

# Work Organization and Problem Solving

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## Introduction

This paper presents preliminary results of an ongoing research project, part of a larger study of the “Reflective Organization,” a cybernetic organizational model intended to increase a firm’s flexibility by utilizing employees’ problem solving capacity (see Nolte 2007, 2010). In order for such a model to succeed, the work organization needs to provide an unusually high level of autonomy to the basic units the firm consists of. The individual position identified with the single employee is regarded as the basic unit in this sense. Since the core problem is to transfer the individuals’ problem-solving capacity to the level of the firm as a whole, the integration of the basic units is predicated on intense flows of information.

While related work organization systems are widely discussed in the conventional literature on knowledge-based firms, such as high-performance work systems in law firms or the consulting industry, and are seen as a prerequisite for this kind of firm to survive in its dynamic environment, there are only very preliminary attempts to introduce work organizations based on employees’ cognitive capacities in industrial mass production.

This paper documents the first steps in introducing a knowledge-based work organization on the assembly line level of a mass producer of cars, Volkswagen. These efforts are presented in the context of the firm’s strategy. A vital question is the balance of autonomy and integration. The core hypothesis states that greater autonomy leads to more and better problem solving. The paper is based on interviews with assembly line workers that took place on November 30 and December 1, 2009, in the main plant in Wolfsburg, Germany.

## The Research Problem: Changing a Car Producer Toward a Knowledge-Based Work Organization

### *On the Practical Level*

In 2010 the Volkswagen Group had a world market share of 11.4 percent, a 1.1 percent increase over 2008 (Volkswagen Group 2010). Volkswagen sees itself in competition with Toyota, which it hopes to pass as the world’s largest car producer by 2018 (Moneycab 2010).

In 2009 Volkswagen was able to take more advantage than their competitors of the varying “cash-for-clunker” programs set up around the world. It is believed that the main reason for this is the company’s flexibility. The cash-for-clunker programs increased the demand for smaller cars, and Volkswagen was able to adjust the production of the Golf model to this demand and take advantage of this temporary opportunity. Although Volkswagen had had short-time work (“Kurzarbeit”) in spring 2009 for one week, never in history had they produced more Golfs in a year.

It may be assumed that there were two main reasons why Volkswagen was able to react so flexibly to this abrupt change in demand: co-determination and the first steps on the “Volkswagen-Weg.”

### *Co-determination*

Having its headquarters in Germany, the Volkswagen conglomerate is under the law of “Unternehmensmitbestimmung,” co-determination on the corporate level. This means that half of the 20

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votes on the supervisory board are those of employees' representatives; the other half are those of the owners. By law, at least seven of the employees' representatives have to actually work in the conglomerate; the other three, for example, might be union officers. In the case of the Volkswagen conglomerate, two of the owners' votes belong to the federal state of Lower Saxony, for historical reasons. This means that of the 20 members of the supervisory board, 10 represent employees' interests, two represent the state/region, and only eight represent the shareholders. So in the end, in case of a conflict, job security has more support than profit: profit is a means, not an end. In a time when the entire world is shaken up by a severe economic crisis, this can be an important point.

In December 2009 Volkswagen decided that the members of top management will no longer get stock options as part of their variable income and that this variable income will not depend on share prices. Instead, if the firm makes a profit, the variable income will depend on customer satisfaction, employee satisfaction, development of market share, and rents. (See, for example, *Automotive News Europe* 2009.) These are also the areas covered by the firm's "Strategy 2018," now renamed "18 plus." Volkswagen-Weg, the new work organization, is one of the major instruments for pursuing this strategy (Volkswagen Group, no date). The four objectives the variable income will depend on show a predominant commitment to stakeholders.

Co-determination at the level of the conglomerate's individual firms and on the shop-floor level is very highly developed, too. Within the firm (not conglomerate) of Volkswagen, the works council has more influence than is provided by law. Volkswagen has a long history of successful co-management of the works council and management. In the end, no management decision is made without close consultation with the works council. This might slow management decision making and limit the freedom of managerial action, but it also means that when a decision is finally made, it is supported by everyone. In 2009 this extensive co-determination showed its strength when it was possible to implement extra shifts each second weekend in the German Golf plants.

A core element of the Volkswagen strategy is to increase market share, given its expected increase in productivity. Otherwise Volkswagen would have redundant employees in Germany in 2018 even if it takes advantage of natural turnover as much as possible. For political reasons layoffs are impossible. Layoffs would also destroy the valuable collaboration between workers' representatives and management as well as the commitment of employees: these core assets would be endangered.

So the alternative solution is to increase the number of cars sold. But at the same time, new production sites in countries with lower labor costs are being set up, both by Volkswagen and its competitors. If the German production sites want to remain competitive, they have to profit from capabilities others do not have and actually treat them as assets.

### *Volkswagen-Weg*

The obvious differences between the low-cost production sites and those in Germany are the Germans' low worker turnover, high level of qualification, and high commitment. For example, in India high turnover is a severe issue for car manufacturers. High turnover means that the employees cannot develop any tacit knowledge about the production process, so each step needs to be made explicit. If each single task needs to be described, taught, and monitored, there are enormous costs of "hierarchy." At the same time, this leads to inflexibility since changes mean a lot of effort. An additional if subtle cost is that, if each single step is made explicit, this renders production methods in a form in which they can be easily imitated by competitors.

While it is seen as a prerequisite to meet Toyota's benchmark, Volkswagen's idea to maintain, or even enhance, its competitive position is to build it upon the workers' tacit knowledge and their commitment to the firm. These personnel-based resources are assumed to lead to a higher level of flexibility. In order to do so the workers need to acquire a higher degree of autonomy, whereas the degree of automation needs to be reduced. This new work organization is called "Volkswagen-Weg" (Volkswagen 2007, Volkswagen Group 2009); its implementation will take several years. Volkswagen-Weg can be translated either as "the way one works at Volkswagen" or "the Volkswagen path of development." Its core components are the following:

*Continuous improvement cascade.* Workshop activities take place in production and supportive units as well as the supply chain. The topics are set top-down, but within the scope a bottom-up approach is pursued. The goal is to improve existing standards. The participants come from different hierarchical levels, and

specialists are included as well as assembly line workers. The works council is involved in planning these workshops and gets feedback, especially regarding the effect of their results on personnel and implementation practices.

*Continuous improvement workshops.* The topics for these workshops are set bottom-up. They aim to solve clearly defined problems, no matter what kind. Each employee can propose a workshop like this, and the participants and the involvement of the works council are similar to the cascade. The intent is to put them into effect within a short time after they are proposed.

*Teamwork.* Teamwork was implemented at Volkswagen years ago. But in contrast to these existing teams, the “new” teams gain a higher degree of autonomy. They are supposed to contribute to continuous improvement, assure the attainment of existing standard processes and quality standards, take responsibility for the maintenance and performance of machines, provide order and cleanliness, manage the organization of their own work and the provision of material, develop new quality objectives, and in general facilitate a continuous production process. The management-by-objective system is extended to these assembly line teams, so they are involved in defining their own goals, deciding how to pursue them, and monitoring their progress in achieving them. This is connected to an ongoing process of task optimization. The teams organize their rotation on the assembly line by themselves, and they are in charge of their own qualification process, communicating performance indicators within the team, and the communication within the team, as well as the communication to other teams and to supervisors or special units. A team spokesperson is the contact for management and has to make sure that the team’s tasks are fulfilled. The team can propose one of its members to be the spokesperson, but he or she needs to be approved by management. Currently that person is supposed to have two hours per day on average away from the assembly line for the specific spokesperson tasks. He or she has also to facilitate the biweekly team meetings of 30 minutes, which follow a standardized agenda. Newly appointed team spokespersons receive training.

*New role of the Meister.* The team spokesperson gets the role the “Meister” used to have to some extent. A Meister in the industry is somebody who typically has an apprenticeship of three years and has passed an extra exam after at least two years of work experience and 1,200 hours of learning (partly in classrooms), covering basic management skills and specific technical knowledge. Since teams are acquiring more autonomy, the traditional role of the Meister is changing. He or she is becoming more an expert for special issues. This person is also getting more of the management tasks employees in supportive units used to have.

*Idea management.* The program of idea management will continue to exist. This means that workers’ ideas concerning improvement of the production process are rewarded financially, depending on the resulting savings. But—in contrast to the traditional system—the focus is on small ideas. Currently each team has the goal of submitting two ideas per month.

The introduction of the Volkswagen-Weg has started only recently. Not all the elements are fully working yet. The research presented in this paper can be seen as part of a formative evaluation of the Volkswagen-Weg, monitoring its introduction and results and thus giving advice about improvements or necessary changes.

#### *On the Theoretical Level*

In the introduction I mentioned that work organizations with a high level of autonomy can be found in knowledge-based firms. Typically these firms pursue a differentiation strategy: inefficiencies caused by the high level of autonomy of the units are more than compensated by meeting the specific needs and thus providing extra value for the customer. But how does the situation look in industrial mass production? In a market where global players compete by prices? Where rents are traditionally sought through standardization? In an industry whose rise was based on the systematic removal of skill and autonomy from the line worker?

### **Theory: Balance of Autonomy and Integration**

The core hypothesis is that greater autonomy leads to more problem solving by the basic units, thus by the workers or the teams. In order to avoid inefficiencies it is necessary to find a balance of autonomy and integration. Moreover, in spite of the fact that by its nature integration is limiting autonomy, integration can be

designed in such a way that it transfers the individual problem-solving capacity to the organizational level.

The basic system—which refers to the individual’s subjective theory as a specific form of strategic knowledge—has a certain structure that enables it to cope with the complexity of its environment. This structure of strategic knowledge is supposed to be transferred to the organizational level, to enable that level to cope with its complexity, too. The complexity of this more comprehensive system needs to reflect its more diverse environment, in the end being the essence of the environments of the individuals this unit consists of. Since the starting point consists of the individual subjective theories, as much of these as possible needs to be preserved on the more comprehensive levels; this calls for integration—which necessarily requires that individual autonomies are restricted by one another. On the other hand, a high degree of autonomy is necessary to enable the basic systems to act according to their subjective theories. A second limit to autonomy is set by the goals of the organization—although, in the end, these goals are also supposed to be developed from the bottom up as well if one takes seriously the challenge of coping with complexity in all its dimensions.

In a previous empirical project, part of the research program of “Reflective Organization,” I interviewed 11 consultants and managers of the Swiss and German subsidiaries of the world market leader in its segment of business software. The main tasks of these consulting units is to identify necessary organizational changes and software customization in order to enable the client-firm to work with this software. The interviews, semistructured and very intense, took one to two hours. The survey was run in winter 2005–2006. The results of this survey illustrate the autonomy–integration issue in the following sections. (See Nolte 2007, 2010.)

*Autonomy on the Individual Level as a Prerequisite for Coping with Complexity*

The starting point consists of the work-related subjective theories of individual employees. Subjective theories are strategic knowledge, which can be reconstructed in a parallel way to “objective”—scientific—theories. Thus they comprise the elements of description, explanation, and technology (Groeben and Scheele 1982). The concept of subjective theories is based on a view of the individual as constructing his or her reality in a manner that is bounded and subjective. As a consequence, the individual is to some extent autonomous with respect to stimuli from outside (Groeben and Scheele 1977). These subjective theories are only “true” (valid) for the single individual—he or she doesn’t change them as long as the contradictions do not get too obvious—but they can be improved by exchanging some of their parts for elements of “objective” (empirically tested) theories. This can be achieved by traditional learning or training, but it occurs mainly by counseling and thus evoking reflection. Subjective theories are very interesting in the work context, because due to their “technology” aspect they lead directly to action—and this occurs immediately.

Subjective theories signify that the information an individual receives from his or her environment is categorized. The more experience an individual has (whether direct, or indirect via an educational program), the more elaborated this categorization schema is. Depending on the categorization of the stimulus, a subjective theory, with its description, explanation, and technology, is triggered. Because of the “technology” part of the process the individual knows which action needs to be taken. This works without any noticeable delay—even fast enough for professional sport competitions. The argument that reflection can be fast enough even in competitive sports is well founded by empirical research run in the field of subjective theories (see Wahl 1991 regarding speed chess and table tennis) or the research program in sports at the University of Hamburg (for instance, for rowing: Lippens 2005, 2009). This is in clear contradiction to Schön’s statement: “There is not time to reflect when we are on the firing line; if we stop to think, we may be dead” (1983:277).

It may happen that a stimulus cannot be categorized mechanically. In these cases reflection is necessary, thus deriving new subjective theories from existing ones. Typically this also transpires so quickly that one can hardly notice it from outside. Only in rare cases does the individual actually need to search for external input to develop adequate subjective theories to cope with a stimulus he or she is not familiar with. This search can consist of trying to get access to “objective” theories or to the subjective theories of others—asking co-workers or consulting a newsgroup, for instance. By deriving new subjective theories from existing ones or integrating “objective” or subjective theories of others into his or her own personal system, the

individual is continually adjusting the complexity of this system to the complexity of his or her environment. Consequently, he or she is able to cope with even high levels of environmental complexity.

In order to allow subjective theories to adjust to environmental complexity, the individual must have enough autonomy to validate these theories—to test whether an action (a technology) actually leads to the expected outcome. If this is not the case, new reflection is required to adjust the system of subjective theories. This means that the individual needs a scope within which he or she can decide independently which action is appropriate in this situation, and the corresponding opportunity to make a mistake.

In the previous survey in the IT consulting business, the results indicated a high level of autonomy:

*Decision making.* The consultants reported they are given a wide scope for decision making. In the end, it is limited only by clients' demands and by decisions made earlier.

*Self-organization for problem solving.* Superiors or specialized positions (for personnel planning, for instance) get involved only if self-organization does not lead to a solution.

*Innovation.* The consultants have a lot of room for improvisation, and they state that this is also obligatory to adjust to the individual client. Improvisation would be their "daily business."

#### *Integration by Information Exchange Between Organizational Units*

The first step of integration means mainly that information about the individual subjective theories is exchanged, and perhaps intersubjective theories are even developed. "Intersubjective theories" emerge when a consensus about subjective theories is achieved—when several individuals regard the same subjective theories as valid and are aware of this fact. As a result, their actions are better coordinated. This integration is also provided by the simple fact that individuals learn from another—their specific environments, their reflections, and their actions taken—incorporating this information into their own reflection and action. Of course, the main tool is communication. It is self-understood that this communication does not need to be verbal; it can also happen, for instance, by observing or learning about the results of the actions that have been taken by others. Thus this communication incorporates formal and informal aspects. Examples of a formal exchange of subjective theories can be found in continuous improvement workshops. Informal aspects play a role in break talks or in close collaboration. The consultants' statements in the previous survey can be summarized as follows:

*Self-organizing substituting for formal structures.* Formal hierarchy is of no practical importance; organizational structure resembles a network, not a pyramid; high importance is given to informal organization; typically a project team is established by self-selection/asking co-workers if they wish to join; competence of teamwork is mandatory; close collaboration is sought in case of a problem; co-workers participate in decision making.

*Very dense communication.* There are many meetings; meetings go beyond project limits; meetings have space for informal communication; clients' co-workers are included in the (informal) communication; spatial closeness encourages communication; communication skills are essential for project managers; several kinds of knowledge databases are assembled.

*Specialists are working closely together.* Typically business consultants and IT specialists are working together in projects; co-workers of the clients are part of the project team; specialists are members of different teams at the same time; project managers are generalists.

#### *Integration by Rules and Monitoring*

If a firm tries to pursue a competitive advantage based on the problem-solving capacities of the workers, the rules and the monitoring system of the whole also need to be founded on these cognitions, since rules represent constraints for actions taken on the individual level. If these constraints are also derived from individual subjective theories, the specific conditions of each position/unit are taken into account in these rules and the monitoring system. Thus the complexity of their specific environment on the one hand and the complexity of the position's/unit's problem-solving process enabling it to cope with this are preserved, too. Of course, it is necessary to "condense" the complexity reported from the individual level—otherwise the system would explode in an endless loop of increasing complexity. This process of condensation consists in

developing intersubjective theories, consisting of shared assumptions and agreement on which actions need to be taken and perhaps how.

Monitoring means receiving information about the actions taken on the individual level and comparing them with the rules. Thus monitoring is a function directly derived from “rules” and the communication mentioned above. This also means that “monitoring” depends on well-functioning communication. The consultants reported in the earlier survey about the following elements:

*Close monitoring of billable days.* There is a rigid system of management by objectives, in which only the (very high) number of billable days is taken into account; monitoring is similar to someone who is self-employed; importance is attached to meeting the goals; weekly reports, time registration, forecasts, and contracts are employed.

*Strong corporate culture.* In case of a goal conflict between units, solutions are found informally; there are hardly any standards or defined processes; subordinates are asked to take care of their own interests (for instance, regarding the choice of project), but during the project the firm’s interest has priority; the style of situational leadership is adjusted to the individual co-worker; decisions are made with discussions; a very strong culture is established encompassing mutual help; there is very low power-distance and a strong feeling of mutual belonging; few optimize on self-interest alone; and an organization of trust emerges, so that problems can be dealt with frankly. Thus monitoring is implicit in the cultural matrix despite the impression that there is no monitoring at all.

#### *Integration for Coping with the Future*

A strategy to build a competitive position upon employees’ problem-solving capacities means to integrate their expectations regarding the future, too. This results in planning.

Beside this, organizational learning can provide individuals with technologies to cope with expected future complexity. The term “technology” refers once again to the aspect of subjective theories that leads to action. These technologies may be derived from “objective theories,” from other individual subjective theories, or from intersubjective theories. It is also possible that individuals generate their private technologies after being exposed to the expectations regarding the future of others. The interesting management challenge is to establish a system that leads to a quasi-automatic development of subjective theories oriented to future complexity.

In the previous survey the consultants’ statements regarding coping with future complexity covered these two aspects as follows:

*Organizational learning.* In this industry (IT-linked consulting) strong organizational learning is a prerequisite, as is continuous learning; tacit knowledge is transferred by close collaboration; learning on the job is common; project reviews and sales cases are employed to support organizational learning.

*Subordinates participate in planning.* Each year the head of a business unit drafts a business plan (encompassing strategy, focus, development of the team, and qualitative goals) that is discussed in a team meeting and possibly changed before it is transferred to the next level of hierarchy; the ideas of the project managers are taken into account to some extent in the planning, and sometimes also those of the ordinary consultants.

### **Methodology: Structure-Laying Technique**

A qualitative approach seems to be appropriate since this current research project is explorative: It aims to identify possibilities to balance autonomy and integration on the assembly line level. As a side effect it can provide advice for adjustments of the Volkswagen-Weg. Moreover, the works council (which needs to agree on any survey involving interviews with workers) wished to minimize the exposure of the work force to questionnaires. The management as well as the works council preferred the kind of problem-centered interview I proposed:

Since the focus of this project is the relationship between work organization and problem solving and thus on a kind of strategic knowledge, I decided to use a simplified form of structure-laying technique (e.g., Flick 2009). The core idea of this interview technique is that the interviewer gives a stimulus (for example, a problematic situation typical of everyday worklife) and the interviewee describes how he or she

cope with this problem, such as the kind of strategies he or she uses to solve it. This initially takes the form of an ordinary problem-centered interview; then the interviewer categorizes it in a general manner, and one or two weeks after the first meeting the interviewer presents the categorization on cards, where the logic of the argumentation given in the interview can be visualized. The idea is to make the subjective theories explicit and to give the interviewee the chance to check if his or her subjective theories are presented correctly. It is important to offer the interviewee an opportunity to change the content or the logic the interviewer has interpreted from the initial interview. This way the structure-laying technique is a tool for validation.

This technique has been developed in interviews with teachers and athletes, typically with interviewees with some time flexibility. The current survey focuses on assembly line workers. It was impossible to get the same respondents off the assembly line twice within a precise time frame for meetings of at least one hour. This made it necessary to simplify the structure-laying technique so that the initial interview and the validation both take place as part of the same meeting. The solution was to apply elements of the popular discussion-facilitating method “Metaplan,” in which arguments are written down on cards and put on large paper walls. One step in this process is to reorganize the cards according to the rule that the person who had originally given an argument is the “owner” of the card and can decide where it is supposed to hang.

To be able to reveal the subjective theories and validate them within the same interview session, the interviews were conducted by teams of two: one interviewer introduced the problem setting and kept the narrative going by asking questions (like “What do you do next,” “Who do you involve,” and especially “Why.” The second, an assistant, wrote down the arguments and put them on the wall paper so that the interviewee could see them while talking. While doing this, the assistant tried to create a visualization of the structure of the respondent’s argument by the placement of the cards. After about two-thirds of the available time the actual interview stopped and the validation process started: the interviewee was asked to look at the cards and correct whatever did not present his or her ideas properly, with the possibility of adding more cards. Typically the interviewee resumed the explanation when a topic was mentioned that was especially important for him or her. Thus the argumentation conveyed in the interview became more elaborated. Sometimes the interviewees asked to express arguments differently or to remove cards from the wall paper. Going through the arguments on the wall papers was also an opportunity for the interviewer to ask whenever he or she was not sure if he or she had actually understood the argument.

It turned out that this simplified structure-laying method worked very well since all the interviewees had already taken part in group discussions facilitated with Metaplan, so the wall paper, the cards, and the role of a second person to take notes on these cards and rearrange them were familiar.

This first wave of interviews was supposed to take place as close to the start of the Volkswagen-Weg as possible. A second wave is planned for spring 2010, a third one for fall 2010. The Volkswagen-Weg is introduced incrementally. In practice there has been a delay in getting it to work, caused by lack of excess capacity: although the world economy is suffering from one of its most serious crises since the 1930s, the Volkswagen plant is operating at a high resource utilization. This is due to the artificial demand caused by the various “cash-for-clunker” programs around the world. The bottleneck has developed at the role of the team spokesperson, which is crucial in the Volkswagen-Weg. These people need to be trained, and they need to have sufficient time to fulfill their extra tasks. Due to the high workload, team spokespeople were not trained as originally scheduled, and they cannot depend on getting time off the line to do their extra jobs the way the role was originally planned in the Volkswagen-Weg.

Although it is surely very favorable that plant utilization is very high, this also had a negative impact on the number and length of interviews in the first wave: after several rounds of bargaining, I was allowed to run 16 to 20 interviews of 60 minutes with assembly line workers from the four assembly lines ML 1, ML 2, ML 3 and ML 4 (ML = *Montagelinie* = assembly line.) From each assembly line I was supposed to get four or five interviewees. Since discussion continued until the works council and the privacy officer agreed, the interviews did not take place before November 30 and December 1, 2009. The research was very carefully supported by the unit that is in charge of implementing and developing the Volkswagen-Weg. That unit contacted the shift supervisors and asked for volunteers, and 16 interviewees were eventually selected. They came from the morning and the afternoon shifts of the two days and represented the four assembly lines. It turned out that 14 of these 16 interviewees were team spokespersons, one was a works-council member and

worked only a quarter of his work time on the assembly line, and only one had no special tasks (but he had finished his apprenticeship only recently). It also turned out that sometimes the original interviewees could not come to their appointments because of a lack of personnel on their teams. In these cases either the shift supervisors or the Meister sent substitutes.

The population of this research project was supposed to be the assembly line workers at the Volkswagen plant in Wolfsburg. The sample for the interviews consists mostly of team spokespersons, who are ordinary assembly line workers but with some extra tasks. In theory, they are off the assembly line an average of two hours a day to do these tasks, but when personnel are scarce they work full-time on the assembly line. By education and similar attributes, team spokespersons do not differ from other workers. The only difference is that they are nominated by the team and have to be approved by the management, so one can assume that they are regarded as trustworthy and reliable by both sides. After having become team spokespersons they are supposed to get training to fulfill their extra tasks, including how to facilitate team discussions. Team spokespersons do not have any supervising tasks, and in general their wage is just a little higher than that of the other workers. Viewed as a sample, then, the team spokespersons can be assumed to represent a subpopulation that differs from the universe of assembly line workers by virtue of being more trustworthy and reliable and having higher communicative skills. Since the research focuses on the balance of integration and autonomy—which differs between the assembly lines—and there is no bias derived from having different proportions of spokespersons across the lines, one can assume that the predominance of team spokespersons in the sample will not have a substantial impact on the results. Interview comments indicate that team spokespersons predominated in this survey because it was easier for them than for the other workers to get some time off the assembly line.

I conducted the interviews with assistance from four students from master's programs in management consulting or business management. Since problem-centered interviews require the interviewer to be open to each move the interviewee wants to take and to be very familiar with the topic the interview focuses on, we had trained for these kind of interviews with Emden students who had work experience on the assembly line in the Emden Volkswagen plant. It turned out that this was sufficient preparation for the actual interviews. Except for me, the interviewers were not familiar with the responses of the IT consultants in the earlier project described above.

## **Results: Automation and Time Perspective Influence Autonomy and Integration**

The four assembly lines differ tremendously. ML 1 started to operate about 18 months ago. It is designed to be a “flexible” line, on which it is possible to produce different models at the same time, although because of demand it currently produces only one model. Its working conditions are considered to be good; the work cycle is within the ordinary range, but on the upper end. The workers were recruited from other Volkswagen assembly lines for this new line.

ML 2 has the reputation of being an ordinary assembly line. It has shorter work cycles than ML 1, and it can produce only one model at a time.

ML 3 has not gone through major changes since the early 1980s. At that time it was the benchmark for highly automated car production. Later it became apparent that the degree of automation was too high, since it was able to produce cost-efficiently only at close to 100% of capacity. Today it remains highly automated. The work cycles are relatively short, and the working conditions have a bad reputation: crowded, hot, loud, and stressful. It can produce only one model at a time. Teams there have undergone a lot of ups and downs recently: first the number of workers was supposed to be reduced, and a lot of personnel left for other assembly lines. It then turned out that the number of remaining workers was too low. Currently additional workers leased from a Volkswagen plant in a different town are working on this assembly line. They will return to this other plant in the future.

ML 4 is a special case, since it was an independent firm within the Volkswagen conglomerate until the end of 2008, even though it occupies the same hall as ML 1. This firm—called “Auto 5000”—was started in 2002 as an experiment. Only the previously unemployed without any experience at car manufacturing were allowed to apply for jobs there. One out of 10 applicants was hired. In the beginning they had three hours a week of “qualification time,” at the end two. The workers could fill the qualification time with topics they



regarded as important; a few were obligatory. Typically they organized their qualification within their teams. They had a lot of support for these qualifications—for example, elaborated knowledge management tools. The teams used to have a high degree of autonomy, with the Meister having rather general management tasks. This assembly line has only a fourth of the typical number of robots. The work cycle is about twice as long as on the other lines, and the ratio of support to production units is very favorable. The entire firm was set up in such a way that close communication between production and support units took place. The workers were given a quota for each shift; if necessary, they were supposed to work additional hours without extra pay—but this never happened. The salaries were lower than in the rest of the Wolfsburg site, the working time longer. Although their performance indicators cannot be compared in detail, one can assume that the production cost per car was lower at Auto 5000 than on the other assembly lines—even if one factors out the lower wages. (For detail see Schumann, Kuhlmann, Sanders, and Sperling 2006.)

Since January 2009 Auto 5000 has been integrated into Volkswagen. This means that the payment, the working time, the role of the teams and the Meister, and so on are formally aligned with the assembly lines ML 1 to ML 3. The qualification time has been abolished as well as the quotas for the number of cars produced on each shift. One research question is to see if the Auto 5000 structure continues to exist informally. This is especially interesting since Volkswagen-Weg incorporates elements of Auto 5000 even though it was not developed from the experience of the Auto 5000 project.

The results presented in this paper are only preliminary; moreover, it is not yet possible to compare the interview statements with performance indicators of the different assembly lines. But one can assume that the hypothesis that greater autonomy leads to more problem solving by the basic units (the workers or the teams) is supported. But, of course, one needs to have a closer look.

In Table 1, the assembly lines are sorted according to the degree of autonomy of the workers or the teams. At ML 4 the experienced level of freedom is higher than the formal level. For instance, the workers have not yet noticed that since January 2009, when Auto 5000 was integrated into Volkswagen, the Meisters have much more power and the teams much less. So ML 4 is located on the right end of the table, while ML 3—the highly automated assembly line with the short work cycles—is on the left.

## **Discussion: The Quality of Problem Solving Increases with Autonomy**

The problem-solving level is higher when the degree of autonomy is also relatively high (ML 1 and ML 4). In the case of ML 3 and to some extent ML 2, external control dominates, and workers seldom act on the basis of their reflections. This is also reflected in the issue of how much the other teams are taken into account. An extreme example is the story reported from ML 3 that the solutions of some teams hinder the work of others. On the other end of the spectrum, teams search with one another for joint solutions, even if this means extra work for them. Similarly with communication concerning the entire assembly line or the plant in general, the workers who are more involved in problem solving also communicate more with other teams or with workers from other lines. At this point one must stress that the “objective” conditions are similar for all of these workers, since they are working according to the same rules in general. One exception must be made: since they are located closer to each other it is easier for ML 1 and ML 4 to communicate, while ML 3 is located on the edge of the site, very far away from the main production hall.

TABLE 1

	ML 3	ML 2	ML 1	ML 4
Problem-solving	Teams involve superiors solve problems and develop ideas	Teams solve their problems and develop new ideas with some involvement of superiors	Developing new ideas and problem solving are part of the everyday job	High level of individual problem solving
	No communication with other shifts about solutions	Communication with other shifts about solutions	Problem solving and developing of new ideas are done in teams	Joint solutions over the different shifts are sought
Integration by information exchange between organizational units	Hardly any communication with other teams	Primarily communication with teams of the other shifts with the same tasks (sometimes requiring extra work); hardly any communication with other teams; hardly any knowledge of (and no interest in) the entire assembly line or the plant	Good communication with teams of the other shifts with the same tasks (commonly requiring extra work); hardly any communication with other teams; hardly any knowledge of the entire assembly line or the plant	Good communication between the teams and across shifts; good knowledge of other parts of the assembly line and the plant
	Only scattered knowledge about the entire assembly line or other parts of the plant	In case of a problem, direct communication with the unit in charge, ignoring the official line of control; superior is only informed	In case of a problem, direct communication with the unit in charge, ignoring the official line of control; superior is only informed	Used to receive a lot of management information, but not any more  In case of a problem, direct communication with the unit in charge, ignoring the official line of control; superior is only informed
Integration by rules and monitoring	External control	Quantitative self-control due to reputation and the impact on working conditions. Informal power is important	Quantitative and qualitative self-control  Impact on working conditions is important Power of the team is important	Currently transitioning from self-control (assisted by clear goals and feedback) to external control
Future oriented integration: organizational learning and planning	Personnel turnover hinders learning	Lack of slack hinders organizational learning Smaller steps are better because of feedback loops	Lack of slack hinders organizational learning Hardly any resistance to change	Past experience of working on problems is very important for solving new problems

Similar observations can be made about the differences regarding rules and monitoring: while the teams on ML 3 seem to have difficulties in developing effective solutions and barely communicate, in effect they are calling for external control. This relationship between weak innovation and external control looks rather like a textbook example. On the other hand, there are the other assembly lines with

increasingly efficient problem solving and a higher degree of self-control—and at the same time a better overview of the production process due to their communication with other teams, extending possibly to workers from other parts of the plant. The different motivations for self-control are interesting as well: they can be based externally on (informal) appreciation by others (ML 2), internally by the desire to improve (ML 1), or a sports-like competition between teams (ML 4). In the case of ML 4, one needs to take into account that until the end of 2008 the teams were necessarily self-controlling: each shift had to determine for itself how it would meet its quota. This is also the background for the practice of the teams on ML 4 having received team-specific performance indicators. One other big difference between ML 3 and ML 4 should be stressed again in the context of rules and monitoring: ML 3 is highly automated, ML 4 relatively less so. When it was still Auto 5000, labor on what is now ML 4 was also cheaper than normal for Volkswagen. So more autonomy—and thus fewer external rules and less monitoring—was less risky at Auto 5000 than, for instance, on ML 3. ML 4 is currently experiencing the introduction of more external control (for instance, MTM). It looks like (another) textbook example in that, corresponding to this process, general tasks (like cleaning up the workplace) go undone; in other words, the degree of commitment has gone down.

When Auto 5000 was set up in 2002, it was designed as a learning organization. This still has some impact on the current situation, when, for instance, one interviewee stresses the importance of past problem solving for the present. The teams of Auto 5000 learned explicitly to go through PDCA circles whenever they worked on a problem. In other parts of the factory, problem-solving circles are seldom taught explicitly. However, the experience at Auto 5000 that the results of PDCA workshops were used for intensifying the work has turned the abbreviation “PDCA” into a taboo.

It is interesting that in general it is reported that the resistance to organizational change is typically only temporary and easily overcome. It looks as if the main obstacle to implementing the Volkswagen-Weg and thus a work organization focusing on the problem-solving capacities of the workers is the current market success of Volkswagen: it is difficult to have continuous improvement workshops and give the team spokespersons the time needed for tasks to carry out self-organization within the teams, with a high level of resource utilization. In the end, this points back to the argument at the beginning of this paper: the benefits of a knowledge-based strategy need to overpass the costs of the slack that this strategy requires.

## **Conclusion: A Knowledge-Based Work Organization in Mass Production Is Possible**

In general the results show that a knowledge-based work organization can be found not only in an industry following a differentiation strategy like the IT-consulting case, but also in one that targets cost leadership, such as a car producer—even in highly standardized assembly line work. But the case of the Volkswagen-Weg also points to some limitations.

Reflection and acting according to the results of these reflections or by problem solving is clearly possible on the level of the individual assembly line workers and their teams. The workers reported a lot of examples, one even stating that “developing new ideas is part of the everyday job.” Compare this with an excerpt from the interviews with the IT consultants: “Innovation is part of the everyday job.” The more autonomy the workers on the assembly line have, the more independently they develop new ideas. When the level of the autonomy is low (as in the example of the highly automated ML 3), superiors are more involved.

The results regarding information exchange between organizational units point in the same direction. In the case of the IT consultants the main issue was spatial distance. For the assembly line workers the most serious problems were caused by time differentiation: the lack of communication between teams from the different shifts. The more autonomous teams were more interested in communicating with the teams of the other shifts and thus searching for self-organized integration. For this purpose, even extra work is common. But even the more autonomous teams like those of ML 1 have difficulties in learning about how the work is done on other parts of the assembly line, not to mention the entire plant. So autonomy goes together with an interest in getting an overview of the process or in horizontal communication, but this may fall short of actually achieving it. ML 4 is a special case in this regard, since Auto 5000 was set up as a learning organization, so being familiar with the entire production process was fundamental. Aside from this, one can

assume that the workers of Auto 5000 were very interested in the other parts of the plant, since they had heard about the higher wages and shorter working hours there. Vertical communication in event of a problem does not follow the line of control: in general, the teams try to solve problems by themselves. If it goes beyond their means, they contact the specialists directly, and the supervisor—the Meister—is only informed. In general, all the teams state that communication within the team is good, although it became obvious that there are also outsiders in the teams and that the closeness within the teams differs.

Closeness within a team can help to coordinate by fostering a strong organizational culture with its shared values and norms. The reports from ML 3 were quite revealing in this regard: it is not only that this line offers a lower degree of autonomy but also less closeness within the teams, due to the high proportion of leased personnel from other plants. So it is not surprising that more difficulties are encountered in this line in solving problems autonomously and that workers call for external control. We were offered an anecdote that a team on one shift uses one trolley for screws on one side of the line, a team on the second shift uses two trolleys on both sides of the line, and a team on the third shift does not use the trolley at all but puts the screw boxes on the ground (and does not put them back into a trolley at the end of the shift)—and thus hinders the next shift—and that the three teams have not managed to find a joint solution by themselves and therefore demand that supervisors solve this problem for them. This is not surprising after learning about the history of these teams. This example shows that, on this line, the teams do not try to have impact on the rules. Due to the ups and downs of this assembly line in the past, its uncertain future and the high proportion of temporary workers from other plants, the degree of commitment seems to be relatively low. On ML 2—an “ordinary” assembly line—self-control is important but the incentives for it are external. This is apparent from the fact that the teams on this line do not really monitor the quality of the ideas they submit, and that the motivation to work on problems is to look good. On ML 1, which provides a higher degree of autonomy, self-control covers not only quantitative goals but also quality monitoring. In this case the team is more important than its individual members. This reinforces the role of organizational culture for coordination. ML 4 is currently in the process of change from self-control, supported by clear goals and feedback, to external control.

Although monitoring and coordination on these four assembly lines differ tremendously, corresponding to differences in the degree to which teams engage in self-control, there is nevertheless a clear difference from the results of the study of IT-consultants: the teams on the assembly lines have little impact on the rules and the standards of monitoring. In the end, it is only a question of the extent to which they follow the letter of these standards or rules as against also caring about their meaning - and thus, for instance, take the quality of ideas into regard as well. So the impact of the assembly line workers on the rules and monitoring is in the interpretation they give to externally set rules and standards, not in formulating them themselves. Here we find a difference in the case of IT-consulting, where, even though the impact of the individual consultant on the standards and rules was minor, it definitely existed. The main reason for this was that there were hardly any explicit rules, but rather most were derived from organizational culture.

There is also a big difference between IT consulting and car manufacturing that goes beyond the interviews: the impact of institutionalized co-determination. In IT consulting there was only a very weak works council, which had little impact on the rules, the standards, or the monitoring for them. At Volkswagen the rules and the procedures for monitoring are always set up under conditions of full co-determination, which means that the works council agrees to them, typically as the outcome of a bargaining process. Thus the teams do have indirect bottom-up impact on rules and monitoring.

Regarding organizational learning and planning the problems stemming from the lack of slack become obvious: in the current phase, as the plant is operating at a high level of resource utilization, labor from other Volkswagen plants is joining the teams. These workers are able only to do a minimum number of jobs, so rotation, which is one of the main planning domains of the teams, breaks down. Organizational learning is also hindered, as we saw before. Organizational learning is an essential part of the concept of Volkswagen-Weg, but the slack required for it is unavailable in times of high customer demand. Taken all together, one can conclude that a knowledge-based work organization can also be found in mass production but that there also some limits and distinctive characteristics:

Reflecting and acting according to the results of the reflection are possible at the level of assembly line workers and their teams. Communication between the organizational units can be structured to some

extent even in the context of assembly lines with rigid work cycles, but personal commitment is necessary. Such communication is also essential to avoid absurd results due to autonomy, as we saw in the anecdote about the trolleys. Top-down rules and monitoring are given, while one can assume that the quality of self-control rises with the autonomy provided. For self-control to actually function there is also a need for permanent teams with a long-term perspective. There is hardly any bottom-up impact from the teams in setting the rules and the standards of monitoring. Only where the team has a strong organizational culture can it monitor quality. But one needs to see the context: rules and the standards of monitoring are defined in a co-determined process, so, while individual workers are not consulted, representatives of them are. Organizational learning and incorporating workers into planning calls for slack, which is not the case at the present time.

In general, one can say that these interviews administered in November and December 2009 provide initial evidence for a knowledge-based work organization in mass production. They also show, however, that the model needs to be adjusted to the specific environment of the firm, including legal and cultural factors like co-determination and the market factors that put a price on the maintenance of slack. It will be interesting to go deeper into the applicability of the model by validating the subjective constructions reported in the interviews with objective performance indicators. In addition, a second wave of interviews is planned for spring. The objective is to see the changes in perceived work organization when the Volkswagen-Weg is implemented to a fuller extent.

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