New Technologies and Post-Taylorist Regulation Models.
The Introduction and Use of Production Planning Systems in French, Italian, and German Enterprises [1]

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The combination of increased competition on the world market, new technological developments, and changes in the labour resources of society has led to changing patterns of industrial development in the leading Western industrialized nations. Economists, political scientists, and sociologists - while using different formulae - have conceived these as a radical break and as a structural change of any Taylor-Ford regulation model that has essentially characterized the industrialization of the last 50 years. In Western European countries, industrial and organizational sociologists have in recent decades repeatedly discussed the social, organizational, and technical implications of the Taylor-Ford regulation model and - especially since the 80s - its possible transformation into post-taylorist models of work organization. Sociologists became increasingly aware of the fact that the supposed "one best way" of an extreme parcellization and routinization of work was probably limited only to a specific phase of capitalist production: the era of standardized mass production with semi-skilled workers for large, price-competitive markets.

In the context of a new, international division of labour between old and newly industrialized countries and an increasing globalisation of industrial competition, West European industries are no longer confronted with the classical alternative between homogeneous, cheap products on one side or custom-built high quality, high flexibility products on the other side. The classical mass producers *and* the producers of diversified quality products (like the machine tools industry) have to reduce their unit costs, increasing at the same time the quality, the innovativeness, and the diversity of their products. The transformation of the classical alternative between "economies of scale" and "economies of scope" into simultaneously to be achieved aims eroded the distinction of mass production and craft production concepts as well. Enterprises in advanced industrial countries are looking for possibilities to combine the two, formerly opposed logics of industrial organization - either deskilled, routinized jobs in low-trust organizations or qualified, autonomous tasks under high-trust conditions: The "lean production" concepts of Japanese car makers (Womack et. al 1990) or the "new competition" between highly industrialized countries (Best, 1990) are characterized by huge production lots of customized, modularized, innovative products. The required flexibility and the increased interdependencies of R & D, engineering, production, production control, and marketing increased the possibilities for broader task structures, higher job discretion, a reduced division of labour and non-hierarchical forms of coordination (e.g. in project groups, quality circles, production teams; cf. Kern & Schumann, 1984; Piore & Sabel, 1984; Reich, 1992).

This means that "post-Taylorist" models of production are not simply the "opposite" of Taylorist models but new, tentative, and instable forms of work organization which are only partly based on previous, Taylorist or craft-based forms of organization and social integration. The flexible spezialization is not simply a return to the past of pre-Taylorist principles (as Piore & Sabel seem to indicate) but an attempt to create new, competitive, flexible, and socially

acceptable forms of production which transcend the former opposition of Taylorist and craftbased principles of organization. This can be discussed in the following three dimensions which refer to central organizational, social and cultural aspects of the emerging models of post-Taylorist forms of production:

1. Idealtypical taylorist companies were - in line with the model of a rationally structured, bureaucratic organization - divided into functionally differentiated domains to which were assigned specific, precisely defined subtasks within the production of huge quantities of homogeneous products. The coordination between different domains followed a previously set plan. The need for coordination and negotiation between individual departments was low, as the "systemic rationality" of the work process was defined a priori and was not the result of permanent processes of negotiation and agreement. On the ideological level, the hierarchical and functional organization of companies - true to the "machine model" of rationally constructed and operated organizations - was justified by technological or economic pressures or by unequivocal scientific findings that were considered to be sufficiently instructive for designing the construction process.

New ways of coordination are not based on the return to the small batches of the craft-based types of production; neither the relative independence of autonomous professional workers nor the corresponding, informal synchronization by qualified work groups are sufficient to coordinate the huge production series of increasingly diversified products. Instead of this, new information and communication technologies (IaC) are used to monitor the required and available material, the production schedules, the production operations already completed, the relevant quality indicators and the time until the finishing of a production lot etc. But these technologies do not solve all the internal coordination problems. In lateral, non-hierarchical forms of cooperation and consultation, especially in project groups, employees have to develop and maintain - as a "non-computerized requirement of computerization processes" - a synthetic, shared view of the organizational processes. This corresponds to a decentralization and de-hierarchisation of responsibilities for the interdepartmental coordination of work processes.

2. The dominant model for the use of labour were "low-trust relations" (Fox, 1974): Ideal typical taylorist companies did not rely systematically on the skills, creativity, and motivation of labour, but attempted to prestructure the work processes as precisely as possible and design them to be controllable. The social integration of labour was based on the logic of an "economic exchange" (P. Blau) guaranteed through directly measurable, shortterm gratifications and sanctions (production bonuses, piecework systems, dismissal).

The new patterns of social integration cannot be characterized as a simple shift to high-trust relations. Even if IaC-systems are not used for the direct and permanent monitoring of employees behaviour - the initial fear of the so-called "transparent man" proved to be an exaggeration -, the transparency of individual and collective achievements has been increased by new IaC-technologies and by an increased accountability of "profit centers", departments and factories. This leads not to a "responsible autonomy" - as Friedman (1977) supposed -, but to a kind of "controllable autonomy", a higher degree of self- and group-control and to "self-created" stress which is less the result of direct hierarchical supervision than the consequence of organizational promotion politics and habitualized forms of work behaviour and commitment.

3. In line with the minimal social integration of the employees, the impact of socio-cultural contexts for Taylorist (but not for professional or craft-based) forms of work organization was low. Taylorist companies used societal norms and values (built into different institutions as the industrial relations systems or the national systems of education or vocational training) only to a limited extent. This use normally was limited to extra-functional norms such as meticulousness,

discipline, high motivation, punctuality, respect for authority, cooperative forms of bargaining, which facilitated the passive subordination under the organizational order. Large mass producers of standardized goods were able to be autonomous from their societal environment because they designed the work tasks to be as simple and repetitive as possible and controlled them directly.

The shift from direct control to a higher, but controllable autonomy corresponds to a higher organizational dependence on external, socio-cultural forms of social integration. The problem is that the stability of institutionally embedded norms and values - like the professional orientations transmitted in the system of vocational education or cooperative forms of conflict resolution typical for some systems of industrial relations - can no longer be taken for granted in front of the pluralization und individualization of life styles and professional biographies (cf. Beck, 1986). This is even true for Japan where the long working hours, the high work intensity, and the low wages especially in smaller firms are no longer regarded as "natural" aspects of the Japanese traditions. National cultures of work and management are no longer - if they have ever been - a type of "iron cage" determing the work behaviour in culturally embedded work organizations but they become more and more a sort of "toolkits" (Swidler, 1986) which are used by culturally embedded, but not culturally determined, individuals in shaping their actions, creating and recreating organizational structures and cultures. Managers confronted with such a "detraditionalized" use of culture must abandon the vision of an integrated, homogeneous "corporate culture" (as a new sort of a "one best way") and can only hope to arrange the context in a way which allows the continuous (partially computer-based) control of organizational performance.

In a cross-national study of computerization processes in eleven Italian, French, and West German clothing and electronics companies we tried to analyze some aspects of the arising post-Taylorist models of work organization. We concentrated on the redefinition of work roles, organizational structures and organizational cultures. We were interested both in the general, transnational aspects of new regulation models of industrial work as in country- and culture-specific patterns of "post-Taylorist" forms of work organization and social integration. Three aspects of new, post-taylorist and post-bureaucratic regulation models will be discussed on the basis of our empirical evidence: (1) The politicization of computerization processes as a consequence of the open, contingent nature of systemic, interdepartmental rationalization processes; (2) a different place of human labour in industry; and (3) a different impact of national cultures for the forms of social integration on the enterprise level.

1.Computerization and Industrial Concepts of Production Planning

An important characteristic of current business strategies is a change in the way they deal with external, above all market-related contingencies. "Turbulent" market conditions are no longer broadly ignored in order to assemble a small range of highly standardized products as cheaply as possible, but the organizational flexibility, the organizational "requisite variety" has significantly increased. This leads to a higher degree of uncertainties to be dealt with within the company. These contingencies are "handled" within the organization in power and exchange relationships; instead of bureaucratic rules, hierarchies, or "economic or technical necessities", complex decisions are taken (in an incremental way) in open negotiation and exchange processes. This has been labeled the "politicization of industrial change" (Heidenreich & Schmidt, 1990).

This politicization is an important feature of the processes in which production planning systems are developed and used. There is no "one best way" for the implementation of these

systems because they represent a specific view of the organization materialized in algorithms and data structures. This computerized representation of organizational information and communication processes is dependent on a previously created, shared view of these processes which has to be developed in interest-based communication and negotiation processes between system developers, production planning and control departments, and production departments. First of all, such a shared, partially homogeneous view of organizational processes instead of the partial views of each department is a necessary basis for the development of interdepartmental information systems; secondly, for the "reasonable" use and interpretation of decontextualized data and control procedures the users have to rely on a non-computerized conception of overlapping, cross-departmental processes. In the following sections, we shall describe the politicized development of information systems, their openendedness, their dependence on company- or even department-specific power constellations, and the legitimization of the respective strategies that lead to a "conceptual rivalry" (Wiedemann, 1989) between different rationalities and logics.

Empirically, four different steps in the development of production planning can be differentiated. In these phases, two logics of production planning, the logic of global, ex-ante optimization and the logic of situational, ad hoc optimization, are combined in a different manner (cf. figure 1). This corresponds to different roles and strategies of the two main protagonists of industrial production planning concepts - production managers and foremen on one side and production planning and control departments and systems development on the other side.

Figure 1: Global control and situational control

	Global control (ex-ante optimization)	Situational control (ad-hoc optimization)
Logic	Production prescriptions based on deductions from abstract goals (deductive/ top-down)	Locally optimizing production decisions, suitable to the given situation
Protagonist of the control concept	Mainly separate production control departments, as well as central EDP and organizational departments	Mainly employees in production but also time and methods departments
Knowledge of production control	In decision algorithms and data banks	Bound to persons, only to a certain extent amenable to systematization; information system as source of data
Means of control	Formalized orders on the basis of bureaucratic rationality (written information and other forms of documentation)	Informal exchange of information (e.g., between foremen) personal contact valued highly
Strongpoint	Systematic consideration of all relevant and available information (in the ideal case)	Flexible response to unforeseeable situations and changing production

	information (in the ideal case)	requirements

1.1 Production Planning and Control by Foremen

The classical model of production planning and control by foremen is based on the practical experience and knowledge of the foremen who are directly responsible for production, their overview of the process of production, and their informal contacts with other foremen. A prerequisite for foreman planning are (hidden) reserves of flexibility in production, such as discontinuously required personnel or machine capacities, intermediate stores of raw and semi-manufactured goods, and the possibility for the foreman to select between a larger number of orders (in the interests of a minimizing setting up costs). More systematic and comprehensive forms of production planning play only a marginal role in this model; the Taylorist time and motion departments were above all responsible for working out production times and defining work methods. The importance of the computer departments for defining, developing, and implementing new production planning methods is also very low in this phase - in spite of their generally very strong position - as available programs are predominantly batch programs for processing mass data in the administrative and commercial departments.

In view of the increasing demands for temporal, material, and social flexibility, this model has reached economic and organizational limits in most branches.

1.2 Upgrading the Status of Product Planning Departments and Centralistic and Deterministic Planning Concepts

One answer to these attendant deficits in production planning is the introduction and utilization of comprehensive production planning systems that are generally used in the dialogue mode. The implementation of integrated information systems has frequently been accompanied by a major upgrading of the status of production planning departments that is documented in (a) an expansion of personnel, (b) the recruitment of personnel with higher formal qualifications, and (c) in a higher position in the hierarchy for the corresponding departments (extending as far as the establishment of logistics directors).

Frequently, the first attempts to set up production planning through external departments were initially based on a centralistic and deterministic planning concept. An attempt was made to develop an abstract, global model of industrial processes and to translate this conception into software structures. This was based on the assumption of an ideal model of industrial processes in which all production planning decisions could either be performed automatically or could be taken over by the planning departments; the role of the foreman was restricted purely to the implementation of the pregiven decisions.

In many cases, however, the limits of comprehensive planning and control concepts very soon became apparent as "in the early, deterministic production planning systems, a decisive 'shot of empiricism' and close-to-practice problem-solving capacity was repeatedly necessary in order to meet deadlines and keep the workshop and the personnel busy ..." (Hildebrandt & Seltz, 1989, p. 287; translated). The intrinsic rigidity of computer systems thus continues to require the autonomous control activity of those responsible for production in order to guarantee the course of real-life production behind the facade of rationally organized computer-assisted processes.

1.3 Complementarities and Juxtaposition of Detailed Production Planning and Experience-based Production Control

A third phase of industrial production planning models can be characterized by a more or less conflict-laden "coexistence" between a computer-assisted framework planning and a detailed, incremental control of the production managers. In such companies, production programs are typically preset by planning departments, while the planning of capacity (and thereby the production schedules) and particularly the coping with unforeseen production breaks (missing parts, insufficient workforce, quality problems, machine breakdowns, etc.) are predominantly in the hands of the foreman.

This differs from the second model of production planning, on the one hand, in that the production planning systems are more efficient, decentralized, temporally more precise, and generally work in a dialogue mode. On the other hand, it is precisely detailed planning that reveals the limits of their planning capabilities to the planning departments. This often results in the acceptance of "spheres of uncertainty" that cannot be planned systematically and, thus, areas in which the foreman is active in planning and control. Precisely because of experiences with the "all-powerful claims" of the earlier deterministic systems, the foremen can now more self-consciously emphasize their contribution to production planning and control against the "imperialism" of the planning departments.

We consider the juxtaposition of global production planning systems, with which the necessary time and materials for the production process can - even if not very precisely in detail and time - be planned in advance combined with experience-based, locally optimizing, ad hoc decisions by the foreman, to be at present the quantitatively most significant form of industrial production planning. It ensures both the autonomy of decision and action of those responsible for production as well as the status of the planning departments, just as, to a certain extent, it permits a more flexible reaction to market conditions. Its advantages are an increase in productivity and transparency: Increasingly more and smaller orders can be processed within the company without additional clerical staff, and precise information on orders and materials can be determined on a computer screen, that is, without time-consuming personal or telephone contacts.

1.4 On the Way to Increased Integration of Computerized and Experience-based Production Planning?

Only when the deficits and weaknesses of computer-assisted framework planning - that "normally" are exploited as uncertainty zones and power resources of production departments - become too onerous to the production managers (stress) or too expensive for the company (increasing stocks, insufficient flexibility, difficulties of dealing with always shorter cycles of product innovation and decreasing production lots) an attempt is made to break up the juxtaposition of the second and third phases by other, better integrated solutions.

Such an open situation was revealed in some of the companies studied; these could be the starting point for a search for new planning conceptions that is characterized by a stronger integration of abstract ex-ante and experience-based ad-hoc forms of production planning.

In one West German electronics company (E2G), for example, efforts are being made to decentralize the production planning systems and increase the participation of foremen. It is being considered whether production cannot be reorganized so that the foremen are no longer

just responsible for certain work procedures but can take on responsibility for the production of a specific product - and thereby for several, previously separate work procedures. The goal of such a conception is to upgrade the foreman's task and to develop a sort of computer-based foreman planning.

This is also the goal of the rigorous reorganization of a French personal computer assembly plant (E1F) according to Japanese kanban and just-in-time principles. Through a very "lean" and transparent design of the production flow, and through the consistent dismantling of buffers within production, the technological and organizational conditions for upgrading the role of the foreman and for the repression of complex, computer-assisted production control systems were established. This solution should be supported by a new production planning system (PPS) aimed at controlling continuous production flows.

Another strategy is being followed in two French clothing companies (C1F; C2F). Because of the deficits in the central production planning concentrated in Paris, the managers in the provinces developed their own computer-assisted solutions. This led to a juxtaposition of centralized and decentralized computer-assisted solutions.

A similar strategy, which aims at having a high degree of autonomy from the directives of external, central production planning, was observed in a West German electronics group (E1G). Here the single plants developed a great deal of their own computer capacity. The development of systems that were not integrated throughout the entire company provided the opportunity to develop planning methods that were better adjusted to local problems.

Regardless of whether responsibility is shared between production and production planning, or is exclusively assigned to production, the result in each case is a more strongly integrated concept of production planning in which the abstract, formalized, comprehensive production planning data of the external departments is combined with the concrete, particular, experience-based knowledge of the foreman and some production controllers that is based on informal relationships. This knowledge is an essential, "non-computerized precondition of computerization processes".

The concrete form of these production planning concepts is to a large extent shaped by the specific negotiation processes within the company or even the department that can often last for years. These risky, uncertain, and open-ended processes, in which the "right" planning models are selected, are generally legitimized by visions and rationalities whose validity has to be asserted in a concept rivalry with other departments. These concept rivalries replace the analysis of a universal logic of rationalization and industrialization, the well-known "one best way." Some examples of such concept rivalries follow:

1. In an Italian electronics company (E1I), the developers of an automatic assembly line started with the vision of a deterministic course of production that could not be, and did not need to be, modified by the foremen or the workers but was completely controlled by computers. Only after an "experimental phase" lasting several years with major optimization and integration problems could those responsible for production - who previously were "wordlessly" confronted with this "modern and innovative" vision - develop their own proposals. Their concept was oriented more toward the real variances of the production process and aimed at a higher flexibility and a weaker computer-technological integration of the individual areas of production.

2. In a French personal computer assembly plant (E1F), it was intended to introduce a new production planning system to demonstrate the functionality of the company's own production

planning systems. Because of previous bad experiences with a similar system, the assembly department was very reluctant to this proposal from the company's central management. Instead, some of the employees developed their own vision - the vision of a very simply organized kanban assembly requiring the support of a production planning system that would have to be principally constructed in a different way. After more than two years of negotiations with the central management, they were able to implement this vision.

3. In a West German clothing company (C2G), the chief manager tried to push through his vision of a deterministic, completely automatic production control without any human intervention. Only after the shortcomings of this vision became obvious, participative introduction and inservice training courses were developed by a department manageress and introduced despite the policy of the top management.

In all, it would appear that the global, comprehensive, "systemic," and often technocratic visions of the 1970s and 1980s (compare, e.g., the MAP and Saturn program at General Motors or the robotized FIAT factories) are losing ground to less perfectionist and less totally integrated visions that also leave space for particular, simple solutions and which are explicitly dependent on the support from "below", from foremen, experienced production controllers and other users. The concept rivalry between different departments and groups of employees illustrated in the examples point to a remarkable change in production control concepts. With increasingly less success internal uncertainties and the corresponding conception rivalries can be "absorbed" or settled by directives from above. Instead of a hierarchical mode of coordination ("order and obedience"), decisions and compromises between different rationalities and action logics particularly have to be justified by the adequacy of their content and their social implementability. In this way, "competence" and "consensus" become a decisive foundation for legitimizing the results of power struggles and for guaranteeing the indispensable support "from below" for the adequate development and use of information systems.

It can be summarized that the design of industrial computerization processes is the outcome of open-ended and company-specific negotiation processes and that the particular action strategies followed in each case are also legitimized by their promoters through reference to commonly shared values and norms. This means that information systems are only a partial solution to increasing demands of flexibility, quality and accountability; without the support "from below" and the "intelligent" use of production planning systems these objectives cannot be achieved. Therefore, we will discuss in the following section ways in which the commitment of the employees has been assured in the different firms of our sample.

2. Computerization and the Utilization of Labour

The change in industrial computerization and organization concepts is not only linked to a greater impact of power and exchange relationships and concept rivalries. It is simultaneously accompanied by a different and broader use of the competences and the commitment of the employees. This aspect of the computerization processes - which points to a changing relationship between organizations and their members - will now be described in the dimensions of changing qualificational and motivational requirements and different patterns of coordination.

The change in dealing with the labour force can be understood as a form of coping with contingencies just like the increased impact of inofficial power and exchange relations sketched above. The company depends on the voluntary engagement of its employees, on their contribution to the development of adequate algorithms, and on their "willingness to join in

actively" in the development of complex information systems and their meaningful integration into previous work routines.

In concrete terms, this means that in all successful processes of system development, some white-collar workers and lower management have actively been committed to "filling the system with life", smoothing out errors, adapting it to fit the demands of their departments, and teaching their colleagues how to use the system. This (voluntary, nonenforceable) commitment is absolutely essential for a successful system implementation, because, on the one hand, the computer departments do not possess the necessary, detailed, task-specific knowledge to develop a system that fits the needs of its users, while, on the other hand, a comprehensive, optimized production planning, and thereby an "intelligent" use of the system cannot be dictated but has to be voluntarily provided by the users - even if this voluntariness has to be guaranteed by adaequate qualification, recruitment, promotion, and gratification policies. The increasingly "communicative rationalization" (Heidenreich & Schmidt, 1990) of work has to be supported by adaequate personnel policies.

This also means that the problem of participative system implementation strategies is not "acceptance" in the sense of a passive willingness to follow but active "commitment." The "systemic qualifications" required in such processes can be classified as follows:

1. The ability to analyze one's own work routines systematically so that they can be modelled as computer programs.
2. Knowledge of the "sense" and meaning of program structures once they are developed and the data is stored, in order to recognize the suitability (and the limitations) of program structures that are nothing other than rigid and decontextualized "micro-worlds" (Dreyfus 1985).
3. The comprehensive utilization of production planning systems as well as their development requires a general understanding of the work processes in other departments. This is even more true since the length of production runs in most companies is greatly shortened, and this leads to increased interdependencies between different departments.
4. Data input in networked systems must also be very carefully performed as the chances of detecting incorrect input are low.

From an organizational perspective, the demands of communicative rationalization correspond to a changed mechanism of coordination that is partially based on nonhierarchical forms of concertation. An example for this are project groups that are normally responsible for the development and implementation of computerized systems. In formal or informal ways, in project groups or ad-hoc discussions among production managers, production controllers, and systems developers, a kind of public space was created in which the relevant actors could express their visions of the system to be developed, in the end creating a relatively homogeneous, consensually shared concept which was incorporated into the algorithms and data structures of the production planning and control system ("hierarchy", however, does not lose its function in this case, as consensusual decisions often cannot be implemented if the project group leader doesn't have a high status in the enterprise).

The reward for participating in communicative rationalization processes is the opening up of individual opportunities for promotion. In this respect, companies do not just control work activity directly (by orders or directives) but also and above all by personnel policies shaping the ambitions and opportunities of employees.

It can be concluded that the uncertainties linked to turbulent environmental conditions and open-ended computerization strategies lead to changes in the relationship between companies

and employees: While in the Taylor-Ford regulation model, the major emphasis was on the differentiation between the labour force and the individual person reducing the dependance on subjectivity, creativity and commitment, on hierarchically structured paths of communication and highly routinized work tasks, now a stronger integration of professional and personal identities, non-hierarchical forms of coordination, and more open, less precisely prestructured work tasks are coming to the fore.

This, however, does not mean a shift to completely individualized career patterns, a clear, unambiguous improvement of working conditions, or a trend to unlimited "trust" - in the sense of the complete abolishing of all control mechanisms.

The individualization of career patterns does not lead to a world of qualified and committed white-collar workers pursuing their individual career strategies and thus increasing the overall performance of the enterprise. Individual career strategies and personal engagement are embedded in a network of institutionalized norms and expectations. We only have to recall the payment schemes and the rules protecting against dismissal established in collective bargaining or by law, the rights of works committees, the protection against the technical supervision of work behaviour and productivity, and so forth. In general, these rules are respected even without an explicit reference to them because their violation would shake the "high-trust relations" that are typical for qualified white-collar workers (see Fox, 1974 and Littek & Heisig, 1991).

The tacit recognition of collective norms and expectations in apparently individual strategies can be illustrated by analyzing the hidden impact of industrial relations. A common pattern in nearly all of the eleven companies studied was the extremely limited impact of trade unions and shop stewards on the computerization process. Union representatives in all three countries were not informed in advance, they did not press for the thorough training of users, and they did not request "ergonomic" terminals and workplaces. Union representatives were unable to prevent the development of new lines of social segmentation (especially between old and young, skilled and unskilled employees), and they did not alleviate the increased employee stress related to the implementation and use of production planning systems. They did not press management to avoid layoffs. Despite the unions weakness and shortcomings, we did not observe attempts by management to take advantage of this situation through strategies designed to exclude unions from, or reduce their influence on, the computerization process. Management was more interested in strengthening and using the cooperative aspects of industrial relations - even in Italy, where management thus helped to redefine the traditionally conflictual culture of industrial relations. In Germany, in particular, this emphasis led to the intensification of traditionally cooperative relations. German "Betriebsräte" (a kind of shop steward) generally obtained all the information they desired, even without insisting on their legally guaranteed information rights; if they opposed the storage of data related to individual workers, these data were not stored; if they insisted on appropriate training, their demands were met; if they insisted, at the instigation of the national union, on companywide agreements concerning the introduction of new technologies, these agreements were concluded (in three of the four companies studied), although they later fell into disuse. This cooperative attitude cannot be explained as simply the continuation of traditional forms of industrial relations, however. The shop stewards did not actively participate in the computerization process, often due to their own reluctance to become involved in this new, unknown field. Instead of responding to union initiatives, management tried to anticipate and avoid union complaints - especially by maintaining an active information policy and by avoiding the storage of individual data. The non-interference of unions was crucial for employee acceptance of the new information systems. Although employees normally did not rely on the union to represent their interests, they viewed

the shop stewards as a collective security net, there to protect them if their usual, more individualistic strategies failed.

A second argument against the vision of a world of highly motivated, individualized and socially integrated white-collar employees are the important ambivalences and ambiguities of communicative rationalization processes. Thus, clerical personnel report that the other side of the higher personal responsibility and the more interesting work tasks is an increase in stress, rush, and psychological strain. Furthermore, there are segmentation lines within the departments in which computer technologies are implemented - as a rule, between younger employees with a higher level of education and older employees with lower formal school qualification (the former are often forming a new kind of "participation elite" using the possibilities of participation and commitment for the sake of their own career). The privileged working conditions of the employees surveyed in comparison to those employed in small supplier companies or even the unemployed also indicate social exclusion processes.

Thirdly, the erosion of the classical, taylorist forms of "low-trust relations" does not necessarily mean the complete dismantling of hierarchical forms of domination and control. Between "direct control" and a "responsible autonomy" (Friedman, 1977) based on an intrinsic, professional control of work behaviour arises a new form of "controllable autonomy" which is characterized by an high transparency of production flows and therefore of work results. Even if employees and their work groups are performing their tasks in a more autonomous way (especially in white-collar departments, where simple, routinized administrative tasks have been reduced), their performance can be controlled and measured more easily. With production planning and material requirement systems it becomes easier to control the stock of unfinished materials in production, the level of the production quality, the lost time due to supply problems, the degree of equipment utilization etc. This increased accountability explains the coincidence of decentralized responsabilities, and increased autonomy and the increased stress employees are reporting.

It can be concluded that the greater reliance on the commitment, the voluntary engagement and the systemic qualifications of white-collar workers and more individualized carrer patterns does not mean that collective rules are increasingly becoming useless and dysfunctional and that the social consequences of computerization processes are unambiguous. Such a positive vision would neglect the transformation of organizational patterns of control because computers increase the possibilities of a combination of a high local autonomy and job discretion and a central supervision of the increasingly transparent production processes.
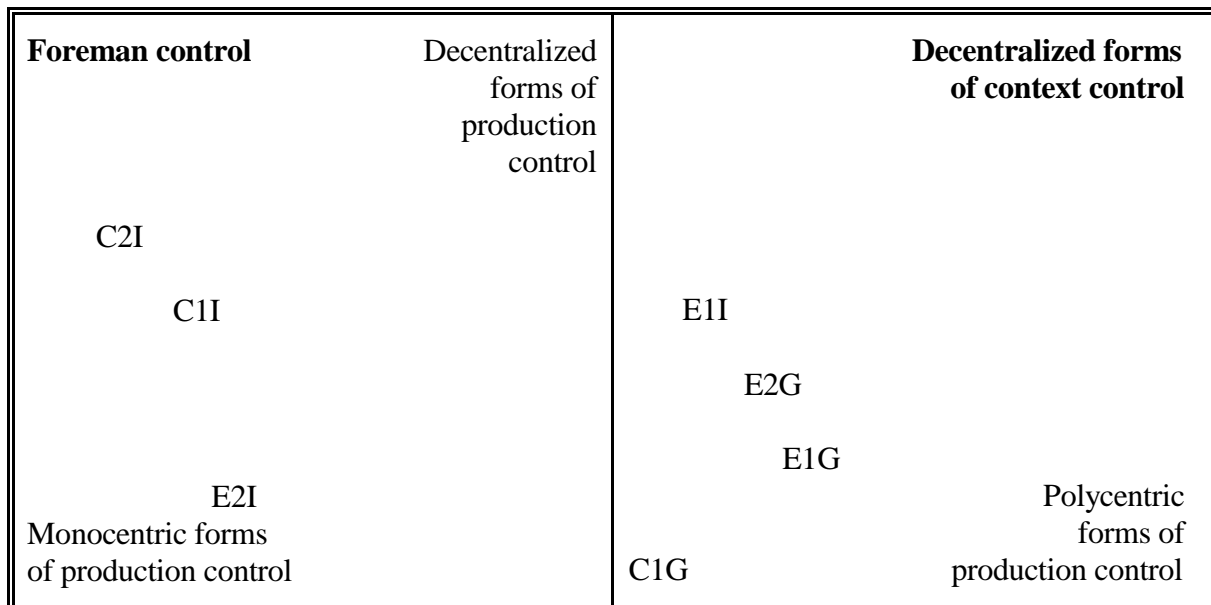
3. National Patterns of Computerization Processes and Sociocultural Contexts

Up to now, we have discussed two modes of coping with uncertainties, namely, their transformation, on the one hand, into "policy" in the sense of internal, organizational processes of power and exchange, and, on the other hand, into "participation" in the sense of greater involvement of employees in communicative rationalization processes. We were able to observe these patterns of changes in all three countries; this points to a broad erosion of the Taylor-Ford regulation model on the organizational level. The myth of the rationally structured organization is reaching its limits. New forms of coordination and social integration (which are characterized by an increased openness and politicization of organizational processes and a higher impact of non-hierarchical forms of coordination) are emerging.

Our thesis therefore was (with particular reference to Lutz, 1976; Maurice et al., 1986) that the politicization of industrial change and the increased reliance on the commitment and the qualifications of the employees is accompanied by an increasing impact of national cultures of work and management which are institutionally embedded for example in the different systems of industrial relations and the vocational training systems. We supposed that organizational structures were shaped according to the patterns of cooperation and conflict resolution, the type of skills and status hierarchies incorporated in these national institutions thus facilitating the need for higher degrees of social integration. We supposed that the "elective affinity" between national and organizational work cultures would explain national patterns of computerization processes.

This required first of all the analytical construction of these national patterns on the basis of our limited empirical evidence. Even if it is not possible to test - on the basis of only eleven case studies - the hypothesis of the existence of national patterns of computerization, we were able to construct on our empirical basis three idealtypical patterns by distinquishing two different dimensions of computerization processes. Besides the dimension explained in figure 1 we asked whether the relevant decisions were unilaterally taken by just one actor - either the organizational and data processing department or the production managers - or shaped in bargaining and exchange processes between different groups of actors [2]).

Figure 2:   *The Production Control Concepts in Eleven Italian, French, and German Enterprises in the Clothing and Electronics Industry*

Foreman control	Decentralized forms of production control	**Decentralized forms of context control**
C2I		
C1I		E1I
		E2G
		E1G
E2I		Polycentric forms of
Monocentric forms of production control		production control
		C1G

C1F C2G C2F **Global,** Centralized **deterministic forms** forms of **of production control** control	E1F **Centralized forms of context control**

Explications: "CIG" refers to the first German enterprise in the clothing sector; "E2I" to the second Italian electronics (computer) company etc.

The most important difference between the computerization processes in the three countries studied consists in the way in which incomplete planning ("missing parts") is dealt with in the relation between production and planning. The typical combinations of model-oriented global production control and empirical production control procedures we observed in the West German, French and Italian companies where we did our case studies can be summarized shortly in what follows. Then we will propose a "cultural" explanation for these national patterns of computerization policies.

In *Germany* a widespread means of dealing with new production control technologies is characterized by reservations about comprehensive, abstract production control concepts in favour of practicable production control concepts. After conflict-ridden and generally unsuccessful attempts to introduce comprehensive, centralized concepts of production control, many of the companies investigated adopted computerization concepts that are not based on comprehensive "top-down" integration. Instead, the experiences of the foremen and their resistance towards abstract, central production control methods leads to more integrated solutions. The consequence of decentralized production control systems is an enhancement of the position of the foremen in questions of information technology and organization. Typical is a permanent, unspecular, day-to-day contact between production control and production departments.

Characteristic for the *French companies* we investigated is a considerable technical, social and even spatial distance between production control and production. The factories are located in the countryside, while the headquarter, the sales, EDP and production planning departments are located in Paris (or some other large city). As a result of the spatial and social distance and the completely different cognitive orientation of the main actors, the two aspects of production control activity are separated: below and alongside the work of the main-frame computers and the abstract production control models a world of PCs and practically applicable production control data arises. The organizational and technical separation of production and production control leads to a minimal connection between the systemic and the "practice-related" aspects of

production control. This separation finds its expression in such contrasts as: production control and production; main-frame computers and PCs; theoreticians and practicians; the company headquarters in Paris and the factories in the countryside; academic education versus training within the company; younger, formally more highly qualified employees versus older, more experienced employees, etc...

What is striking about the computerization processes in the four *Italian firms* investigated is the temporal and technical divorce of the processes of systems development and of systems use: In a firm we investigated (E1I), for example, the conception of an automatic assembly line was worked out within a few months by a four-man project group and then the necessary equipment was purchased. This group designed the system without the participation of the middlelevel foremen, the workers, the union representatives, or the maintenance and repair sections. Since the systems developers did not depend on cooperation with those who would be using the system there was no strong conflict between the two groups, but the development of a kind of side-by-side existence. This eventually resulted in a mutual blocking that led to frequent work-stoppages and the year-long minimal use of the system. In the other investigated firms, too, comprehensive material requirement planning systems were developed that left the practical work of the control and production sections largely untouched. In one firm (C2I), on the occasion of the introduction of a planned new development, the former production control system was turned off without serious consequences; in another firm (C1I) production control was actually carried out using hand-written index cards and documents; and in a third company (E2I) it was the foremen who, for the most part, actually ran production control. This parallelism of computerized ex-ante and experience-based ex-post production control (contrasted with opposition, as in France, or cooperation, as in Germany) is typical for the Italian firms of our sample.

The decisive question for the form of future planning concepts could thereby be how far production is granted a strategic role in the development of planning conceptions. The second aspect of our central "cultural" hypothesis is that national patterns of computerization are also shaped by sociocultural factors, for example by national differences in the social ranking of "mental and manual work" (differences which are certainly more pronounced in France than in West Germany). One consequence of the greater social proximity of production and planning departments in West German firms could be the stronger emphasis on the inclusion and integration of production in comprehensive planning concepts, as the computerization of production planning can more easily be dealt with as a shared project because of the greater professional and social proximity.

Such a culturalistic approach may lead to voluntarist explanations. Given the overwhelming variety and heterogeneity of norms and values it is difficult to determine in a systematic way the relevant and stable characteristics of the broader societal context. Therefore, we decided to concentrate on the institutionalized forms of national cultures, expecially on the different systems of general education or vocational training (for other institutional variables and their impact on computerization processes cf. the different articles in Heidenreich 1993). The concentration on institutions has been justified by Child (1981, p. 329) pointing out that institutions are the result of past interest and legitimation struggles and the cultural embodiment of lines of compromise reached in past conflicts and debates.

In *Germany*, the national system of vocational training was initially aimed primarily at blue-collar workers, but now about half of the apprentices are trained for white-collar positions. Apprentices undergo a period of "dual" training, typically three years in length, involving both a part-time study in a vocational or professional school and part-time work with an employer in

the relevant field. Thus, apprentices acquire not only abstract knowledge, but also professional skills, norms, values, and patterns of behaviour which can be put to immediate use in the workplace. Significant social esteem is accorded to the official certificate ("Facharbeiterbrief") awarded for completion of an apprenticeship. The holder of such a certificate is generally classified as a skilled worker, and thus obtains the corresponding pay level and status in the enterprise according to industry-wide collective agreements. The vocational certificate also opens the way to further professional training programs, which are credentialed by a foreman diploma ("Meisterbrief") or even a university degree ("Diplom-Ingenieur/Fachhochschule"). This apprenticeship is the most important form of initial professional or vocational training - for both blue- and white-collar workers. Even with the expansion of higher education since the 1960's, about two thirds of each age-group begin their careers with an apprenticeship.

In *France*, there is a very close connection between the level of academic education and the status within an organizational hierarchy. In the absence of a developed, campany-based vocational training system, emphasis is placed on mastery of abstract knowledge acquired through the educational system, while practical experience and applied knowledge are devalued. Socially recognized credentials are available only for abstract, theoretical knowledge, in the form of technical and university degrees. The low social recognition of applied knowledge is at least partially due to the fact that executive blue-collar jobs are mostly filled by employees who failed in early phases of their school career. Differences in levels of success in a highly selective school system, and differences in types of knowledge, deepen the cleavages between the occupational groups who design information systems and those who use the information systems in the production and production control departments.

In *Italy*, employees' status and responsibilities within organizations are largely decoupled from professional schools or academic institutions. There are at least three reasons for this. First, due to the extreme heterogeneity of Italian schools, companies are reluctant to grant a nationwide, general recognition of educational diplomas or certificates. Second, a high youth unemployment rate reduced the chance for young employees to claim a higher classification than older, more experienced, but formally less qualified employees. Third, in small and medium-sized enterprises (which have employed an increasing proportion of the labour force since the 1970's) scholastic achievement and formal diplomas are less important than personal relationships and non-standardized, individual credentials and qualifications. In Italy, the meritocratic coupling of school diplomas and organizational status typical of French enterprises (and - with reference to professional degrees - of German ones as well) is lacking; scholastic qualifications have only a minor impact.

Why would national differences in the relationship between educational attainment and status within organizations lead to differences in the organizational forms and processes surrounding the introduction of new computer technology? We explained before that the exploitation of their "systemic" capabilities depends to a considerable extent on the involvement of the users and their practical knowledge of the functioning of the organization. Therefore, a condition for successful implementation is an intense, open-ended cooperation among data processing departments, production planning and control services, and production lines. The integration of experience-based forms of knowledge and abstract, company-wide control methods of production control is a crucial issue for the success of the computerization process. This "problem of reference," located at the interface of production, production control, and EDP and organization departments depends upon whether young, highly and abstractly qualified, white-collar production controllers and computer experts can cooperate with their older, formally less

qualified, but experienced blue-collar colleagues in the production and production control departments.

In *German* firms, the development of production control systems that are closely adapted to the production process is facilitated by the presence of both employees with practical experience in production and white-collar employees with commercial or technical training. Both groups have experienced a similarly structured program of vocational training. Moreover, logistics and EDP experts cannot simply impose their abstract, theoretical knowledge on foremen and production controllers, whose practical, experience-based knowledge is also formally recognized and enjoys high social esteem. In contrast, in the three *French* firms investigated, a professional and social distance is maintained between the EDP and administrative departments, on the one hand, and the production control and production areas, on the other. This distance reflects the different types of knowledge - abstract and general versus empirical and application-oriented (cf. Lutz & Veltz 1989) - characteristic of French employees with higher and lower levels of education. In both German and French companies, the competition between younger and older employees leads to the mutual limitation of purely abstract and purely pragmatic methods of production planning and control. The integration of both logics into a unified, comprehensive and efficient information system is less likely in French than in German firms, however, because French employees are more inclined to choose strategies of separation and distinction (cf. Bourdieu 1984).

In the four *Italian* firms, there were no open power struggles and conflicts between the production, production control and systems development departments, but rather a parallel development of the two approaches to production control, resulting frequently in a year-long isolation of the new information technologies. Once the limitations of abstract, global production control became apparent - when management realized that the support of the foremen was crucial - an intense and informal cooperation sometimes developed. The difficulties in establishing cooperation between proponents of pragmatic and abstract approaches may be explained by the fact that in Italy there are no "modernized," institutionalized and socially accepted patterns of cooperation and behaviour such as the crafts model in Germany. As a result, cooperation between the production, production control and systems development departments is not blocked by status hierarchies based on education, as it is in France, but neither is it facilitated by a vocational training system in which the majority of both white- and blue-collar employees participate, as it is in Germany.

However, the use of national institutions to operationalize culture may lead to an overestimation of the internal coherence and consistency of national cultures and to a minimization of its internal cleavages. It may also promote an undue focus on nationally specific aspects of culture and obscure important transnational cultural elements (Rose, 1985). An even more radical critique points to the implicit cultural determinism of the institutionalist approach. Culture is less a kind of iron cage which determines individual behaviour; social actors can always reformulate or even re-invent "traditions." Institutions can be used in new ways by actors facing new challenges, or can even be changed.

The most important examples of a nontraditional, individualized use of cultural patterns were nearly "invisible," taking place as part of open-ended, non-hierarchical and politicized computerization processes. In project groups and other "open" bargaining arenas, traditional status differences and formally certified qualifications were less important than the ability to communicate, to structure problems, to persuade, and to reach agreement. Especially for young employees with a higher education, this opened new opportunities to demonstrate to their older colleagues (who generally had a higher hierarchical status, but a lower education) their personal

and professional abilities. Because of the openness and indeterminacy of the political processes related to computerization, it was possible for these employees to define their own tasks and create new channels for upward mobility. For example, some production controllers - due to their close involvement in the development of information systems - became experts in the practical analysis of organizational and informational systems, knowing how to transform practical knowledge into algorithms and data structures. In small and medium-sized companies, in particular, it was often the case that one such expert, often young, enthusiastic, and communicative, who had been socialized within the company and who was intimately acquainted with its problems and power structures, became the key person for the organization of computerization processes. Members of project groups were sometimes able to move to different departments (e.g., from production to production management), due to their new contacts. This created "diagonal" chains of mobility across department boundaries, reducing the importance of traditional vertical mobility patterns and employees' dependence on their immediate supervisors. In sum, computerization processes are often associated with a decrease in the importance of hierarchical, professional and status-based social divisions and an increase in the importance of individuals' active use of their individual social and cultural competences - which are also shaped (but not determined) in local or national institutions.

It can be concluded that with the reduced impact of the classical agencies of socialization in the industrial society, the relevant sociocultural contexts of industrial companies also have to be determined anew. Modern societies seem to be characterized by the progressive erosion of external sources of legitimation and normative integration; the "non-contractual elements of contracts" (Durkheim) must increasingly be produced by the contractors themselves. Due to the limits of "low-trust relations" and bureaucratic forms of integration, organizations are experiencing an increasing demand for policies that actively promote social integration but they can rely less on external, institutionalized pattern of cooperation, participation, and conflict resolution.

On the other side, it is not clear whether a corporate culture can really be created, modified or maintained by top management or by human resources departments. Rather than attempting to impose uniformity on the diversified, culturally embedded interpretations and behavioural patterns of employees, management could follow a more promising approach by limiting its focus to the definition and strategic modification of relatively autonomous organizational arenas. Management can only attempt to shape the context for the autonomous, culturally embedded strategies of employees in such a way that the enterprise will survive in an increasingly turbulent environment. That is exactly what is happening in project groups: managers try to understand and evaluate the outcomes of these groups without interfering with the open, indeterminate processes of negotiation and re-interpretation taking place within them.

The increased reliance on a higher normative integration of the employees and the difficulties of assuring this integration by the creation of a homogeneous "corporate culture" or the use of external sources of legitimation points to another central difference to the Taylor-Ford regulation models of the postwar period which can be characterized by a reduced dependency on national cultures of work.

4. Conclusion

In summary, the previous empirical "impressions" regarding some aspects of new, post-Taylorist models of work organization and social integration should once more be contrasted in

a simplified manner with the three dimensions of the Taylor-Ford regulation model mentioned above on a company level:

1. Instead of bureaucratic, rationally structured organizations, there is an increase of openended negotiation processes and "concept rivalries" that extend beyond set areas and hierarchies.

2. Alongside low-trust relations as a dominant paradigm of the use of labour, there is a broader access to labour's capabilities and willingness to participate which should not be taken as unconditioned high-trust relations because the relative autonomy of employees is situated within the frame of an increased transparency and accountability and the social consequences of the increased autonomy and job discretion are far from unambiguous.

3. Instead of a minimal normative integration of the workforce and besides the use of institutionally embedded and relatively stable norms and values of the "broader society" (such as those in trade unions, vocational training systems, and structures of social inequality), a "detraditionalized" use of culture arises. Especially younger employees use their social and cultural competences in a more individualistic way - beyond the boundaries of professionally defined competences or competences assigned to a specific hierarchical status - to support the systemic rationalization processes in enterprises and to facilitate their own promotion.

Neither the increasingly indeterminate, flexible task structures nor the more educated, qualified and self-conscious work force accustomed to making their own choices (and to taking the responsibility for them) will facilitate the continuation of the old top-down forms of organizational coordination. Post-Taylorist models of work organization and social integration will rather be characterized by broader task structures, a higher but controllable autonomy of employees, an increased participation of employees in politicized, communicative processes of rationalization, a reduced importance of hierarchical forms of coordination and control, and more individualized patterns of inequality between younger, higher qualified, sometimes even female "participation elites" and older, sometimes foreign, less qualified workers.

A new incentive for such new forms of organizational coordination and social integration will result from the emerging new division of labour between Eastern and Western Europe. Labour-intensive operations, traditional products and the classical mass production tasks can and will be delegated to the adjoining Eastern sites which can offer low wages but suffer from serious infrastructural disadvantages (in transport, telecommunication, research and development know-how, supplier networks). Only with a flexible, qualified and intrinsincally motivated workforce and increasingly flexible forms of coordination within and between enterprises West European enterprises can survive in a new, global competition on prices, quality, innovation, and flexibility.

Footnotes

1 This joint paper from the German-Italian-French Research Team (GIFT) on New Technologies has been translated from the German by Jonathan Harrow, Bielefeld University. Other members of GIFT are Luigi Benedetti (ISFEL and University of Bologna, Italy); Giancarlo Cerruti (IRES di Torino, Italy), Maura Franchi (Regional administration of the Emilia Romagna, Italy), Stefan Heiner (Villazzano, Trento, Italy), and Solange Montagné-Villette (University of Poitiers, France). A reader with nine articles based on our common empirical work (11 case studies on the basis of 145 interviews with production controllers, systems developers, top managers and shop stewards) has been edited by Heidenreich (1993). The 11 companies are indicated by abbreviations like C1I. The first letter refers to the branch (clothing or electronics industry); the second to the country where the company is located.

2   In monocentric, centralized forms of production control, homogeneous production plans and planning methods are imposed by a central computer and production planning department, in decentralized, monocentric forms of production control the foremen retain the essential role in determing the job order, the capacity planning etc.. In polycentric, contextual forms, production control plans result from negotiation, communication and exchange among the various local production and production control units and the central department. The central department defines general production control methods and production schedules (thus guaranteeing a companywide homogeneity of production plans and data bases), while local production controllers and foremen are responsible for optimizing decisions locally. In decentralized forms of context control even the companywide production control methods result from bargaining processes between different production departments, local production control departments and central production planning units.

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