the design of computer applications based on linguistic criticism, e.g. "program design" by informal English descriptions (Abbott 1983, see Ortner / Schienmann, 1996 for more examples). They can be characterized by their use of natural languages, e.g. user expert languages, in contrast to approaches that focus on artificial languages, e.g. diagram languages. Those methods of the natural language approach include representatives from all involved parts of the organization, not excluding anybody because of his or her inability to deal with design methods respectively design tools. They aim at a consistent, clear and literal description of all relevant facts basing on the natural language spoken by the members of the organization.

But there are differences in the quality of company slangs: depending on the area of business and the branch of industry the company slang may be elaborated and precise or redundant and rough. To deal with this problem, two variants of the natural language approach were developed: the empirical approach and the constructive approach.

The empirical approach can be used if the company slang is sufficiently exact and meets the needs of development techniques, usually for the development of computer applications. The company slang becomes the basis of data modelling, the statements and descriptions given by the members of the organization are used directly in the design of the data model. There is an analytical form of the empirical approach which does exactly represent the statements on the facts in an application area by formal means, while in the experimental form circumstances of communication are simulated by recorded speech acts (cf. Ortner / Schienmann, 1996).

If the company slang is contradictory, not as exact as needed and if it does not meet the needs of development techniques, a new, quasi-natural and regulated language – a normative language – has to be developed. Those methods are summarized under the term constructive approach. The development of that language, of course, has to be done in a participative and systematical process together with the members of the organization (for more information see Ortner / Schienmann, 1996).

Although the different forms of the natural language approach have been described as democratic and fair methods, they are not necessarily participation-oriented. Sometimes they are misused as a mean of separation, e.g. between application developers and application users, but they are supposed to work the other way round: they can bring developers and users together, let them find an adequate common language. The methods of the natural language approach can be seen as communication facilitators.

Sometimes it is expected that the methods of the natural language approach can be used to close the communicative gap between experts and members of the organization automatically. They are regarded as automatic translation tools between the different languages. But there can never be a tool like that, as the communicative gap is a semantic problem, not a syntactical one. Therefore, a tool for information exchange is needed, not a sort of "language compiler".

The methods of the natural language approach are fostering communicative processes among all involved groups by equalizing the power of influence on the process. One of the side effects of these methods is that nobody can hide behind formal (in)correctness. The process does no longer depend on the ability of formal abstraction, it uses the potential of everyday language and the human skill of talking. There is nothing strange to be learned for those who take part in the process of data modelling, only using the words and phrases of working life.

6.7   From Approaches to Practice: How to Bring Things to Everyday Life

The natural language approach and the advantages of its methods for the redesign of data models as an integrated element of company renewal are so advantageous that one might wonder why those methods are not everyday's practice. The reason why is not a methodical one, the largest hindrances still are the gaps between the involved expert groups. A surmounting of the gaps is required, but not all groups are prepared.

The smallest gap exists between staff and management. In an increasing number of companies staff and management have come to the conclusion that their real interests and aims are not that much contradictory. "Good jobs and sound finances go hand in hand.", the Danish Technological Institute summarizes its findings – findings that are not only made in Denmark.

But gaps become wider and wider the more expertise comes into play. They all have their idea how to change the world of work and what the most important aspects are: work psychologists, industrial scientists, engineering scientists, software developers, computer scientists. Cooperation of these expert groups – along with management and staff of a company – is seldom found. Most of the organizations are left alone with their organizational problems or there is only one of the external expert groups. The cooperation of all expert groups in charge is required, the coordination of methods and the exchange of (interim) results. Organizational change is not the task of one single expert group, there is no exclusive right for the one and only method, the ultimate approach.

Organizational change is a very complex task and the support of a changing organization is the task for a spectrum of expert groups – including the members of the organization themselves. It is no job that can be done without any involvement, it requires to come closer and to take part. When you are close enough, you will see that company renewal and organizational change are permanent challenges for successful organizations. That is what makes the support of the change process so complex: the organization has to become able to adapt itself to the changing environment and to qualify itself for new challenges. Flexibility and agility have to become the normal case – a goal that can be reached only by cooperation.

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References

Abbott, R.J., 1983, Program Design by Informal English Descriptions. In: Communications of the ACM (26/11). 882-894.

Fröhlich, D. / Pekruhl, U., 1996, Direct Participation and Organisational Change – Fashionable but Misunderstood? An Analysis of Recent Research in Europe, Japan and the USA, Dublin: European Foundation for the Improvement of Living and Working Conditions.

Ortner, E. / Schienmann, B., 1996, Normative language approach – a framework for understanding. In: Thalheim, B. (ed.), Conceptual Modeling – Proceedings of ER '96, Berlin: Springer. 261-276.

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