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From means to ends: The transformation of ERP in a manufacturing company

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Abstract

In this paper, we present a case study of the restructuring of an Enterprise Resource Planning (ERP) system within a manufacturing company, in particular the combination of Material Requirement Planning (MRP) with a Just In Time (JIT) material management procedure at the assembly lines. We focus in this study upon the mutual shaping of technology and organizational culture, in particular the virtualization of the organization. It is argued that the implementation of ERP in this specific context was more than an adaptation of a standardized information system relative to organizational requirements, and that the organizational adaptations were more than a re-engineering of business processes relative to ERP. Instead, we suggest that in this case the ERP system itself has been transformed, including a change in the signification of ERP within the company.

Keywords: ERP; MRP; Organizational culture; Sense-making; Management; Information technology; Virtual Organization; Case study

1. Introduction

During the 1990s, the market for standardized ERP systems grew enormously. Many organizations have implemented ERP, in most cases with the aid of specialized business consultants. ERP systems reflect a new phase in the informatization of organizations, integrating various business processes within and between organizations. With this

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organizations usually seek to improve management control over complex business processes, an increasing efficiency and effectiveness and a reduction of production and transaction costs (Davenport, 1998; Dong, 2001; Holland and Light, 2001). In this respect, ERP was advocated and welcomed as highly promising. However, after this initial and very promising phase, since the end of the 1990s the enthusiasm over ERP was seriously tempered, due to the substantial exceeding of time-and money budgets, technical failures, the loss of control over business processes and organizational side effects (Hanseth et al., 2001; Trott and Hoecht, 2004). Instead of a highly promising technology, ERP appears to be a highly demanding technology. Problems associated with ERP are, at least in part, attributed to an underestimation of the social and cultural side of ERP (Alvarez and Urla, 2002; Fui-Hoon Nah et al., 2001; Kawalek and Wood-Harper, 2002; Soh et al., 2002).

In this paper, we focus upon the mutual shaping of ERP and organizational culture in the case of a complex B2B (business-to-business) vehicle manufacturing company.[2] We address, in particular, the quite dramatic management decision, made in early 2001, to exclude the entire Material Requirement Planning (MRP) module from the ERP system, and the impact the new Just In Time (JIT) management procedures had on the working routines of the teams operating at the assembly lines. This remarkable development indicated a serious misfit between the organization and its Enterprise System and suggests that the role of technology can be inverted from leading to following organizational change.

First, we sketch the theoretical background to this case study. In this part of the paper, we will address the interplay of organizational culture with ERP as a process of sensemaking. We further specify this process of sensemaking in reference to the virtualization of the organization driven by ERP. In our focus upon the mutual shaping of technology and organizational culture, we combine a body of literature referring to the 'Social Shaping of Technology' (MacKenzie and Wajcman, 1999; Orlikowski, 2000) with theories of organizational culture (Alvesson, 2002; Czarniawska, 1998; Martin, 2002; Weick, 1995).

In the second part, we move to the organizational context of the manufacturing company and the management of the organizational changes following the decision to work around MRP. After that we analyse the implications for the teams working at the assembly lines. In the conclusion of this paper, we discuss (in line with our theoretical framework) how in this case the transformation of ERP can be seen as process of sensemaking and how it added up to a virtualization of the organization. We will argue why the process in which the ERP system was amended entailed in our view a serious transformation in the signification of the ERP system itself.

2. A cultural approach to ERP

In an earlier discussion of the literature on ERP, we started from the observation that ERP-systems are not easy to define, certainly not if we want to take the actors point of

[2] The firm has been anonymized but it could for example manufacture aircraft, military vehicles, fire wagons, trains and the like.

view seriously (Boersma and Kingma, 2005). ERP-systems are complex and dispersed within and between organizations, affecting many if not all organizational domains. In a sense these systems are elusive; they are in constant flux and to be found everywhere (a little bit) and nowhere (entirely). Those involved in the (re)production of ERP will, dependent upon their position in the organization, have quite different views of and experiences with ERP. Individual or group definitions of ERP will vary according to their 'awareness context' (Glaser and Strauss, 1964).

The present case study deals with the organizational dimension of cultural analysis. The basic question relates to how organizations are themselves transformed through the development of ERP systems. Within the history of ICT systems, ERP is generally considered and defined on the basis of its capacity to integrate formerly segregated business processes. A typical definition, characteristic of most of the recent literature on ERP, is for instance:

> "An enterprise resource planning (ERP) system is a packaged business software system that enables a company to manage the efficient and effective use of resources (materials, human resources, finance, etc.) by providing a total, integrated solution for the organization's information-processing needs. It supports a process-oriented view of the business as well as business processes standardized across the enterprise." (Fui-Hoon Nah et al., 2001: 285).

Such a definition, however, is not particularly suited for the purpose of cultural analysis. It represents ERP from a straightforward management point of view and reduces the meaning of ERP to the instrumental value of this technology for the improvement of business processes. From this perspective organizational culture is, if taken into consideration at all, usually defined as merely one of many relevant aspects, which is subsequently studied in terms of 'integration' (cf. Martin, 2002). It is then assumed that culture is widely shared within an organization and that culture is manageable to a considerable extent. Cultural aspects are considered relevant in so far as they are (dys)functional for the implementation of ERP. An instrumental perspective presents ERP as a sophisticated means to better reach organizational ends, but at the same time disregards the fact that this technology also influences 'the range of these ends and their conditions of possibility' (Sotto, 1997: 37). Information technology is not simply a tool, but, as stressed by Sotto (1997) in his discussion of the 'ontological status' of information technology in organizations, is above all a specific mode of representing the world that affects whatever it absorbs. From this perspective we are particularly interested in the cultural question of what kind of organizations and organizational identities (of management, workers, consultants, customers, suppliers) emerge in the context of ERP.

Within this rationale organizations and technologies are studied as cultural phenomena in their own right, i.e. the meanings, norms and values associated with particular organizational activities and technologies (Alvesson, 2002). This conception of culture refers less to culture in terms of certain parts or aspects of organizational life and more to culture as a system of signification that permeates various organizational subsystems, including power relations and technological systems. Since culture is part and parcel of the entire organization and affects all kinds of actions and relations, it is difficult and often

misleading to establish direct causal links between organizational culture and (technological) performance.

In particular, Weick's concept of sensemaking aligns with this approach. For Weick (1995: 6) sensemaking is about 'such things as placement of items into frameworks, comprehending, redressing surprise, constructing meaning, interacting in pursuit of mutual understanding and patterning.' He analyses sensemaking as an ongoing process, which is grounded in identity construction and rooted in history. It involves the enactment of meaningful environments, including rituals and symbols. Sensemaking according to Weick is furthermore both an individual and a social process, which focuses on extracted cues and is driven by plausibility or belief rather than accuracy or 'facts'. These properties of sensemaking can be of analytical value in situations where people are confronted with rapid changes, complex problems and unexpected outcomes of innovations. These circumstances, typical for ERP developments, force people literally to make sense of what is going on. They do this through discussions about the expectations and (un)intended consequences of technologies. Sensemaking consists, viewed from a slightly different angle, of attempts to integrate a new event into a plot, by which it becomes understandable in relation to the context of what has happened (Czarniawska, 1998).

Since our case study deals with an event involving the disconnection of (part of) a technology Weick's notion of the 'fallacy of centrality' is of particular interest (1995: 3): the more advanced a technology is thought to be, the more likely are people to believe the information that comes out of it. Weick also seems to refer to, and further illustrates, this fallacy in the essay *Drop your tools* (Weick, 1996). Discussing the case of firefighters who, facing life threatening danger, literally failed to drop their tools, Weick gives an array of possible reasons as to why people tend to stick to their equipment. These reasons can vary from bad communication and lack of skill to trust, the perception of possible consequences and matters of identity. This last point is of specific cultural and technological significance. Weick remarks that 'implicit in the idea that people can drop their tools is the assumption that tools and people are distinct, separable and dissimilar' (Weick, 1996: 308). In contrast to this Weick holds that tools are often essential in defining identities. This is in line with debates in technology studies about the proper object of analysis, which should not only focus upon the actors operating technologies. Actors within the network are entities 'that do things' (Callon et al., 1992), which means that the technology itself can very well be considered as an 'actant'. In our view this does not imply that we can treat things like human actors, but that we should examine empirically the relationships between humans and non-humans in social interaction (cf. Mutch, 2002).

As mentioned in Section 1, the organizational cultural change this case study primarily deals with, refers to the virtualization of organizations through ERP. We are, for our purpose, not so much interested in the possible instrumental benefits stemming *from* the various ICT systems that virtual organizations are build with (Davidow and Malone, 1992), as we are interested in the qualitative change of the organization following the development of virtual ICT systems. This can be highlighted if we adopt a phenomenological or expressive perspective on ICT systems as developed by notably Sotto (1997) or Shields (2003). ERP is then recognised as a really existing cultural form—it not merely refers to a set of abstract options (cf. Shields, 2003). ERP facilitates the management of information flows between many organisational subsystems.

This management concern involves crucial know-how about the system-integration of organizations, without which organizations immediately would fall apart. This integration was of course already taken care of in other ways prior to the development of ERP. But ERP performs this function from an entirely new digital space, a single database that contains the software protocols that define the interactions between the various business processes. This new digital space extends the virtual dimension of organisations and this raises expressive questions about the content of this virtual environment and the way organizational actors interact with it (Sotto, 1997).

In particular, two properties of virtual environments are highly relevant for the purpose of cultural analysis. First, the organizational representations of information systems refer to 'ideal' situations, which are not (yet) 'actual' or 'concrete' (Shields, 2003). In terms of technology studies, information technology contains 'scripts', informing users about what actions should be undertaken, when, where and how (Akrich, 1992). Moreover, the knowledge and procedures formalized in software programmes are derived from situations other than the ones in which the software is being implemented. Software programmes, in other words, usually contain a 'decontextualized textuality' (Weick, 1985, cited by Sotto, 1997). This not only applies to the 'distance' between the enterprise system and its organizational context, but also to the entire industries 'best business practices' that standardized ERP packages claim to represent. Therefore, in most cases either business processes have to be re-engineered in order to conform to ERP standards, or standard ERP packages must be adapted or customized in order to fit organizational practice.

Second, and following from the first point, it is only through interfaces between the virtual and the material that virtual systems become effective. The virtual remains a 'potentiality' when it is not called upon to perform (cf. Benedikt, 1991). It is always in a state of 'becoming real'. Therefore, a cultural study of information technology should focus upon the interactions between the virtual and the material (Sotto, 1997; Shields, 2003; Woolgar, 2002). Organizational actors to a greater or lesser extent can choose to use, to neglect or to work around the options presented to them by technologies (Orlikowski, 2000). According to Sotto (1997) this results in a 'playfullness' in organizational action mediated through the devices of information technology. This means in our view that the virtual involves a relatively autonomous organizational sphere. This approach also makes it possible to do justice to the differences, inconsistencies and ambiguities often found in organizational cultures (cf. Martin, 2002).

The case study before us is directed at a reconstruction of a context specific technology story, based on the experiences of various organizational actors involved with the management and use of an ERP system. We do not pretend to present a comprehensive analysis of an entire ERP system or a cultural analysis of an entire organisation. We do expect, however, to make a convincing case for the usefulness of this cultural approach to ERP and the insights that can be gained or accentuated by it.

2.1. The case study: ERP in a vehicle manufacturer

The case study is about the redesign of an ERP system during 2001–2003 in a complex vehicle manufacturing company named TransPort with the aid of a multinational ICT service provider named CompuCom (all names in this paper are pseudonyms).

It is important to include service providers in the research because they influence the meaning and use of ERP in specific situations (Boersma and Kingma, 2005). As part of the actor-network that deals with the development of an ERP system, the consultants of service providers translate the requirements of concrete business processes into (their interpretations of) the technical possibilities of ERP.

Because we take social identities, interactions and processes of sensemaking as our object of analysis, the emphasis in data selection during our research, which took place in the first half of 2003, was on discourses and narratives about ERP and about organizational changes generated by interviews, reports and minutes of meetings. The objective was to offer insights into the ways an ERP system is used and changed in the work environment (cf. Alvarez and Urla, 2002). The accounts are also used to put the process of redesign into a certain perspective and social context. This narrative approach (Czarniawska, 1998) is aimed at reconstructing the various 'technology stories' (Law and Singleton, 2000) guiding the development of ERP. This method perfectly fits a research design directed at the tensions between the expectations regarding ERP and everyday experiences.

A specific context was selected so that we were able to study the cooperation of a consultant and a client as well as the use of an ERP system in a manufacturing environment. Two social settings were relevant for this study.

The first setting was the head office of CompuCom-Holland, which is part of the USA based multinational CompuCom-International with over 90,000 employees worldwide. CompuCom-Holland is an ambitious but medium sized ICT-service provider with some 600 employees. The company aims at the high-end of the ICT-market, i.e. business consultancy for major companies rather than software development, maintenance support or outsourcing. It also claims to combine a local cultural orientation with international expertise. At CompuCom-Holland we selected two managers and two consultants to examine their knowledge and views regarding enterprise systems, their consultancy strategies of knowledge exchange and client relationships. Our most important informant for this case study was Peter Uphill, in his early fifties and CompuCom consultant at TransPort. He has a long career that started behind the lathe in a Dutch steel company. Confronted with problems regarding the control of materials in that company, he followed courses on logistics. Later, as a production manager in the same company, he became involved in the implementation of the first ERP-like software packages at the company. Looking back to this period he described his training as learning-by-doing. He learned to deal with a myriad of computer related business problems.

The second setting was the complex B2B vehicle manufacturer TransPort, which built its first vehicles in the 1930s. The core activities of TransPort consist of the development, production, sale and after sales service of complex professional vehicles. In 2002 it has a total personnel of over 500 of whom some 450 people work in the factory. In May 2003 TransPort became part of a holding that consists of over 40 business units in seven countries with almost 4000 employees. TransPort, however, functions as a quasi-independent part of this holding. It is a small but important manufacturer in their specific branch of the vehicle-industry that has approximately a 10% share of the European market.

At TransPort we have had some extensive meetings with the company CEO and with four foremen on the floor. The careers and identities of these men are strongly tied to the company. They all have in-company careers and a great affinity with the company

and its products. TransPort definitely has a male dominated culture with a traditional work ethic. The interviews were semi-structured and each interview lasted about one and a half hour. We analysed the interviews in terms of technology management, organizational culture, communication and negotiation processes, power relations and working routines related to specific production processes. In addition we got access to relevant company documents like minutes of meetings to reconstruct the dynamics of the process of redesigning the logistical system. Some observations with regard to working practices on the shop floor were made to get a good idea of the daily routines of the machine workers.

The ratio behind the presentation of the case study is that we focus upon the actor-network structure around the production problems concerning ERP and the logistical system. An overview of the development of this logistical problem at TransPort is outlined in a timeline attached to this article (Fig. 1). First, we will go into the managerial questions that arose within TransPort with regard to the logistical system. The most important actor in this part of the story is the CEO of the company, Paul Vermeer. In this section we will discuss his understanding of the production crisis and the decision to work around MRP. In the second part of the story, we will discuss how the external consultant of CompuCom-Holland, Peter Uphill, analysed the production problems and developed a new logistical system—named 'Folly'—in interaction with the TransPort people in the so-called Steering Committee. We will show how the ERP system became re-defined as a result of this interaction. This interaction will be described as a management of change. In the last section we highlight the main consequences the new logistical system had for the daily routines on the shop floor. In this section the foreman of the production lines at TransPort are presented as the main actors. In this way we aim at a balanced account of the views and contributions of the various actors (management, consultant and foreman) involved in (re)defining and developing the logistical system.

2.2. The production crisis or the decision to work around MRP

TransPort's most successful product of the last four decades is the vehicle Solid, which has been on the market since 1982. It is this vehicle that gave the company an international reputation of a manufacturer of sober but sound and reliable vehicles. However, partly as a result of market-pressure caused by competitors in the so-called low-wage countries at the end of the 1980s, and partly because of a reorganization of the company, TransPort decided to diversify its product portfolio. In 1999 TransPort entered the market with a new generation of luxurious vehicles, called Glamour. A whole new assembly line has been set-up.

The first Glamour vehicle was introduced at an international transport-show in Amsterdam. Insiders as well as outsiders of the complex vehicle-industry were impressed of the quality of the Glamour. According to the today's CEO of the company, Paul Vermeer '…the focus of the presentation was on the elements of show and emotion rather than technical information and details'. It was symbolic for the cultural shift at that time within TransPort: from sober and trustful towards design and glamour. This signalled a shift in the management focus from inner directedness and the product to outer directedness and the market. TransPort's culture began moving away from an informal,

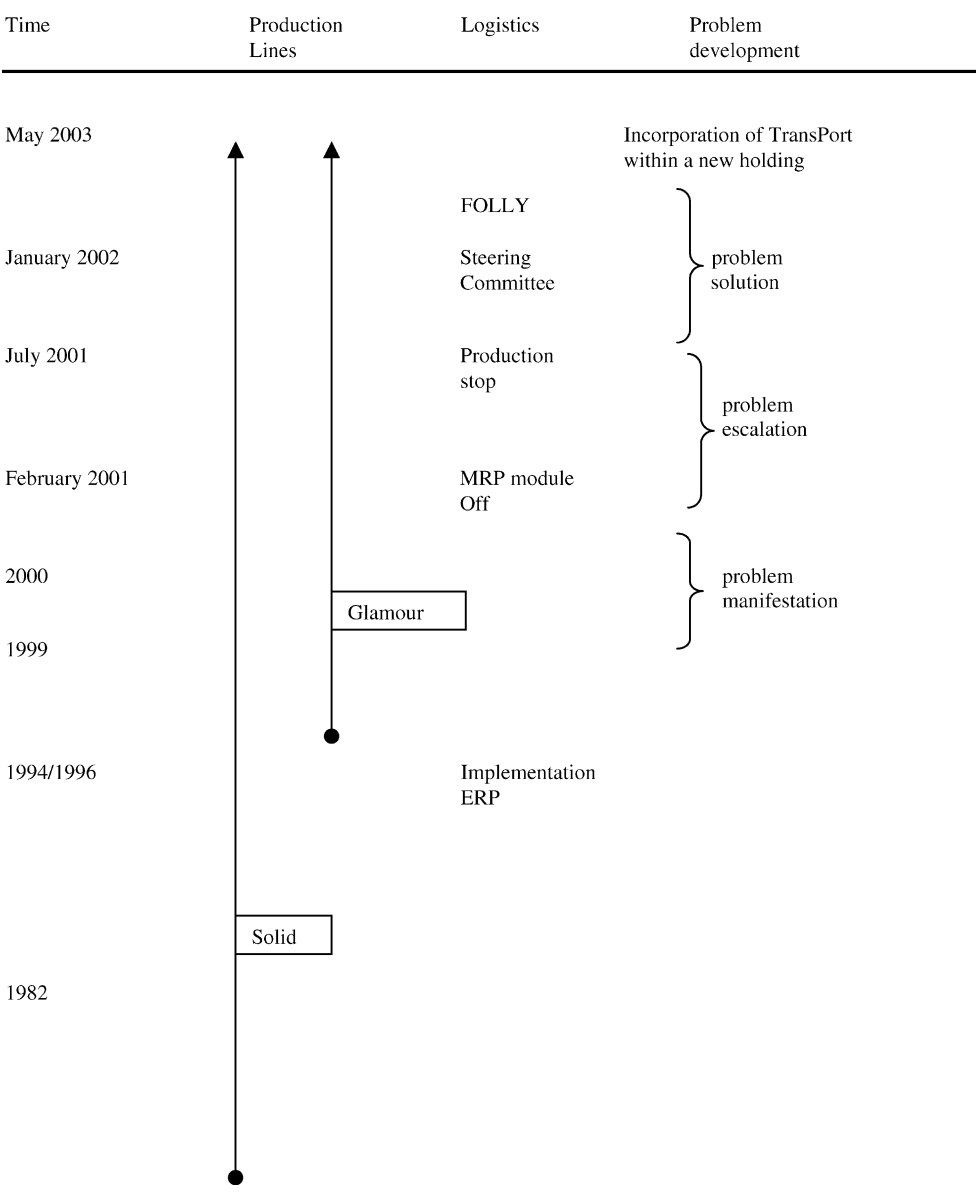

Fig. 1. Timeline problem development regarding logistics at TransPort.

sober style to a more formal and professional style. Along with the introduction of Glamour, TransPort restyled the company.

> "We needed a cultural change. Assembling the Glamour in this way, with this esthetic appeal, with the sensitivity in assemblage, demands a different culture… Before [the development of the Glamour] we looked like a barn, so the first symbolic

act was a new beautiful fence in front of the factory building and a new company logo…" (Interview, Vermeer).

The introduction of the Glamour meant a short period of great optimism and pride within the company.

Although management considered the new product as very promising, the organizational and cultural change of TransPort had its side effects. After the introduction of the Glamour many employees treated the new vehicle with ambivalence. Investments and expenditures on the new product were seen by some as extravagant and wasteful. It was, however, not only the new image and expenditures that created doubt about the right course among factory workers. Besides, organizational tensions grew within the company and production problems became apparent. First of all, these problems had a management-aspect. Too many orders for the Glamour had been accepted, whereas at the same time the factory was not ready for production at all. Moreover, the market demand for the traditional vehicle of TransPort's, Solid, remained unexpectedly high. As a result, TransPort, that had a good reputation as it comes about product delivery, faced the first serious production crisis in its history. A period of reorganization and tensions, for instance between units dealing with product development and units dealing with procurement, followed.

At the end of the year 2000 tensions in the factory had reached an unacceptable level. The most direct and serious problem was caused by a discrepancy between the demands of Transport's ERP system BAAN and the daily routines of the workers in the factory. It was especially the Material Requirement Planning (MRP) part of the ERP system that did not perform in the way as it should be. One of the prerequisites of MRP, theoretically speaking, is that the forecasts of the demand for materials must be accurate, otherwise severe problems can occur which can cause both over production and shortage. In the ideal situation the information of the ERP system predicts the actual amounts of materials needed at the assembly lines. At TransPort, however, that ideal was out of reach. An important reason for this was that the new assembly line for the Glamour was build upon the principles of World-Class-Manufacturing, based on clean work spaces, human engineering, assembling modules and visual steering of the material flow (cf. Schonberger, 1986). In particular a Just In Time (JIT) management of the material flow contradicts the planning logic of MRP. Peter Uphill stresses this discrepancy in his reconstruction of the ERP history at Transport:

> "They [TransPort] implemented ERP in the nineties without preparing the organization. They did't understand what MRP does. Only a few people could work with it, so the system became dependent on two or three men. That is not a desirable situation… And then they developed a completely new vehicle. For that vehicle they introduced a completely new manufacturing process: world class manufacturing… The consultants who implemented this also redesigned the logistical process, because world class manufacturing requires visual steering of the material flow, the Toyota model: Just in Time (JIT) management… not quite planning in advance as with MRP…" (Interview, Uphill).

Based on experience the materials needed to build a Solid were well known and relatively easy to predict. But with the introduction of a new production line

the complexity of the production process, and therefore also the forecasting of needed materials, increased exponentially.

In addition the production of the traditional vehicle Solid has flourished for many years by standard procedures and informal communication lines. The severe problems with the material flow laid a heavy burden on TransPort's informal working culture. Within this culture the position of the so-called 'heroes' was crucial. These heroes were employees with years of experience that possessed a lot of tacit knowledge about the production processes and had a high informal status within TransPort. They were called 'heroes' because they were the ones who were called upon to overcome practical assemblage problems. However, with the increase of such problems the continuation of production became almost entirely dependent upon the heroes. Moreover, since their informal status depended upon this, these heroes had a personal interest only in problem solving and not in the prevention of problems, which, according to management, contradicted the company's interests.

At the beginning of 2001 management came to the conclusion that MRP was unfit for steering the complex material flow at TransPort. They took a radical and far-reaching decision: to disconnect the entire MRP module from the ERP system.

> "I will never forget it: D-day. We switched off MRP. We took out the heart of our logistical control system! Why? Actually, because we wanted to bring about a paradigm shift. We also lacked the time for a carefully planned new logistical system. So we had to try something else… we changed so much in people's environment that they HAD TO start thinking and acting differently." (Interview, Vermeer).

After this, the material management became almost completely dependent on the knowledge and creativity of factory workers.

> "Yes, what have you got left then? Nobody knew which materials were exactly needed for a vehicle, except the people on the shop floor. They wrote lists with what they needed on beer-mats. In fact, they created bills-of-material in that way… This episode involved a lot of ups-and downs. We managed to continue the production until the summer of 2001 when, at a certain moment, we halted the assembly lines. There were so many unfinished vehicles that we simply had to stop… This was very dramatic, because the production at TransPort had never been stopped before…" (Interview, Vermeer).

According to Paul Vermeer, a complete loss of control meant the necessity of an organizational and cultural change for the company as a whole. Motivation of personnel and assigning new responsibilities became primary management issues. The informal communication lines and the power position of heroes should be breached.

> "We are breaking the informal circuits that TransPort previously relied on, but that, because of the growth and innovation, became a problem of control… We believe that if you don't experience protest you haven't changed a thing. We felt a lot of resistance, so we are changing. We have to do this, otherwise we will not succeed in demolishing the informal barriers…" (Interview, Vermeer).

Also, the role of the companies ERP system should be redefined. ERP should, according to Vermeer, no longer be 'a goal in itself for the administration of certain business processes, but rather a means to company ends'. Vermeer was rather surprised to learn that people seem to be inclined to accept systems information as valid and tend to act accordingly, almost irrespective of the consequences.

> "We ended MRP because it was too complex. Nobody could fathom the system any more. The screen had become a projection of reality which was used in such a way that they didn't even bother to take a look on the shop floor anymore… We actually put the people who were in charge of the supply into the warehouse: "how's that you say that all of the material is present? You go tell the people who can't find it!"" (Interview, Vermeer).

Long completion times of vehicles were in Vermeers view in part caused by personnel clinging on to the information system. Therefore, the control of the materials-flow should be carried over from the ERP system to the employees on the shop floor. Instead of a 'push' strategy based on MRP, the company should aim at a 'pull' strategy based on Just In Time (JIT) management at the assembly lines. However, at the time TransPort didn't have operational procedures to take care of that.

> "In fact, we didn't really have a logistical system. Everybody knew what should be put where, after all we were manufacturing the same vehicle for 20 years. Harry of the warehouse simply knew that if certain components were delivered, where they were needed. We did use MRP to calculate certain needs. And this worked, as long as the situation was stable, but when things started to change, it became a tragedy…" (Interview, Vermeer).

At TransPort it was still a big question how the teams and individual factory workers should function after MRP was shut down. In preparation of a new logistic control system management decided to only finish the vehicles which had at that moment already been taken into production. That is why, in the summer of 2001, it was even decided to temporarily stop the production lines, which meant a great (virtual) loss of vehicles and an actual financial loss of millions of Euro.

2.3. The 'Steering Committee' or the management of changes

In January 2002 a gathering was held in one of the rooms of TransPort in which five men came together to discuss a project concerning a new logistic system for the manufacturing processes of the company, called FOLLY. Peter Uphill, the consultant of CompuCom-Holland, was present at this first 'steering committee' meeting. Shortly after this meeting he would give a presentation of the CompuCom-Holland logistic concept to the management team of TransPort.

Peter Uphill had an important position in the steering committee. Together with Paul Vermeer, TransPort's CEO, and some of TransPort's foremen, he would reshape the logistical concepts of the system. From the first meeting in January 2002 to the summer of 2003 he would cooperate with the TransPort people within the steering committee. His input in number of days, estimated at 143, could not be defined beforehand.

The CompuCom philosophy regarding logistics is based on the concept of Value Chain Management, one of the core-competencies CompuCom has defined in its knowledge-management policy. Value Chain Management, a concept originally coined by Porter (1985), is based on the process view of organizations, the idea of seeing a manufacturing (or service) organization as a system, made up of subsystems each with inputs, transformation processes and outputs. Value chain analysis aims at optimizing and coordinating linked activities within the system and can also be useful in outsourcing decisions. It involves the identification of subsystems and their relative contribution to the entire value chain, in particular directed at activities where waste can be diminished and competitive advantages can be realized. The principle of value chain management has been applied in a wide range of organizational contexts, ranging from firm specific value chains, via value networks of firms with suppliers and buyers to the relative position of for instance developing countries within global value chains.

Taking value chain management as a starting point for (re)designing ERP implies that ERP is made subsidiary to value chain management. From this perspective Uphill considered ERP relevant for TransPort only in so far as it contributed to specific business problems and with that to the firms value chain.

> "Regarding Value Chain Management, we are only in the beginning. We are only preparing the organization to be able to take this step. Although, internally we are of course integrating the value chain with information technology… TransPort wants to produce faster and smarter. And because of the level of outsourcing, the supply of pre-manufactured components is getting higher and higher. This means that you exert less influence on the cost price of these parts. That is were Value Chain Management comes in, to see how you can manage the complete production chain, so that you can realize the lowest possible cost price across the chain with maximum performance. Well, that is the idea." (Interview, Uphill).

From the standpoint of CompuCom and Peter Uphill ERP should no longer be regarded as a technological fix for certain business processes. This position connected well with TransPort managements above-mentioned conclusion that ERP should no longer be a goal in itself but rather a means to organizational ends. In order to substantiate this, Uphill formulated specific objectives for TransPort's ERP system, so-called 'critical process indicators'. He sees himself as a 'business architect' rather than as an IT-consultant.

The main aim of TransPort's steering committee was to develop a logistical concept for the shop-floor and to steer the process of development and implementation. The objective was to formulate an ideal logistical system, the so-called 'should be-situation', and to develop this situation out of the current working practices. In other words, the activities of the committee were seen as a process of continuous iteration between a management vision and the shop-floor practice. It was the urgency of a workable control-system that brought the five men together.

> "After the shut down of MRP and the introduction of provisional bills of material, we were constantly improving. Since we started the assembly of new vehicles again we increased efficiency by 30 percent, because of skipping indirect handlings and planning activities… After about half a year, we saw it through. We said: Yes it

> works fine, but we are still dissatisfied with the flow of materials as it is right now. For two reasons: the physical material flow is running, but there are a lot of irregularities, and the control over the material flow, in particular the cost price calculation, is lacking… This ultimately gave rise to start with FOLLY." (Interview, Vermeer).

The outcome of the committee's work should be a workable logistical system with a scope of 5 years.

Over the initial months of the development period, Peter Uphill intensively shared and discussed his technical knowledge about ERP. He worked closely together with managers, purchasers and blue-collar workers. According to himself, this is the only way to successfully integrate a logistical system into a production environment. His idea to see an implementation of a software system as a bottom-up process is congruent with his long practical experience with learning-by-doing which is a characteristic of his career.

One of Peter's first tasks in the committee was to formulate the pre-conditions for the system's development. This included his position, shared by many ERP consultants, that customization of the ERP package should be avoided since this involves risks of software errors, can be very costly and can hamper the introduction of future software improvements and innovations. So they had to operate within the scope offered by the parameters of the BAAN software. But at the same time Peter wanted to make sure 'that the software solutions represent the optimal business processes'. He explicitly did not want to make 'the software leading *for* the business processes', although he sometimes feels 'biased by the Baan software'. One of the major conditions was that the new system should not be detrimental to what was called '…the feeling of ownership' of the individual foremen at the assembly lines. That means that ERP should be complementary to the shop-floor routines.

Peter, with his roots in the mechanic(s) industry, seemed to be the right man in the right place. He had studied the daily routines in the factory by observation and by interviews, which he had held with foremen on the floor. According to Peter he combined his knowledge of the local routines and circumstances with the theoretical notions of ERP and Value Chain Management. At TransPort he used his theoretical knowledge but, equally important, he started with training-sessions and instructions for the key-users of ERP in the factory. But one thing Peter initially underestimated was the strong aversion against MRP at TransPort, which was blamed for the severe logistical problems.

> "At first I couldn't use the word MRP, that was considered swearing. One of the first days I was talking to one of the suppliers and said: perhaps we should do some calculations in advance. He said: 'You mean MRP again?'. In his next meeting with his boss he said: 'We are going back to MRP'. My remark was completely misunderstood, there was a lot of commotion about this… But I said: with World Class Manufacturing you are missing important things. And we can perhaps use MRP for controlling the process, not steering it… Gradually this idea was accepted." (Interview, Uphill).

In the first 3 months of 2002, the steering committee intensively studied and (re)defined the logistical practice. In the process they found out that MRP could be combined with responsible teams.

> "At TransPort every team was responsible for its materials and went shopping in the warehouse where they could take the parts they needed. Now we have a structured warehouse with an information system they discovered: we should be trading instead of shopping… that is a different way of looking at the same things." (Interview, Uphill).

The logistical system the steering committee ultimately came up with, consisted in Uphills view of a hybrid model combining MRP procedures at the warehouse with JIT procedures at the assembly lines. Uphill explains the logic of a combination between MRP and JIT as follows:

> "After MRP was shut down they soon realized this doesn't work either. They were introducing ad-hoc solutions for supply problems, and weren't allowed to use MRP any more… A few months later I designed a model, in which the properties of World Class Manufacturing were leading, and that is after all based on the visual steering of material and a human scale. So, difficult ICT's on the shop floor were out of the question… but I did reintroduce MRP, not as a steering but as a controlling device. Just MRP didn't work and just JIT didn't work at TransPort, so I combined the two, a hybrid model. The funny thing is that a few weeks later I found out on the Internet that this is in fact what they call 'synchronised manufacturing', a logistical system used at Yamaha were the Toyota model didn't work properly…" (Interview, Uphill).

JIT is possible with the use of a Kanban-like method, based on boxes with materials at the assembly lines together with the administration of needed materials on cards (Tiptus et al., 2000). Kanban puts an upper limit on the quantity of materials at the assembly lines. The simple principle of Kanban, however, should not be treated mechanistically. Such a logistical method requires a relatively high frequency of material delivery and efficient working routines. It has, in several forms, a human side (Schonberger, 1993). At TransPort they still had to develop this method. After MRP was shut down, it remained for a long time a big question which logistical procedures the teams and individual workers actually had to follow.

In April 2002, the committee took an important decision, namely that: 'A decision of the steering committee is put into practice only after the permission of a pilot-committee'. The findings of the pilot-committee were called 'theoretical evidence', i.e. a proof of applicability. After this proof a solution would be tested and eventually put into actual practice. In this way FOLLY was given a top-down character regarding the design of the logistical system, while its implementation was given a bottom-up character. The purpose of this procedure was to increase the commitment of the teams at the assembly lines with the logistical process and to put the primary responsibility for this process in their hands. But the steering committee also saw it as its objective to make the tasks, responsibilities and the competencies of each individual employee visible. TransPort's CEO, Paul Vermeer, was held responsible for the introduction of FOLLY to the personnel. For him the motivation of his personnel was leading, as he told us. In some cases this even meant that he personally demonstrated to some personnel at the finance department how to deal with new situations.

Looking back on the achievements of the steering committee, Peter Uphill has the strong impression that the management interest for logistics has increased considerably:

> "We had 28 steering group meetings of approximately three hours. In the beginning of this process TransPort's management basically seemed to think "we are a vehicle manufacturer which involves a lot of logistics," now they found out that they are in fact a logistical company manufacturing complex vehicles." (Interview, Uphill).

In this respect management changed its idea of what the organization was all about.

2.4. 'FOLLY' or the implications for production teams

In July 2001, the crisis at TransPort reached its highest level. It was obvious to all that '…something had to happen'. The reactions to the crisis, however, varied between units, teams and individuals. The tensions on the floor began to take its toll especially on the so-called heroes. These heroes had formulated and enforced norms by personal involvement, and functioned as informal control agents. In the period of crisis, some of the heroes lost their status and a few even left the company with a burnout.

Also the problems with production and material flows in the factory varied from production team to team. In the vehicle-industry, the production of a vehicle takes several steps. Main assembly contents are welding of the vehicle body, painting, interior decoration and the general assemblage of the vehicle. In this way, at TransPort the manufacturing of a single vehicle is the outcome of a line-production-process in which several teams cooperate. According to the foreman of one of these teams '…the reorganization was inevitable'. Although they relied upon the knowledge of the heroes, the introduction of the Glamour and the extra amount of work became too much a burden for the teams. A foreman gives us the following impression:

> "Look, all these changes came around the same time. We got a new product that was supposed to make it. 80 new people were hired, most of them with temporary contracts and no experience. They got blue collar cloth, a tool case and were instructed to do this or that… But they had to learn a job, you know, so a lot of parts were wasted of course. I had to deal with all of this… And then, at a certain point in time, the material flow gets out of control. Too much in stock of what we didn't need and lack of parts we desperately needed. It became a terrible mess… At the time everything was taken care of on an ad-hoc basis" (Interview, Foreman III).

Because of the fact that TransPort's production was the outcome of informal communication lines in the factory, it was unclear which persons were to be held responsible for the quality of the material flow.

In 2000, during the period in which problems became apparent, one team (consisting of 15 workers) started to experiment with a material flow control system that could anticipate shortages of materials at the assembly lines. The foreman of this team, only recently appointed, was alarmed by the production controller:

> "He said: what the hell are you doing? Parts arrived too late [at the assembly line] or it were the wrong parts. He said: you are doing things the wrong way. You are

> responding too late to supply problems. This made me think. He was actually right, you know, because he was responsible for line control and had to make up for our delays, and that is not the way it should be done." (interview, Foreman IV).

This foreman made one person in his group responsible for the material flow, the Technical Specialist (TS). The TS got a half day a week on average at his disposal to take care of this task and organize the handling of materials at the assembly lines and the contacts with the warehouse. The TS functioned as an intermediary between the warehouse and the team workers. This visual control system worked so well, that his group became an example for others. Instead of using MRP to control the material flow, the team introduced small boxes in which they put certain amounts of material parts needed for the production of a vehicle. At the bottom of each box was a form that should be completed by those who used the last part in the box. In this way, one was able to make the material flow visible. In this way this team 'invented' a Kanban-like logistical system (without initially calling it that), characterized by a material pull instead of the material push by MRP.

It was this logistic system that became the model for the FOLLY steering committee. In the new situation the ERP system, the efforts of the TS's and the handling of material bins on the shop floor had to come together and function as a linked logistical system. The teams had the strong impression that they were the ones who primarily had to solve the logistical problems and experiment with the new procedures.

> "They [management] changed the whole system from one day to another, while nothing was taken care of. Nobody knew exactly how it should be done… we were made responsible for everything, they said… But there were no bins, and we even had to arrange the labels by ourselves… The introduction of the new system went very uneven, very chaotic…" (Interview, Foreman II).

This foreman even sighed that according to him every logistical system could work at TransPort, even MRP, provided that it was executed in an orderly, disciplined fashion.

In the perception of the teams the new logistical system had a huge impact. It required a new way of thinking and dealing with materials.

> "I thought it sensible to do it that way. But we noticed… in discussions among each other, that it was very different from what we were used to do. It implied a changeover in the patterns of thinking, also for the people on the shop floor, because the specifications were changing. So, it brought about a lot… I got the impression that it would have a huge impact…" (Interview, Foreman I).

The introduction and the use of cards and boxes asked for a considerable period of (re)learning and supposed a re-shaping of working routines. To overcome problems, TransPort's management ordered the several foreman to hold TS's responsible for the material flow of their team.

The members of the pilot-committees were TransPort-employees who were familiar with the work-floor routines. Implementation of a new working routine only took place after a detailed pilot-study carried out by this committee. That was, however, not a process without problems. In fact, these committees had to find ways to change working routines that had existed for years. The foremen told us that in some cases they had '…to enforce

their personnel to incorporate the new system into their work.' More than once, machine workers on the floor frustrated the system by not using the cards and bins (accurately). One team-leader told us that he sometimes had the feeling to be a '…kindergarten cop', instead of a factory worker:

> "The introduction of the two bin-system wasn't easy at all. Some workers weren't willing to put boxes on the racks for others. They thought: The box is empty, well let me take a new one from behind and put it in front, so I don't have to take that one away. That was the way they worked… People aged 56, whom I had to tell: how childish you are… They didn't think over what happens when you have no material left anymore…" (Interview, Foreman IV).

The necessary changes in working attitudes and routines proved in particular problematic to some of the older team members (of over 50), who were slow to adapt to the new situation and were not easy to convince of the necessary changes.

> "If you have people working in a company for 25 years, and you want them to switch to new procedures, that is very hard. They are stubborn and think they know it better. The elderly thought that in the past they had always done it right…' 'They didn't appreciate the new procedures, while in fact it is much easier to them, because they don't have to go after the parts by themselves. This is taken care of for them, provided they deliver the [Kanban] cards and put the bins in the racks…" (Interview, Foreman III).

This issue reflects the labor culture of the teams at the assembly lines, which can be characterized as rather traditional and task oriented. The workers have a relatively low level of technical education and their work requires strong discipline, hard and precise work, obedience to foremen, loyalty to the firm, egalitarian manners among team members and quick operations that can be mastered in only a few weeks. The new Kanban procedure required a shift from this task and product orientation to a team and process orientation. It required a mutual responsibility among team members including a reflexive attitude regarding logistics.

In an MRP situation stockrooms intervene between people. Under Kanban, process-to-process, person-to-person, interaction is frequent. An assembly cell with minimal Kanban quantities within the boxes, almost requires the teamwork of a bucket brigade (Schonberger, 1993). As we have seen, some workers seemed unaware of, or were indifferent to, the serious consequences in case Kanban boxes or cards were dealt with inadequately, or were not dealt with at all because a particular worker felt he could leave this task to somebody else. For the foremen themselves, and in all cases they were recruited from the teams, the changes implied an extra appeal on their leadership capabilities. Not all of them were equally successful in implementing the Kanban procedures and in motivating team members. A foreman explains:

> "I have had difficulties in leading our team. I used to ask: "Will you do that?". But that doesn't work. You have to give orders: "You are going to do that!". It is a different usage… They used to be fellow team members, but now you have to tell

them how to work… Sometimes you even have to correct them six times in a row…" (Interview, Foreman IV).

After some months the management clearly saw the positive results of the FOLLY-project. Most of the foremen had a positive attitude towards the introduction of Kanban. However, one foreman told us that he was curious about the long-term success of the system. According to him, the system is quite vulnerable '…when there are persons who neglect the cards and the boxes, the whole system becomes useless'. Another foreman expressed some indifference regarding the specific logistical system, as long as it was a comprehensible and shared system. The steering committee discussed such possible problems. As they stated it, the FOLLY project was above all '…a matter of belief in the system…'.

The employees on the shop-floor still had to overcome some frustrations. For the members of the steering committee it was clear that the entire firm was '…in a process of learning and relearning'. It was especially the cross-border material-flow that caused for many problems. After all, the single teams at TransPort do not function in an isolated situation but within a chain of production. Each team depends on the input from others. However, in June 2003 everybody in the steering committee agreed that '…it has been a good idea to introduce the FOLLY system as a bottom-up process.' Also the foremen recognized the importance of their responsibility concerning the material-flow. After almost one year, the new logistical system seemed to be a do-able system for TransPort's assembly lines.

3. Discussion

In line with our theoretical framework we now want to discuss the mutual shaping of technology and organizational culture. Although management and employees seem to regard the new logistical system (for the time being) as effective and efficient, this instrumental concern was not the objective of our analysis. As we stated in the introduction, we wanted to address the interplay of organizational culture and ERP as a process of sensemaking. We further specified this process of sensemaking in reference to the virtualization of the organization as driven by ERP.

The organization under consideration was a vehicle manufacturing company. We focused specifically upon the process of development and implementation of TransPort's new logistical system. This became a hybrid logistical system: a combination between a virtual ERP system, with MRP controlling the material flow in the warehouse, and a physical JIT system, with Kanban boxes and cards used for steering the material flow at the assembly lines. Our analysis included the management of the change process as dealt with by a 'steering committee', and the contributions of the teams working at the assembly lines to the new logistical system and the consequences this system had for these teams. The new system was seen by management as well as the foreman of the teams as a mutual accomplishment. These parties developed the new logistical system in close cooperation, be it not without serious controversies. The new system was born out of necessity and its rudimentary forms were practically invented at the assembly lines. Management evoked

this change with the decision to shut down MRP, formalized and refined the Kanban procedures and integrated these, with the aid of a consultant, in the companies overall ERP system.

To a certain extent the new logistical system represents the virtualization of TransPort. In the following discussion we highlight how processes of sensemaking (Weick, 1995) were involved in this virtualization, and how significant these processes in fact were. Three subsequent and mutually related processes of sensemaking can be discerned.

First, ERP is not a well-defined and easily recognized information technology organizational actors are constantly aware of. This is in contrast with most studies about ERP that tend to define ERP in advance, and seem to assume implicitly that organizational actors are aware of the system. With ERP at TransPort we have not so much focused on the internal development of the whole ERP system, but all the more on the strategies of management and workers regarding the highly specific sequence of events related to only certain parts of the ERP system and the organization. These organizational actors only became aware of ERPs MRP module when major organizational changes, related to the development of a new product and a new assembly line, interfered with the functioning of MRP. Before that time only a few people in the company understood the role MRP was playing. In addition, virtually nobody was aware of the 'scripts' (Akrich, 1992) of the new technologies, in particular the contradictions between the material push logic inscribed in MRP and the material pull logic of World-Class-Manufacturing, the new production line was set up with. It was a major production crisis that forced management and other organizational teams and individual actors to try to understand and reflect upon the role MRP should, or should not, play in the control of the material flows. In a way this crisis brought MRP within their 'awareness context' (Glaser and Strauss, 1964) and subsequently made them open the 'black box' of MRP and the company's logistical system. In this way, sensemaking is directly involved in defining ERP in relation to the actual user practices.

Second, this 'discovery' of MRP and the worrying role it was playing, did not so much mark the end of MRP at TransPort but the beginning of a transitional phase which resulted in the new hybrid logistical system of JIT management at the assembly lines and MRP at the warehouse. The development of this new logistical system involved a differentiated network of organizational actors who gradually 'enrolled' in this project, notably managers, a consultant and the foreman. They all had to make sense of the confusing production crisis and think of possible explanations and experiment with possible solutions. In these processes of sensemaking the various actors related, as we have seen, their understanding of logistics and MRP to their specific organizational practice, i.e. their position, tasks and identity within the company. In these processes, organizational structures were modified and new structures emerged. In terms of actor-network-theory, the development and distribution of the new logistical system went together with the translation of ERP into the terms of the various organizational actors involved. The consultant for instance redefined ERP in terms of Value Chain Management. With these processes of sensemaking a light can be shed on how precisely ERP is interwoven with the entire organization and how exactly ERP relates to cultural change.

Regarding this crucial point we stressed in the outline of our cultural approach the relevance of Weicks notion of the 'fallacy of centrality' (Weick, 1995: 3) and his

discussion of the fact that people are often reluctant to drop their tools, even if they are ordered to do so or if they will become in serious danger if they fail to do so (Weick, 1996). This fallacy has also been associated with ERP systems. It has for instance been suggested that ERP may reduce a firms flexibility and may lead to a culture where risk taking and experimentation becomes less desirable, notably because 'diligent users of the ERP system are more difficult to blame for their mistakes or lack of achievement' (Trott and Hoecht, 2004: 375). At TransPort management explicitly attributed the production crisis in part to the tendency of personnel to follow the information produced by ERP, even in cases where this information was obviously incorrect and detrimental. Management as well as some of the foreman furthermore expressed that it was not just a matter of implementing the 'right system' but also of a 'belief in the system'. In addition this case study clearly shows that organizational actors can be seriously inconvenienced once they abandon a system they used to work with, because they hardly have an idea of how to act alternatively. With the development of the new logistical system the organization regained control over its ERP system and made this technology subject to organizational ends. This also makes clear that information technology, in this case ERP, is essential in defining the organization itself. The organizational culture of Transport can hardly be understood without reference to its ERP system.

Third, processes of sensemaking are involved in defining the 'interface' or the interactions between organizational actors and the system. The new logistical system at TransPort made a sharp distinction between the logistical functions performed at the assembly lines and the functions performed by MRP as managed by the warehouse employees. The detailed Kanban routines operate as an interface between the assembly line and ERP, synchronizing the assemblage of vehicles and the planning of required materials. Kanban on the one hand enabled the continuous delivery of materials at the assembly line and on the other hand assured correct data input for the ERP system. In a way this meant the introduction of a new norm in the logistical practice, demarcating the virtual from the physical. At TransPort MRP and Kanban were integrated and formed a (new) meaningful whole. This hybridity, in which the virtual system derives meaning from the material context, and vice versa, can also be called characteristic for the virtual organization (Sotto, 1997) in which TransPort gradually evolved through the development of ERP. Indeed, the virtual organization should not be understood in terms of a simple replacement of traditional physical procedures with new digital technologies. The virtual only operates as a *relatively* autonomous sphere. It is itself shaped by a material environment which on its turn is deeply affected by the system. The development of ERP rather involves a redefinition and a reorganization of the systems material context. In this respect in the case of TransPort we prefer to speak of a virtualization of the organization instead of a virtual organization.

4. Conclusion: the transformation of ERP

With this article about ERP in a vehicle manufacturing company we wanted to make a clear case for the cultural and contextual analysis of ERP. We have seen how ERP became problematic in the context of organizational changes at TransPort.

As a consequence this technology has been problematized, in particular the black box of MRP was opened. The production crisis at TransPort can itself be presented as a highly specific and localized part of a more general change in the understanding of ERP, from a primarily promising technology to a highly demanding one, stressing the organizational pre-conditions and consequences of this technology. Also, we explicitly addressed the mutual shaping of technology and organizational culture. We analysed in particular how processes of sensemaking (Weick, 1995) are deeply involved in situational definitions of ERP, in the signification of ERP throughout the entire organization and in the construction of interfaces between the virtual system and its material environment. Regarding this last point we have specified the organizational changes at TransPort as a virtualization of this organization (Sotto, 1997; Shields, 2003). We have stressed the paradoxical relationship between the virtual system and its material context. After all, while the implementation of information technology is often meant to replace more physical parts of the company, this technology at the same time places new demands on the material context.

The virtualization of TransPort can of course be explained in different ways. In our view there are two extreme and opposing explanations. On the one hand, it can be argued that ERP systems are flexible and adaptable to various organizational situations. This can be done by setting parameters within the system or developing specific software customizations. A basic problem we have with this interpretation in our case is that the Kanban system required significant cultural and organizational changes within the factory, which were developed only after MRP was shut down. The exclusion of MRP from the ERP system can hardly be seen as the adaptation of a system to existing organizational structures.

On the other hand ERP has also been closely associated with Business Process Re-engineering (BPR). ERP is sometimes even seen as an almost deterministic element, forcing organizations to adapt to the logic of the enterprise system (Baskerville and Smithson, 1995; Koch, 2001). From this perspective the development of a new Kanban logistical system for the assembly lines can be interpreted as an adaptation of the organization to the enterprise system. A basic problem we have with this interpretation in our case is that the logistical principle or the 'script' of MRP is quite different from Kanban. The new Kanban procedures and working routines can therefore hardly be seen as following the rationale of the original ERP system.

Because of the problems we have with these extreme and contradictory explanations, we suggest a third and combinatory explanation, which focuses upon the transformation of ERP and the organization itself. We suggest that the function and meaning of ERP within TransPort has changed significantly, ultimately leading to a new kind of virtualized organization in which the material organization and the information technology define each other.

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