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## **Organisational learning and knowledge sharing: The use, documentation and dissemination of work process knowledge**

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The European Conference on Educational Research (ECER) is a conference of the European Educational Research Association (EERA).

Abstract: The concept of organisational learning as differentiated from individual learning is often lacking of theoretical clarification and empirical evidence. This contribution presents findings from the 5th FP project OrgLearn, i.e. results of an empirical investigation into processes of organisational learning in large chemical companies within 4 European countries. One essential content of measures for organisational learning found in our empirical investigation are methods of knowledge sharing and knowledge management. In particular, a case study from Germany is presented which describes both a managerial and a participatory approach.

### **1 Introduction**

According to German managers the 'learning organisation' does exist to a high degree in German companies. A survey on the use of new management concepts in 102 medium and large companies in Germany showed that for 90 per cent of them the concept of the 'learning organisation' was known and 70 per cent said they used it (see Perlitz, 1997: p.9). In another company survey, the concept of the 'learning company' was seen as important by 90 per cent of the sample and 49 per cent said they had implemented it (Bullinger et al., 1997: p.81).

The problem of these empirical surveys is that they only sound out the interviewees on 'buzzwords'. These managers may only be attributing learning organisation characteristics to themselves. They are more a reflection of the image the managers have of their companies rather than what actually happens. This impression is reinforced if we look more closely at the concepts managing directors have of a learning company or a learning organisation. The German management magazines (*Manager Magazin*, 1995: pp.141-144, and *Personalführung*, 1995) reported that several companies claimed to be learning companies. One of them saw itself as a learning company because it had significantly reduced its 'door-to-door times, set-up times and stocks'. Others regard themselves as learning organisations because they 'deal with cost systems, report systems and special orders in project teams'. The 'introduction of group work and flat hierarchies' was also mentioned as evidence as were 'measures for continuous improvement', 'customer orientation', 'lean management' and so on.

Apparently, it is necessary to relate empirical findings in the realm of organisational learning to theoretical considerations. Terms like ‘organisational learning’ ‘learning company’ etc do not make much sense if they are solely identified with a number of individuals who learn. In this paper the framework of an empirical investigation into processes of organisational learning in the European chemical industry is presented. It is based on the question how organisational learning can be differentiated from pure individual learning. Concepts which give answers to this question are briefly mentioned. These concepts have been transformed into criteria under which it is justifiable to speak of a ‘learning company’ as differentiated from learning individuals on one hand and corporate restructuring on the other hand.

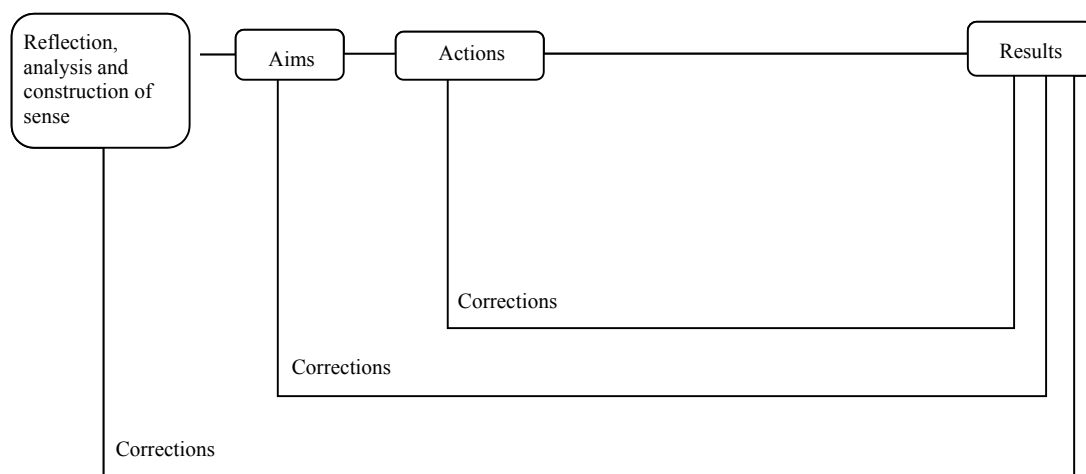
## **2 Considerations towards a framework concept for investigating measures and processes of organisational learning**

Many definitions of organisational learning emphasise that individual learning processes are seen as a precondition for organisational learning. However, they also emphasise that learning by a company is different from and should be regarded as more than the sum of individual learning processes (cf. Probst & Büchel 1998: 19; Senge 1997: 171; Sonntag 1996: 67). How could that be?

One of the early answers to this question stems from Argyris & Schön ((1978). According to Argyris & Schön organisational learning takes place within a defined framework, which is set by the collective theories-in-use of the members of the organisation. This framework describes also an ideal state of the organisation. Argyris and Schön have built three levels of organisational learning on this basis: the single loop learning, the double loop learning and the deuterio learning.

In figure 1 the concept of deuterio learning is interpreted by the St. Gallen School of Economics in Switzerland (Gilbert Probst et al. 1998) as reflection, analysis and sense-making on a company level, as learning about individual learning processes which happened in the company. In accordance to Chris Argyris and Donald Schön we speak of a learning organisation especially if this organisation engages into processes of double-loop and deuterio learning. This means that the individual not only receives a feedback by chance concerning his or her (unsuccessful) work acting so that he or she might draw conclusions from this feedback in order to avoid futures mistakes (single-loop learning). Organisational learning in the sense of double-loop and deuterio learning implies that the organisation has created a *structure* through which individual learning is

permanently stimulated, documented and evaluated. It is this organisational structure by which organisational learning is differentiated from pure individual learning. In other words: organisational learning changes the *structures* and not only the *people*. The structures regarded as all the personal, interpersonal and non-personal preconditions of an organisation (cf. Neuberger 1991).



after Argyris/Schön, 1978

Figure 1: Deutero-learning (source: Probst & Büchel 1998: 38)

Such a structure is only put into practice, however, if organisational learning is not only a formal demand but a *cultural phenomenon* - an idea which is represented by Edgar Schein (1992, 1995) who conceptualised a culture of organisational learning: ‘a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be taught to new members as the correct way to perceive, think and feel in relation to these problems’.

How to implement such a culture of organisational learning? Peter Senge (1996, 1997) gives an answer to this question by describing elements of a *systemic interventionist management practice*.

All of these concepts claim to point beyond the individual learning of the employees. As a common denominator they share their focus: the companies’ practice of systemic reflection and change of the company culture towards learning. This should reach the

level of considering the *relationship between enterprise and society*, as Harald Geißler (1996) pointed out.

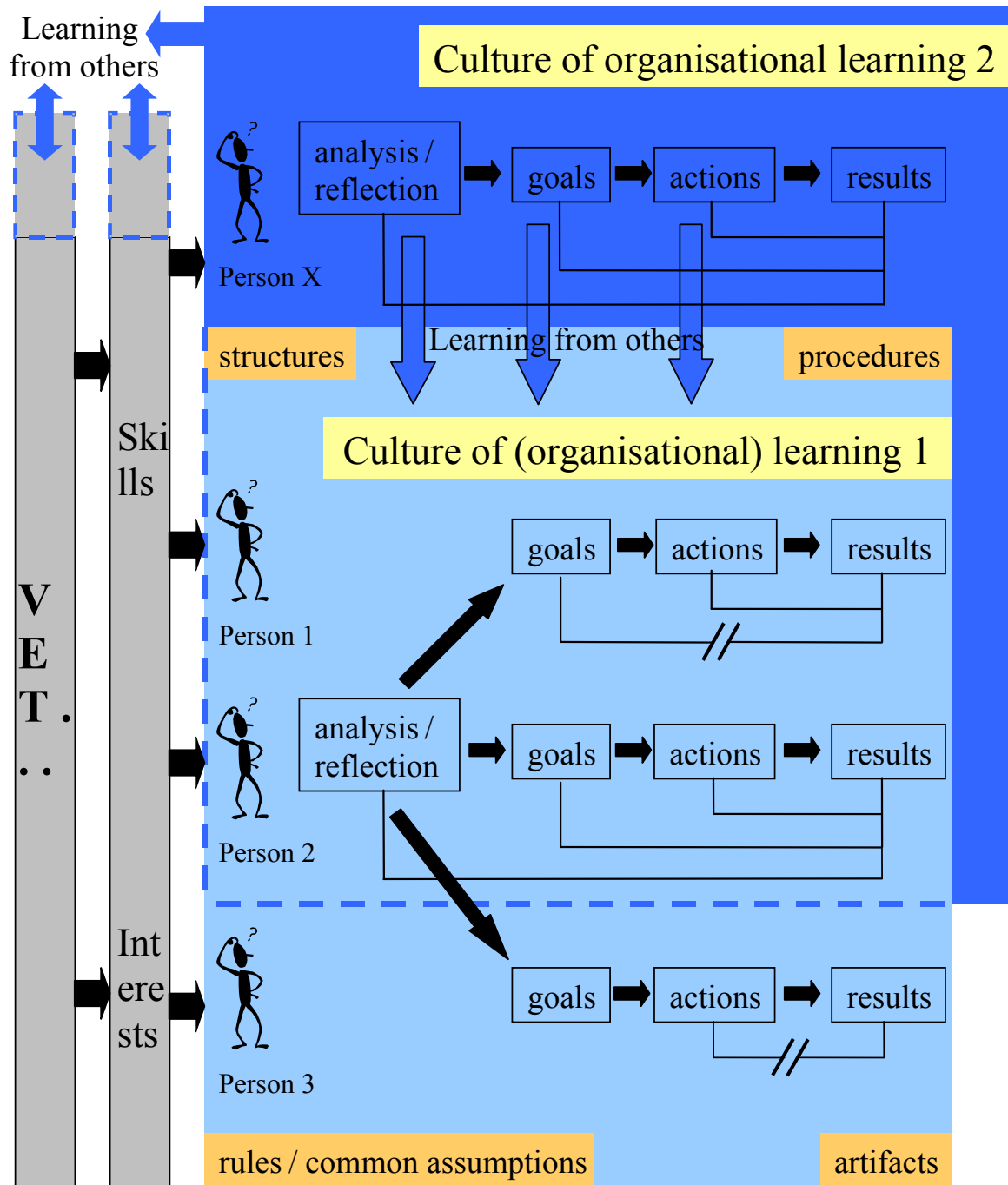


Figure 2: Organisational learning as a change of culture

If we integrate the concepts mentioned into each other then the subject of empirical research about organisational learning becomes clearer. The main question is how companies transform their current culture of learning which contains elements of learning-refusal, individual and organisational learning into a culture of learning which stimulates individual learning processes and benefits from them on a organisational level. Such a transformation is visualised in figure 2.

It has to be discussed how the structure of a learning organisation (the structural dimension of organisational learning) may influence processes of learning within the organisation (the process dimension of organisational learning) and how these learning processes lead to an improvement of the organisational structure again. The most relevant criteria derived from a literature review (Fischer & Röben 2001) for this are indicated below:

**Criterion 1. Organisational work routines are being evaluated and improved.**

**Indicators**

- 1.1 The organisation's overall market position, strategic objectives and business plan are under constant review and revision.
- 1.2 Problem-solving groups (either task groups, or self-managing teams) identify and solve problems in standard operating procedures and make recommendations for altering them.
- 1.3 Finding ways of improving performance, and communicating these when necessary to colleagues and management, is an accepted part of everyone's job.
- 1.4 Organisational developments that create opportunities for learning are integrated into the work process.
- 1.5 There is a willingness to change procedures to meet quality management and continuous improvement requirements.

**Criterion 2. Formal and informal learning processes are being evaluated and improved.**

**Indicators**

- 2.1 There are formal inquiries into organisational learning processes in order to identify learning deficiencies and to draw conclusions from them.

- 2.2 People are prepared to challenge assumptions, to question and exchange ideas to gain maximum learning.
- 2.3 The active exchange of ideas and information is frequently and actively sought across boundaries.
- 2.4 Learning processes are stimulated, supported, evaluated and results disseminated.
- 2.5 Managers take on the roles of coaching, mentoring and facilitating learning.
- 2.6 A plurality of modern forms of learning exist.
- 2.7 Roles and careers are flexibly structured to allow for experimentation, growth and adaptation.

**Criterion 3. Transformations are occurring in the culture of the organisation.**

**Indicators**

- 3.1 Staff perceive a difference between the organisation's current standards and what they ought to be.
- 3.2 Staff feel personally committed to closing the gap.
- 3.3 Staff are empowered to change, and are actively participating in the change process.
- 3.4 There is a readiness to change the structure of work and learning.
- 3.5 There is a readiness to introduce and improve artifacts in order to increase learning opportunities.
- 3.6 There is a readiness to change rules and common assumptions.
- 3.7 There are feedback loops in place to evaluate any intervention aimed at achieving change in response to external challenges.
- 3.8 There are systems in place to allow people to make different contributions and draw different rewards.

**Criterion 4. Knowledge is being created within the organisation, at different levels (not only by the managers/scientists) and it is being shared within the organisation.**

**Indicators**

- 4.1 Knowledge creation projects are officially sponsored throughout the organisation.

- 4.2 Informal knowledge creation is encouraged.
- 4.3 There is a formal system for distributing knowledge throughout the organisation, and everyone has up-to-date information about the performance of the company against its objectives.
- 4.4 Systems and structures are in place to code, and store knowledge and to make it available to those who need it and who can use it.

**Criterion 5. Learning from the environment is encouraged and systematically evaluated. The results are assimilated and accommodated to the company's objectives and local constraints and opportunities.**

**Indicators**

- 5.1 Inter-company learning is an accepted part of the company's overall policy.
- 5.2 Boundary workers act as environmental scanners.
- 5.3 External audits by private and public bodies to evaluate the company's performance are seen as valuable learning opportunities.
- 5.4 There are systems and procedures for acquiring and sharing information from outside the company.
- 5.5 Internal training is outsourced to external training providers when doing so offers an outsider's perspective on the company's performance.
- 5.6 Informal and formal networking is encouraged.

### **3 Organisational learning and knowledge sharing in the chemical industry: a case study from Germany**

Following the above mentioned criteria several cases of organisational learning have been identified in those four large chemical companies who participated in our study (see Fischer & Röben 2002). In this section a case study is introduced which describes the participative production of the operations manual for running the chemical plant. The enterprise was intensely confronted with the impact of the company's policy of promoting job cuts using early retirement arrangements – the loss of experience and know-how in the shift teams due to the loss of experienced workers. In order to counteract this loss of knowledge and experience, a project was launched in 1998 in collaboration with the training division that envisages the participative production of an

operations manual for all process stages of that plant. The operations manual became a kind of organisational memory for a major proportion of the know-how essential for operating the plant. It became the central basis of a skilling system and was linked to the salary system. Currently the concept is distributed to a lot of other plants at the site of company G.

However, the project had its origin in a particular plant – a so-called steam cracker. A steam cracker is the starting point for a chain of chemical production stages and outputs the first intermediate products (mainly ethylene and propylene) that are then delivered to other chemical plants and to the ethylene network system in Germany. As intermediate products, ethylene and propylene have to go through further production stages before they are made into the many synthetic materials that the company markets. The steam cracker produces on a continuous basis and is able to vary its production volumes or products within narrow limits only.

### **Learning at the steam cracker – Producing the operations manual by the work force**

In the chemical industry standard operating procedures are determined and documented in plant-specific operations manuals. These manuals are of much importance as they contain knowledge which is needed for running the plant, complying with safety regulations and for trouble-shooting. Usually, these manuals are produced by engineers who have an academic education and often have constructed the technical installations of the particular plant in question. Those engineers, however, usually do not have acquired much experience in running the plant day by day. To our knowledge, it was the first time that normal shift workers were charged with the production of an operations manual for a rather complex chemical plant.

Drafting and editing the operations manual for the steam cracker is organisationally controlled. At regular intervals, a team comprising one beginner, an experienced worker and a moderator meet in a container near the workplace and draft the description for a particular process stage. On average, every team has three up to four weeks time for writing their particular chapter. The manual explains how each process stage functions, how it is operated and which safety instructions must be complied with. The team is also responsible for producing exemplary questions which will be used for a technical examination that is going to be executed with the help of the handbook. The entire operations manual consists of 35 single folders (each containing one chapter).

The team starts its work with the collection of all relevant material (i.e. technical drawings, flow charts, list of devices) and information about a particular process stage. After doing so they start writing the text at a meeting. Whenever they have finished a section they pass it to the shifts requesting comments and corrections. By the next meeting, the team tries to clarify anything they do not know by talking to colleagues on the shift, the shift foremen, the day foremen or even the works management. It can be stated, that a very intensive discussion about the function of technical devices and the operation of the plant takes place during the work of the team.

The greatest learning effect arises in joint discussions within the manual team and in discussions with experienced workers on the shift. The shift foreman does not usually send the excellent workers to the container where the manual is produced, because there are only a few very experienced workers on the shift. However, direct participation of shift workers ensures that the manual is easy to understand.

“It’s easy to understand because you yourself are doing the writing and there aren’t many complicated words in it.” (Shift worker interview)

Employees who were not involved in producing the manual also confirm that the text is easy to comprehend.

The learning that occurred when writing the operations manual is without doubt the most intensive form of learning. The very act of writing compels the workers to think very carefully and precisely about what actually occurs in a particular process unit. Most workers understand rather quickly how a process unit is operated or what its most important function is when engaging in these kind of questions, whereas during continuous operation there is a lack of opportunities and motivation to think about the plant in any depth. Writing the operations manual provided such occasion.

Producing the operations manual tends to be welcomed more by younger workers. Some of the elder workers, especially some masters (*Meister*), seem to consider the work involved in producing the operations manual to be a waste of effort as they do not see the advantage of working hard for fixing a kind of knowledge what they already have acquired and what they expect to be acquired also by the younger workers in the course of time.

### **Using the operation manual**

The extraordinarily strong training effect in producing the operations manual might be seen rather as a singular event. In the beginning of our investigation it was not yet clear in which way the updating of the handbook would be performed in the future (today a

team for updating the operations manual is vested). Within our empirical investigation we have therefore also focused on the normal and everyday use of the operations manual. Especially novices use this manual intensively who are extremely motivated due to the link between learning (respectively the success of learning) and the salary system (see next section). Because of the work-oriented content of the operations manual it is particularly used whenever work at a specific process unit has to be envisaged. As it is exactly described in the manual how a process unit is structured, and, first of all, how it has to be operated in particular situations, novices are able to prepare their work well with the help of the handbook.

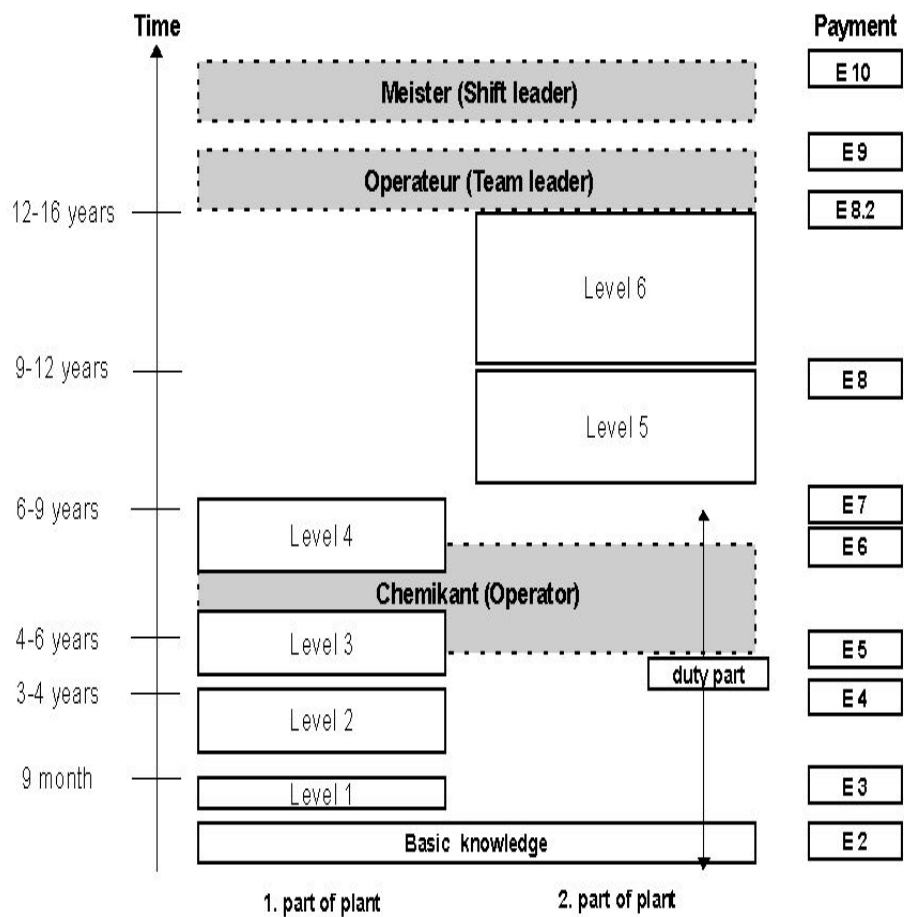


Figure 3: The link between qualification levels and salary. E1, E2 etc are wage groups. Left scale: average time to reach this qualification level.

In case questions arise concerning the use of the manual, users often contact the authors responsible for the description of a particular process unit. If mistakes in the manual are

detected and amendments seem to be necessary then a master who is registered as responsible person for the respective section cares for the up-to-dateness of the manual.

### The link with the wage system

Novices with vocations from outside the field of chemistry receive rather few money when being engaged by the company. The difference between this primary wage group and those of a skilled chemical worker is four to five wage groups. Since the operations manual was introduced there is the opportunity that novices raise one wage group in salary each time they successfully pass an examination (a kind of technical discussion). They are able to prepare this technical discussion very well with the operations manual as it contains exemplary questions (similar to the examination questions) for each qualification level. In former times the rise in salary was dependent on a judgement by shift- and day masters. Today workers may register to the technical discussion at the higher management level independently from the master.

<b>Basic knowledge</b> “Approach to the plant”	→ <b>Knowledge:</b> give information about, name → <b>Recognition:</b> to refer to, define → <b>Ability:</b> describe, assign
<b>Basic program</b> “Operate inside and with the plant/facilities ”	→ <b>Knowledge:</b> Overview about some parts of the plant (steps of the process) → <b>Recognition:</b> Early recognition of causes (assumption) of irregularities in the process → <b>Ability:</b> Monitoring, “Approach to regulation and control”
<b>Intermediate program</b> “Operate with a complex plant“	→ <b>Knowledge:</b> Describing effects of regulation and controlling of the plant, the processes and the open- and closed-loop control → <b>Recognition:</b> Distinguish between reaction and consequence → <b>Ability:</b> correct description of irregularities, intervention and regulation
<b>Extended program</b> “Independent forms of practical planning and action”	→ <b>Knowledge:</b> Explaining complex connections inside the plant facilities → <b>Recognition:</b> Explaining preventative measures to avoid disturbance → <b>Ability:</b> Eliminate disturbances, measures of starting and shutting down the plant

Table 1: Taxonomy of training goals of the different qualification levels (Quotation from an operational document).

Each wage group is connected to a qualification level which itself is related to a taxonomy of training goals. The beginner uses the operations manual in order to get a general idea of the plant. He or she then reads the part of the text that gives an overview of the functioning of a particular equipment and answers questions from the operations manual which are related to basic knowledge.

### **Interpretation as organisational learning**

Producing and updating the operations manual, as well as integrating it into the process of skilling workers, must be interpreted as an organisational learning process. Previously, the process of skilling shift workers primarily depended on the initiative of shift foremen and experienced shift workers. The organisational process of preparing and updating the operations manual implies that an important part of the knowledge of employees is added to the organisation's 'memory'. The skilling system, linked as it is to the payments system, provides organisational processes for distributing the knowledge stored in the various documents comprising the operations manual.

The process of writing and using the plant manual matches our criteria 1, 2 and 4, to some extent criterion 3, having its main emphasis on criterion 4 (knowledge creation and knowledge management):

- The knowledge about the plant which is necessary for direct operation is documented, generalised and assessed. This was to a certain extent formerly done only by engineers.
- The knowledge about the plant which is not immediately useful for direct operation but might be necessary in case of emergencies is also activated by the plant manual: On one hand, during the writing, when systematically all parts of the plant have to be considered; on the other hand, during the systematic examination which is organised on the base of the plant manual. Up to then workers did not have the opportunity for systematic reflection.
- By the participation of the shift workers in preparing the plant manual, they will be able to use all of the information sources of the company. In former times there was hardly an opportunity for the workers to come in contact with the department of documentation. During the preparation of the plant manual, the workers always have to collect all necessary documents.
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- By the correction of the texts written by the teams, the workers from a certain shift

will be stimulated to discuss the concepts of controlling the plant, running the plant and the connectivity of the functions. In former times there was no occasion for such kind of discussions. The concepts of controlling the plant, running the plant and the connectivity of the functions were explained to the novices by the master or experienced workers. The novices had no other possibility but only to accept these explanations. By fixing the explanation as text of the operations manual, it can be critically re-examined. In former times it was very hard for workers to make this kind of consideration.

- Every team that has prepared a part of the plant manual was composed of workers from all of the shifts. During the discussions about the correct version of a text, the workers became aware that every shift has its own style to run the plant. In former times there was little communication among the shifts, so the workers from one shift considered their way to run the plant as the only possible one.

The mental models of the shift workers and the master about their plant and the way to operate the plant were changed through the process of preparing and using the operations manual. The concepts about the role of workers in the work organisation have been changed, too. For example, the female moderator of the teams reported in an interview, that at the beginning of the project angry shift masters complained about shift workers who were sent by themselves to the teams. The main point of the complaint was the awakened self-consciousness of workers who made themselves independent from the information flow controlled by the master. From then on workers regularly ask questions about technology and functions in the plant and they did not immediately trust the information given to them by masters and foremen.

If we call in memory that organisational learning in the sense of double-loop and deuterio learning implies a structure created by the organisation through which individual learning is permanently stimulated, documented and evaluated, then a conclusion as follows has to be drawn:

In former times individual learning of novices in the steam cracker happened in an informal way and to some extent coincidentally. If novices were motivated to learn then masters answered their questions and stimulated them to continue learning if time and opportunities were appropriate. The transformation of this informal training process into a structured introduction to the knowledge necessary for running the steam cracker must be regarded a process of organisational learning. Of particular importance is in this case the link to the wage system through an examination (a “technical discussion” in the terminology of the company). Due to this link it became necessary to set up a taxonomy of training goals and to provide learners with a structure of contents within the manual which were oriented to the needs of the learners and not exclusively to the functionality of the technical installations. By the examination through the technical discussion it

shall be ensured that learners have understood the contents of the manual. For this reason there are not any marks or grades as a result of the examination. The learner has successfully passed the examination if he or she could correctly report at least 80% of possible answers. Who has surmounted this hurdle will be rated in the next higher wage group.

For the preparation on the examination by means of the exemplary questions from the operator manual it must be made clear what is expected from the examinee. For this reason a discussion about the contents to be studied takes place at the steam cracker. In former times there were no need for such a discussion. Every master and every shift regulated the skilled worker advancement after their own criterion. The present examination system has moved this situation to a rather objective basis. The participation of all shift employees has contributed to this particularly. It was made sure that the correct contents are being examined. The evaluation of these procedure in the sense of an organisational inquiry after Argyris and Schön is dependent on how thoroughly the operations manual is revised by the work force. The operations manual is not only used for the examination, but as well for preparing real work tasks within the plant. It does not have to be expected, that the contents of the operation manuals and the contents which are needed for work, drift very much apart from each other.

### **The culture of the steam cracker**

In the eyes of one of the works managers we interviewed, no major change has occurred in the way members of management treat the workers. Thanks to improved skilling of workers, however, he does expect certain impacts leading to greater independence of workers and more individual responsibility, although more in the sense that workers extricate themselves from management control than that the works managers change their own behaviour. Some of the works managers are described by some workers as unapproachable persons. Traditionally, leading managers in the German chemical industry were doctors of chemistry who valued a strict hierarchy and made sure that this hierarchy is respected by other persons.

Nevertheless, it must be noticed that there are changes in the corporate culture. In former times a project like the participative production of the operations manual was unfeasible, and the reason for this seemed to be rooted in the thinking of the managers. In their opinions, workers did not have the ability to write something like a plant manual. Such a task, they thought, could only be done by a graduates. Nowadays, workers write the operations manual by themselves and they do this with great success.

Quite obviously, the exchange of the leading works manager did not have much impact on changing the behaviour of the management level below. In workshops, some workers expressed criticism of the foremen, who failed to pass on much of their dissatisfaction to the management. These dissatisfied workers were obviously afraid of approaching the leading works manager directly. This is despite the fact that, at meetings in the control centre attended by all the workers, the leading works manager actually requested the work force to express their comments and critical remarks.

In the eyes of most of the work force, it is not a common practice that the workers consult the management directly, despite the fact that the work manager asked for comments and remarks. In former times the relationship between works management and the employees was regarded as not satisfactory, at least by a part of the work force. This is clearly evident in the cautious comments by various workers who said that the demands imposed by the works management were increasingly intensified with little consideration for human interests. This also led to an employee survey, which was evaluated according to the various divisions within company G, indicating a negative atmosphere in this particular plant.

The Training Officer in that plant considers it essential to introduce measures for building confidence between the works management and the shift workers. For example, he proposes that each shift should introduce 'consultation hours' in which the works management can get in direct contact with the shift workers, and not just communicate with them through the shift foremen. The Training Officer would also prefer to implement an established set of measures, between works management and workers, through which discrepancies between self-perception and perception by others could be explored.

### **Employee survey**

In the employee survey, workers are given the opportunity to assess the leadership qualities of their works managers. The works managers then receive feedback on the results for their particular plants or departments. However, little use is made of this opportunity to identify potential for change. One interviewee noted, that the employee survey enables criticism to be vented, but provides little opportunity for initiating change. When a senior member of staff is assessed poorly, he can always justify his doing by saying that he is not the one who has to change or that he is not responsible for initiating change, but that this lies in the responsibility of his senior manager. The many

levels of hierarchy foster a situation in which problems are passed on to others instead of being tackled.

In a particular works, the workers and also the foremen usually only know their immediate superiors. Only in very rare cases do they get to know other managers, such as departmental or divisional managers:

“Well, we actually see little of any heads of department or heads of division. When we do see them, then something serious is going to change in some way or other, or something serious has happened. Then you see them, otherwise you don’t see them.”(Shift worker interview)

### **Knowledge management at the steam cracker**

An important field of knowledge that has to be conveyed to as many workers as possible in a single enterprise concerns the causes for disruptions in production. In the steam cracker a large proportion of the knowledge available to the organisation about such disruptions and their causes was lost because experienced workers retired early. Early retirement by experienced workers has adverse impacts on the dissemination of knowledge during the shift. Because the remaining experienced workers are mostly deployed on management tasks, those who are remaining on the shift are often the ones who cannot teach much to the novices.

The experience of losing this knowledge was a factor that stimulated the participative production of the operations manual, which can be interpreted as corporate knowledge management. Reports on the most important accidents are integrated into the manual. The most important knowledge creation was the fixing of informal knowledge in documents of the organisation. Before this process of knowledge creation started, the organisation has not learned what the workers know, because the knowledge of the workers was not fixed in a form accessible for organisational measurements. Now, this part of workers’ knowledge which is fixed in organisational documents is accessible for organisational measurements like the personal development system or the qualification system of the company.

However, there are still some barriers visible towards knowledge acquisition and knowledge management. For example, one interviewee who completed training as a chemicals operator outside company G is highly interested in regulation concepts as part of process control. In his opinion, the elder workers in company G have acquired knowledge about regulation concepts which enable them to act efficiently, but they are not able to communicate the background facts that explain the success of their actions. Their knowledge about chemical reactions, technical installations and the process

control system was acquired in their daily work, which leaves little scope for more in-depth exploration of underlying causes and effects. Trained chemicals operators, on the other hand, had time during their training to familiarise themselves with process control principles and the functional principles in the technical field. The explanations given by elder shift workers are often based on experiential values that they are unable to explain any further and for this reason are dissatisfying for the younger, trained chemicals operators.

The informal exchange of knowledge is fostered by various activities, for example sports events. The works management supports indoor bowling and football. Within company G there are tournaments involving various works teams.

### **Learning from the environment**

Operating a plant as complex as the steam cracker permanently confronts the work force with major or minor problems, the solutions to which accumulate in the course of time as experience-based knowledge of the steam cracker employees. For this reason, every works manager, every works engineer and indeed every employee is interested in how the typical problems faced in a steam cracker are solved by work forces elsewhere. Within company G experience is exchanged between specialists with steam cracker experience – an exchange that originated in the German site. This is where the first two company G steam crackers were built and a body of know-how amassed that was also used in building a steam cracker of company G in Belgium, for example. In 2001, during the large-scale shut-down in the German site, workers from the steam cracker in Belgium came to the German site to learn how the total shut-down can be carried out efficiently and which cleaning methods have proved to be particularly effective.

The involvement of experienced workers from the German site when building other steam crackers (e.g. the world's largest steam cracker is being built in the USA at Port Arthur in Texas), or when carrying out total shut-downs, enables these workers to gather further experience that greatly benefits the German site as well, because a steam cracker during normal operations provides much fewer opportunities for training than when constructing, starting or shutting down a steam cracker.

The workers who spent some time abroad on one of these projects tend to advance their careers, with some of them joining the shift management team, for example. In addition, because company G has at least six steam crackers, some opportunities exist for the work force to gain experience.

Collaboration between company G and other steam cracker operators is confined to safety issues only. For example, when a plant discovers that a certain welding seems to cause safety problems, then problems of this kind are communicated. Problems of a general nature and ways of solving them are not discussed with competitors, however.

In the German site, learning from the respective other steam cracker was fostered by merging the two control rooms. For the day shift foremen and higher levels in the hierarchy, both crackers are part of the same organisational entity. Workers may be swapped between the two crackers, but this is not for systematic reasons.

Almost all steam crackers in the world are subjected to benchmarking. In the so-called 'Solomon Study', the data for various parameters of steam cracker operation are listed:

“And according to which criterion are the crackers compared?” “How many dollars you can squeeze out of it. The basic criterion, such as use, operation, personnel, production stoppages, availability, products, product range, what you get out of it, what you do with it, how much this is, what the ratio is between different product volumes, what the energy prices are, what kind of energy is used, and if yes, at what prices. So 2 kg – the report – is what comes out of it.”  
(manager interview)

This study ranks the steam crackers and if one is given a bad ranking the works manager has to justify this. However, as the study mainly focuses on details that are financially interesting, it is not easy to explain good or bad performance on the scale. Whenever a steam cracker is designed, many boundary conditions are set that cannot be changed during actual operation. In particular, the size of a steam cracker is very important for efficient use. Older, smaller plants in Europe are competing with newer, bigger plants in Asia and America. It is not possible, on the basis of the Solomon Report, to compare different ways that the plants are operated, or other factors relating to work organisation at the steam cracker. From the economic perspective, only the number of employees per tonne of ethylene or propylene produced is interesting.

It seems that the steam cracker in the German site does not learn too much from other steam crackers, but they transfer a lot of knowledge to other steam crackers. These organisations are now constructing their own knowledge. The question remains open how the German organisation could benefit from the experience being accumulated by the other steam crackers. It seems that the German site has not recognised yet that they can learn from others. At least, they have not taken up any measures.

## 4 Conclusions

Altogether, it can be stated for company G that organisational routines and processes (e.g. standardised work procedures) are evaluated (the first criterion). The company provides help (Treffpunkt-i-procedures) for the check and the redefinition of the organisational procedures of the plant. This support and particularly the participative production of the operations manual has led to a real change and redefinition of organisational routines and procedures. However, it was not a result of an organisational inquiry to launch such a project, but the individual idea and decision of the leading works manager.

The second criterion (formal and informal learning processes are being evaluated and improved), is also fulfilled. First, a number of new learning processes have been inspired in the case described above. Furthermore, the steam cracker experiments with new forms of learning to find out the adequate one. This is the explicit goal of the project “active learning” where the trainers of the steam cracker learn how to conceptualise and to perform work-related teaching methods, and the trainees are getting acquainted with different types of learning methods. A remarkable project is the participative production of the operations manual. This project fulfils the criterion the best.

The third criterion (transformations are occurring in the culture) is fulfilled only to a certain extent. On one hand the traditional hierarchy still exists and leads to problems of communication and co-operation between management and work force. On the other hand a more implicit change in culture can be recognised: There is an awakened self-consciousness and there are improved competencies of workers

The fourth criterion (knowledge is being created within the organisation, at different levels and is being shared within the organisation) is strongly fulfilled. The knowledge for the running of the steam cracker is created by the workers. Through the qualifications system based on the participative production of the operations manual, this knowledge is shared within the organisation.

The fifth criterion (learning from the environment) is fulfilled only to a minor extent, as some possibilities for learning from the environment are used by the steam cracker, however not in the case of the handbook project. Also the above mentioned actions (like exchange of personnel) cannot be regarded as measure of organisational learning as there is no intentionally created and systematically controlled relationship to ‘learning from the environment’.

The development and use of knowledge within a company has always been a cause for dispute in regards to its usefulness for the individual or the company respectively. The concept of the learning organisation interprets this dispute anew. Our findings lead to preliminary conclusions as follows:

- The case described meets the criteria 1, 2 and 4 which were suggested in the theoretical framework of the OrgLearn project as important for organisational learning:
- In the case described the main emphasis lies in the provision of an organisational structure for knowledge creation and knowledge sharing. The knowledge to be created and shared is what we call work process knowledge: knowledge about the whole labour process within the factory including reflection on practical and theoretical knowledge that might be useful for work (Boreham et al 2002).
- There is an increase of self-organised learning and a reduction of personally controlling and determining learning processes by masters and foremen. Learning processes are on one hand more independent from personal control (by middle managers), on the other hand more objectified through manuals, procedures and regulations, however not eliminating partial self-organisation. The content of learning is oriented towards the running of the plant, combined to some extent with career opportunities. The content of learning is not oriented towards job descriptions and the range of vocational competencies which are defined by the German “Beruf” (cf. Fischer 1998).
- Processes of organisational learning were stimulated by a remarkable reduction of personnel and a loss of experienced workers. Organisational learning can be regarded as an attempt to compensate the loss of know-how. In particular, measures of organisational learning are taken up in advance to protect the company from a loss of know-how that might happen in the future.
- Knowledge which formerly belonged to the individual worker or a group of individuals is objectified in two ways: It is objectified through a process of generalising individual knowledge and it is objectified through artefacts – means by which knowledge can be stored in a “memory” of the organisation. It is not yet clear to what extent organisational learning may support an outsourcing-and-insourcing policy (Mariani 2002) and to what extent the individual worker benefits from processes of organisational learning he is involved in, especially if he is leaving the company.

## **Bibliography**

- Argyris, C; Schön, D.A. Organizational learning: a theory of action perspective. Reading (Mass.): Addison-Wesley, 1978.
- Boreham, N. C.; Samurcay, R.; Fischer, M. (eds.). *Work process knowledge*. London: Routledge, 2002.
- Bullinger, H.-J; Brettreich-Teichmann, W; Wiedmann, G. Kundenorientierte Dienstleistungsmodelle - Intelligente Produkte und kreative Organisationsmodelle. In: Perlit M.; Offinger A.; Reinhardt M.; Schug K. (eds). *Strategien im Umbruch. Neue Konzepte der Unternehmensführung*; Stuttgart: Schäffer-Poeschel Verlag 1997, pp. 67-82.

- Fischer, M. Bildung als Kernbereich des Unternehmens? Betriebliche Strategien im Umgang mit der Berufsbildung. In: Haase P.; Dybowski G.; Fischer M. (eds). *Berufliche Bildung auf dem Prüfstand. Alternativen beruflicher Bildungspraxis und Reformperspektiven*. Bremen: Donat Verlag, 1998, pp. 109-126.
- Fischer, M. & Röben, P. (eds.) Ways of Organisational Learning in the Chemical Industry and their Impact on Vocational Education and Training. A Literature Review. ITB-Arbeitspapiere Nr. 29. Bremen: Universität, 2001.
- Fischer, M. & Röben, P. (eds.) Cases of Organisational Learning in European Chemical Companies. An Empirical Study. ITB-Arbeitspapiere Nr. 35. Bremen: Universität, 2002.
- Geißler, H. Die Organisation als lernendes Subjekt - Vorüberlegungen zu einer Bildungstheorie der Organisation. In: Geißler H. (ed.). *Arbeit, Lernen und Organisation*. Weinheim: Deutscher Studien Verlag, 1996, pp. 253-281.
- Manager Magazin*, N° 2, 1995.
- Mariani, M. Work process knowledge in a chemical company. In: Boreham, N. C.; Samurcay, R.; Fischer, M. (eds.). *Work process knowledge*. London: Routledge, 2002, pp. 15-24.
- Neuberger, O. *Personalentwicklung*. Stuttgart: Enke Verlag, 1991.
- Perlitz, M. Strategischer Wandel - helfen neue Managementkonzepte? In: Perlitz M.; Offinger A.; Reinhardt M.; Schug K.(eds). *Strategien im Umbruch. Neue Konzepte der Unternehmensführung*. Stuttgart: Schäffer-Poeschel Verlag, 1997, pp. 3-17.
- Personalführung, Sonderheft: *Lernende Organisation*, 1995.
- Probst, G; Büchel, B. *Organisationales Lernen. Wettbewerbsvorteil der Zukunft*. Wiesbaden: Gabler, 1998.
- Schein, E.H. *Organizational culture and leadership*. San Francisco: Jossey Bass, 1992.
- Schein, E.H. *Unternehmenskultur. Ein Handbuch für Führungskräfte*. Frankfurt/ New York: Campus, 1995.
- Senge, P.M. *Die fünfte Disziplin. Kunst und Praxis der lernenden Organisation*. Stuttgart: Klett-Cotta, 1997.
- Senge, P.M; Kleiner, A.; Smith, B; Roberts. et al. *Das Fieldbook zur fünften Disziplin. Kunst und Praxis der lernenden Organisation*. Stuttgart: Klett-Cotta, 1996.
- Sonntag, Kh. *Lernen im Unternehmen. Effiziente Organisation durch Lernkultur*. München: Beck'sche Verlagsbuchhandlung, 1996.

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