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Results from a Matched Employer-Employee Survey in French Manufacturing

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N° 28
septembre 2003

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ISSN 1629-7997
ISBN 2-11-088624-2

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Abstract

In this paper, we use a French matched employer-employee survey, the C.O.I. survey, conducted in 1997, to describe the general features of organizational change in manufacturing firms with more than fifteen employees. We work with a sample of 3,286 firms and two samples of "core" employees (with at least a year of seniority): 2,612 blue collars and 1,162 technicians and supervisors. We have two main aims: discuss new ways of measuring organizational change, allowing for diversity in its orientation and analyze empirically how new organizational practices have been shaping production jobs in French manufacturing firms throughout the nineties.

In the first section, we describe the statistical anatomy of organizational change, using the point of view given by management in the business section of the C.O.I survey. We then turn to the labor force section of the survey where we analyze the patterns of work organization in our samples of blue collars and of technicians and supervisors. We finally confront the information gathered on these two different levels.

We find that a common ingredient to new organizational practices is the production of a collective knowledge on the shop floor allowing continuous improvement of the production process. In other words, organizational changes would drive a new way of rationalizing knowledge making where production workers are asked to explicitly contribute to technological progress. The structure of blue-collar effort becomes more complex as they are required to participate intensively both in information and production flows. However, some results suggest that the core of organizational changes in the nineties has changed direction after the 1993 recession, switching from product and quality strategies to low cost strategies and implying more pressure on the work of technicians and supervisors and a slowdown in the "enrichment" of blue-collar jobs.

Key words: matched employer/employee survey, organizational change, division of work, technological change, organization of production.

JEL Classification: D23, L23, O33, C81.

Comment les nouvelles pratiques organisationnelles façonnent-elles les emplois de production ?

Résultats d'une enquête auprès d'employeurs et d'employés de l'industrie française

Résumé

Nous utilisons, dans cet article, une enquête française menée en 1997 auprès d'employeurs et de salariés, l'enquête « Changements organisationnels et informatisation » (COI), pour décrire les caractéristiques générales du changement organisationnel dans les entreprises industrielles de plus de cinquante salariés. Nous travaillons sur un échantillon de 3 286 entreprises et deux échantillons de salariés « permanents » (ayant au moins un an d'ancienneté) : 2 612 ouvriers et 1 162 techniciens et agents de maîtrise. Nous poursuivons deux objectifs principaux : discuter de nouvelles façons de mesurer le changement organisationnel, qui tiennent compte de la diversité de ses orientations, et analyser empiriquement comment les pratiques organisationnelles ont façonné les emplois de production dans l'industrie française au cours des années quatre-vingt-dix.

Dans la première section, nous décrivons les formes prises par le changement organisationnel, telles qu'elles sont exposées par le management *dans le volet « entreprise » de l'enquête COI. Nous nous tournons ensuite vers le volet « salariés » de l'enquête pour analyser les profils d'organisation du travail qui se dégagent de la description des postes de travail faite par les ouvriers, techniciens et agents de maîtrise de nos échantillons. Nous comparons, enfin, les informations recueillies à ces deux niveaux différents.*

Nous trouvons qu'une composante commune aux nouvelles pratiques organisationnelles est la production, dans les ateliers, d'un savoir collectif qui permet une amélioration continue du processus de production. En d'autres termes, les changements organisationnels induiraient une nouvelle façon de rationaliser la construction du savoir, qui inciterait les salariés de production à contribuer explicitement au progrès technologique. La structure de l'effort des ouvriers devient plus complexe puisqu'il leur est demandé de participer activement à la fois à la circulation de l'information et au flux de production. Cependant, certains résultats suggèrent que l'orientation dominante des réorganisations a changé après la récession de 1993, passant de stratégies de produits et de qualité à des stratégies de compression des coûts impliquant plus de pression sur le travail des techniciens et des agents de maîtrise et un ralentissement de l'« enrichissement » des emplois ouvriers.

***Mots-clefs** : enquête couplée employeurs/employés, changement organisationnel, division du travail, changement technologique, organisation de la production.*

INTRODUCTION[1]

They are many theoretical definitions of organizational change. For example, following Sah and Stiglitz (1986), we can define an organization (or "architecture") to include the way decision-making units are structured within the firm, the way decision-making power and skills are distributed and the type of information and communication structures in place. Thus, any change in the distribution of power, skills, information or in the lines of communication constitutes an organizational change. We may also refer to an evolutionist framework (Nelson, Winter, 1982) and define organizational change as a change in the routines with which the firm operates.

Recent theoretic models of organizational changes generally consider a unique direction of change, firms moving from an old style of organizational design to a more modern one (Greenan, 2001). In modern organizations, information systems use decentralized information, process it through networks and develop horizontal communication channels. Their production system is characterized by multi-tasking, autonomous decision-making in teams of production workers and horizontal technical interdependencies stemming from quality, time and cost-cutting constraints. No theoretical model deals with all these dimensions at the same time, but many focus on "decentralization" or "increased flexibility".

According to management, organizational change is correlated with performance improvements. Firms change their organization to gain competitive advantage. However, in France, statistical studies on firm level data relating organizational change and productivity measures (Coutrot, 1996; Greenan, Guellec, 1998; Greenan, 2003) show rather weak evidence of this relation. At the same time, labor force surveys indicate that between 1984 and 1998, greater pressure has been imposed on employees leading to deteriorated conditions of work (Cézard, Dussert, Gollac, 1992; Gollac, Volkoff, 1996). The increased strain imposed on workers has also been underlined by empirical studies based on data for the US (Cappelli *and alii*, 1997). But empirical research on productivity impacts of organizational change in the US leads to results that are more positive than in France[2] (Ichniowsky, Shaw, Prennushi, 1997; Black, Lynch, 2000; Bresnahan, Brynjolfsson, Hitt, 2002; Askenazy, Gianella, 2000). This suggests a great diversity in changes implemented by firms and/or the presence of large adjustment costs impeding performance.

Moreover, the economic rationale behind organizational practices implemented by firms is not clear cut. They adopt total quality management and just-in-time devices, they de-layer, re-engineer, outsource, focus on their core competencies, downsize, subcontract, etc. Are all these changes belonging to the same scale or do they imply different directions? Depending on the practice, higher involvement, empowerment, higher formalization, cost reduction or flexibility are favored. Hence, these practices do not necessarily go hand in hand with one another. For example, tight deadlines may interfere negatively with a thorough management of quality (Keren, Levhari, 1989). Or increased formalization may limit empowerment: employee has full responsibility in a tight framework defined by precise procedures.

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[1] Preliminary versions of this paper have been presented at the NBER conference on organizational change and performance improvement (Santa Rosa, California, April 1999), at the CIRANO conference on "Innovation and Supermodularity" (Montréal, Quebec, June 2000), at the DRUID's Nelson and Winter conference (Aalborg, Denmark, June 2001) and at the International Conference on Organizational Designs, Management Styles and Firm Performance (Bergamo, Italy, June 2001). We are grateful to David Author, David Encaoua, Michel Gollac, Ned Lorenz and Fredrik Tell for their useful comments. The views expressed in this papers are those of the authors and do not reflect those of their institutions.

[2] The same kind of difference in French/US empirical results on productivity impacts is obtained when IT indicators are used.

This paper has two main aims: discuss new ways of measuring organizational change, allowing for diversity in its orientation and investigate empirically the rationale of organizational changes in French manufacturing, trying to understand how new organizational practices have been shaping production jobs.

It has been widely acknowledged by structural contingency theory and its multiple attempts to gather statistical information on a wide scale that organization and organizational change were hard to measure. We are going to address this issue here once again, using an unusual measurement strategy embedded in a matched employer/employee survey on Organizational Change and Computerization (C.O.I.) conducted in French manufacturing in 1997[3]. Existing econometric literature suggests that firm level information about the use of new organizational practices is a good way to indirectly seize organizational change. The business section of the C.O.I. survey adopts this point of view.

A key element in understanding what firms do when they implement new organizational practices is to identify how job contents and employees' efforts are affected. The interactions between the efforts spent by individual workers and the structure of the organization are also a key issue as far as performance is concerned (Harris, 1994). We are thus going to augment the first set of firm level measures by a second one deriving from the labor force section of the C.O.I. survey. More precisely, we focus the descriptions given by "core" employees (with at least one year of seniority) in production jobs: blue collars on one hand, technicians and supervisors on the other.

The COI survey is a group of three business surveys matched with one labor force survey[4]. Small samples of employees have been randomly selected within each firm and interviewed in the context of their home. In the paper, we focus on the manufacturing sector where the survey benefited from high response rates both on the firm side (88%) and on the employees' side (71%).

We first describe the statistical anatomy of organizational change, using the point of view given by management in the business section of the C.O.I survey (section 1). We then turn to the labor force section of the survey where we analyze the patterns of work organization in our sample of blue collars and in our sample of technicians and supervisors (section 2). We finally confront the information gathered on these two different levels, trying to understand how new organizational practices change the work of employees and the structure of their effort (section 3).

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[3] The idea of the survey originated from a seminar on innovation and performance improvements organized by Dominique Foray and Jacques Mairesse in 1994-1995. A first description of the project was discussed collectively in a group and written up by Michel Gollac and Nathalie Greenan (Caby *and alii*, in Foray and Mairesse, 1999). In the 1990's, in response to the labor market situation, the Ministry of Labor (Dares) became more and more interested in understanding how it related with firm practices. Furthermore, labor force surveys tended to suggest that an increasing share of workers felt high pressure at work. On the other hand, the Ministry of Industry (Sessi) wanted to improve knowledge on the skill bias of technological change. As a result both statistical services adopted the project that was to become the C.O.I. survey. Insee got involved because it was interested in the new methodology of the survey and was sub-contracted by Dares to conduct the labor force survey.

[4] One business survey covers manufacturing and food industries. The Ministry of Industry (Sessi) conducted the survey in the former while the Ministry of Agriculture (Scees) took care of the later, the two others are exploratory surveys in a branch of commerce (home depots type of stores) and in a branch of business services (accountants) carried out by Insee (National Institute for Statistics and Economic Studies). The labor force survey has been conducted by the Ministry of Labor (Dares). 8812 workers have been interviewed, belonging to 4025 firms with more than fifteen employees in manufacturing and food industries and with more than twenty employees in the service branches. The conception of the business survey in manufacturing and of the labor force survey and the coordination of the four surveys has been directed by Nathalie Greenan at the Centre d'études de l'emploi.

1. THE NEW MANAGERIAL TOOL BOX

1.1. A list of organizational practices to measure organizational change

Table 1 gives an example of a list of managerial tools extracted from an American management book by Hall (1987) which French translation has been a best seller at the beginning of the 1990's. The table describes the set of practices that a manufacturing firm should adopt in order to reach excellence[5]. Practices can be grouped under three headings: just-in-time (JIT), total quality management (TQM) and people involvement. JIT and TQM are viewed as overall process approaches or organizational devices inducing a more thorough management of production flows and of quality issues. Organization in cells or preventive

Table 1: General View of Manufacturing Excellence

Total quality	***Qualité totale***	**People involvement**	***Implication des hommes***	**Just-in-time**	***Juste-à-temps***
Defined quality to customers	*Qualité définie selon les besoins du client*	**Survival perspective**	*Objectif de survie*	**Workplace organization**	*Organisation du poste de travail*
Total company effort	*Effort de l'ensemble de l'entreprise*	**Total organization reform**	*Changement complet de l'organisation*	**Visibility**	*Visibilité*
Targets for improvement	*Objectif /cibles d'amélioration*	**Responsibility at the source**	*Responsabilité à la source*	**Limited inventory**	*Stocks limités*
Quality process: quality product	*Qualité du processus : qualité du produit*	**More skills, less effort**	*Plus de qualification, moins d'effort*	**Reduced setup times**	*Temps de changement de série réduits*
Responsibility at the source	*Responsabilité à la source*	**Flexible workers**	*Personnel souple et polyvalent*	**Small lot sizes**	*Faible taille des lots*
Statistical process control	*Contrôle statistique de processus*	**Broad perspective**	*Recherche d'une vision globale*	**Reduced lead times**	*Cycles de production réduits*
Immediate feedback	*Correction immédiate*	**Full work**	*Plein emploi*	**Reduced space: Group technology Standard routings, Cell layouts**	*Réduction de la surface : Technologie de groupe, Gamme, Implantation en cellules*
Cause and effect methods	*Méthode d'analyse de causes et d'effets*	**People developement**	*Enrichissement des compétences*	**Producible designs**	*Conception « manufacturable »*
Reduced variance in process	*Réduction de la variabilité dans le processus*	**Problem solving atmosphere**	*Atmosphère de résolution des problèmes*	**Stable, repeating schedule**	*Charge stable et renouvelée*
Failsafe operations	*Opérations conçues pour empêcher les défauts*	**Performance measurement**	*Mesure des performances*	**Preventive maintenance**	*Maintenance préventive*
Standardization	*Standardisation*	**Continuous improvement**	*Améliorations continues*	**Cycle time analysis**	*Analyse des temps de cycle*

After Hall (1987, p.25) and its French translation (1989, p.43).

[5] Of course many books have been written on manufacturing excellence, we choose this one in particular because of its French translation.

maintenance are examples of just-in-time practices, statistical process control or methods for analyzing causes and effects examples of total quality management practices. In order to produce just in time, to reach total quality and to promote continuous improvements, firmshave to induce a high level of involvement in their employees. This involvement does not only imply a high level of effort. The design of production jobs entails collective work and diversified tasks in the horizontal as well as in the vertical dimension: job rotation, decentralization of operational decisions and teamwork are employee involvement practices. Thus "high performance" organizations tend to induce an expansion of effort in various dimensions implying physical, problem solving and interpersonal abilities.

This model of "manufacturing excellence" stems from the world of management, not from the world of economists. However, industrial relations economists have been attracted by it and have tried to assess its economic performance (Ichniowski *and alii*, 1996). In France, in the beginning of the nineties, a model of "skill enhancing organization" (*organisation qualifiante*), which has some common features with the "manufacturing excellence" model has been promoted by management science scholars (Zarifian, 1990; Veltz, Zarifian, 1993).

Osterman (1994) who tries to measure the use of "flexible work organization", Ichniowski, Shaw and Prennushi (1997) who investigate the productivity impact of "human resource management practices", Cappelli and Neumark (1999) who focus on the establishment-level outcomes of "high performance work practices" and Black and Lynch (2000) and Bresnahan, Brynjolfsson and Hitt (2002) who are interested in "workplace innovations" favour two aspects of the model of manufacturing excellence described by Hall (1987): employee involvement and quality practices. They thus make the implicit assumption that the adoption of managerial tools identified as "new" or "innovative" leads to organizational change. They also choose to focus on a subset of tools. Three main reasons may play a part in this choice: the fact that these practices describe the progressive version of workplace transformations rather than the regressive "low cost" one (Godard, Delaney, 2000), the need for a simple definition of the new "high performance" model and the underlying reference to the Japanese model.

In this paper, we try not to make any particular assumption on what makes the core of the new management model. We are more interested in what firms actually do. As a result, our measure allow for more diversity than usual in empirical papers on new organizational practices. The questionnaire of the business section of the C.O.I. survey is built on a large list of organizational practices. A representative sample of about 5000 manufacturing firms over twenty employees was questioned. It benefited from a 88% response rate (95% in terms of turnover)[6].

It is a self administered survey. The firm response is given by a firm representative chosen by the headquarters of the firm. In fact the statistical office of the Ministry of Industry is in contact with an interlocutor in all firms for the annual survey of manufacture. The C.O.I. questionnaire has been sent to this person with a letter saying that the headquarters, the human resources department, the production department and the IT department were concerned. The letter also informed the firm that some workers randomly selected were being interviewed, but of course it did not give their names. The last question of the survey is about the affiliation of all the persons that participated in building the firm's response. In more than half of the cases, the general manager is the main contributor to the firm's response.

[6] In manufacturing, the C.O.I survey was compulsory, that is firms could be penalized by a fine if they did not answer. The option of making it compulsory has been discussed with representatives of the statistical administration, of trade unions and of employers' federations.

Firm representatives have a clear picture of strategy matters and understand the managerial vocabulary. If they have not just arrived in the firm, they know what kind of organizational practices are being used or adopted, why, and they also have their own feeling about obstacles and implementation difficulties. We measured the diffusion of the new managerial toolbox in French manufacturing firms through their interviews (business survey questionnaire). In this paper, we use seven sets of questions (118 questions in total) from the business survey questionnaire that deal with innovative work practices. All these questions are reported in Appendix 1 with weighted percents for each type of answers from the whole sample of interviewed firms with more than fifteen employees.

The variables stemming from these questions are of a qualitative type, either dichotomous or with three ordered items. After analyzing their distribution, we decided to build up new variables in order to deal with a smaller number of them while loosing little information. We use sixty-one questions describing the situation in 1997 and build up twenty "primary" variables with a varying number of items, summing up to fifteen. They can be classified into three main groups: manufacturing excellence, decentralization and "output" variables. In focusing on practices used in 1997, rather than on changes between 1994 and 1997, we implicitly decide to concentrate on medium term organizational change rather than on short-term organizational change. The tools used by the firm in 1997 results from "organizational design" decisions made by firms throughout the nineties. This is partly so because the vocabulary we use to describe these tools is especially adapted to the period of the nineties.

1.2 Manufacturing excellence, decentralization and "output" variables

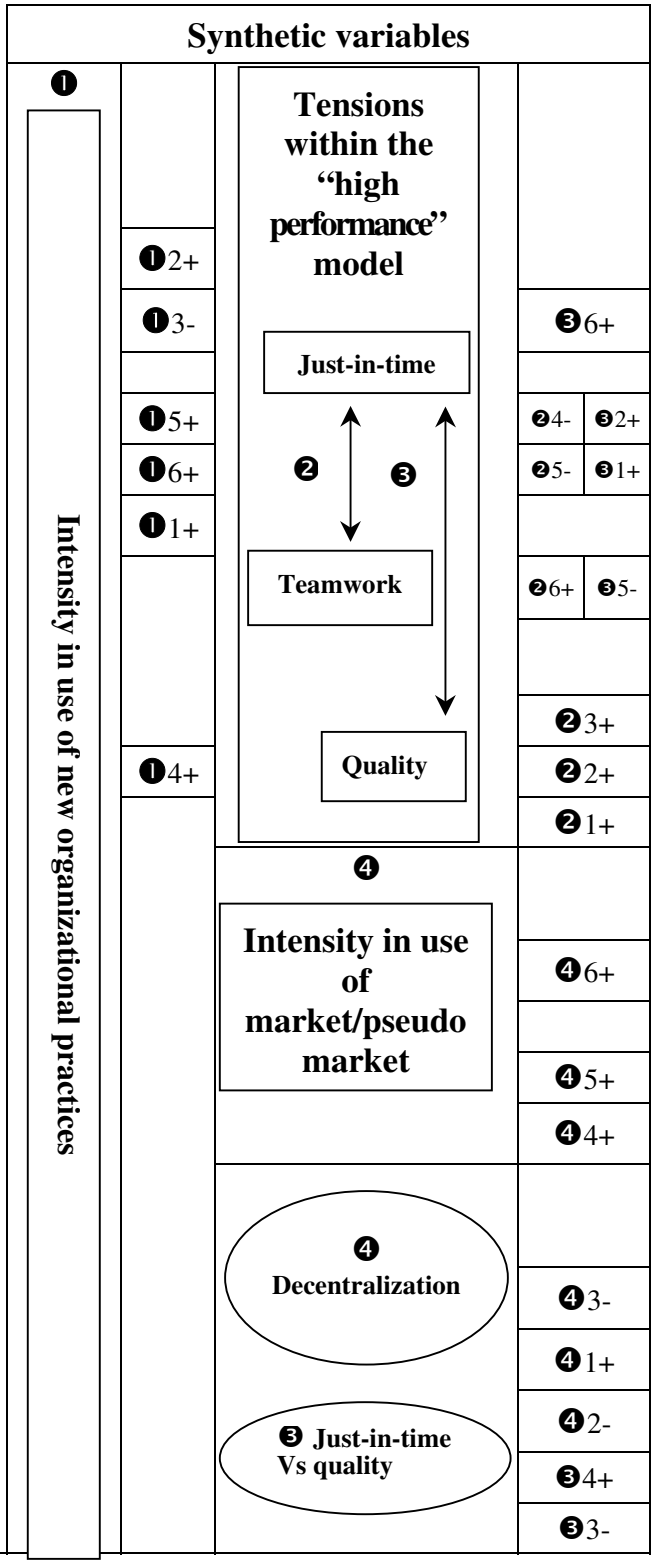
The column "primary variables" in Table 2 gives an overall view of the twenty variables through a list of selected items. It also gives their names as they are going to appear in some further tables and weighted percentages. The first three categories of variables may be grouped under the heading "manufacturing excellence". They list practices that aim at optimizing quality objectives and time constraint objectives and practices that aim at spurring employee involvement in information processing and decision.

Four practices testify the place taken by ***quality management*** in the firms' strategy. Three of them are implemented by the firm: ISO or EAQF certification (**ISO**), other certification or total quality management (**TQM**), value analysis, functional analysis or AMDEC methods (**AMD**). Quality certification and total quality management are well diffused practices. 49% of manufacturing firms are certified and 35% declare having implemented total quality management. Value analysis, functional analysis or AMDEC methods are less common (26% of firms). These methods aim at analyzing the consequences of design choices on products and processes. Hall (1987) suggests considering them as part of a total quality strategy (see Table 1). The last practice consists in a special requirement to the suppliers and/or subcontractors of the firm: to comply with ISO certification or other formal quality approaches (**SISO**). A majority of manufacturing firms (66%) declare that they make this type of requirement, which drives the diffusion of quality devices. These figures demonstrate the horizontal interdependencies implied by quality standards along the flow of intermediate goods: there is no point in managing thoroughly quality if inputs are not spotless.

Four practices contribute to a thorough ***management of time constraint***: just-in-time delivery (**DJIT**), just-in-time production (**PJIT**), 5S method or total productive maintenance (**TPM**) and just-in-time delivery required to suppliers and/or subcontractors (**SJIT**). In 1997, 39% of firms deliver just in time and 38% produce just in time. 5S method originated in Japan. Like

Table 2: The Measure of Organizational Change in 1997:
The Point of View of Management

Primary variables	Name	%
Quality		
ISO 9001, ISO 9002 or EAQF certification	**ISOY**	49
Other certification or Total Quality Management	**TQMY**	35
Value analysis, functional analysis or AMDEC method	**AMDY**	26
Suppliers do **not** comply with ISO or other standards	**SISON**	34
Just-in-time		
System of just-in-time delivery	**DJITY**	39
System of just-in-time production	**PJITY**	38
5S method or Total Productive Maintenance	**TPMY**	16
Suppliers are **not** asked to make JIT deliveries	**SJITN**	49
Involvement of employees		
More than 10% of production workers in…		
… Self-managed teams	**SMTM**	31
… Problem solving groups	**PSGM**	28
… Project teams	**PTM**	19
Decentralization		
Organization in profit centers	**OPCY**	31
Formal in-house customer/supplier contracts	**CSCY**	29
Outsourcing of more than 3 tasks	**OUT3M**	45
Subcontracting of production	**SUBY**	54
Suppliers take part in designing end products	**SDPY**	42
"Output" variables		
High implication of production workers (7 to 10 tasks)	**HIPW**	22
High implication of specialists (7 to 10 tasks)	**HIS**	18
Low implication of management (0 to 3 tasks)	**LIM**	20
High implication of management (8 to 10 tasks)	**HIM**	24
From 0 to 2 hierarchical layers	**HL0_2**	28
From 5 and 9 hierarchical layers	**HL5_9**	17



Source: C.O.I survey, 1997, business section, MEFI-Sessi, MAP-Scees.

Note: This table gives the percentages computed on the sample of 3,286 manufacturing firms with more than fifteen employees where at least one employee responded to the labour force section of the C.O.I. survey. ❶5+ in front of "just in time delivery" means that this variable contributes positively to factor 1 and that it is the fifth variable contributing the most to its inertia.

total productive maintenance, it aims at motivating workers in collecting information about all the small hitches into the production process. 5S method insists on tidiness and order in the working environment so that problems are more easily detected. Hall (1987) associates these methods with just-in-time because small hitches can delay production if they are not identified quickly enough. Only a small number of firms had adopted one of these methods in 1997 (16%). Like for quality devices, manufacturing firms ask their suppliers to deliver just in time more often than what they do themselves: 51% have that type of requirement. This is an indication of the horizontal interdependencies generated by time constraints.

Three practices that try to induce a ***higher involvement of employees*** in information processing and decision are considered: self-managed teams (**SMT**), problem-solving groups (**PSG**) and project teams (**PT**). In those teams or groups, blue collars complete cognitive tasks. They are allowed to make operational decisions by themselves or collectively on production matters and/or they exchange information within horizontal networks. Thus, work in teams or groups practices change the allocation of cognitive tasks on the shop floor. Three different intensity items are used giving the percentages of concerned direct producers in 1997 (0-10%, 10%-50%, more than 50%). Manufacturing firms with more than 50% of blue collars involved in problem-solving groups or project teams are scarce: 4% and 2% respectively. This figure reaches 11% for self-managed teams which is higher but still low. Thus, we grouped together the medium and high item. The resulting variable measures the existence of such groups on a non negligible scale (more than 10%). Respectively 28%, 19% et 31% of manufacturing firms have more than 10% of their blue collars in problem-solving groups, project teams and self-managed teams.

The fourth category of practices has to do with the way transactions are organized within the firm and with other firms, through market mechanisms. These practices are seldom taken into account by the "high performance" literature, but they are analyzed in transaction cost approaches that try to explain the size of the firm or the determinants of its frontier. In a way, we could say that the practices we measure give account of the degree to which the firm uses contracts to organize flows of intermediate goods and services. We group them under the heading of "decentralization of the organizational structure". We think of decentralization in the sense used by traditional theories of hierarchy: a hierarchical structure is more decentralized when its units are more autonomous in their decisions or if mechanisms, others than authority, contribute to the coordination of activities.

The ***decentralization of the organizational structure*** is seized through the use of five practices. Two of them influence internal organization: organization in profit centers (**OPC**) and the use of formal in house customer/supplier contracts (**CSC**). 31% of manufacturing firms over fifteen employees are organized in profit centers in 1997 and 29% use formal in house customer/supplier contracts. We call the organizational tools in this category "pseudo-market" practices. The three other practices we consider shape external organization: outsourcing of functions (**OUT**), sub-contracting of production (**SUB**) and asking suppliers to take part in designing end products (**SDP**). In 1997, 45% of manufacturing firms outsource more than three functions, 54% sub-contract part of their production and 42% ask their suppliers to take part in designing end products. We group outsourcing, sub-contracting and partnership in design activities under the heading of "market" devices.

Firm representatives were also asked about aspects of the organization that could be affected by the implementation of new managerial tools. This is why we call variables deriving from these questions ***"output" variables***. The first group of "output" variables considered come from a series of question about the allocation of responsibilities between management,

production workers and specialists[7] for ten "indirect" tasks on the shop floor that have to do with the preparation of work (sharing work, setting machines), information processing (controlling quality, contributing to performance improvement) and with decision (setting machines, stopping and starting production in case of an hitch). We decided to make up three "primary" variables measuring the size of the responsibility sphere of each worker category in 1997. Management is implicated (**IM**) in more tasks (in the listed range) than production workers (**IPW**) or specialists (**IS**), but the degree of implication of these two latter categories is informative about the decentralization of shop-floor operational decisions and about the role of technical expertise. We think that theses variables could react in response to the use of "manufacturing excellence" practices (quality, just-in-time and employee involvement). As suggested by theories of hierarchy, we also consider that the number of hierarchical layers within the firm (**HL**) is a potential organizational "output" measure of decentralization through "pseudo-market" and "market" devices.

By selecting questions and building up "primary" variables, we tried to manage a rich but not too large information set on organizational change. In the following section, we are going to use this set to describe the main directions of changes adopted by manufacturing firms.

1.3. Intensity and orientation of organizational change

Most of the time, empirical studies in economics concentrate on a small number of quantitative variables: IT investment, R&D expenditures, etc. The difficulty with organization is that it cannot be summarized with one quantitative variable. Rather, a large set of qualitative variables are potential candidates. Most econometric studies relating new organizational practices and performance have focused on a small number of variables in this set, like TQM, job rotation, self-managed teams. Others use "output" indicators like the reduction in the number of hierarchical layers.

We have underlined that this choice was sometimes guided by the will to promote a virtuous organizational model. It some studies, it also derives from narrowly defined sample of firms also visited through field work, where the richness in implemented practices is smaller that in a national survey (Ichniowski, Shaw, Prennushi, 1997). Focusing on one or two practices has another advantage. It makes it easier to discuss results and to test additional relations like interaction terms between practices.

However, if we measure organizational change through a national statistical survey, it does not make sense to focus on one specific practice. On a large sample of firms, all types of firms coexist and some of them have adopted multiple devices. Thus, as all implemented practices may interfere with performance improvement, we must take them all into account. And in this case, we have to face the issue of synthesizing parsimoniously information. In the following, we opted for the use of multiple correspondence analysis. Such a tool is suitable to describe a multi-faceted endogenous shock such as organizational change. In France, it is often used in quantitative sociological research (Kramarz, 1986; Gollac, 1989) and economists sometimes recourse to it to describe firm behavior (Salais, 1992, Greenan, Guellec 1998; Greenan, 2003). This tool may show that the heart of information is embedded in a small number of variables highly correlated with all the others. In this case, it helps choosing these variables. Otherwise, it can be used to build up synthetic indexes that are

[7] The questionnaire gave the following indication: Management (*hiérarchie*) groups all the workers with a formal authority on other workers, production workers (*opérateurs*) are the staff that deal with direct production either in an isolated situation or within teams or groups and specialists (*spécialistes*) are employees with a specific technical knowledge (quality or maintenance for example) and which activity is specialized in this domain.

particularly helpful when the variables of interest are latent, indirectly measurable through a large number of qualitative variables.

We work with the sample of 3,286 manufacturing firms with more than fifteen employees where employees have been randomly selected for the labor force section of the survey. The column "synthetic variables" in Table 2 gives an overall "picture" of the main results of the multiple correspondence analysis. First, we give the interpretation of factor 1, along with the six variables that contribute the most to its inertia. We then give the same information for the three following factors.

The first factor measures the intensity in use of new organizational practices. The three others describe orientations in changes: factors 2 and 3 describe tensions within the model of "manufacturing excellence" and factor 4 gives the intensity in use of "market" and "pseudo market" devices.

Clearly, practices under examination cluster. Firms are first discriminated by the intensity with which they use new organizational practices. This indicates that all types of practices go hand in hand with one another. The result on the clustering of practices was already observed in 1993 (Greenan, 2003). What we find here is in line with the idea that new organizational practices are complementary in the sense that the effectiveness of one practice is enhanced by the implementation of others.

If we look more closely at the contribution of the different items to the inertia of the factor, we find that the item with the strongest contribution corresponds to the less diffused practices for its positive part (5S method or TPM, value analysis, functional analysis or AMDEC method, problem-solving groups) and to the absence of the most diffused practice for its negative part (suppliers have to comply with ISO or other standards). In terms of "output variables", the intensity in use of new organizational practices goes together with a higher number of hierarchical layers, expressing a size effect. We also find a higher involvement of production workers and specialists in "indirect" tasks that make the everyday life of the shop floor. This supports the idea that new organizational practices are correlated with more responsibilities given to bottom line employees. The increased role played by specialists in a position of "experts" is another interesting result, less discussed in the literature on organizational change than the "empowerment" of production workers. It was also found in the 1993 survey.

The model of "manufacturing excellence" suggests that total quality, just-in-time and employee involvement go hand in hand together. Factors 2 and 3 tell us that in practice there are some tensions between these three different orientations of organizational change. More precisely, just-in-time carries a conflicting relation with production work in teams and groups on the one hand (factor 2), with quality management devices on the other hand (factor 3). The just-in-time practice that contributes the most to the first opposition is just-in-time delivery, whereas just-in-time production and delivery is opposed to quality certification practices on the second factor.

"Output" variables allow going a little deeper into the understanding of these tensions. Work in groups or teams, as opposed to just-in-time delivery implies a higher involvement of direct producers in indirect tasks and a lighter presence of management. This confirms the fact that our variables about the sharing of responsibilities on the shop floor react to teamwork practices. When opposed to quality management devices, just-in-time systems are used by firms with a small number of hierarchical layers (zero to two), which are less inclined to outsource tasks and to give a lot of responsibilities to specialists. This type of just-in-time organization has been portrayed by field work studies in sub-contracting firms of the French automobile industry (Gorgeu, Mathieu, 1995). Thus, the tensions registered in factor 3 could

discriminate small sub-contracting firms required to deliver just in time from large industrial firms putting emphasis on quality issues.

The intensity in use of "market" and "pseudo market" devices is a second orientation in organizational change. We have described these practices as contributing to the decentralization of the firm's hierarchical structure. The fact that they cluster on the fourth factor tends to indicate that they belong to the same class of organizational design variables. Like the preceding "manufacturing excellence" orientation, "market" orientation appears partly independent from the intensity of use in organizational practices. Firms with different levels of intensity in use of new organizational practices can experiment tensions within the "manufacturing excellence" model or different levels of intensity in use of within or between firms market transactions.

Moreover, these practices interact strongly with "output" variables, but not with the expected ones. There is no simple correlation between the decentralization of the hierarchical structure and the number of hierarchical layers or the involvement of bottom line workers. However, the intervention spheres of management and of specialists are negatively correlated with "market" and "pseudo market" devices. More decentralization in the hierarchical structure implies a lesser need of management authority and of experts with specialized knowledge.

2. PATTERNS OF WORK ORGANIZATION DESCRIBED BY EMPLOYEES

Until now, we have exploited the same type of information as the one used in most econometric studies about organizational change: information given by a firm's representative speaking in the name of the whole organization. In this section, we are going to cross-check this "firm" level information with information given by randomly selected workers.

2.1. Words of the firm and words of employees

In business surveys, information on organizational change may be influenced by what the respondent thinks a modern corporation should be. This may induce a bias towards a positive correlation between organizational devices, if this picture is one of a firm with the latest managerial tools. This is a major problem in "organizational design" studies that try to measure the complementarities between managerial practices.

But what kind of information can be gathered in a labor force survey? The vocabulary that has been used in the business section of the C.O.I survey can only be understood by a small fraction of the firms' workforce that is part of the managerial staff. The C.O.I. survey option is to ask workers to describe precisely their everyday work, using a very simple and factual vocabulary. While testing different questions on the two types of interlocutors, it appeared that firm representatives could answer more easily questions about organizational changes than questions about the state of organization, while the reverse was true for workers. As a result, most of the questions asked to firms are of a dynamic type ("what has changed between two dates?") whereas most of the questions asked to workers are of static one ("how do you work at the date of the survey?").

Numerous organization studies have pointed out the discrepancy between formal organization and current practices. Firm representatives generally describe formal organization, whereas workers can be asked about what they really do and how they adapt

assignments to the context of their work. Topics like empowerment, worker involvement and greater autonomy on the shop floor cannot only be investigated through what management knows about it. It is even truer for considerations about work rhythm, stress or all type of adjustment costs caused by organizational change. Thus, the interview of employees allows to measure the various dimensions of effort. As a result, crossed interviews of firms and employees allow to go one step further in the understanding and description of interactions between the efforts spent by individual workers and the structure of the organization.

In the C.O.I survey, interviewed workers have been randomly sampled in the staff of interviewed firms from a file of government origin that gave the list of all the workers present in the firms on the 31st of December 1996. Workers have been interviewed about one year later. As a result, the sample we use is representative of 'core' employees with at least one year of seniority within interviewed firms. The labor force survey has been carried out by phone or face to face when the selected person could not be reached by phone. In both cases workers have been interviewed in the context of their leisure time.

We also know that the content of work depends strongly on the job and on the position occupied by the worker in the organization. Answers of all types of workers on organization cannot be treated symmetrically. As we have decided to investigate manufacturing industry, we have also chosen to focus on the answers of the largest categories of employees: blue-collar workers on one hand, technicians and supervisors on the other one. With their one year of seniority, they belong to the "core" of the shop-floor workforce. The sample of the labor force section of the survey includes 2,612 blue collars working in 1,710 firms and 1,162 technicians and supervisors working in 943 firms.

As we have already mentioned it, workers describe how everyday work is carried out within the firm. We kept all the questions that were connected with the selected business survey variables. For example, blue-collar workers are asked if they have to meet precise quantified quality standards like wastage rates or measurable characteristics of the product. We guess that the answer to this question should be connected with the answer of the firm representative about quality registration systems or total quality management practices. Appendix 2 gives the forty-one questions selected from the labor force survey and the weighted percentages of positive answers from the whole samples of interviewed blue collars and technicians and supervisors.

2.2. Flows of information and decisions and production flows

Like with the business section of the survey, we decided to make up a smaller number of "primary" variables, fourteen in total. Most of the questions lead to an answer of a "yes or no" type. By adding up the number of positive answers on precise topics, we are able to build up variables that give an idea of the intensity of various dimensions of effort. The column "primary variables" in Tables 3 (blue collars) and 4 (technicians and supervisors) gives an overall view of the fourteen variables through a list of selected items. It also gives their names as they are going to appear in some further tables and weighted percentages. We distinguish between variables that measure flows of information and decisions and variables that contribute to the description of production flows.

Table 3 : Patterns of Work Organization in 1997:
The Point of View of Blue Collars

Primary variables	Name	%
Flow of information and decisions		
Very intense communication with bosses	**HVCOM**	20
Very intense communication with colleagues	**HHCOM**	13
Very intense communication with other services	**HCOMOS**	11
Very intense communication with outside the firm	**HCOMEX**	7
Regular or permanent contacts with the customer	**HCUS**	4
Attendance to more than one meeting per month	**MEET1M**	26
Very high scope of initiative	**HSCOPE**	17
No propositions for process improvements	**PPIN**	39
Production flows		
Nearly permanent production work within a group	**HPGROU**	28
Prescription of precise quality norms	**QUALY**	48
Product testing	**TESTY**	48
Work rhythm fixed by immediate response to demand	**WRIDEM**	27
No prescribed time weighing on the work rhythm	**NOPRES**	26
Work rhythm fixed by the customer	**WRCUS**	19
Work rhythm fixed by colleagues	**WRCOL**	26
Work rhythm fixed by customers and colleagues	**WRCUCO**	20
No horizontal linkages weighing on the work rhythm	**NOHLIN**	35
Work rhythm fixed by high technical constraints	**WRHTEC**	38
No technical constraint weighing on the work rhythm	**NOTECH**	41

Synthetic variables			
❶		❸	
	❶6+	Pushed by colleagues ⟶	
Intensity of communication	❶3+		❸5-
	❶2+		
	❷6-		
	❷3-		
	❶5+		
	❶4-		
❷		flows	
Intensity of industrial constraints			
	❷4+		
	❶1+		❸1+
	❷5-		
			❸2+
			❸6-
		⟵ pulled by demand	❸4+
			❸3-
	❷2+		
	❷1-		

Source: C.O.I survey, 1997 labour force section, MES-Dares.

Note: This table gives the percentages computed on the sub-sample 2,612 blue-collar workers with at least one year of seniority in a firm with more than fifteen employees that responded to the business section of the C.O.I. survey. ❶5+ in front of "very high scope of initiative" means that this variable contributes positively to factor 1 and that it is the fifth variable contributing the most to its inertia.

Table 4: Patterns of Work Organization in 1997:
The Point of View of Technicians and Supervisors

Primary variables	Name	%	Synthetic variables			
Flow of information and decisions			❶		❷	
Very intense communication with bosses	**HVCOM**	34	**Intensity of communication**	❶6+	**Pushed by colleagues → flows ← pulled by demand**	
Very intense communication with colleagues	**HHCOM**	16		❶4+		
Very low intensity of communication with colleagues	**LHCOM**	13		❶1-		
Very intense communication with other services	**HCOMOS**	27		❶2+		
Very intense communication with outside the firm	**HCOMEX**	30				
Regular or permanent contacts with the customer	**HCUS**	42				❷3+
No contact with the customer	**NCUS**	46				❷1-
Attendance to more than one meeting per month	**MEET1M**	70				
Medium low scope of initiative	**M1SCOPE**	5		❸3+		
No propositions for process improvements	**PPIN**	15		❶3-		
Production flows			❸			
No production work within a group	**NPGROU**	29	**Intensity of technical, time and hierarchical constraints**	❶5-		
Nearly permanent production work within a group	**HPGROU**	12		❸6+		
Prescription of precise quality norms	**QUALY**	47				
Product testing	**TESTY**	60				
Work rhythm fixed by deadlines to meet in 1 hour at most	**WR1HOU**	12				❷4-
Work rhythm fixed by immediate respond to demand	**WRIDEM**	47		❸4+		❷5+
No prescribed time weighing in the work rhythm	**NOPRES**	27		❸2-		
Work rhythm fixed by the customer	**WRCUS**	43				❷6+
Work rhythm fixed by colleagues	**WRCOL**	18				❷2-
No horizontal linkages weighing on the work rhythm	**NOHLIN**	22		❸1-		
Work rhythm fixed by high technical constraints	**WRHTEC**	4		❸5+		

Source: C.O.I survey, 1997 labor force section, MES-Dares.

Note: This table gives the percentages computed on the sub-sample 1,162 technicians and supervisors with at least one year of seniority in a firm with more than fifteen employees that responded to the business section of the C.O.I. survey. ❶5- in front of "no production work within a group" means that this variable contributes negatively to factor 1 and that it is the fifth variable contributing the most to its inertia.

Workers' involvement ***in information processing and decision flows*** is seized through a group of eight "primary" variables. A first set of five variables gives some indications on communication: vertical and horizontal communication (**VCOM** and **HCOM**), communication with other services (**COMOS**), communication with outside the firm (**COMEX**) and contact with the customer (**CUS**). On the shop floor, a majority of blue-collar workers communicate with their boss and their colleagues in one way or in another. Communication with other departments in the firm is rarer: nearly half of blue-collar workers attached to the core of firms' workforce do not discuss, nor are helped, nor exchange indications with other departments. Finally, 80% of blue collars are not involved in information exchanges about their work with persons from outside the firm and 87% are never in direct contact with the customer. This leaves 20% of them involved in such exchanges, 6% of them doing it for multiple purposes and 2% being in constant contact with the customer. As compared with blue collars, technicians and supervisors are involved in more communications, especially with distant interlocutors: colleagues from other services, people outside the firm and customers.

The number of meetings attended per year (**MEET**) measures institutionalized or formal ways to communicate. In a meeting, communication takes place between a group of people whereas the other forms of communication that we mentioned are more bilateral. On the whole, 35% of blue collars and 8% of technicians and supervisors never participate in meetings in the context of their work and respectively 26% and 70% attend one or more meeting per month.

The synthetic variable on the scope of initiative (**SCOPE**) sums up different types of hierarchical constraint. Do supervisors give precise instructions about how to do the work? Is the employee not allowed to modify what he has to do? Does he follow instructions to the letter? Is he frequently checked? When unforeseen contingencies occur, does he call on other people to fix the problem? 23% of blue collars have to comply with three or more of these hierarchical constraints. On the other extreme, 35% of blue-collar workers have some scope to adapt assignments to their need or to define themselves the content of their work. The remaining 42% experiment moderate hierarchical constraint: they have no scope for changing things, but direct supervision is not very strong. Technicians and supervisors have a larger scope of initiative than blue collars: only 7% have to comply with very strong hierarchical constraints and 62% are clearly autonomous in their everyday work.

Employees are also asked if they make propositions for process improvement (**PPIM**) measuring their participation to the building up of a collective knowledge on how to improve processes. 61% of blue-collar workers declare such propositions, which is rather high and 85% of technicians and supervisors.

The description of ***production flows*** relies on six "primary" variables. A first variable tells how much time the employee spends doing production work within a group or collectively (**PGROU**). 45% of interviewed blue collars never work within a group or collectively, but 28% do it all the time. These figures reach respectively 29% and 12% for technicians and supervisor: they are more involved than blue collars into collective production work, but they do it with lower intensity.

Two questions are related to ***quality management*** practices. Does the worker have to follow some precise quality norm (**QUAL**) or to participate in product testing (**TEST**)? 46% of blue collars and 47% of technicians and supervisors are concerned by the former and respectively 48% and 60% by the latter.

A last set of three variables are connected with the ***management of time constraint***. They describe different constraints weighing on the work rhythm. Is work rhythm constrained by

quantitative norms or deadlines (**R**) or by horizontal linkages with his colleagues or with the customer (**RC**)? Or is it constrained by machines or by the design of the work process (**RTEC**)? We consider that all these variables measure some sources of interdependencies between workers in the work done: due to time schedule, production flows, equipment or to the production process itself.

Very tight time constraints are declared by 27% of blue-collar workers and 46% of technicians and supervisors: in this case, work rhythm is defined by an external demand needing an immediate response. This complements information on contacts with customers. If only 4% of blue collars have direct contact with customers, they impose tight work rhythm on about one third of them. These two figures are closer in the case of technicians and supervisors (42% and 47%). Another 47% of blue collars (27% of technicians and supervisors) have production norms or deadlines to meet between one hour and one day. The remaining 26% (27%) work with slack deadlines.

The identity of the person, colleague or customer, who drives horizontally the production flow, gives another information. We have already measured whether the customer was imposing a tight time constraint. But external demand may not always require immediate response. We find that 35% of blue collars and 22% of technicians and supervisors do not have their work rhythm imposed by either customers or colleagues. On the opposite side of the scale, respectively 20% and 17% refer both to the influence of customers and colleagues on their work rhythm. The remaining half is shared between situations where only colleagues are a source of pressure (respectively 26% and 18%) and situations where only customers (respectively 19% and 43%) are so. We can derive a third information on the influence of customers on production work from this variable: it concerns 39% of blue collars and 60% of technicians and supervisors if we take into account both tight and slack pressures on work rhythm.

Technology itself is another, more traditional, source of horizontal pressure on work rhythm. The conveyor belt is the best example. We built a synthetic indicator on technological constraints summing up a variable on rhythm imposed by automatic moving of a product or a part, a variable on rhythm imposed by automatic pace of a machine and a variable on repetitive work. 41% of blue collars are not concerned by those constraints and 38% are concerned by two or all of them. Thus, more traditional ways of constraining direct production work are not out of date in manufacturing as far as blue-collar work is concerned. If technicians and supervisors feel the constraints imposed by customers more strongly than blue collars, 83% of them are able to avoid technical constraints.

2.3. Intensity of communication, intensity of constraints, customers and colleagues

In order to better understand the various dimensions that structure the work and efforts of blue-collar workers and of technicians and supervisors, we use multiple correspondence analysis. Variables built on the answers given by employees are less correlated with one another than firm level variables: to reach a proportion close to 20% of total inertia, three factors have to be considered in the worker level analysis, whereas two were sufficient in the firm level analysis. This happens even though some of the respondents belong to the same firm. If organizational practices cluster, shop-floor job profiles are quite varied. We retain the three first factors of the analyses to describe parsimoniously blue collars' and technicians' and supervisors' work organization. We interpret them as describing the intensity of communication on the shop floor, the intensity of constraints and the opposition between work "pulled" by demand or work "pushed" by colleagues. The columns "synthetic

variables" in Tables 3 and 4 give an overall "picture" of the main results of the multiple correspondence analysis. These two "pictures" are built according to the same principles as in Table 2. We first consider the results obtained with the sample of 2,612 blue-collar workers. Then we outline the differences found in the analysis based on the sample of 1,162 technicians and supervisors.

Vertical, horizontal, within firm, between firm and group communication in meetings comes together on the first factor of the blue collars' multiple correspondence analysis. This is why we interpret it as measuring the ***intensity of communication on the shop floor***. Like new organizational practices, different types of communication cluster. Blue collars are either part of a large communication network where they share information with various interlocutors or they do not discuss at all about their work. But there is one "communication variable" that is excluded from this clustering: regular or permanent contact with the customer. Although it implies communication, it does not favor a very large communication network. One reason could be that blue collars in such situations have jobs where they are more isolated, like in storehouses.

Three other variables have a strong contribution to the first factor without measuring directly communication: scope of initiative, proposition for process improvements and work rhythm fixed by external demand needing an immediate response. The first two variables are directly connected with employee involvement. Workers with low intensity of communication experiment high hierarchical constraints whereas numerous information exchanges are correlated with some scope of initiative. This does not imply that horizontal and vertical communications are substitutes: workers with more initiative also communicate more intensively with their boss. Besides, they are more prone to proposing process improvements whereas workers under tight hierarchical supervision seldom do it. If some blue collars communicate more intensively than others, it seems that it is because they are more autonomous and have to find their own ways when they face problems in the course of production.

The third variable is an indicator of high time pressure weighing on work. We are surprised to find it contributing strongly to the inertia of the first factor. Intense communication and low supervision do not mean no constraints on work. This result tends to indicate that in order to cope with external demand needing immediate response, blue collars need to have the scope to interact directly with those that will help them fulfilling their task. About a third of blue collars work under high time pressure, the analysis shows that these workers have a complex structure of effort where, at the same time, they have to produce intensively to reach tight deadlines and to interact with a large network of contacts. Another consequence is that high hierarchical constraint and high time pressure are antagonistic.

The second factor adds constraints other than high time pressure and hierarchical constraints to the description of blue-collar work organization. These additional constraints can coexist with different levels in intensity of communication. We group them under the heading of ***intensity of industrial constraints***: like different types of communication, high technical constraints (work rhythm fixed by the pace of a machine), medium time pressure (deadlines to meet in one hour at most), quality norms and permanent production work within a group are correlated with one another. Vice versa, some blue collars do not experiment any of those constraints. Workers that have a regular or permanent contact with the customer are more frequently in this situation. The same interpretation as the previous one for this variable holds. These workers are isolated on the shop floor; they do not interact with other workers either through information flows or through production flows.

These results are in line with the ones obtained in a similar analysis using the 1987 TOTTO survey (Greenan, Guellec, 1998). Intensity of communication and intensity of constraints

appeared to be two strong dimensions structuring blue-collar jobs. However hierarchical constraints were correlated with both factors whereas, here, they are clearly isolated from the other types of constraints. This can be interpreted as a piece of evidence showing that constraints tend to shift in time with the diffusion of new organizational practices.

The third factor separates ***jobs that are "pushed" or influenced by colleagues from jobs that are "pulled" by demand or close to the market***. On one side, workers are in contact with the customers or have their work rhythm constrained by them within very tight deadlines, on the other one workers communicate with colleagues or have their work rhythm influenced by immediate dependence on them in the work done.

When production flows are pushed by colleagues and technical constraints are high, then colleagues impose a time constraint on work. If, on the contrary, technical constraints are low, time constraints are also weak and information exchanges are dense between colleagues. The same kind of association is observed with the influence of the market. When production flows are pulled by demand and technical constraints are high, then the customer imposes time pressure on production flows. On the opposite, with low technical constraints the proximity of the market does not mean increased time pressure for the worker, but rather information exchanges and direct contact with the customer.

The dimensions that structure technicians and supervisors work organization are close to the one characterizing blue-collar work, with some small differences. The first factor measures the intensity of communication, the second one the opposition between work "pulled" by demand or work "pushed" by colleagues and the third one, the intensity of technical, hierarchical and time constraints.

If we consider the sample of technicians and supervisors, we observe that different types of communication cluster, participating heavily to the construction of factor 1. We have observed that intense communication was positively correlated with a high scope of initiative and heavy time pressure weighing on the work rhythm of blue collars. This does not hold for technicians and supervisors whose communication intensity is more specifically connected with quality issues and meetings.

This contributes to shape differently the constraints weighing on work. Some blue collars experiment high time pressure, but it is generally associated with low hierarchical constraints and a low or medium level of industrial constraints. On the contrary, all these constraints cluster for technicians and supervisors. We interpret the third factor as the intensity of technical, time and hierarchical constraints whereas we have interpreted the second factor of the blue collars' multiple correspondence analysis as the intensity of industrial constraints.

Finally, for technicians and supervisors like for blue collars, information and production flows can either be "pulled" by demand or "pushed" by colleagues. In the case of blue collars, high information flows with colleagues and customers are associated with low industrial constraints and production flows "pushed" by colleagues and not "pulled" by customers are associated with a low intensity of communication. In the case of technicians and supervisors, things work out differently. Information exchanges with colleagues do not play any role in the shaping of the factor and contacts with the customer are not correlated with the intensity of constraints.

Some further investigations on the two multiple correspondence analyses bring another result to the fore: blue collars, technicians and supervisors cannot develop a high involvement in information processing and decision and have, at the same time, their work rhythm fixed by heavy industrial constraints. There is a kind of physical and/or organizational limit to some patterns of work organization.

3. ORGANIZATIONAL CHANGE AND PRODUCTION JOB CHARACTERISTICS

We have now three pictures. The first one is built on managerial representations and shows patterns of use of new organizational practices in French manufacturing firms. The second and third ones are made out of descriptions given by blue collars, technicians and supervisors of how their day to day work takes place and show patterns of work organization. In this section, we are going to put these pictures together thanks to the matching possibilities between the two sections of the C.O.I. survey which allows us to check whether and how new organizational practices shape the design of production job. This linkage is important both because it defines the size of potential productivity gains and because it is a source of tensions that may impede performance.

We are first going to consider methodological problems raised by the fact of relating firm level information with information given by small samples of workers within firms. Then we are going to relate "primary" variables and finally, we are going to work with "synthetic" variables.

3.1. Methodological issues

The C.O.I. survey took the option to interview small samples of workers within each firm: two workers have been interviewed in firms with less than five hundreds employees, three workers in bigger firms. This choice may appear questionable. It seems difficult to build up serious measures without a large sample of workers within each firm. But this would have been very costly, especially when compared with traditional business survey where the answer of "the firm" is most of the time the answer given by one person allowed to talk in the name of the organization. However, it has been backed up by previous empirical work showing that if workers are randomly selected within the firm and interviewed at home, away from the influence of the context of their work and knowing that the firm ignores their being interviewed, then the answers given by small samples of workers can be usefully included in a model specified at the firm level. In this case, employee-based variables are subject to important errors. But they are sampling errors that can be assessed, as long as there is a large enough sample of firms with two or more employees selected at random. Moreover, results about the significance of coefficients are robust (Mairesse, Greenan, 1999).

We have on one hand firm level variables and on the other one variables built on answers given by small samples of employees (one, two or three whether blue collars or technicians and supervisors) within each firm. Let's consider the following simple regression model specified at the firm level:

$$y_i = \alpha\, x_i^* + \varepsilon_i$$

for i = 1 to N, where i is the subscript for the i th firm in the sample of N firms considered, where y_i is "explained" by x_i^* and α is the parameter of interest. As usual ε_i denotes the disturbance term in the regression, summarizing all sources of "errors", which we assume to be uncorrelated with x_i^*[8]. However, unlike the dependent variable y_i, the explanatory variable x_i^* is not directly observed at the firm level. The "true variable" x_i^* can however be estimated or proxied by the firm level empirical average x_i of an employee survey based variable. To

[8] We also assume that ε is i.i.d., with $E(\varepsilon_i) = 0$ and $Var(\varepsilon_i) = \sigma_\varepsilon$, and we delete the constant in the regression for simplification without real loss of generality.

give an example, x_i^* could be the share of blue collars making propositions for process improvement in firm i and y_i the number of indirect tasks production workers are responsible for according to the declaration of firm representatives.

If n_i employees are surveyed in the i^{th} firm and if h denotes the h^{th} surveyed employee, we have:

$$x_i = \left(\sum_{h=1}^{n_i} x_{ih}\right) / n_i$$

where the variable x_{ih} either directly corresponds to the answer given by the h^{th} surveyed employee in firm i to an appropriate question or is constructed from his or her answers to a relevant set of questions, and where the summation is over all the n_i surveyed employees in firm i[9].

Depending on the number n_i of surveyed employees per firm, the observed x_i is more or less affected by sampling errors, and using it to approximate the "true" x_i^* in the model will cause $\hat{\alpha}$, the ordinary least squares estimator of α, to be more or less severely biased. It is easy to see that we are in a classical case of random errors in variables where we can estimate the error variance and hence compute a consistent corrected least squares estimator.

We compute the correction on the sub-sample with two employees and apply it to the coefficient estimated on the whole sample of employees. If we note σ^2 the sub-sample "within firm" (across employees) variance and $Var(x_i)$ the sub-sample "between firm" variance of the individual employee variable x_{ih}, the corrected least square estimator α is simply given by:

$$\alpha = \hat{\alpha}\left[\frac{1}{1-\frac{\sigma^2}{2\,var(x_i)}}\right]$$

In what follows, we are not going to run regressions. More simply, we are going to compute size (four items) and sector (sixteen items) controlled correlations between firm level variables (y_i) and firm level averages of employee level variables (x_i). We can also compute a corrected correlation coefficient ρ:

$$\rho = \hat{\rho}\left[\frac{1}{\sqrt{1-\frac{\sigma^2}{2\,var(x_i)}}}\right]$$

3.2. Correlations between primary variables

The "primary" variables we used in our multiple correspondence analyses are numerous: we work with fifteen different items at the firm and at the worker level. We choose to focus on

[9] For simplicity and since our model of interest is specified at the firm level, we use the notation x_i rather than the usual notation $x_{i.}$ (where the dot subscript indicates over which index the mean of x_{ih} is computed). Note also that we simply use x_i rather than the more precise x_i or x_i (with the overbar or the overhat reminding that it is an estimate over the random sample of the n_i surveyed employees in firm i).

the items that contribute the most to the inertia of the selected factors. At the firm level, we keep the twenty-two "primary" variables that are displayed in the lines of Table 2. They appear in the columns of Table 5. Panel 1 shows the correlations for the variables measuring practices connected to the model of "manufacturing excellence" and Panel 2 shows variables measuring "pseudo market" and "market" practices and "output" variables. The name given to each firm level variable in Table 5 appears in Table 2, together with its literal explanation. At the employee level, we focus on the fifteen "primary" variables that are common to the analysis of blue-collar (Table 3) and technician and supervisor (Table 4) work organization. The figures displayed in Table 5 are corrected size and sector-controlled correlation coefficients (ρ) between firm level and employee level "primary" variables. They are significant at least at a 10% level. "B" (respectively a "T") in front of a coefficient indicates that it is based on a blue-collar indicator (respectively a technician and supervisor one). Grey areas correspond to line and columns where many coefficients are significant. We are first going to discuss correlations focusing on the description of firm level practices and organizational "output" variables (grey columns), and then we are going to discuss the responsiveness of "primary" variables built from employees point of view to the different firm level indicators of organizational change (grey lines).

The "high performance" practices that are the easier to characterize in terms of shop-floor work organization are ISO certification, value analysis, functional analysis or AMDEC method and Total Productive Maintenance (TQM). ISO certification has some incidence on the whole firm. This might be the reason why it is more easily characterized. The two other groups of practices can be precisely defined and where not frequently used at the time of the survey (26% and 16% of firms respectively) which could explain a higher precision in the firm level response. TQM, JIT and employee involvement practices are more ambiguous, or leading to more diversity in terms of their implication on every day work organization.

In firms that try to manage thoroughly quality issues, technicians and supervisors tend to communicate more intensively with distant interlocutors, but to be less in contact with the customer. Blue collars attend more frequently meeting to which technicians and supervisors also participate and they make propositions for process improvements. In those firms, technicians, supervisors and blue collars have to follow precise quality norms and they participate into product testing.

There is one similarity between quality practices and just-in-time practices: blue collars more often attend meetings and they also comply with quality norms and product testing activities. Management of production flows appears specific in firms using just-in-time practices, but in a surprising way. We expected to find a higher time pressure on work rhythm, driven by customer demand, and we do not find it. Instead of that, we find that blue-collar work is structured by high technical constraints and dependence upon colleagues in the work done. As compared with blue collars, technicians and supervisors are not as involved in information flows and quality issues and they also less often have their work rhythm determined by immediate dependence on colleagues.

Table 5: Firm Representatives and Production Workers: Controlled Correlations on Primary Variables (Panel 1)

B: Blue collars, N_F^B=1,710 T: Technicians and supervisors, N_F^T=943		Quality				Just-in-time				Involvement of employees		
Flow of information and decisions		**ISOY**	**TQMY**	**AMDY**	**SISON**	**DJITY**	**PJITY**	**TPMY**	**SJITN**	**SMTM**	**PSGM**	**PTM**
Very intense communication with bosses	**HVCOM**	T 0.07*		B -0.06*						B 0.06		
Very intense communication with colleagues	**HHCOM**								T 0.09**			
Very intense communication with other services	**HCOMOS**	T 0.05		T 0.07*								
Very intense communication with outside the firm	**HCOMEX**			T 0.07*			B –0.08*					
Regular or permanent contacts with the customer	**HCUS**	T-0.10**			B 0.06* T 0.08**		B –0.05	T –0.07*			T –0.06	
Attendance to more than one meeting per month	**MEET1M**	B 0.07* T 0.07*		B 0.04 T 0.06*	B –0.09** T –0.06	B 0.06*	B 0.09**	B 0.13** T 0.08*	B –0.07*	B 0.08**	B 0.12**	
Propositions for process improvements	**PPIY**	B 0.10**		B 0.07*				B 0.14**		T 0.06	B 0.11**	B 0.07*
Production flows		**ISOY**	**TQMY**	**AMDY**	**SISON**	**DJITY**	**PJITY**	**TPMY**	**SJITN**	**SMTM**	**PSGM**	**PTM**
Nearly permanent production work within a group	**HPGROU**											
Prescription of precise quality norms	**QUALY**	B 0.09** T 0.12**			B –0.07* T –0.07*	B 0.07*		B 0.07* T 0.06	B –0.06		B 0.08**	
Product testing	**TESTY**	B 0.13** T 0.06		B 0.08*		B 0.07*		B 0.10**			B 0.09**	B 0.12**
Work rhythm fixed by immediate response to demand	**WRIDEM**			B 0.11**				T –0.06*				
Work rhythm fixed by the customer	**WRCUS**						B –0.05*					
Work rhythm fixed by colleagues	**WRCOL**					B 0.06 T –0.06	B 0.05 T –0.07*	T –0.07*	T 0.09**	T–0.06*		
No horizontal linkages weighing on the work rhythm	**NOHLIN**			B –0.06				T 0.07*				
Work rhythm fixed by high technical constraints	**WRHTEC**			B 0.09**		B 0.10**	B 0.09**	B 0.08**	B –0.08			

Source: C.O.I survey, 1997 labour force and business sections, MES-Dares, MEFI-Sessi, MAP-Scees.
Note: Displayed coefficients are sector-size controlled (respectively 16 and 4 dummies) correlations between firm level variables built from the answers of firm representatives (column) and firm level variables based on respectively one the frequency of blue collars' (B) and technicians and supervisors' (T) answers within a given firm (lines). These correlations have been corrected for the downward bias resulting from the sampling error in measures built from the answers of employees. **, * and no star respectively indicate that the coefficients are significant at a 1%, 5% and 10% level.

Table 5: Firm Representatives and Production Workers: Controlled Correlations on Primary Variables (Panel 2)

B: Blue collars, N_F^B = 1,710 T: Technicians and supervisors, N_F^T = 943		Decentralization					"Output" variables					
Flow of information and decisions		**OPCY**	**CSCY**	**OUT3M**	**SUBY**	**SDPY**	**HIPW**	**HIS**	**LIM**	**HIM**	**HL0_2**	**HL5_9**
Very intense communication with bosses	**HVCOM**				B 0.07*	B 0.11**						
Very intense communication with colleagues	**HHCOM**								T –0.08**	T 0.06		
Very intense communication with other services	**HCOMOS**						T 0.05		T –0.06	T 0.06		
Very intense communication with outside the firm	**HCOMEX**							T 0.06*				
Regular or permanent contacts with the customer	**HCUS**		B 0.06*			T 0.06			B 0.08**	B –0.06*		
Attendance to more than one meeting per month	**MEET1M**	B 0.08** T 0.06			T 0.09**	B 0.07*	B 0.06*			T 0.05	B –0.05	
Propositions for process improvements	**PPIY**				B –0.05		B 0.09*			T 0.08**	T–0.08**	
Production flows		**OPCY**	**CSCY**	**OUT3M**	**SUBY**	**SDPY**	**HIPW**	**HIS**	**LIM**	**HIM**	**HL0_2**	**HL5_9**
Nearly permanent production work within a group	**HPGROU**							B 0.07*		B 0.05		
Prescription of precise quality norms	**QUALY**			B 0.05	T –0.07*		B 0.07*	B 0.07* T 0.07*	T–0.09**		B –0.06	
Product testing	**TESTY**						B 0.11**	B 0.07*	T –0.07*	T 0.06	T –0.06	B 0.06**
Work rhythm fixed by immediate response to demand	**WRIDEM**				T 0.08**		T–0.10**	T 0.06		T 0.05		B –0.06
Work rhythm fixed by the customer	**WRCUS**	B 0.05		T –0.05	T 0.09**	T 0.07*						
Work rhythm fixed by colleagues	**WRCOL**	T –0.06		B 0.05	B –0.07*				T 0.07*			B 0.07*
No horizontal linkages weighing on the work rhythm	**NOHLIN**				T–0.08**	T –0.06	T 0.08**	T –0.06				
Work rhythm fixed by high technical constraints	**WRHTEC**							B 0.13**		B 0.06		

Source: C.O.I survey, 1997 labour force and business sections, MES-Dares, MEFI-Sessi, MAP-Scees.

Note: Displayed coefficients are sector-size controlled (respectively 16 and 4 dummies) correlations between firm level variables built from the answers of firm representatives (column) and firm level variables based on respectively one the frequency of blue collars' (B) and technicians and supervisors' (T) answers within a given firm (lines). These correlations have been corrected for the downward bias resulting from the sampling error in measures built from the answers of employees. **, * and no star respectively indicate that the coefficients are significant at a 1%, 5% and 10% level.

We cannot really go any deeper into the description of employee involvement practices. We even find no significant correlation between them and the fact that shop-floor workers do production work within a group. The only tangible results concern problem-solving groups: in firms where more than 10% of production workers are involved in such groups, blue collars attend more frequently meetings, they make propositions for process improvements, they participate into product testing and they have to comply with precise quality norms. This result is close to the one found for quality practices.

Like "employee involvement" practices, "pseudo market" and "market" practices, leading to a higher decentralization of the overall organizational structure, have light implications on patterns of work. This is not very surprising, given their aim and nature. The subcontracting of production has the strongest impact and there are some common features between subcontracting and asking suppliers to take part in designing end products: blue collars communicate more intensively with their boss and their work rhythm is more often fixed by the customer. Moreover, in subcontracting firms, blue-collar workers experience high time pressure, they do less propositions for process improvements and technicians and supervisors less often have to follow quality norms. We were expecting that type of work pattern to be associated with just-in-time practices, which is not the case. The decision to subcontract might be connected with some peaks in the activity, explaining why workers are subject to higher time pressure and less work enrichment.

"Output" variables about the implication of production workers, specialists and management in indirect shop-floor tasks are well correlated with worker level variables. This confirms that they complement usefully questions about practices in firm level questionnaires on organizational change. When, according to the firm representative, production workers are implied in more than seven indirect tasks (out of a list on ten tasks), blue-collar workers declare that they attend meetings more frequently, make propositions for process improvements, follow quality norms and participate into product testing. In those firms supervisors and technicians communicate more with other services and experiment less time pressure on their work. When specialists have a high implication, technicians and supervisors more often exchange information with outside the firm, they follow quality norms and work under high time pressure, while blue collars work under high industrial constraints: they spend most of their time doing production work within a group, experiment high technical constraints, have to comply with quality norms and participate into product testing. Finally, when management is highly involved, technicians and supervisors are more deeply involved into information and decision flows, they work under high time pressure and test products, while blue collars seem to be specialized in direct production under high technical constraint.

Taking the point of view of practices, we have found that some of them where more easy to characterize with our worker level variables; that the practices we grouped together in our firm level analysis have common features; and that we could identify some tensions between quality and just-in-time practices, confirming our result based on firm level multiple correspondence analysis. Quality and just-in-time practices do not have the same implications on the work of blue collars, technicians and supervisors. However, the main difference is not in more "work enrichment" *versus* "more time pressure on the work rhythm", but in "more communication", especially for technicians and supervisors *versus* "higher technical constraint" weighing on blue-collar work. The trade-off between "work enrichment" and "time pressure" is more characteristic of subcontracting firms or of firms with one or two hierarchical layers.

We are now going to check whether we can identify a common feature from the point of view of production workers in all the firm level variables that we measure. In other words, are there some worker level variables that are systematically responsive and with the same

type of response to all our firm variables whether built on blue collars or on technicians and supervisors answers?

Four variables are in this case: attendance at more than one meeting per month, propositions for process improvements, quality norms and product testing. Firms that use new organizational practices and where production workers and/or specialists are more involved into shop-floor indirect tasks have blue-collar workers, technicians and supervisors who attend meetings more frequently, who more often make propositions for process improvements and who more frequently follow quality norms and participate into product testing.

However, three exceptions to our main results have to be discussed: firms that subcontract, firms with a low implication of management and firms with one or two hierarchical layers react negatively to our four employee level variables. These firm-level variables define a high intensity in use of "market" and "pseudo-market" devices in our firm level multiple correspondence analysis, an orientation of organizational change that is independent from its intensity and from the tensions within the "high performance" model. The employee level results we find here show that this orientation may correspond to a "low cost road" in organizational changes.

The responsiveness of meetings and propositions for process improvements indicate that a common ingredient to all firm level variables has to do with the production of a collective knowledge on the shop floor allowing continuous improvement of the production process. New organizational practices would build up a new way of rationalizing knowledge making, where all workers are asked to explicitly contribute to technological progress. This is only a possible interpretation of our results. More meetings and more suggestions could also be an indirect measure of the adjustment cost associated with the implementation of new organizational practices. When ways of doing things change in an organization, people have to meet to find agreements and to work out solutions to unforeseen problems. If the first interpretation holds, then the characteristics of production jobs in manufacturing would durably be altered. But if the second interpretation is right, then patterns of work organization could move back to another equilibrium.

The responsiveness of quality norms and product testing tells us that in the nineties, many changes have aimed at improving quality and products. This is even clearer when variables about information technologies are added in the analysis (Gollac, Greenan, Hamon-Cholet, 2000). Throughout the nineties, investments in computers, together with organizational change, have aimed to enhance product quality, increase product differentiation and favor the renewal of products range upon the pressure of market uncertainties and of customer request. Thus, focus on product and quality identifies a dominant orientation in technological and organizational changes starting early in the decade. However, the analysis of the firm level information on short-term evolutions after the 1993 recession could indicate some changes in this orientation at the end of the period: time constraints become more central, together with an expanding use of "market" and "pseudo-"market" devices, backed up by the development of network facilities and upon the pressure of financial restructuring. This may imply that the "low cost road" has become more prevalent, contributing to a deterioration of working conditions.

Finally, two variables are also quite responsive to the use of new organizational practices: regular or permanent contacts with the customer and work rhythm fixed by colleagues rather than customers. But they respond differently depending on practices or on the professional identity of the worker. When manufacturing firms implement practices connected with the "manufacturing excellence" model, blue collars, technicians and supervisors less frequently have regular or permanent contacts with the customer, but they do when firms decentralize

their overall structure. Whatever the type of change implemented by firms, blue collars more often have their work rhythm determined mainly by the immediate dependence on colleagues in the work done (except for sub-contracting), when the reverse is true for technicians and supervisors.

3.3. Correlations between synthetic variables

We are now going to turn to the corrected size sector-controlled correlations between our "synthetic" variables. The firm level "synthetic" variables are simply the coordinates of firms on the four first factors of our firm level multiple correspondence analysis (FF1 to FF4). The employee level "synthetic" variables are the firm level average of the employees' coordinates on the three first factors of our employees' multiple correspondence analyses: one for blue collars (FB1 to FB3) and one for technicians and supervisors (FT1 to FT3).

We apply the same correction on the correlation coefficients as for "primary" variables, based on the sub-sample of firms with two interviewed employees, but we consider two different ways of building worker level "synthetic" variables: running multiple correspondence analysis on the whole sample of employees (MCA1) or running it on the sub-samples of employees affiliated to a firm where two workers of the same type have responded (MCA2). Results are given in Table 6. We first discuss correlations involving the intensity in use of new organizational practices (FF1) and then we turn to the orientation of organizational changes (FF2 to FF3).

We find that firms with an intense use of new organizational practices (FF1) have their blue-collar workers who communicate more intensively (FB1) and who experiment higher industrial constraints (FB2). Thus, intense organizational change is correlated both with higher autonomy or more decentralized information processing and with higher constraints on work due to automated technology, repetitive tasks and quality standards or due to high time pressure generated by an external demand needing immediate response. On the other hand, weak organizational change goes with high hierarchical constraints, and light technical constraint and time pressure. As far as technicians and supervisors are concerned, we also find that the intensity in use of new organizational devices is positively correlated with the intensity of communication (FT1). In firms with intense organizational changes, technicians and supervisors communicate more with distant interlocutors and in the context of meetings and they spend more time dealing with quality issues. In the opposite situation, technicians and supervisors are not involved in information flows and they have a low scope of initiative.

The linkage we find between a high intensity of communication and organizational change confirms what Gant, Ichniowki and Shaw (2002) found in the steel industry. Using a personally collected database on worker interactions and communication patterns in seven steel finishing lines, they show that a move to a high-performance workplace "would involve a disruptive overhaul in the entire network of interactions among all workers at the plant" (p.326).

But the fact that a high level of blue-collar communication is also correlated with heavy time pressure and the correlation between organizational changes and intensity of industrial constraints also shows that as they work smarter, blue collars also work harder, especially in environments with heavy equipment. As a result, the structure of blue-collar effort becomes more complex as they are required to participate intensively both in information and production flows. This is consistent with the idea that reorganizations are a source of work intensification (Gollac, Volkoff, 1996; Green, 2001).

Table 6: Firm Representatives and Production Workers: Regressions on Synthetic Variables

		Intensity in use of new organizational practices (FF1)	Teamwork *versus* just-in-time practices (FF2)	Just-in-time *versus* quality practices (FF3)	Intensity in use of market/pseudo market practices (FF4)
Blue collar workers (MCA1: N^B=2398, N^F=1,710; MCA2: N^B=1252, N^F=626)					
Intensity of communication (FB1)	**MCA1**	0.10**	0.10**		
	MCA2	0.09**			0.08
Intensity of industrial constraints (FB2)	**MCA1**	0.13**			-0.11**
	MCA2	0.18**		0.13*	-0.14**
Flows pulled by demand *versus* pushed by colleagues (FB3)	**MCA1**		-0.06*		
	MCA2		-0.11*		
Technicians and supervisors (MCA1: N^T=1,104, N^F=943; MCA2: N^B=306, N^F=153)					
Intensity of communication (FT1)	**MCA1**	0.11**			-0.16**
	MCA2	0.22*			-0.20*
Intensity of technical, time and hierarchical constraint (FT3)	**MCA1**				
	MCA2				
Flows pulled by demand *versus* pushed by colleagues (FT2)	**MCA1**			0.07	0.08*
	MCA2				

Source: C.O.I survey, 1997 labour force and business sections, MES-Dares, MEFI-Sessi, MAP-Scees.

Note: Displayed coefficients are sector-size controlled correlations (respectively 16 and 4 dummies) computed using synthetic variables stemming from firm-level, blue collar-level and technicians and supervisors level multiple correspondences analyses that ran on the whole sample (MCA1) and on the sample of firms with two responding blue collar workers or technicians and supervisors (MCA2). These correlations have been corrected for the downward bias resulting from the sampling error in measures built from the answers of employees. **, * and no star respectively indicate that the coefficients are significant at a 1%, 5% and 10% level.

Furthermore, we have checked in our sample that patterns of work with simultaneously high communication (and time pressure) and high industrial constraints were exceptional, showing a kind of physical and/or organizational limit to some structures of effort. Thus, firms that implement new organizational practices have to deal with this internal contradiction. The difficulty stressed in the case of blue collars does not hold for technicians and supervisors. New organizational practices increase their communication activity, but do not seem to add more constraints on their work apart from the fact that they are more heavily involved in quality issues.

The orientation of organizational changes also influences the nature of blue-collar job profiles. If we consider tensions within the model of "manufacturing excellence", we observe some significant correlations with the orientation towards just-in-time when it is defined in opposition with teamwork practices (FF2). In this case, just-in-time implies less communication (FB1) while demand pulls information and production flows (FB3). On the opposite, teamwork is associated with more intense blue-collar communication and flows pushed by colleagues rather than by customers. Note that here, the trade-off between communication and work intensity is alleviated because when changes are oriented towards just-in-time, even though customers structure flows, blue collars are not asked to respond immediately to demand and when changes are oriented towards teamwork, even though communication is high, time and technical constraints remain intermediate and are mitigated by colleagues.

Finally, the orientation of organizational changes towards "market" and "pseudo-market" devices (FF4) is negatively correlated with the intensity of industrial constraints weighing on blue-collar work (FB2) and with the intensity of technicians and supervisors' communication (FT1). For the latter, it is positively correlated with information and production flows pulled by demand (FT2). In a way, firms that choose to use intensively internal and external market transactions tend to "export" their industrial constraints. This type of environment seems harder on technicians and supervisors work because they have to deal with stronger customer pressure while participating into a smaller communication network, implying less autonomy and fewer sources of help.

CONCLUSION

In this paper, we had two main aims: discuss new ways of measuring organizational change, allowing for diversity in its orientation and analyze empirically how new organizational practices have been shaping production jobs in French manufacturing firms throughout the nineties.

Methodologically, we have underlined the advantages of matched employer/employee surveys of organizational change. From a statistical point of view, samples of interviewed employees within firms do not need to be large which allows mitigating the cost of such an operation. The central criterion for a high quality survey is the random selection of employees. It is also important to be able to conduct interviews outside the context of the firm. These two conditions are fulfilled in the C.O.I. survey. We also show that it is important to work with a large pool of questions and variables. Questions about the use of specific managerial tools work well and have the advantage of being asked in many surveys. But some tools are more precisely perceived by firm representatives than others: there is more diversity between firms that declare using just-in-time practices or teamwork than between firms who declare being ISO certified. Moreover, firm representatives may be tempted to declare the use of more tools than they effectively do if they feel that "modernity" or "being in the fashion" is important. Other firm level questions may be usefully designed like our questions on organizational "outputs". In all cases, the employee level questionnaire is a very interesting complement to the firm level questionnaire. Finally, we show that multiple correspondence analysis is useful to synthesize information. This is because "organizational change" is a latent variable that cannot be described by a unique "primary" variable. Each "primary" variable that can possibly be used is too imprecise to grasp the essence of organizational change. Multiple correspondence analysis, which takes into account the information embedded in large sets of variables allows to built indicators which are more precise and which take diversity into account. Two "primary" variables could however be second bests. The number of new organizational devices used or implemented by the firm is not too bad because practices tend to cluster. It can be built from firm level questionnaires. From labor force surveys, the number of meetings attended to in a week, a month or a year is also a good variable.

Our empirical study leads to many results. First, if we focus on results stemming from the business section of our survey, we find that the first dimension of organizational change in French manufacturing is its intensity and this because, as we have already underlined it, new organizational practices tend to cluster. But we also find two different and independent types of orientations in organizational changes: one of them is towards the implementation of the model of "manufacturing excellence", the other one is towards a more extensive use of internal and external market transactions. Within the model of "manufacturing excellence",

there are tensions between the management of quality issues and the management of time constraints.

Second, the intensity of communication, the intensity of constraints and the fact that information and production flows are "pulled" by demand or "pushed" by colleagues are discriminatory features of blue collars' as well as technicians and supervisors' work organization patterns. Differences between blue collars and technicians and supervisors lie in the structure of constraints. High time pressure comes with high intensity of communication and scope of initiative in blue-collar work and it is independent from industrial constraints that group moderate time pressure, technical constraints and quality standards. High time pressure, technical and hierarchical constraints come together in the work of technicians and supervisors while quality standards are correlated with the intensity of communication. We also find that shop-floor workers cannot develop a high involvement in information processing and decision and have at the same time their work rhythm fixed by heavy industrial constraints. There is a kind of physical and/or organizational limit to some structures of effort.

Third, when we confront firm level measure with employee level measures, we find that the common ingredient to new organizational practices is the production of a collective knowledge on the shop floor allowing continuous improvement of the production process. In other words, organizational changes would drive a new way of rationalizing knowledge making where all workers are asked to explicitly contribute to technological progress. This result is in line with theoretical models that focus on decentralization of operational decisions. But, it also stresses another important dimension of changes, not always present in theoretical models: the fact that workers are more dependent on one another in the work done. They have to communicate, exchange ideas, meet together, and help one another.

However, further results tend to suggest that the core of organizational changes in the nineties has changed direction after the 1993 recession, with some implications on the characteristics of production jobs. Firms which use of new organizational practices results from choices taken in the beginning of the nineties seem to search a way of better mastering quality issues rather than a way to give a quicker response to market demand. We show that tensions within this strategy could drive a phenomenon of blue-collar work intensification. After the recession, it seems that more manufacturing firms have chosen to develop strategies based on the extension of internal and external market transactions and on quicker response to demand pressure. If this is confirmed, it could lead to a situation with more pressure and tensions weighing on the work of technicians and supervisors while the "enrichment" of blue-collar work would slow down.

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Appendix 1

THE BUSINESS SECTION OF THE COI SURVEY: FROM THE QUESTIONS TO SYNTHETIC INDICATORS

1. Selected questions from the COI questionnaire

We selected seven sets of questions that follow each other in the COI questionnaire (118 questions in total, 61 questions for 1997). We give the corresponding questions, keeping the same presentation as in the questionnaire except that we have replaced the original numbers given to the questions (3.1 to 3.15, 4.1 to 4.8, 5.1 to 5.3, 6.1 to 6.10, 7, 10.1 to 10.3 and 14.8) by names (in between brackets and in capital letters) corresponding to those that we use in the tables and figures.

For each set of questions, we give the percentages of manufacturing firms (excluding energy and food industries) with more than fifteen employees that ticked each cell computed from the sample of respondents (3,286 firms) and using weights to adjust for sampling rates and non response. Frequency counts from the business part of the COI survey are published in Favre, François and Greenan (1998). The whole questionnaire and some descriptive results have been translated in English. They are available upon request.

3. Does your company outsource any of the following tasks? (OUT)	**In 1997**		**Change since 1994**		
	Yes	**No**	**+**	**=**	**-**
Research/development/design	28	72	12	86	2
Purchasing	8	92	2	97	1
Production engineering/production management/scheduling	5	95	2	97	1
Manufacturing/production	10	91	4	94	1
Quality assurance	14	86	8	91	1
Maintenance	23	77	8	91	1
Sales	10	90	4	95	1
Marketing/advertising	24	76	8	90	2
IT	40	60	17	80	3
Telephony/networks	17	83	9	90	1
Human resources/staff training	20	80	7	91	2
Accounting/management control	17	83	4	95	1
Finance/cash management	11	89	2	96	2
Legal affairs	49	51	13	85	2
Environment/health and safety	16	84	7	92	1

4. Does your company use the following organizational device?		**In 1997**		**Change in the % of employees affected since 1994**		
		Yes	**No**	**+**	**=**	**-**
(ISO)	**ISO 9001, ISO 9002, EAQF certification**	49	51	30	69	1
(TQM)	**Other certification or total quality management**	35	65	20	80	0
(AMD)	**Value analysis, functional analysis or "AMDEC" method**	26	74	13	87	0
(TPM)	**5S method or TPM (Total Productive Maintenance)**	16	84	9	90	1
(OPC)	**Organization in profit centers**	31	69	10	89	1
(CSC)	**Formal in-house customer/supplier contracts**	29	71	13	87	0
(DJIT)	**System of just-in-time delivery**	39	61	19	81	0
(PJIT)	**System of just-in-time production**	38	62	18	82	0

5. In 1997, what percentage of company employees took part in the following types of teams or groups of…?		**Production workers**			**Other workers**		
		0%-10%	**10%-50%**	**50% +**	**0%-10%**	**10%-50%**	**50 % +**
(SMT)	**Self managed teams**	69	20	11	71	22	7
(PSG)	**Problem solving groups**	72	25	3	66	28	6
(PT)	**Project teams**	81	17	2	67	28	5

6. In general, who is/was authorized to do the following in your company workshops? (more than one answer possible)	**In 1997**			**In 1994**		
	Management **(MAN)**	Production worker **(PW)**	Specialist **(SPE)**	Management **(MAN)**	Production worker **(PW)**	Specialist **(SPE)**
Adjust installations	23	57	50	24	49	51
Perform 1st level maintenance	11	64	42	13	51	49
Allocate tasks to production workers	15	10	8	85	7	7
Inspect quality of supplies	39	37	42	40	32	40
Inspect quality of production	48	52	40	51	41	41
Participate in performance improvements	79	54	37	81	40	33
Participate in projects teams	71	39	37	71	29	33
Stop production in case of an incident	73	46	26	75	38	24
Troubleshoot in case of an incident	55	46	42	58	37	41
Start production again in case of an incident	75	25	28	77	20	25

7. How many hierarchical layers are/were there between production workers (level 0) and the head of the company (level N)? (HL) and (EVHL)			
In 1997, N =1	7	**In 1994, N =1**	8
N=2	20	**N=2**	18
N=3	30	**N=3**	29
N=4	25	**N=4**	24
N=5	12	**N=5**	13
N=6 and +	6	**N=6 and +**	8

10. Did your company ask suppliers or subcontractors to do any of the following in 1997?		**Yes**	**No**
(SDP)	**...take part in designing end-products**	42	58
(SJIT)	**...make just-in-time deliveries**	51	49
(SISO)	**...comply with ISO standards or other formal quality approaches**	66	34

14. Does your company use any of the following means to adjust output to demand?		In 1997		Change since 1994		
		Yes	No	+	=	-
(SUB)	Subcontracting	54	46	19	75	6

2. From questions to variables about organization

Using the answers to the sixty-one questions about the situation in 1997, we built up twenty qualitative variables describing the state of the organization (fifty items or modalities in total).

With the first set of question, we built an indicator of the number of tasks outsourced (**OUT**), taking four modalities, **OUT0** for no function, **OUT1_2** for one or two functions, **OUT3_5** for three to five functions and **OUT6_15** for six to fifteen functions.

The second set of questions identifies firms that are using new organizational tool (noted **ISO, TQM, AMD, TPM, OPC, CSC, DJIT** and **PJIT**) in 1997. We built up a set of eight variables indicating, whether the firm is using (**Y**) or not (**N**) a special organizational tool.

From the third set of questions, we built three dichotomous variables, using the answers given about the participation of production workers to teams or groups (SMT, PSG or PT). They indicate weather more (M) or less (L) than 10% of the production workers participate in the group in 1997.

Three variables have been constructed from the fourth set of questions, which is very rich in terms of information, describing the number of tasks (in the list of ten tasks given by the questionnaire) each type of worker is responsible for in 1997. Each variable takes four modalities depending on its distribution: from zero to three tasks, four or five tasks, six or seven tasks and from eight to ten tasks for the hierarchy (noted LIM, M1IM, M2IM and HIM); from zero to two tasks, three or four tasks, five or six tasks and from seven to ten tasks for production workers (noted LIPW, M1IPW, M2IPW and HIPW); zero or one task, two or three tasks, from four to six tasks and from seven to ten tasks for specialists (noted LIS, M1IS, M2IS and HIS).

A variable gives the number of hierarchical layers in 1997 (**HL**), grouped in four items: zero to two noted **HL0_2**, three noted **HL3**, four noted **HL4** and five and more noted **HL5_9**.

The sixth set of questions gives some further information about the requirements of the firm towards its suppliers and sub-contractors. Three variables have been built from it (noted **SDP**, **SJIT** and **SISO**), indicating whether the firm requires (**Y**) or not (**N**) each of the devices.

The last question used is about subcontracting of production. It has been isolated from the set it belongs to, dedicated to the issue of quantitative flexibility. A variable has been built from it: **SUB** indicating whether the firm subcontracts (**Y**) or not (**N**).

3. Building up synthetic indicators with multiple correspondence analysis

We conducted a multiple correspondence analysis with these variables: **OUT0**, **OUT1_2**, **OUT3_5**, **OUT6_15**, **ISOY**, **ISON**, **TQMY**, **TQMN**, **AMDY**, **AMDN**, **TPMY**, **TPMN**, **OPCY**, **OPCN**, **CSCY**, **CSCN**, **DJITY**, **DJITN**, **PJITY**, **PJITN**, **SMTL**, **SMTM**, **PSGL**,

PSGM, **PTL**, **PTM**, **LIM**, **M1IM**, **M2IM**, **HIM**, **LIPW**, **M1IPW**, **M2IPW**, **HIPW**, **LIS**, **M1IS**, **M2IS**, **HIS**, **HL0_2**, **HL3**, **HL4**, **HL5_9**, **SDPY**, **SDPN**, **SJITY**, **SJITN**, **SISOY**, **SISON**, **SUBY**, **SUBN**. We use the four first factors as synthetic indicators of the use of new organizational devices in 1997. The following table describes the factors, in terms of interpretation and quality.

Correspondence analysis, levels in 1997 20 variables, 50 items, N^F=3,286	**Singular value**	**% of inertia explained by the factor**
Factor 1: intensity in use of organizational practices	0.46	14
Factor 2: use of teamwork *versus* just-in-time practices	0.29	5
Factor 3: use of just in time *versus* quality devices practices	0.28	5
Factor 4: increase in use of market/pseudo market practices	0.25	4

Appendix 2

THE LABOR FORCE SECTION OF THE COI SURVEY: FROM THE QUESTIONS TO THE SYNTHETIC VARIABLES

1. Selected questions from the COI questionnaire

First, we give all the "primary" questions from the labor force questionnaire that we used for the purpose of this study (forty-one questions in total). They are grouped together according to the different topics we want to measure. Thus, we do not follow the order of the questionnaire, but all the questions starting with the same letter come together in the questionnaire.

In capital letters we give the names of the synthetic variables that are reported in tables and figures and the corresponding number of items. Most of the variables lead to a "yes/no" type of answer. When it is different, we mention it and "if it applies" indicates that there is also an item "does not apply". In between brackets, we give the percentages of blue collars (respectively technicians and supervisors) belonging to manufacturing firms with more than fifteen employees that gave a positive answer, using weights to adjust for sampling rates and non response (sample of 2,612 blue collars and 1,162 technicians and supervisors).

1. Intensity of vertical communication (VCOM, five items)

(a) Do you have occasion to modify the nature and quantity of the work which you will have to do, or the manner of proceeding? If yes, is it…

(a_1) while discussing with your superiors alone (if it applies)? (29%, 53%)

(a_2) while discussing with your superiors in the presence of your colleagues (if it applies)? (25%, 34%)

(b) If you have a temporary excess workload or if you are uneasy with a difficult or tricky task are you helped by…

(b_1) your superiors? (if it applies) (44%, 59%)

(c) In general, does your superior intervene…

(c_1) to show you how to do the work? (32%, 27%)

(c_2) to share the work between you and your colleagues? (if it applies) (63%, 51%)

(c_3) when you have a problem with a customer? (if it applies) (9%, 41%)

(c_4) when you have a technical problem? (if it applies) (74%, 49%)

(c_5) when you have relations problem with colleagues from the same department? (if it applies) (57%, 58%)

(c_6) when you have relations problem with other departments (if it applies) (50%, 70%)

2. Intensity of horizontal communication (HCOM, four items)

(a) Do you have occasion to modify the nature and quantity of the work which you will have to do, or the manner of proceeding? If yes, is it…

(a_3) while discussing between colleagues, without your superiors being present (if it applies)? (24%, 34%)

(b) If you have a temporary excess workload or if you are uneasy with a difficult or tricky task are you helped by…

(b_2) colleagues you usually work with? (if it applies) (79%, 72%)

(d) Do you give indications to other persons on what they have to do…

(d_1) to colleagues you usually work with? (if it applies) (67%, 86%)

(**e)** Apart from your superiors, are there other persons that give you indications on what you have to do:

(e_1) colleagues you usually work with? (if it applies) (52%, 62%)

3. Intensity of communication with other departments (COMOS, four items)

(a) Do you have occasion to modify the nature and quantity of the work which you will have to do, or the manner of proceeding? If yes, is it…

(a_4) while discussing with colleagues from other departments? (if it applies) (6%, 23%)

(b) If you have a temporary excess workload or if you are uneasy with a difficult or tricky task are you helped by…

(b_3) persons in the firm other than the colleagues you usually work with? (if it applies) (20%, 33%)

(d) Do you give indications to other persons on what they have to do…

(d_2) other persons or departments in the firm? (if it applies) (30%, 69%)

(e) Apart from your superiors, are there other persons that give you indications on what you have to do…

(e_2) other persons or departments in the firm? (if it applies) (35%, 59%)

4. Intensity communication with outside the firm (COMEX, four items)

(b) If you have a temporary excess workload or if you are uneasy with a difficult or tricky task are you helped by…

(b_4) persons from outside the firm? (if it applies) (10%, 24%)

(d) Do you give indications to other persons on what they have to do…

(d_3) persons from outside the firm (customers, suppliers, order-givers…)? (11%, 48%)

(e) Apart from your superiors, are there other persons that give you indications on what you have to do…

(e_3) persons from outside the firm (customers, suppliers, order-givers…)? (9%, 25%)

5. Intensity of contact with the customer (CUS, four items)

(m) Are you in direct contact (face to face or by phone) with customers? All the time (1%, 27%), regularly (3%, 15%), occasionally (8%, 12%) or never (87%, 46%).

6. Number of meetings per year (MEET, five items)

(f) How frequently do you participate into meetings in the context of your work? (at least once a year: 65%, 92%)

7. Scope of initiative left by hierarchy (SCOPE, five items)

(a) Do you have occasion to modify the nature and quantity of the work which you will have to do, or the manner of proceeding? (44%, 69%)

(g) Instructions given by your superiors in the company tell you what must be done. In general do they also tell you how to do the work? (34%, 15%) or do they tell you the objective of your work, but leave you to decide how to achieve this objective? (66%, 85%)

(h) You receive orders, assignments, instructions. In order to perform your work correctly, which of the following applies (if it applies)? You carry the assignments to the letter (64%, 55%). In certain cases, you act differently (31%, 33%). You act differently most of the time (2%, 4%).

(i) In general, when in the course of your work, something unforeseen occurs, what happens? You fix the problem on your own (41%, 69%). You manage it with the colleagues around you (23%, 22%). You call on other people (a superior, a colleague, a specialist department) (36%, 9%).

(j) Is your work rhythm imposed by the following…

(j_1) Permanent (or at least daily) checks or supervision by the hierarchy? (41%, 31%)

8. Propositions for process improvement (PPI, two items)

(k) In the context of your work, do you make propositions in order to improve your post, processes or equipment? (61%, 85%)

9. Intensity of production work within a group (PGROU, four items)

(l) Do you sometimes do your work in group or collectively? (56%, 71%)

(l_1) If yes, how much of your working time does it take? Almost all the time (28%, 12%), more than ¼ of your time (10%, 27%), less than ¼ of your time (17%, 32%).

10. Work rhythm fixed by prescribed times (WR, four items)

(j) Is your work rhythm imposed by the following…

(j_2) Production norms or deadlines to meet in an hour at most? (36%, 20%)

(j_3) Production norms or deadlines to meet in a day at most? (63%, 43%)

(j_4) External demand (customers) needing an immediate response? (27%, 49%)

(j_6) Immediate dependence of one or more colleagues in the work done? (46%, 35%)

11. Work rhythm fixed by horizontal linkages (WRC, four items)

(j) Is your work rhythm imposed by the following…

(j_4) External demand (customers) needing an immediate response? (27%, 49%)

(j_5) External demand (customers) not needing an immediate response? (29%, 53%)

(j_6) Immediate dependence of one or more colleagues in the work done? (46%, 35%)

12. Work rhythm fixed by technical constraints (WRTEC, three items))

(j) Is your work rhythm imposed by the following…

(j_7) Automatic moving of a product or a part? (39%, 10%)

(j_8) Automatic pace of a machine (49%, 7%)

(n) Do your work consist in continually repeating the same series of actions or operations?

(n_1) If yes, does each series last for less than a minute? (22%, 4%)

13. Precise quality norms prescribed (QUAL, two items)

(o) Do you personally have to meet precise quantified quality standards (for example: wastage rates, measurable characteristics of the product)? (48%, 47%)

14. Participation in product testing (TEST, two items)

(p) In the context of your work, do you sometimes get to test the quality of products or try them? (48%, 60%)

2. From questions to variables describing work organization

The preceding questions are used to build up fourteen qualitative variables (fifteen items or modalities in total). We explain how the variables are built from the questions keeping in line with the notations in the previous section. In between brackets, we give the percentage of blue collar workers from manufacturing firms with more than fifteen employees in each category, using weights to adjust for sampling rates and non response (sample of 2,612 blue collars).

1. Intensity of vertical communication (VCOM, five items)

With **(c)**, a synthetic variable, taking its values between zero and one indicates the size of the intervention sphere of the superiors:

ISPHERE = (number of answers "yes" at questions c_1 to c_6)/(1+number of questions that apply)

The intensity of vertical communication is measured by the following variable:

VCOM=[ISPHERE+(a_1=yes)+(a_2=yes)+(b_1=yes)]/(1+ number of questions that apply)

From which a variable with fivz items, is constructed: **LVCOM**=(VCOM≤0.125), **M1VCOM**=(0.125<VCOM≤0.25), **M2VCOM**=(0.25<VCOM≤0.4375), **M3VCOM**=(0.4375<VCOM≤0.625), **HVCOM**=(VCOM>0.625)

2. Intensity of horizontal communication (HCOM, four items)

The intensity of horizontal communication is measured by the following variable (varying from zero to one): HCOM=(number of answers "yes" to questions a_3, b_2, d_1 and e_1)/(number of questions that apply)

From which a variable taking four items is constructed: **LHCOM**=(HCOM≤0.25), **M1HCOM**=(0.25<HCOM≤0.67), **M2HCOM**=(HCOM=0.751), **HHCOM**=(HCOM=1)

3. Intensity of communication with other departments (COMOS, four items)

The intensity of communication with other departments is measured by the following variable (varying from zero to one):

COMOS=(number of answers "yes" to questions a_4, b_3, d_2 and e_2)/(number of questions that apply)

From which a variable taking four items is constructed: **LCOMOS**=(COMOS=0), **M1COMOS**=(COMOS=0.25), **M2COMOS**=(0.25<COMOS<0,75), **HCOMOS**=(COMOS≥0.75)

4. Intensity of communication with outside the firm (COMEX, four items)

The intensity of communication with outside the firm is measured by the following variable (varying from zero to one):

COMEX=(number of answers "yes" to questions b_4, d_3 and e_3)/(number of questions that apply)

From which a variable taking three items is constructed: **LCOMEX**=(COMEX=0), **MCOMEX**=(0<COMEX≤0.5), **HCOMEX**=(0.5<COMEX<1)

5. Intensity of contact with the customer (CUS, two items)

A variable with three items is built from the answers to question I: **NCUS**=((m)=never)), **OCUS**=((m)=occasionally, **HCUS**=((m)=regularly or all the time)

6. Number of meetings per year (MEET, five items)

A variable measuring the number of meetings per year with five items is constructed from this question:

MEET0=((f)=0), **MEET1**=((f)=1 or 2), **MEET2**=(3≤(f)≤10),

MEET3=(11≤(f)≤16), **MEET4**=((f)≥17)

7. Scope of initiative left by hierarchy (SCOPE, five items)

To compute the scope of initiative left by the hierarchy, we codify the answers with –1 if the worker has no scope of initiative, 0.5 if the scope of initiative is bounded and 1 if it is unbounded. A missing response or a response "does not apply" is coded with a 0. The overall scope of initiative is thus given by: SCOPI=(a)+(g)+(h)+(i)+(j), which varies between –5 and 4. From this variable, we build a variable with five items: **LSCOPE**=(SCOPI≤-3),

M1SCOPE=(-3<SCOPI≤-1), **M2SCOPE**=(-1<SCOPI≤0.5), **M3SCOPE**=(0.5<SCOPI≤2), **HSCOPE**=(SCOPI>2)

8. Propositions for process improvement (PPIM, two items)

A variable with two items has been constructed: **PPIY**=((k)=yes) and **PPIN**=((k)=no).

9. Intensity of production work within a group (PGROU, four items)

A variable with four items is built from the answers to questions I and I_1: **NPGROU**=((I)=no), **LPGROU**=((I)=yes and (I_1)=less than ¼), **MPGROU**=((I)=yes and (I_1)=more than 1/4), **HPGROU**=((I)=yes and (I_1)=almost all the time).

10. Work rhythm fixed by prescribed times (WR, four items)

A variable with four items has been computed to measure the tightness of quantitative norms and deadlines:

NOPRES=(negative answers to j_2, j_3 and j_4), **WR1DAY**=((j_3)=yes and (j_2)=no and (j_4)=no), **WR1HOU**=((j_2)=yes and (j_4)=no), **WRIDEM**=((j_4)=yes).

11. Work rhythm fixed by horizontal linkages (RC, four items)

A variable with four items measures if work rhythm is fixed by horizontal linkages:

NOHLIN=(negative answers to j_4, j_5 and j_6), **WRCUS**=((j_4)=yes or (j_5)=yes and (j_6)=no), **WRCOL**=((j_6)=yes and (j_4)=no and (j_5)=no), **WRCUCO=**((j_4)=yes or (j_5)=yes and j_6=yes).

12. Work rhythm fixed by technical constraints (WRTEC, three items)

A variable with three items measures the intensity of technical constraints: **NOTEC**=(negative answers to j_7, j_8 and n_1), **WRMTEC**=(one positive answer), **WRHTEC**=(more than one positive answers).

13. Precise quality norms prescribed (QUAL, two items)

A variable with two items has been constructed: **QUALY**=((o)=yes) and **QUALN**=((o)=no).

14. Participation in product testing (TEST, two items)

A variable with two items has been constructed: **TESTY**=((p)=yes) and **TESTN**=((p)=no).

3. Building up synthetic indicators with multiple correspondence analysis

We conducted a multiple correspondence analysis involving the preceding variables: **LVCOM, M1VCOM, M2VCOM, M3VCOM, HVCOM, LHCOM, M1HCOM, M2HCOM, HHCOM, LCOMOS, M1COMOS, M2COMOS, HCOMOS, LCOMEX, MCOMEX, HCOMEX, NCUS, OCUS, HCUS, MEET0, MEET1, MEET2, MEET3, MEET4, LSCOPE, M1SCOPE, M2SCOPE, M3SCOPE, HSCOPE, PPIY, PPIN, NPGROU, LPGROU, MPGROU, HPGROU, NOPRES, RW1DAY, RW1HOU, WRIDEM, NOHLIN, WRCUS, WRCOL, WRCUCO, NOTEC, WRMTEC, WRHTEC,**

QUALY, QUALN, TESTY, TESTN. We use the three first factors as synthetic indicators of the organization of blue collars work on one hand, technicians and supervisors work on the other hand. The following table describes the factors, in terms of interpretation and quality.

Correspondence analysis, blue collars 41 questions, 14 variables, 50 items, N^B=2,612	**Singular value**	**% of inertia explained by the factor**
Factor 1: intensity of communication	0.47	9
Factor 2: intensity of industrial constraints	0.37	5
Factor 3: customers *versus* colleagues	0.33	4
Correspondence analysis, technicians and supervisors 41 questions, 14 variables, 50 items, N^T= 1,162	**Singular value**	**% of inertia explained by the factor**
Factor 1: intensity of communication	0.45	8
Factor 2: customers *versus* colleagues	0.41	7
Factor 3: intensity of technical, time and hierarchical constraints	0.35	5

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