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European perspectives on learning at work

The acquisition of work process knowledge

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the acquisition of work process knowledge

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Executive summary

Work process knowledge provides a framework for understanding the complex knowledge required by employees in modern organisations. This knowledge is necessary because of the introduction of more flexible ways of working and information and communication technology to promote greater competitiveness.

The concept of work process knowledge is a generative one which enables us to resolve contradictions between theory and practice and indeed contradictions within work itself. It also provides a framework for forging partnerships between vocational education and training institutions concerned with formal learning and enterprises that focus on work-based learning.

This book draws together the writings of experts from the fields of learning theory, knowledge development and education and training who have either worked on the development of the concept of work process knowledge or have drawn inspiration from it.

From the earliest manifestation of the concept in German discussions, its originality lay in an attempt to blend explicit learning with implicit learning into a single cognitive process. This distinguished it from more simplistic concepts of experiential learning. More recent contributions to the concept have been made through studies in many countries on new forms of working and in particular research on the impact of new technology on work organisation and competence requirements. In this respect, the concept has become more dynamic in that it provides a way to understand restructuring processes and not only describe new work roles.

Because computerised systems typically run many operations in parallel, and integrate activities previously carried out by different departments, it is important for system controllers in, for example, the area of flexible manufacturing, to know how the whole production process is organised. When computers change the industrial workplace, they do more than change the job descriptions of individual employees who supervise the computerised processes. They also bring about a general reframing of collective practice, including changes in the customary patterns of communication between different groups of employees, extending to those not directly dealing with new technology.

The acquisition of work process knowledge means negotiating new relationships with one's colleagues in a transformed work context. Emphasis is placed on interfaces between workers as much as on the content of individual jobs. This implies having the ability to evaluate the impact of the social structure on relationships between people in the workplace.

Over the last few years, the concept of work process knowledge has been further developed by a more theoretical enquiry into industrial epistemology. This question has come to the forefront of debates in vocational education and training because of the emergence of what has been termed the 'knowledge-based' economy. While it is increasingly recognised that knowledge possessed by the workforce drives industrial activity, there is a gap in our understanding of the relationship between theoretical/academic knowledge and practical knowledge. Underpinning efforts to devise new ways to manage the theoretical component of vocational education and training has been the desire to develop ways of teaching and learning theoretical knowledge that have a greater impact on professional practice.

This book captures discussions that have taken place in recent years on the above issues, but in particular on the relationship between professional competence, learning on-the-job and organisational development and the interfaces between individual and collective knowledge. It brings us up to date with current debates about work process knowledge, through presenting the research findings of authors from Austria, Belgium, Germany, Finland, France, Italy, Spain, Switzerland and the UK.

Among the questions that contributors to this book address are the following:

- Who is the learning subject of work process knowledge? Is it the individual, the 'community of practice' or the organisation?
- What is meant by the tacit dimension of work process knowledge? Can it be verbally communicated and exchanged or is it totally embedded in non-codifiable experience?
- What are the drivers of, and barriers to, the acquisition of work process knowledge? Is learning stimulated by the challenges of the content of the work, the social interaction in the company or possibly the career ambitions of employees?
- What are the most appropriate environments for teaching and learning work process knowledge? How can work process knowledge-oriented curricula be designed?

As well as relating the results of empirical studies, this book also includes an examination of the implications of work process knowledge for European vocational education and training policy. It is proposed that the future policy research agenda should focus on establishing a more organic relationship between the learning that takes place in education and training institutions and the learning that occurs through daily working processes.

Preface

The creation of a *'knowledge-based economy'* and an *'area of lifelong learning'* are perhaps the two central themes running through current policy debates about vocational education and training (VET) in Europe. This book examines these themes. Indeed, it proposes a conceptual framework for understanding the interdependent relationship between them, which is termed 'work process knowledge'.

The authors of the different papers in this book draw on the rich scientific traditions and current research in VET in nine European countries to present a distinct European response to the challenge of learning for the knowledge economy. The book challenges current assumptions about the nature of knowledge and promotes a deeper understanding of the complexity of human learning processes.

In the first place, the book attempts to identify the respective roles of skilled workers (the 'practitioner vocational community') and the 'expert scientific/technological community' in generating knowledge. It argues that these are two indispensable sources of knowledge with their own distinctive intellectual and indeed scientific traditions. The knowledge economy, therefore, can only be created through a union of bottom-up and top-down types of expertise. This is a co-construction process.

Secondly, the book argues that due to the contextual and situated nature of the knowledge and competence required for working life, much greater emphasis must be placed on work-related learning. Indeed some people argue that the essential dimension of working-life knowledge can only be acquired in 'practice' settings. Different authors discuss the validity of the above assertion in an attempt to understand the relationship between theoretical and practical knowledge and between formal and informal learning.

Thirdly, as well as theoretical debates about new theories of knowledge development and learning, major parts of the book examine ways of designing and implementing practical teaching and learning approaches and curricula based on the concept of work process knowledge.

This book is to be welcomed for bringing together the writings of researchers from different cultural and research backgrounds, with a common focus on the question of how European workplaces can address their knowledge development and learning challenges. The book, which is being published in the context of the Cedefop research arena – Cedra – (see http://www.trainingvillage.gr/etv/Projects_Networks/Cedra/), illustrates the benefits to be gained when small networks are established to enable researches to share knowledge on a certain topic.

Cedefop would like to thank everybody who has contributed to this publication which it hopes will be used to stimulate discussions about ways in which Europe can move towards becoming a knowledge-based economy.

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SECTION I

Introduction and overview

CHAPTER 1

Work process knowledge: origins of the concept and current developments

Martin Fischer, Nicholas Boreham

1.1. Introduction

The purpose of this book is to provide a theoretical understanding of the concept of work process knowledge (Boreham et al., 2002) and to examine its practical applications. The book can be placed in the wider context of debates about creating a knowledge-based economy in Europe as declared in the Lisbon EU Summit of the European Council in 2000. It draws on recent research and practice in vocational education and training that is concerned with enhancing people's capacity to develop and acquire knowledge in and through their work. An examination of this issue which began in the European research network WHOLE (Work process knowledge in technical and organisational development) that was funded under the Fourth framework programme of the EU, was continued in the Cedefop project ([1]) on which this book is reporting. The book brings together the work of researchers on the topic of work process knowledge from different countries – Austria, Belgium, Germany, Finland, France, Italy, Spain, Switzerland and the UK – presenting theoretical models, reviewing work-related teaching and learning practices and outlining new curriculum design approaches. The first half of the book partis particularly relevant for researchers and scientists, as the epistemological assumptions and empirical findings concerning the concept of work process knowledge are presented and discussed. The second halfpart of the book is central to the practice of professionals in vocational education and training (VET) and human resource development (HRD), as the implications of the concept of work process knowledge are applied in pragmatic contexts. This also leads to a consideration of policy

([1]) The title of this project which took place in the framework of the Cedefop (European Centre for the Development of Vocational Training) research arena (Cedra) is the 'production of research resource materials related to the theme of work-related learning'.

issues which are addressed in the final sectionpart of this book.

The current debate about work process knowledge has been stimulated by the fundamental changes taking place in work organisation and in the use of new technology in European industry. The speed of corporate restructuring has increased, leading to complex results (see Drexel, 1998, p. 58). Although in recent years no clear direction of industrial change has been recognisable, which has led sociologists to speak of a 'new obscurity' ('*neue Unübersichtlichkeit'* – Schumann, 1998) and a 'delayed transformation' (Huys and van Hootegem, 2002), most European enterprises share a common perspective: they are realising that the knowledge possessed by all levels of their workforces is a major driver of economic success (van Berk, 1998). In a recent sociological survey among skilled workers in Germany, Martin Baethge et al. (1998, p. 5) observed that the traditional skilled worker profile of manual craft skills is changing to include tasks such as problem-solving and supervising and regulating the work system. These new profiles include coping with critical situations on a decentralised level and even involve the proactive search for problems of product or process quality. The authors concluded that an understanding of economic factors, plus extended competences in the acquisition and use of knowledge, are prerequisites for these new profiles. Knowledge needs to be communicated not only within narrow communities of practice but also between company departments and even within producer-customer-interrelations (see Endres and Wehner, 1996; Weilnböck-Buck et al., 1996). It becomes necessary for the occupational profiles of skilled workers to expand to include issues of theoretical understanding, and the social-communicative skills and problem-solving competences that are embedded in the organisational and social context of the company and the labour force (Baethge et al., 1998).

The concept of work process knowledge can be seen as a way of describing the kind of knowledge which employees need for working in organisations which have developed more flexible structures, and which have introduced new technology in search of greater competitiveness. The concept of work process knowledge is increasingly used in discussions exploring the relationships between work, learning on-the-job, organisational development, individual knowledge, collective knowledge and occupational competence. The concept signals more than practical know-how or 'procedural knowledge', for this way of knowing also encompasses theoretical understanding. For this reason, the concept is a generative one which provides a framework for understanding how contradictions between theory and practice – and contradictions within practice – are resolved in the context of work. It also provides a framework

for building effective partnerships between vocational education carried out in institutional settings and learning on-the-job.

1.2. The origins of the concept of work process knowledge

Although discussions of 'process knowledge' can be traced to the 1920s, perhaps the earliest appearance of the term in recent times, in its German form *Arbeitsprozesswissen*, occurred in the context of a German debate about the need for reform of vocational education and training. The German word has two English translations: 'labour process knowledge' and 'work process knowledge'. Whilst the latter is more widely used in contemporary debates (see Fischer, 2000), the former provides a better translation of the original meaning of the term. When Wilfried Kruse introduced the term *Arbeitsprozesswissen* in 1986, his notion included both skills which are needed for work in more flexible work settings and orientation knowledge in a more participatory perspective. Even in Kruse's early notion the originality of the concept lay in the fact that theoretical knowledge had to be related to knowledge gained from experience (see Kruse, 1986, 2002).

Many years later, the concept was applied in a series of projects carried out by the *Fundacio Centre d'Iniciatives i Recerques Europees a la Mediterrania in Barcelona* (CIREM). One CIREM project had the aim of improving the performance of a group of hotels on the island of Mallorca (Kruse, 2000). The hotel group wished to attract a more up-market clientele, but it realised that it could do so only by developing the ambience which distinguishes high-class hotels, i.e. providing a personalised service for each guest. Consequently, the project was launched to develop a higher standard of service through 'continuous quality improvement'. The philosophy which guided this project was a quality-circle methodology, in which staff were encouraged to identify and solve problems which stood in the way of a high quality product or service. Following standard practice, staff met in cross-departmental groups to analyse the origins of the problems which they had reported. This exercise led quickly to the realisation that a problem which manifested itself in one department of the hotel (e.g. in reception) might have been caused in another department, and might well have repercussions in a third. It was also realised that employees working in one department could throw light on problems in others. These brought to the fore the concept of the 'internal customer': in addition to providing a service to their guests, hotel employees needed to provide a service to colleagues in other

departments. Inevitably, the quality circles increased the participants' awareness of the interdependency of the different departments in which they worked, and the interconnectedness of their roles. In short, this awareness was labour process knowledge.

As the context in which it emerged makes clear, labour process knowledge here refers to a way of knowing which employees developed as an unintended outcome of activities designed to develop a collaborative work culture. Initially, there was no involvement of formal training, nor was the knowledge of the labour process acquired extensively codified. The nature of labour process knowledge was not so much the kind of technical knowledge which is taught in formal institutions of learning, as a feeling which grew naturally out of the interdependence of the different departments of the organisation in which the employees worked, and a willingness to collaborate in ways that involved crossing the boundaries of their formal job descriptions. Such knowledge is largely tacit (Polanyi, 1958, 1966). While it might be possible to articulate it, labour process knowledge as originally described was an experientially acquired 'feeling-sense'. Nonetheless, it should not be assumed that it was impossible or necessarily difficult to codify significant aspects of this way of knowing. One of the activities carried out by CIREM was to use the employees' growing awareness of the overall labour process to write procedure manuals, thus codifying the knowledge into material that could be used in more formal types of training. However, it is important to note that such a codification has to be seen as a re-construction of personal knowledge (Ryle, 1949; Neuweg, 1998) which implies, on the one hand, a process of abstraction from the particular knowledge a person actually has, and, on the other, a process of re-contextualisation whenever this kind of knowledge is used again. This blending of explicit and implicit ways of knowing in a single cognitive process has remained one of the characteristics of the concept of *Arbeitsprozesswissen* which distinguishes it from earlier and more simplistic concepts of experiential knowing, such as procedural knowledge.

Another source of the concept of work process knowledge has been studies in manufacturing. At approximately the same time that Kruse pointed out that labour process knowledge is needed while companies are introducing new technology, alternative ways to a Tayloristic-inspired implementation of technology and organisation were being developed in several European countries including Scandinavia (see Ehn, 1988), Germany (see Brödner, 1985) and the United Kingdom (see Rosenbrock, 1989; Cooley, 1988, 1989). At that stage the project 'human centred CIM systems' – funded by the Esprit programme of the European Union – marked

a cornerstone in the development of work and technology. Partners from Denmark, Germany and the UK tried to establish an interdisciplinary way of developing computer-aided production systems better suited to human needs and competences (Corbett et al., 1991; Rauner et al., 1988, 2001). As a background to the development of these technical systems, the organisational concept of 'island production' was used. This is a production concept in which previously separated stages in the processing of an order (design, machining, quality control etc.) are integrated into a single work unit.

The underlying process of industrial change was the same as in the Spanish hotels: the transformation of fixed, bureaucratic work systems into more organic, flexible ones believed to be more capable of adapting speedily to shifting customer requirements. However, in extending the concept of work process knowledge to embrace manufacturing, a new factor entered the arena: the nature of the production process itself. In recognition of this, the meaning of the original term *Arbeitsprozesswissen* was extended from labour process knowledge to 'work process knowledge', the latter being defined as knowledge of both the overall labour process and the overall production process within the company.

Work tasks within 'island production' demand close linking of indirect work such as planning to direct tasks such as machining. The experiential knowledge of skilled workers regarding the specific features of people, machinery, material and tools should be integrated into the more abstract knowledge required for planning. Decision-making skills are expected from the skilled workers in the island with respect to production-relevant events affecting quality and meeting deadlines. In the past, some events at shop floor level have been regarded as unforeseeable simply because workshop-specific features, such as flaws in specific machinery, are unknown to the central planning department and disturb planning, or in the end even reduce it to chaos. However, they are made foreseeable and plannable by means of island production. Additionally, in this context the workers are able to deal more adequately with events such as sudden machine breakdown. The appropriate response to failures now requires not only judging and making decisions concerning pre-set aims but also tasks of aim setting.

Thus, new production concepts such as island production assumed decentralised planning and the delegation of decision making to the workshop. But how do skilled workers and apprentices react if they are confronted with such requirements when island production is introduced? What experiences can they incorporate into such tasks? These issues were analysed in a survey of skilled workers and apprentices (Fischer, 1995). The research aimed to explore what skilled workers and apprentices knew about

planning and organising order processing and therefore, broadly speaking, about the operational set-up and workflow in the organisation as a whole. The participants were asked to draw a workplace in connection with the operational information and flow of materials as typified by their previous work experience. In many cases, a detailed overview of order processing was presented in the skilled worker's sketches. Some of the more experienced workers could not only name the stages of order processing, but also knew which particular contributions were made, and in which order they were made, by the various departments during the process. This knowledge had been acquired through experience. What is especially interesting here is that the skilled labour in most cases had no formal responsibility for planning order processing. That was normally a matter for the production planning department. Their knowledge of planning and organisation of production had been gained in informal situations, where spontaneous and intensive cooperation with other departments became necessary because of problem situations such as unforeseen events and disruptions to production. This emphasises that the variety of work-related and everyday issues impacting on work within the plant are often overlooked if production concepts are considered exclusively from the viewpoint of formal task allocation. More specifically, it shows how work process knowledge can be acquired naturally in the course of resolving production problems.

The introduction of new technology often broadens work roles, although not always. When employees make the transition from manual worker to supervisor of an automatic process, they may take responsibility for managing a sequence of operations instead of being restricted to a narrower range of activities, as with manual work in Tayloristic factories. They need broader knowledge of the work process. Moreover, because computerised manufacturing systems typically run many operations in parallel, and integrate activities previously carried out by different departments, it is important for the system controllers in flexible manufacturing to know how the whole production process is organised. The significant implication of this is that when computers change the industrial workplace, they do more than change the job descriptions of the individual employees who supervise the computerised processes. They also bring about a general reframing of collective practice, including changes in the customary patterns of communication between different groups of employees, extending to those not directly employed on the new technology.

Work process knowledge emerges as a dynamic concept, a way of conceptualising the continuing processes of restructuring patterns of

communication, not just a way of describing static work roles. Viewed in this way, work process knowledge becomes reflexive. Realising it involves making explicit one's image of competent performance in a workplace which is undergoing transformation, and negotiating new relationships with one's colleagues in the new context. To put it another way, the concept of work process knowledge places an emphasis on interfaces between workers as much as on the content of individual jobs. It implies an understanding of the social structure which facilitates complex relationships between people in the workplace.

At this point, it is appropriate to draw attention to another European source of the concept of work process knowledge. This was a research project entitled 'cognitive approaches to dynamic environment supervision', sponsored by the French national research organisation CNRS. This project investigated the knowledge requirements of new kinds of complex, computer-driven manufacturing systems. One of its conclusions was that, to carry out preventive maintenance on these systems, employees needed 'a broadening of the conventional knowledge base' (Boreham, 1995b, p. 103). In most maintenance training, the knowledge base had hitherto been conceived in terms of the causes of specific faults, together with strategies for narrowing the search process. Now, as maintenance personnel were being integrated into production units, and the systems themselves were becoming more complex, the need was identified for training them to think in terms of 'whole systems interacting with their environment' (Boreham *ibid*.), a concept not dissimilar to work process knowledge.

1.3. A new industrial epistemology

Thus far, work process knowledge has been represented as the broadly-based work-related knowledge acquired by employees of organisations which have introduced more flexible ways of working and new technology as a means to greater competitiveness. However, the development of the concept of work process knowledge over the last few years has also been stimulated by a more theoretically-inspired enquiry into industrial epistemology, that is, the nature of the knowledge needed for work. This line of enquiry is itself an offshoot of the fundamental philosophical question of how ideas can influence practical activity, a question that can be traced back to Aristotle. Perhaps one reason why this arcane philosophical question has come to the forefront of debates about vocational education and training is the emergence of the 'knowledge-based' or 'learning'

economy (Lundvall, 1996; Lundvall and Borras, 1999). While it is increasingly recognised that knowledge possessed by the workforce drives industrial activity, there seems to be a gap between 'academic knowing' and practical skill. After all, we do not ride a bicycle by thinking about the mathematical equations which explain how the machine maintains its balance, so how can theoretical knowledge impact on practical activity?

Underpinning the development of different ways of managing the theoretical component of vocational education and training over the last few years has been an ongoing debate about the ways of knowing that inform professional practice. Within this debate, the theory of work process knowledge offers a unique contribution which may provide a better explanation of the kinds of theory that are useful in practical contexts. To appreciate this point, we need to compare the emerging theory of work process knowledge with two alternative theoretical approaches.

1.3.1. Cognitive ergonomics

The first of these is the field of cognitive ergonomics, which represents ways of knowing in the workplace in terms of a model of a worker as an information-processor. The salient features of this model are: receiving inputs from the task environment, processing them with knowledge structures stored in memory, and generating outputs from this internal process in the form of words, thoughts and actions. This approach assumes a Cartesian mind-body dualism, differentiating the task from the operator's internal representation of it. By analysing the task, it is assumed, we can identify the stimulus ensembles that occur in the real world and are internally represented by the worker. By analysing his or her internal representation, we can discover what sense the individual makes of these inputs, for example, whether he or she discriminates between stimuli requiring different actions. The central question for training and decision support becomes the congruence between the internal and the external models of the task environment. By comparing expert and novice representations, we can explain why experts tend to get things right more often than novices, or why they use a different strategy, or why they seek different kinds of information in the course of problem solving, or indeed why they seek less information than novices.

Studies of industrial operators in complex, dynamic work environments have generally attributed superior performance to better adaptation of internal representations to the external demands of the task. This is interpreted as the result of years of accumulated experience, stored in

memory in a manner comparable to a highly compiled computer programme. Likewise, novices' non-optimal performance is explained in terms of the deficiencies of their representations. Let us briefly review the epistemological assumptions of this approach:

(a) the worker may be considered a symbol processing system whose main activities are:
  (i) constructing symbolic knowledge out of experience;
  (ii) storing it;
  (iii) using it to effect motor and linguistic output;
(b) the worker's knowledge is stored in his or her memory;
(c) the worker's activity is the result of external stimuli triggering these stored schemata automatically;
(d) the worker's knowledge can be elicited off-line by 'think-aloud procedures'.

The crucial distinction which cognitive ergonomics suggests as the dividing line between that knowledge which is needed for work and that which is not, is the distinction between 'declarative' and 'procedural knowledge'. The former is knowledge 'that', and the latter knowledge 'how'. Procedural knowledge is said to be useful for guiding action, while declarative knowledge is not. The basic assumption is that the real world (in which, for example, an aircraft needs guiding into the airport, or a breakdown in a production system needs troubleshooting) is represented inside the mind of the operator in the form of a procedural knowledge consisting of 'frames', 'schemata', 'production systems', 'operative images' or other types of mental picture. Giving directions to the pilot or fixing the breakdown is theorised as a process of manipulating the symbols in the mental picture, then using this picture to guide physical actions in the external world.

For a long time, it was accepted that this perspective revealed the kind of knowledge required to perform work in the real world. However, while researchers have had some success in using it to explain how experts and novices differ in well-defined symbolic tasks such as playing chess, this is not a fully satisfactory account of the knowledge required in complex, dynamic working environments, especially where work processes are collaborative, or the exact procedures to follow are clouded with uncertainty. Studies of work-related knowledge carried out within a work process knowledge framework have isolated three weaknesses of the cognitive ergonomics perspective:

(a) it represents work-related knowledge as consciously-held symbolic knowledge;

(b) it represents it as existing within the mind of the individual worker, not the community;
(c) it represents such knowledge as a kind of stored computer programme.

But field studies of the knowledge employees actually use in real working environments tend to contradict this account (Boreham et al., 2002). To take the first point, this implies that consciously held symbolic knowledge is communicable to others, and capable of being elicited by interviewing. However, the studies carried out into work process knowledge by the European Framework IV TSER research project WHOLE (Boreham et al., 2002) show that much of the knowledge in organisations is tacit, for example embedded in social relations in the workplace, and difficult to put into words.

Taking up the second point, another weakness of cognitive ergonomics theory is the assumption that work-related knowledge is stored within the mind of the individual worker. Against this, the studies carried out by the WHOLE project emphasise that much knowledge that is useful in the workplace is held collectively – indeed, such knowledge can best be viewed as part of the culture of the workplace. Some of this knowledge consists of organisational routines, collective habits which embody the accumulated experiences of years, and some of it is constituted in the collective problem solving processes which break these routines and create new perspectives. Fischer and Nakakoji (1997) argue that much of our knowledge comes from the collective memory of communities of practice, and from the artefacts and technology within them. The WHOLE project's research into work process knowledge endorses this view (Boreham et al., 2002). Part of what it means to possess work process knowledge is to accept the norms of collective, collaborative work, through participation in the work itself. On the third point, a computer programme does not seem a good analogy for the kind of knowledge discovered in studies of actual workplaces. The essence of a computer programme is that it can be printed out and examined separately from the hardware on which it runs. However, the activities of many work communities are unfathomable unless they are viewed from within the culture they sustain, for it is the culture which determines the way in which workers see their world and interact with each other.

1.3.2. Social anthropology

A popular alternative theoretical perspective is that of social anthropology, which represents work-related knowledge as one aspect of the culture of a community of practice. Work-related knowledge is no longer identified with the worker's inner mental state. Rather, it is a shared understanding

constructed through interaction in the workplace. Though the worker still brings his or her memory to work, its contribution is not a stored plan which he or she executes when called upon to do so but rather a 'capacity to interact' (Clancey, 1993, p. 14). Hence, to ensure a knowledgeable workforce, rather than engineering a better match between the operators' internal representations and the external reality, the aim is to improve the social construction of knowing by ensuring more effective participation in the community of practice.

Influential formulations of this view, widely known as 'situated cognition theory', have been made by anthropologists such as Lave and Wenger (1991) and Suchman (1987). The epistemological assumptions of situated cognition theory are:

(a) most knowledge crucial for doing work is constructed at the point of use (not stored in memory to be retrieved in these contexts);
(b) this construction is a social process, occurring through interactions with others (and with physical objects);
(c) the meaning of the words or actions through which this knowledge is realised is determined by the nature of the activity, context and culture in which they are used;
(d) learning is a process of enculturation of learners into authentic practices through authentic activity and increasing degrees of participation in interpersonal activities in the workplace;
(e) learners acquire knowledge by acquiring the capacity to interact with colleagues in the community of practice; the greater their participation, the greater their knowledge.

Situated cognition theory offers important insights into key aspects of work:

(a) most work is performed collectively;
(b) most work is creative: even in a highly proceduralised environment, such as a hospital or railway, people generate their own practices for achieving the goals set for them;
(c) the particular activity a worker needs to perform to achieve an objective depends on the specific context in which he or she is working.

1.3.3. **Paradigm weaknesses**

The studies on work process knowledge carried out in the WHOLE project endorse many of the points on situated cognition theory outlined above. They refer to kinds of knowing that are becoming critical as companies adopt more flexible structures. However, the social anthropologic account still has major weaknesses. If we characterise the knowledge people use in

the workplace in terms of how it is 'constructed' there, our view is restricted to the worker's current performance rather than his or her capability, and to his or her participation within an existing community of practice rather than his or her potential. This emphasises performance at the expense of the lifelong learning career of the individual, which generally contains major periods of preparation for work through study. It is revealing that in the tradition of the social anthropological paradigm developed by Lave et al., apprenticeship is the sole paradigm of learning (see Collins et al., 1989); but this is an oversimplification. Surely, capability, potential and vocational preparation are as important in defining the knowledge requirements for work as the process of learning on-the-job. It has to be questioned whether situated cognition theory emphasises the context of learning at the expense of the learning content, and whether the role of the individual (e.g. individual biographical strategies of learning in a life-span) is underestimated in favour of the community of practice as the determining factor for learning.

The theory of situated cognition seems to permit any form of training as long as it is 'authentic' i.e. occurs in the work situation. Against this, Hoppe (1993) states that it is 'not acceptable to use such a hypothetical and highly undetermined model as situated cognition to justify general principles for orienting and organising practical educational processes' (p. 50). He criticises Clancey, (1992) who, writing from a situationist perspective, has proposed the following general principles of learning:

(a) learning situations should offer real world complexity rather than selective cuts of reality that aim at directly transmitting certain predefined, abstract concepts;
(b) active engagement through practical experience is superior to passive learning taught through exposition;
(c) group work and social interaction are superior to individualised learning. *(Clancey, 1992)*

However, Hoppe asserts that these principles beg as many questions as they answer. The real world is not the ideal place to learn. Countless studies show that 'selective cuts of reality that aim at directly transmitting certain predefined, abstract concepts' facilitate learning (and facilitate acceptance into the community of practice). One may cite the many studies of pilot training which have improved the authentic process of actually flying an aircraft by means classroom instruction in visualising the layout of the cockpit, mental practice in manoeuvres, etc.

The theory of work process knowledge provides an advance on both these theoretical models. While acknowledging the role of experience, the theory does not ignore the relevance of knowledge acquired in a classroom

context. And the concept implies, contrary to cognitive ergonomics, that knowledge used at work cannot merely be regarded as an 'application' of scientific theories or a 'proceduralisation' of 'knowing-that' learned in school. When contradictions occur between goals and working practices (like machine failures, electricity breakdowns etc.) skilled workers use pragmatic concepts of theoretical knowledge to resolve them. Empirical investigations in the WHOLE project (Boreham et al., 2002) depicted workers trying to establish a relationship between critical events at the workplace and underlying theoretical assumptions to make sense out of events at work. This was a dialectical process in which they constructed work process knowledge by synthesising contradictions.

This account of the dialectics of work process knowledge was suggested by earlier work on the skills of prescribing in medicine. Despite the fact that the prescribing of drugs is often inappropriate, doctors receive remarkably little instruction in this skill. Partly, this is due to a lack of understanding by medical schools of what the skill entails, and a consequent failure to develop appropriate methods of teaching it. In a series of investigations, Boreham (1989, 1992, 1994) and Boreham et al. (1989, 1992, 1996) studied expertise and error in prescribing a drug. These studies included investigations of the prescribing errors made by medical students in simulations and in-depth studies of the knowledge used by expert doctors when prescribing the same drug. One of the major educational controversies in medical education is whether doctors use the theoretical knowledge of pharmacokinetics when making decisions about the doses of drugs to give their patients. This theory was taught in medical school, but students found it impossible to make effective decisions in prescribing exercises by trying to 'apply it' to new cases, leading many to assume that such theory had no practical relevance. In fact, the conclusion of the series of studies was that expert prescribers do use this theory in practical prescribing, but not that they 'apply' it. Rather, a three-stage model of prescribing was developed in which the clinician uses experience of previous cases to understand the patient's problem, selects a dose using practical rules of thumb based on previous experience, and modifies this (provisional) decision in the light of anomalies identified by construing the proposed action in the context of pharmacokinetic theory. Although described as a three-stage process, the 'stages' were integrated into a single mental process. The expert doctor's knowledge base included both experiential knowledge and theory, and the decision-making process was a dialectical one of resolving contradictions between them in the context of trying to solve a problem. This became another defining characteristic of work process knowledge (Fischer, 2000)

and helped to define the essentially constructivist nature of work process knowledge in the course of the project WHOLE (Boreham et al., 2002).

One pressing concern in vocational education and training is the problem of 'inert knowledge'. Empirical investigations in the USA and Germany have shown that knowledge which one learns in institutions such as a school or university can be regarded as 'inert' (Perkins, 1992; Mandl et al., 1993; Renkl, 1996). Inert knowledge may be described as a kind of book-knowledge which is not immediately useful for work and which can be hard to adapt to different work situations. For example, Mandl and his colleagues discovered that students in industrial management failed to achieve better results in managing a computer-simulated enterprise than a control group comprising students of pedagogics (Renkl et al., 1994). The educational significance of this is that vocational curricula frequently attract criticisms: first, that they contain too much theory and, second, that the theory which is taught lacks practical usefulness for guiding action. These criticisms have long been endorsed by industrial psychologists, who have claimed that industrial and professional training often contains unnecessary theoretical content. This conclusion is based on a large number of studies which have failed to find a relationship between the level of practitioners' theoretical knowledge and their practical competence. These findings are summarised in Duncan (1981), Patrick et al. (1986) and Morris and Rouse (1985).

In the UK, the dual system of vocational training (i.e. combined college-based and industry-based components) which existed up to the 1980s was criticised in these terms, leading to the curtailment of theory-based courses in technical colleges for intermediate level trainees. Different positions have been taken up in the long-running debate on this issue. Wolf (1989), for example, sets wide boundaries to the range of active knowledge, so that very little theoretical content would be excluded from vocational curricula on the grounds that it does not enable performance at work. On the other hand, scholars such as Schön (1983) have developed 'epistemologies of practice' which emphasise the discontinuity between practitioners' ways of knowing and the ways of knowing presented in textbooks and learned journals. The builders of the national system of vocational qualifications in the UK adopted an extreme position in this debate, arguing that virtually any theory taught in college is inert, on the grounds that active knowledge is necessarily constructed out of performance in the workplace. However, the concept of work process knowledge enables us to go beyond these simplistic representations of the problem. Empirical studies (Boreham et al., 2002) have shown that the knowledge actually used by intermediate level employees is often the result of synthesising experience-based know-how,

learned through working, and theoretical understanding of work roles and production processes acquired off-the-job. Such a synthesis is the result of the dialectic already described. Thus, the acquisition of work process knowledge has to be conceptualised within a framework of:

(a) individual learning (in the context of biographical strategies) versus collective learning (in the context of participation within a community of practice;
(b) implicit learning on the way to personal mastership versus exchange of knowledge within the life-world of a company;
(c) given working conditions and technical artefacts versus their subjective (individual and collective) appropriation and, furthermore, their social shaping to adjust technology and work to human competence;
(d) experiencing and exploring events at work versus their theoretical explanation;
(e) integrating learning on the job with classroom-based education.

1.4. What is in this book: current research results and developments

1.4.1. **Overview of book**

If, as we have argued, work process knowledge has its roots in the culture of the workplace as well as that of the classroom, then developing this way of knowing in employees cannot be accomplished by formal vocational education alone. Neither work experience nor academic knowledge alone lead to skilled work activity. The work process knowledge that underpins action is constructed in the workplace by making links between the two. Formal education must thus be considered as an aspect of organisational development. As enterprises develop more flexible ways of working, or introduce new technology, or establish better internal communications, or place greater emphasis on customer relations, their employees need to acquire broader understanding of the overall work process. If work process knowledge is a synthesis of theoretical understanding and direct experience of a specific organisation, it needs to be developed by a combination of vocational school training and experiential work-based learning. One way of achieving this is the ‘work process coproduction of vocational curricula’, involving collaboration between companies and technical schools. As described in detail in Chapter 17, dealing with the automobile industry, such collaboration may take place within the framework of a model of the work process in that industry.

However, on the way to a better recognition and acquisition of work process knowledge there are tensions that have to be considered and barriers to be surmounted. In this part of the introductory Chapter 1 we present an overview of the contributions to the understanding and management of these tensions which can be found in this book. These contributions discuss the necessity of work process knowledge: is such knowledge needed by companies and is this need explicitly acknowledged? Contributors to this book also try to answer the fundamental question about the learning subject: is it the individual, is it a community of practice, or is it the organisation? Another question addressed is the tacit dimension of work process knowledge: is it verbally communicated and exchanged? Or is it embedded in non-codifiable experience? Contributions also shed light on the drivers of and barriers to the acquisition of work process of knowledge: are the stimuli to acquiring it the challenges of the content of the work, the social interaction in the company or possibly the career ambitions of employees? How much does the division of labour prove to be a barrier to on-the-job-learning? A further step in the argument leads to teaching and training matters: can work process knowledge be taught, and is it more effectively acquired in certain learning environments than in others? The book concludes by discussing the general implications of work process knowledge for European vocational education and training policy.

The book is divided into seven sections including this introductory chapter (which comprises section one). The titles of the other six sections are as follows:

- Section II: Individual and organisational dimensions of work process knowledge
- Section III: Explicit and implicit learning at work
- Section IV: Learning at work: obstacles and opportunities
- Section V: Analysis of work process knowledge for teaching and learning
- Section VI: Design of curricula and work process knowledge
- Section VII: Policy issues

The chapters contained in the above six sections are discussed below.

1.4.2. Individual and organisational dimensions of work process knowledge

One frequent assumption in this book is that employees' work process knowledge is increasing in importance within more flexible working arrangements. If there is a tendency to make problem-solving an integral part of skilled workers' job profiles, then there is an objective need for workers to:

(a) acquire knowledge about criteria for 'good solutions' within the life-world of the company;
(b) collaborate with colleagues both inside and outside their narrow working area to gain knowledge to solve open problems, and to negotiate solutions between individuals and departments;
(c) relate their experience-based local knowledge to knowledge derived from science and technology and to the overall objectives of the production process or the business.

However, stating that there is an objective need does not mean that this need is objective in terms of empirical data. Authors speak of a 'new obscurity' or a 'delayed transformation' with regard to the growth of working conditions based on non-Tayloristic production concepts like self-managing teamwork and island production. Moreover, flexibility appears in various forms, not only as functional flexibility (concerning the range of work tasks performed) but also as labour market flexibility (including casual part-time or short-term contracts and the inevitable concomitant, social exclusion).

Moreover, examples demonstrate that the acquisition and transmission of work process knowledge is stimulated within companies not only as a by-product but as an intended outcome of a company's approach to human resource development. Michele Mariani and Massimo Mazza present case studies on this in Chapter 2 entitled 'The value of internal knowledge: work process knowledge and corporate restructuring'. They refer to the growing global phenomenon of corporate restructuring and provide a detailed account of an Italian chemical company which has turned itself into a knowledge creating organisation. Previously, the company focused on manufacturing but, in the face of the competition from second world chemical industries, it lost its competitive edge in that field. Today, the company retains a leading position by concentrating on creating and marketing knowledge of new chemical processes and the technology needed to give them commercial advantage. To perform successfully in this sphere, however, it has had to change its internal structure from the traditional Taylorist/Fordist one, associated with mass production, to a more flexible one. Whereas previously, the emphasis was on long manufacturing runs, now it is on setting up experimental production processes, running them long enough to discover how to create the new product, then replacing them by another experimental process designed to pilot the next new product. As competitive advantage derives from maximising the number of new production processes that can be tried out, the requirement is for a flexible, adaptable labour force. The basis for this is work process knowledge: an understanding of the work processes in the organisation as

a whole, not only the knowledge of one work role in one department (as was the norm in the Taylorist/Fordist system). The company assumes that if everybody in a company knows everything that is known in that company, its profitability will increase. Given the emphasis on innovation, this implies that all employees are involved in knowledge creation. A range of work-based learning methods are used to develop such a culture. These include a novel system of apprenticeship, designed to impart work process knowledge as well as more specialised ways of knowing, job rotation and a highly structured system of meetings in which new understandings of the work process are developed.

Mariani and Mazza's contribution leads to the questions who is acquiring work process knowledge and who is the subject of learning? Traditionally, learning was seen as an activity of the learning individual, taking place in the brain of the individual. In recent times, this view has been questioned through ethnographical research claiming that communities of practice are the learning subjects, or through concepts of organisational learning which consider the individual as a component in the collective process of improving the company's knowledge base. Mira Waibel, Michael Dick and Theo Wehner discuss these questions within Chapter 3 entitled 'Local knowledge in activity systems: the socio-cultural perspective of knowledge development'. They describe the phenomenon of local knowledge which focuses on the local conditions and borders of knowledge development, and reveals that knowledge is held by local collectives like communities of practice. Such knowledge is summarised as follows:

(a) knowledge is not a static copy of real life phenomena, but covers dynamic structures which support the personal mastery of action demands. In a pragmatic sense, this means a primacy of action and experience over cognitive representation;
(b) knowledge is not limited to an individual memory structure but is also embedded in the physical and social conditions in a field of action. In this perspective, knowledge or knowing cannot be analysed as a pure structure independent of any contextual influence;
(c) individual knowledge is developed through participation in a socio-cultural practice. This concept of learning implies the interaction between individuals, the interaction between people and artefacts, and the values, rules and institutions of social life.

For their theoretical framework, these authors use socio-cultural activity theory as developed by Engeström (1987). Following Engeström, and presenting empirical findings in favour of their approach, they point out that local knowledge is restricted to the loci of knowledge distribution within a

local activity system, referring to the subject, the instrument and the object of an activity accomplished by the culturally mediated structures, i.e. cooperation within a community, coordination by rules and the division of labour. However, it was found from empirical research that knowledge developed in such a framework does not necessarily meet the requirements of coordination over the whole work process.

The chapter helps to clarify different lines of argument within the discussion about work process knowledge. There is a normative approach which uses work process knowledge as a concept to express what workers should acquire and an empirical approach which uses the term to describe the kind of knowledge workers have acquired in the course of assimilating their actions within the life-world of the company. Following the latter approach, it is obvious that there is going to be a variety in the scope of such knowledge (from an understanding of the local demands of the workplace to knowledge about the overall work process) and that acquiring this knowledge will depend on personal initiatives as well as on collective working practices and planned human resources development.

Knowledge management is the term that is currently used for the measures by which the internal knowledge within a company is deployed and distributed. However, in Theo Wehner and Christoph Clases' Chapter 4 entitled 'Cooperation for knowledge development: a work psychology perspective', several shortcomings of the discussion about knowledge management are identified. They point out that issues of micropolitical relevance (power relations, trust, etc.) and societal implications (education, forms of socialisation, democratisation of the access to knowledge) are often underestimated or neglected: the issue of participation in forms of dialogue and cooperation is overlooked. Wehner and Clases see cooperation as a crucial factor within any form of work-related knowledge management. In their theoretical conceptualisation of cooperation they introduce three basic modes of joint activity: cooperation, coordination, and coconstruction. These forms of joint activity are structured through processes of:

(a) institutionalisation (initial and renewed coordinatedness);
(b) regulation (in corrective cooperation and coordination);
(c) expansion (expansive cooperation, coconstruction, remediative coordination).

Of particular interest within this work-psychological approach to cooperation are processes of transition between different modes of joint activity. The authors suggest that there can be no understanding of cooperation without an analysis of coordination, and no analysis of

coordination without an understanding of the logic of cooperation triggered by unexpected events in the framework of a specific form of coordinatedness. Thus, the (initial) coordinatedness of actors represents a necessary starting point for empirical investigations and is equally important for analysing cooperation in the case of unexpected events.

Based both on their theoretical framework and their empirical research, Wehner and Clases propose three areas for process design to stimulate sociotechnical innovation within companies:

(a) the exchange of employees;
(b) the inter-area manager;
(c) the inter-firm workshop circle.

These measures go beyond the scope of individual learning, just as the concept of 'organisational learning' does.

In Chapter 5 entitled 'Organisational learning in the European chemical industry: concepts and cases' Martin Fischer, Nicholas Boreham and Peter Röben present the framework of an empirical investigation into processes of organisational learning in the chemical industry in four European countries. The question is posed 'How can organisational learning be differentiated from individual learning?' and concepts are presented which give answers to this question by suggesting:

(a) structures of organisational inquiry as proposed by Argyris and Schön (1978);
(b) a process of culture change as discussed by Edgar Schein (1992);
(c) a systemic interventionist practice by the company's management as described by Peter Senge (1994);
(d) and the social shaping of the interrelation between company and society as postulated by Harald Geissler (1996).

In this chapter, Fischer et al. transform these concepts into criteria which make it justifiable to speak of a 'learning company' as differentiated from learning individuals on one hand and corporate restructuring on the other hand. They suggest and describe the following criteria:

(a) organisational work routines are being evaluated and improved;
(b) formal and informal learning processes are being evaluated and improved;
(c) transformations are occurring in the culture of the organisation;
(d) knowledge is being created within the organisation, at different levels (not only by the managers/scientists) and it is being shared within the organisation;
(e) 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.

German and the British case studies, which meet these criteria, are presented. In their conclusions, the authors point out that 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 work process knowledge: knowledge about the whole labour and production process within the organisation, including reflection on practical and theoretical knowledge that might be useful for work. In both cases, processes of organisational learning were stimulated by a remarkable reduction of personnel and the loss of experienced workers. Thus, organisational learning can be regarded as an attempt to compensate for the loss of know-how and, in the authors' opinion, it is not yet clear to what extent the individual worker benefits from the processes of organisational learning that he or she is involved in.

1.4.3. Explicit and implicit learning at work

One of the most important resources for organisational learning is the process of transformation between implicit and explicit kinds of knowing (Nonaka and Takeuchi, 1995). However, terms like 'the knowledge creating company' (ibid.) are built on the basic assumption that it is knowledge which is guiding our actions. This assumption was recently questioned by Georg Hans Neuweg (1998) and he develops his argument in Chapter 6 entitled 'Tacit knowing and implicit learning'. Neuweg refers to arguments which had been originally developed by Gilbert Ryle in the late 1940s who had criticised what he called the 'intellectualist legend' (1949, p. 31). This is based on the assumption that successful action is characterised by a preceding act of theorising which, as Ryle demonstrates, leads to an infinite regress because any action carried out intelligently would need another – preceding – action carried out intelligently, and so on.

Rather than being a substance, Neuweg postulates that tacit knowledge consists of abilities. Such knowledge is incorporated in the expert's actions comprising a variety of meanings from doing something intelligently in an intuitive manner, through knowing more than one is able to tell, and, finally, knowledge that cannot be transmitted didactically. From his theoretical framework developed on the basis of Polanyi's work he proposes the following conclusions for vocational education and training.

Although tacit knowing is not teachable it might be coachable. Effective teaching and learning aim at avoiding inert knowledge by shifting the emphasis from expertise in verbalising to expertise in doing. Learning has to be essentially situated and experiential. Favourable ways of transmitting this

kind of knowledge are found in real world learning, within master-novice relationships, within cultures of expert practice and in environments that have a strong focus on casuistic knowledge in connoisseurship and case-based instruction.

However, it might not be sufficient simply to confront the learner with practice. To avoid 'tacit blindness' it is suggested that experiential knowledge should be accompanied by reflection which includes the synchronisation of language and things; the strengthening of a mutual interrelationship between experience, analysis, reflection and the integration of knowing into action; and also the principle of direct assessment.

Throughout Neuweg's chapter the need for recognising and acknowledging the element of tacit knowing for the acquisition of work process knowledge is stressed while, at the same time, not eliminating the power of reflection and theoretical understanding. The latter is sometimes excluded in Anglo-Saxon notions of apprenticeship.

While Neuweg discusses organised learning, it is also a matter of interest how work-related knowing might be transmitted in everyday practice. If and how knowledge can be exchanged is the subject of Karin Moser's chapter entitled 'The role of metaphors in acquiring and transmitting knowledge' (Chapter 7). Moser describes new demands in flexible working arrangements, such as communicating perceptions about one and the same product from a variety of perspectives, which she regards as an essential component of work process knowledge. She concludes that new forms of work and their demands are making it necessary to turn implicit elements of work process knowledge into explicit ones. For this purpose language is of crucial importance.

In particular, Moser demonstrates how metaphors can be used to explicate the implicit understanding various actors have, as well as create a mutual basis for communication and knowledge in interdisciplinary work groups. Her understanding of metaphors is based on the following assumptions:

(a) when a metaphor is created, experience that was originally sensory is transposed onto abstract contents according to the principle of analogy building. Metaphorical transposing, therefore, transmits a sensory quality as well as providing an aid towards cognitive structuring that make abstract concepts comprehensible, 'tangible', and accessible. Thus, metaphors can reduce complexity and establish meaningful references to known experience;
(b) the models that underlie metaphors are not an expression of language, but rather an expression of thought. These models are an indication of

the cognitive structuring of experience, which in turn itself determines actions and thinking;

(c) metaphorical expressions cannot be generated and combined arbitrarily. Cultural and social conventions determine whether a metaphor is comprehensible and socially acceptable in a particular language culture. These conventions are reflected in the lexical metaphor-stock of the language, and they undergo historical development.

Moser presents several examples of how metaphorical analysis can be used within knowledge-management and knowledge-based cooperation. These examples show that the analysis of metaphors not only allows the explication of implicit knowledge, but also reveals differing actor-perspectives on the same object. Both of these – explication of implicit knowledge and revealing different perspectives in the life-world of a company – are regarded by Moser as central aspects of work process knowledge. She claims that by means of a cooperative metaphorical analysis of underlying mental models, involving, for example, members of a work group, a deeper and shared understanding of cooperation partners can be achieved, as such analysis goes beyond a mere understanding of facts and figures.

In this connection, language is clearly considered as a tool for the construction of knowledge in the workplace, its use reflecting organisational culture. In the Tayloristic organisation, talking is regarded as a waste of time, even a misdemeanour, but learning organisations encourage the free exchange of ideas and information. Attention should therefore also be devoted to the boundaries arising from the spatio-temporal arrangement of places of work. Many of these have been created by new technology and by traditional occupational demarcations. They simultaneously point to a need for work process knowledge so that employees can coordinate their work more effectively while also highlighting obstacles to the acquisition of such knowledge by direct work experience.

1.4.4. Learning at work: obstacles and opportunities

It has been demonstrated that the acquisition of work process knowledge must be analysed and discussed within a framework that goes beyond the individual. However, whatever collective learning structures companies do or do not implement, whatever learning cultures do or do not develop, in the end is it the individual who acquires or does not acquire work process knowledge. What are the stimuli for such work-related learning, and what are the barriers to the acquisition of work process knowledge?

On the one hand, we have to consider what workers do to cope with

unforeseen situations and how they actually interact within the life-world of a company. On the other hand, their actions are informed, although not totally determined, by what they are obliged to do. This brings us to the constraints on learning created by the obligatory aspect of work. Rik Huys and Geert van Hootegem in Chapter 8 entitled 'The division of labour and its impact on learning at work' focus on the crucial factor of the learning opportunities afforded by a job and describe the conditions which must be met if learning opportunities are to be maximised. The central concept they focus on is the division of labour. In relation to the automobile assembly industry, they suggest that teamwork is the essential development that is needed to improve learning opportunities. When a team is responsible for a complete part of the production process, much more freedom to regulate its own activity can be delegated to it. Many writers have argued for the benefits of organising manufacturing in teams, but Huys and van Hootegem argue that it also increases the learning opportunities of jobs. However, most assembly work is still organised on the line system and this limits learning opportunities.

The barriers to learning opportunities which Huys and van Hootegem have identified lead to the question of how to design on-the-job training. In Chapter 9 entitled 'Promoting learning at the workplace: challenges in shaping the work environment', Georg Spöttl emphasises the importance of learning at the workplace as distinguished from didactic forms of further training which, in the eyes of many, are of limited value. Within the framework of the European Community ADAPT programme Spöttl carried out a survey on learning by employees while undertaking operational tasks within companies. The topic of the survey was deliberately not focused just on 'learning during working' or 'learning by working' but on the many facets and trends of learning in the workplace. It was found that there is no universally valid approach 'for learning during work' or 'learning in the workplace'. In a previous German survey, learning in the workplace was the dominant form of learning (43 % of all cases) whereas seminars and conferences accounted for just 22 % of cases. Learning by adapted further training (14,9 %), career further training (13,7 %) and further training during leisure hours (8,8 %) played only marginal roles. Apart from learning at the workplace, other forms of learning could now also be identified in Spöttl's study. Product-related briefings and seminars are still widespread in many companies. Product-related further training was often assigned to learning in the workplace. Spöttl argues that such an assignment needs to be questioned in the light of the objectives of 'product briefings', which are mainly focused on learning how to handle products or serve a certain

purpose. Usually, there were no further demands for learning compared to what kind of knowledge could be acquired through learning at the workplace.

In summary the effectiveness of learning at work is a blending of practical knowledge and theoretical knowledge to form expert knowledge. Elements that make an expert are seen in movements from experience to realisation and from knowledge to skills through an integration of action in the context of work.

However, successful approaches to learning at the workplace have, and still, run the risk of not being recognised as such. Consequently we can postulate shaping requirements for learning at the workplace as follows:

(a) learning at the workplace must be clearly contrasted with the traditional didactic system;
(b) there must be a link to learning by work processes;
(c) the learning of concepts must be visibly coordinated with learning in the workplace;
(d) there must be a clear connection to organisation and personnel development;
(e) learning in groups and through cooperation relationships must be supported;
(f) applied 'new technologies/media' must directly support learning at the workplace;
(g) there must be innovative models for the involvement and participation of companies and their employees.

Some of these demands directly refer to the employee's motivation to take part in such processes of learning for work-related purposes. From Georg Spöttl's findings, it can be concluded that learning at work is one of the most important resources for the acquisition of work process knowledge. However, as the contribution by Walter R. Heinz, Thomas Kühn and Andreas Witzel demonstrates, the motivation to acquire work process knowledge depends on the individual's strategies of vocational learning through the life span. In Chapter 10 entitled 'A life-course perspective on work-related learning' Heinz, Kühn and Witzel present the results of a longitudinal study from two German regions. This was a quantitative and qualitative panel study of young skilled female and male workers in six major occupations in Bremen and Munich, conducted between 1989 and 1997. The six occupations selected are among the most popular ones in Germany: bank clerks, office clerks, engine fitters, car repair mechanics, hairdressers and sales clerks. Participants in the study followed different transition pathways after having received their apprenticeship certificate, motivated by

efforts to strike a balance between their work experiences and career expectations on the one hand, and labour market changes and employment opportunities on the other.

It is a basic assumption of the study that life-course transitions are linked to processes of self-socialisation which mediate experiences relating to vocational choice, occupational options, work conditions and careers into biographical action orientations and further decision-making. Self-socialisation refers to the microdynamics of an individual agency in varying social contexts across time. By identifying such biographical action orientations, an empirically grounded typology was constructed. This typology distinguishes six patterns of action orientations or modes of biographical agency in the context of work and career:

(a) company identification: the firm is regarded as a kind of home, interpersonal relations at work are highly valued; social support and recognition are expected in exchange for trust and loyalty, even when the income is moderate;
(b) wage-worker habitus: employment is regarded as a necessity and sometimes as a burden; to improve income and working conditions, jobs and employers will be changed, the most highly valued aspects being job security and employment continuity;
(c) career orientation: careers in a company offering progression or promotion through the ranks are favoured. To advance to higher level positions, much time will be devoted to further education;
(d) optimising chances: advancement and a wide scope for shaping one's work history is most important; this is attempted by keeping as many occupational paths open as possible and by accumulating additional qualifications;
(e) personality growth: an occupation is seen as a space for fulfilling personal interests; conditions at work, promotion and income are evaluated with a focus on autonomy/self-direction;
(f) self-employment habitus: freedom in economic and business activities is highly valued, risks are taken to become an independent actor regarding the goals and conditions of work which are viewed as prerequisites for business success.

These modes of biographical agency are seen as specific ways of constructing a fit between the person and the context of work. Such modes are rooted in prevocational socialisation, work experiences and vary according to the contingencies of careers. They generate patterns of career decisions and actions and extend across work situations. The manners in which particular modes of biographical agency influence patterns of work-

related learning and the acquisition of work process knowledge is discussed in this chapter.

Success and failure in translating one's work process knowledge into career process learning are closely linked to the person's efforts to maintain or improve his/her biography-work-fit. The authors conclude that, in Germany, the occupation and its career prospects form a dominant context for self-socialisation that guides young skilled workers in their efforts to adapt to employment discontinuity. Their qualitative data analysis suggests that there is an association between occupation, gender and modes of biographical agency and a correspondence between the modes of biographical agency and the way work process knowledge and career process learning are acquired by skilled young people.

1.4.5. Analysis of work process knowledge for teaching and learning

In some European countries, initiatives have been started which use work process knowledge as the reference point for vocational learning. These developments, however, depend on the identification and representation of work process knowledge for training purposes, traditionally the responsibility of psychological work analysis. Janine Rogalski's Chapter 11 entitled 'Psychological analysis of complex work environments' describes a French approach to such work analysis which places work process knowledge in that context. Specifically, she presents a model of operator behaviour in which work process knowledge is one of the factors involved in the construction of understanding a work environment. The concepts of 'operational knowledge' and 'professional competence', developed by French work psychologists and vocational trainers, are compatible with the conceptual approach proposed by the theory of work process knowledge. Like work process knowledge, operational knowledge encompasses the world to be acted on, the organisation the employee works in and the processes performed in other parts of the organisation. It articulates knowledge about the 'world to be acted on' with knowledge about the 'system of actors and the flow of work'. Rogalski sets these concepts and the concept of work process knowledge within a model of operational competence. This model, KEOPS, is articulated through four dimensions: knowledge (K), experience (E), operative cognitive tools (O) and problems and solutions (PS). Within KEOPS, work process knowledge maps on to the K-P-E triangle. Work activity is analysed as the core of a twofold regulation loop, representing work performance as distributed activity between actors in an operational device which articulates three dimensions: operational knowledge (including work process knowledge), schemes of action and instrumented activity organisers, together

with the individual's relations with the objects of the world of action (including him/herself and other actors). Work process knowledge integrates knowledge (defined at the level of 'what is conceived') with the organisation of the activity in a given field of action ('the world being acted on'). This proposed framework may be used for different research purposes: analysing work situations as either enabling or not enabling the development of work process knowledge and individual competences, or analysing actors' competences and attitudes with regard to work situations. It may also be used for designing training interventions, examples of which are discussed in this chapter.

Rogalski shows how work process knowledge could be identified and represented using established psychological techniques. However, the identification and representation of knowledge for vocational education and training is not merely a problem of empirical analysis. It is also a problem of social construction, as the empirical analysis of given work situations does not deliver answers to future challenges, nor to the question of which kinds of work situation are socially desirable and which kinds of training have to be developed. There is obviously great variety in Europe in the extent to which (and the purposes for which) working conditions and work-related education and training are regulated. Thus, the difference between occupation-related work analysis and pure empirical work analysis of given work situations is significant in countries where an occupation is defined by national-level institutions and where providing occupation-related education is a public obligation. In such countries, work analysis aiming at the development of vocational curricula has to be representative of the entire occupational profile. However, in countries like Germany, France and Italy there is a problem that teaching and training for vocational purposes does not make sufficient reference to the knowledge which is really needed at the workplace. Chapter 12 by Felix Rauner entitled 'Work analysis and curriculum based on the *Beruf* concept' addresses these kinds of problems. Here, it is assumed that single case studies are not sufficient to serve as a basis for vocational curricula which, in some European countries, such as Germany describe an occupational profile at a national level.

Rauner categorises different approaches in the development of vocational curricula: the scientific systematic curriculum; the curriculum based on learning theory; and the curriculum based on the *Beruf* (occupation) concept. He also makes strong demand for investigations based on vocational science (VS). Previous superficial analyses were not adequate as far as the identification of the content of training is concerned. Rauner's review of social science qualifications research reveals that the issues of the actual content of vocational training, which are so crucial for vocational

development, the development of vocational training regulations and curricula, as well as vocational training concepts, largely escape the attention of researchers. Moreover, after three decades of qualification research in Germany, it can be concluded that vocational education and training research, curriculum development and social science qualifications research have taken little account of each other.

Rauner suggests three focuses of analysis:

- the processes of work;
- the learning and training processes;
- the regulatory system for the vocation/profession/occupation.

These all stand in non-deterministic interrelationships.

Three major tasks for vocational science research are formulated:

(a) criteria for the development of occupational profiles and clusters need to be identified and developed; this approach characterises the so-called social shaping orientation in VET (Rauner et al., 1988, 2001): education and training is not simply derived from tendencies within the world of work, but serves as a resource for the social shaping of work and technology;

(b) vocational task analysis research explores the question of what vocational tasks need to be undertaken now and in the future, and what learning content results from them in terms of the development of vocational training planning;

(c) vocational work process research investigates questions about the work process knowledge of skilled workers and investigates the knowledge incorporated in practical vocational work.

Rauner proposes criteria for dynamic and open occupational profiles. Within these initiatives the concept of work process knowledge is differentiated and structured into 'learning fields' – 'orientation and overview knowledge', 'integrating knowledge', 'detailed and functional knowledge' and 'specialised advanced knowledge'. Traditional subjects and thematic modules recede into the background as task orientation takes centre stage. As a result, the mutual relations between complex content-related structures become the focus of attention.

In identifying work tasks in occupational settings, various divergent and conflicting concepts of work organisation may exist which influence the way tasks are both distributed and carried out. The tasks identified should also be broadly representative of the various workplace/workshop contexts. Within this framework the operational/economic, technological/organisational, normative and industrial/cultural contexts constituting the work are taken into consideration. Occupational work tasks become the

subject of the analysis, in relation to the vocational development and the shaping of vocational training processes, not merely in terms of their current content and methods and as an expression of specific forms of work organisation, but also in relation to their genesis and their possible and desirable developments.

The social shaping orientation suggests the involvement of workers in work analysis. In response to this need, Peter Röben describes methods of participative work analysis in Chapter 13 entitled 'Identifying work process knowledge in accordance with characteristic occupational tasks'. To characterise the content of occupational work, an approach was pursued that describes the potential range of work performed within a particular occupation in terms of a collection of characteristic occupational tasks. Skilled workers identified as experts in their field were involved in identifying and representing these tasks. This entailed organising expert-skilled worker-workshops under the aegis of a large German automobile manufacturer. A total of 23 workshops were conducted for five occupations in all, with the involvement of approximately 230 participants. Each workshop was scheduled for eight hours and was conducted by two researchers, one of whom had vocational training in the respective occupational field (e.g. technical college teacher or engineer in electrical engineering). Workshop participants were selected according to the following criteria:

(a) based on their occupational history, occupational competences and current tasks, expert skilled workers were selected to identify current developments at the workplace as well as emerging future trends. These expert skilled workers had progressed through a number of key stages in their careers in recent years, knew various departments of the company and participated in innovative projects;
(b) these expert skilled workers cannot be regarded merely as representatives of existing occupational structures, but personify occupational practice that is innovative and suggestive of future trends in a particular occupational field (prospectivity).

The content of the workshops included:

(a) the introduction of the participants' occupational biographies;
(b) presenting the concept of occupational tasks;
(c) specifying occupational tasks as relevant for different stages in the participants' careers;
(d) collecting and analysing characteristic tasks through contrastive task analysis;
(e) classifying tasks which were found to be relevant according to the level of difficulty (from novice to expert);

(f) development from novice to expert through milestones;
(g) assessment of apprentices and vocational training, professionals;
(h) evaluation of the outcomes on the basis of (photographed) pinboards and audio recordings.

The problem of the narrow empirical knowledge-base in qualifications' research, mentioned above, was mitigated (but not solved) in this project because the workshops generated data specific to that automobile company. For this reason, lists for each occupation were validated by a national survey of experts. Peter Röben regards the concept of expert skilled worker workshops as an attempt to solve the problem of the discrepancy between theoretical VET curricula and the real content of work, to address the skill formation that is actually needed.

1.4.6. **Design of curricula and work process knowledge**

Toni Griffiths and David Guile in Chapter 14 entitled 'Practice and learning: issues in connecting school and work based learning' present a typology of work experience, which includes experience of the processes. The typology includes the traditional model (launching students into the world of work), the experiential model (work as codevelopment), the generic model (work experience as an opportunity for key skill development), the work process model (attuning students to the context of work) and the connective model (a form of reflective learning). This typology helps to highlight some of the differences between the reasons for providing work experience. We agree with Griffiths and Guile when they say that no specific work experience programme fits neatly into any of their models and some programmes may contain elements of more than one model. As several of the chapters in this book make clear, vocational curricula which take work process knowledge as their guiding principle emphasise reflective learning, so it is misleading to contrast them with the connective model. In the German system of vocational education and training, work experience has always had a predominant role: German apprentices usually spend approximately 75-80 % of their training time in companies. However, it was realised at the beginning of the 1990s that in-company training, especially in the large companies, was organised in a way rather similar to school learning: compartmentalised into specific learning environments, mentally and physically disconnected from the shop floor. In the context of changing methods of production including decentralised decision-making, a strict distinction between theoretical learning, on one hand, and practical learning, on the other, became increasingly questionable. As in other European countries, in Germany the gap between theory and practical application needed to be addressed in a new way.

This situation serves as a background to the approach described by Peter Dehnbostel and Gabriele Molzberger in Chapter 15 entitled 'Decentralised learning: integration of working and learning'. A series of projects was launched by the German national institute of vocational education and training (BIBB – *Bundesinstitut für Berufsbildung*) to develop new forms of integrating learning and working on the shop floor. The concept of 'decentralised learning' was developed to account for the application of work process knowledge according to occupational profiles. The concept comprises two central aspects, an organisational and a didactical one. On the organisational side, new learning venues were established in or closely related to the shop floor. These learning venues – learning bays, learning stations or technical centres – were placed within a network of different learning venues, including training centres and vocational schools to maximise the advantages of both centralised and decentralised learning venues. On the didactic side, decentralised learning aims at the integration of learning and working. The didactic concept combines formal and informal learning processes.

The authors of Chapter 15 describe two new learning venues in detail: 'learning bays' and 'work and learning tasks'. These were structured as follows:

(a) work and learning tasks involve holistic work and learning processes through which technical, social and interdisciplinary skills are acquired;
(b) they are increasingly tackled in self-organised teams with each team member bearing a high degree of responsibility;
(c) the learning processes are driven by action and experience, the learners thereby acquiring experiential knowledge;
(d) issues relating to the design and organisation of the work are considered in depth and associated with a continuous process of improvement;
(e) the selection and enrichment of these tasks is added to the profile of training regulations and directives.

The authors have systematised the evaluation of these learning assignments by defining kinds of learning and working in enterprises and have identified further research needs. It is claimed that both different theoretical knowledge and experiential knowledge lead to action knowledge, which is regarded as the central objective of today's initial and further vocational training. Action knowledge, as Dehnbostel and Molzberger understand it, includes work process knowledge, but additionally focuses on the learners' mental processes in integrating formal and informal learning.

A similar approach towards the integration of work and learning is presented by Falk Howe in Chapter 16 entitled 'Learning and working tasks

as elements of work-related vocational education and training'. The expression 'learning and working tasks' indicates that experiential learning is combined with vocational training in both vocational training schools and companies. The concept 'shaping-oriented', as Howe interprets it, indicates that the trainees learn how to tackle job tasks critically with respect to the applicable techniques, work organisation and working conditions. They also seek alternative solutions and are able to put them into practice. This chapter describes:

(a) how vocational school teachers and in-company trainers can collaborate closely;
(b) how apprentices may participate within such a collaboration;
(c) how the identification of relevant work processes serves as a reference point for vocational learning assignments.

Steps leading to such a framework for teaching and training include:

(a) developing 'shaping-oriented' learning and working tasks (mainly by teachers and trainers): identifying in-company tasks; checking whether or not they fulfil criteria of shaping-oriented training; assessing the learning opportunities; selecting the appropriate in-company tasks for training, preparing the tasks, and formulating assignments;
(b) the performance of shaping-oriented learning and working tasks (mainly by trainees): discussing the assignment; collecting and analysing the necessary information; coping with the task; and planning and monitoring its progress and reporting the findings in a continuous way;
(c) the completion of shaping-oriented learning and working tasks (partly by teachers/trainers, partly by trainees: preparing the project report; presenting the project and its results; and performing the final appraisal of the project's progress and output.

As the author asserts, vocational training based on learning and working tasks supported the integration of learning and working and improved the quality of training. Inasmuch as the learning and working tasks were identified, selected, performed and evaluated jointly by the trainers and teachers, they intensified their collaboration to a remarkable degree. Howe suggests that collaboration between schoolteachers and in-company trainers cannot be prescribed but needs 'common matter' in the form of the development, performance and assessment of common learning and working tasks.

In both the cases described above, the decentralised learning approach and the shaping-oriented learning and working tasks, efforts were made to bridge the gap between the different types of learning experience in schools and companies and, consequently, between theoretical and practical

learning. But how can such approaches be evaluated in an adequate manner, and what kind of competence development is brought about by such approaches? These questions are addressed by Rainer Bremer in Chapter 17 entitled 'Developing a modern curriculum for the automobile industry'. Bremer writes about a project that set out to transform 27 occupational curricula into five new ones that meet the criteria of open and dynamic core vocations (see also Rauner in this book). The five new occupational profiles are:

- industrial mechanic,
- industrial electrician,
- industrial toolmaker,
- automotive mechanic, and
- industrial office-worker.

Using an approach informed by work process knowledge, Bremer derives the following demands for the development of vocational curricula and the design of didactics:

(a) demands on curricula: reference to work and technology by fixing vocational tasks; horizontal and vertical limitation of vocational tasks being identified; analysis of each vocational task according to its demands (with regard to competence-related, technical, pedagogical and societal issues);
(b) demands on didactics: methods of learning have to fit to methods of work; methods of learning have to support the development of professional competences and vocational identities; learning and working tasks have to be applied in a learner-supportive way.

As learning and working tasks themselves do not comprise criteria of competence development, the concept described here contains a further hypothesis about the way of learning. This is called the 'logic of development'. It can be regarded as a principle for enabling an apprentice to develop from novice to expert. The main instrument that was developed to assess this logic of development was a concept of evaluating one's professional development. Apprentice development is evaluated in various ways, for example, their competences in handling the instruments, working in professional contexts, and working in social contexts. First, levels of development have to be identified, followed by the steps that lead from one level to the next one. Through this instrument the following can be ascertained:

(a) which concept of learning the apprentice has developed, questioning if he or she made a shift from a school-oriented concept of learning to a concept of vocational learning;

(b) which concept of work the apprentice has developed, questioning whether he or she has moved from the concept of work in school life to the expectations of work in employment;
(c) which concept of social integration the apprentice has developed, questioning if he or she has switched from a peer-to-peer orientation to participation within a community of practice.

The interim results of this evaluation as presented by Bremer reveal a large variety of responses by apprentices after 16 months' training. Despite the goals of the project, some of them developed neither an appropriate idea of vocational learning nor an idea of what employment is about. Bremer concludes that the results can be attributed to what is called the 'training workshop stereotype' – the apprentices reproduce what they have learned about methods and tools that are typical for a training workshop, but not for real work in industry. Thus there is a gap between the concepts/curricula and the reality of this large automobile company's vocational education and training programme.

1.4.7. Policy issues

Several of the chapters examine the policy implications of research in this field. Pekka Kämäräinen in Chapter 18 entitled 'Learning through work experience: prospects for European knowledge development' explores the work of two European Framework – WHOLE – IV TSER projects (Work process knowledge in technological and organisational development and work experience for the 21st century – WEX) and relates these to the changing policy contexts within which they were conducted. He makes suggestions for the future agenda of research and policy analysis on work-related learning. The main need for future research is the culture of education and training and the main objective should be to try to bring about a culture change in which the relationship between the curriculum and work is more organic than is often the case. In the envisaged future, work would not become something to be 'related' to education, but part of a more integrated and homogeneous world-view. This requires more integrative curricula and the involvement of the social partners.

Another policy concern is 'training the trainers'. Roy Canning in Chapter 19 entitled 'Process knowledge and the development of further education professionals in Scotland' traces the history of the way the Scottish further education system has developed in the context of the UK government's policy of narrow definitions of competence and the privatisation of further education colleges. In this context, colleges become businesses and the lecturers either consultants or instructional technicians. Canning sees this as

an unnecessary limiting of roles, and advocates a reconceptualisation of our thinking about the learning processes inherent in the training of these teachers. In this context, he argues for alternative learning constructs developed from the theoretical work on situated learning and work process knowledge.

The concept of work process knowledge can also inform lifelong learning policy. Mike Osborne in Chapter 20 entitled 'Work process knowledge and lifelong learning policies' places concepts relating to work process knowledge in the wider context of lifelong learning policy and practice in Europe. He concludes that the work process knowledge model fits within policy frameworks which emphasise expansive education, rather than the limited competence models which have been developed in the UK.

The final chapter in this book (Chapter 21) by Karsten Krüger is entitled 'Work process knowledge and labour relations in the Spanish steel industry'. The question posed is: 'What form of labour relations is needed for the introduction of new forms of work organisation based on work process knowledge?' Krüger refers to research-and-development projects undertaken in the last five years in the Spanish steel industry. These projects were based implicitly on the concept of work process knowledge, and had the objective of elaborating instruments and tools for steel companies to help them adapt to new conditions. Based on Bourdieu (1997), Krüger develops a theoretical framework distinguishing and describing five types of capital or fields of power resource: economic capital, cultural capital, social capital, symbolic capital and organisational capital. His main assumption is that organisational transformations based on work process knowledge change the configuration of the capital structure in the organisation and the power games being played between different actors. Work process knowledge is regarded as the workers' resource of power against the power resource of the employers and their associations.

An empirical study carried out in the Spanish steel sector revealed that companies were aiming at a 'new professionalism' based on the following hypotheses:

(a) technological change in the steel sector implies that work is becoming less manual and more abstract, requiring changes in worker competence profiles. These changes in skill formation were introduced through continuous training programmes focused on technical tasks. However, they were not always carried out adequately and caused failures in production;
(b) companies have introduced the principle of polyvalence due to technological change and the need to reduce the number of employees.

This implies that workers acquire skills and especially work process knowledge, to enable them to work in a broad field. Nevertheless, most companies do not apply this principle universally, as the original schemes of polyvalence were only realised more or less half-heartedly and also because intended measures of work enrichment were only partly carried through.

The situation in these steel companies is seen as neo-Taylorist. Compared to traditional Taylorism these new forms of work are based on the workers' knowledge about working procedures, but without recognising their possession of such knowledge explicitly, and without using this as a reason for fundamentally reorganising decision-making procedures. This situation has been improved in two current projects which are described in detail and which are explicitly based on the concept of work process knowledge.

The success of these projects is explained in terms of the above theoretical framework by a sector-specific bargaining structure which defines the rules of the game and clarifies the benefits and deficits for all the actors involved. The employees' work process knowledge was not only used to benefit the enterprises, but also used by individual workers seeking to improve their working conditions. Two themes can be discerned, one of which is the need to distinguish between:

(a) work process knowledge as the form and content of skilled worker-specific knowledge which can be found in any company in one form or the another;
(b) work process knowledge as a concept that is used for reframing work organisation and working conditions within companies, for defining occupational profiles and VET curricula, and for improving work-related learning.

The authors of this book have contributed to both of these aspects, which are distinct but necessarily interwoven. If work process knowledge does not exist at all it would not make much sense to build concepts of work-process oriented working and learning practices, occupational profiles and curricula. Moreover, if such knowledge is automatically acquired and acknowledged, there would be no need to reframe and modernise learning and working practices. Empirical and normative conceptual approaches to work process knowledge inform each other. This kind of knowledge itself must be seen as a dialectic, inspired by attempts to make sense of events at the workplace (Boreham, 1995a), drawing on the local and individual know-how incorporated in action, embedded within a community of practice or an activity system, and related it to the world of science and technology. It is this that gives the concept of work process knowledge its generative character.

A second theme can be found in Karsten Krüger's chapter. This is the theme we started with in this introduction and can be reformulated as a question: is there a demand for work process knowledge among companies and in educational institutions throughout Europe? Krüger comes to an emphatic conclusion: 'Work process knowledge is strongly related to the balance of power within enterprises, the economic sectors, the educational and training systems, and society as a whole. Work process knowledge is, in all these areas, a basic power resource'.

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SECTION II

Individual and organisational dimensions of work process knowledge

CHAPTER 2

The value of internal knowledge: work process knowledge and corporate restructuring

Michele Mariani, Massimo Mazza

2.1. Introduction

In recent years, in response to increasing global competition, companies have put much effort into continuous improvement and corporate restructuring initiatives. Internal practices and skills have often been regarded either as factors that slow down the process of change and/or as commodities to be identified and stored in dedicated IT (information technology) systems. However, the validity of such approaches has been criticised by various authors for the following reasons:

(a) downsizing results in 'corporate amnesia' (Davenport and Prusak, 1998);
(b) business process reengineering approaches that claim to sweep away old practices ('forget all you know') never come close to the results promised (Blair et al., 1998);
(c) technological solutions (knowledge management tools) have limitations, principally because they detach knowledge from processes and people (Dixon, 2000).

Based on evidence from recent studies in the research centre of a world-leading Italian chemical company (referred to here as CER), we will argue for the importance of the concept of internal knowledge, especially work process knowledge (Boreham et al., 2002) in corporate restructuring and discuss three examples of how such knowledge can be valued, maintained and transferred.

2.2. The company

Within the context of two European projects ([2]), various studies were undertaken in the research centre of the above-mentioned chemical company in an attempt to understand how knowledge is created, shared and transferred.

Like other chemical companies in Europe, this company reached its maximum occupational level (5 000 workers) in the 1960s, when the chemical industry was highly profitable (Bordogna, 1989). Over the years, the introduction of a new, highly efficient, production process and increasing global competition led to a progressive reduction in production workers. However, the occupational level of the research and development department of CER has always remained stable, if not increased.

The site employs approximately 900 workers in around 20 departments, the majority operating on a continuous 24-hour basis. The site is split into two main areas dealing with 'manufacturing' and 'technology'. The manufacturing area employing approximately 200 workers, is devoted to the production of large quantities and it is divided into five subdivisions:

(a) management,
(b) maintenance and engineering,
(c) logistics,
(d) services,
(e) three production plants.

The technology area, employing approximately 700 workers, is devoted to research (new products and technologies) and it is split into six subdivisions:

(a) management,
(b) business support,
(c) technical service,
(d) seven laboratories,
(e) four pilot plants,
(f) five catalyst plants.

On the production side (manufacturing), the market's limited capacity to absorb polyolefins heightened the need for efficiency in attempting to produce the same quantities of product using fewer resources and at a lower

([2]) These are:
(a) the WHOLE research project - work process knowledge in organisational and technological development (http://www.education.man.ac.uk/euwhole/about.htm);
(b) the OrgLearn project - ways of organisational learning in the chemical industry and their impact on vocational education and training (http://www.itb.uni-bremen.de/projekte/orglearn/orglearn.htm).

cost. It was thought that this could be achieved through two main strategies: first, by streamlining all parts of the supply chain (from procurement to product delivery) and second, by applying 'best practice' in compounding facilities.

On the research side (technology), the challenge, given uncertainty about the final product, relates to the effectiveness of the laboratory in performing more experiments and getting the product to market as quickly as possible ([3]). To reach this goal, two main strategies were adopted: first, a joint development scheme for both products and processes and, second, programme-centred organisation. Given that the research division is the most advanced in terms of the organisation of work, its strategies and their relevance for work process knowledge are the focus here.

To decide which research programmes are to be undertaken, a joint committee, comprising researchers and product development workers ([4]) meets every four months. The activity of the technology department as a whole is determined during such meetings ([5]). Research ideas are developed in three stages, all performed at the same site:

(a) testing in very small reactors in the laboratories;
(b) testing in scaled down plants (pilots);
(c) (eventual) production in manufacturing.

This process is staggered because once a new product/reaction has been successfully tested in the small reactors of the laboratories it is not convenient to transfer the same reaction directly to industrial plants. The production process has to be tested beforehand. Such testing takes place in the pilot plants ([6]), which are also necessary to produce macro samples for quality testing on a wide range of new products. A key characteristic of the site is that the invention phase (whereby new chemical components are invented) and the experimentation phase (whereby new technological solutions for the production of the components are designed) are closely

([3]) With a very small increase in personnel, the pilot plant performance grew from one test every month (beginning of 1980s) on one installation, to two tests per week in three installations. Thanks to the introduction of continuous cycles of work (24 hours) laboratory activity shifted from two to three tests per day to 20 to 25.

([4]) These people keep in contact with clients to ascertain that there is a market for new products and to take purchase orders.

([5]) Organisational functioning is programme-oriented: the organisation configures itself as a function of the following:
- research programmes to be developed;
- product to be delivered;
- services to licensee plants.

([6]) Catalyst plants are similar to pilot plants, although the former are more devoted to production than to research. Trial and error in these plants can be very costly.

merged. Products and processes are jointly developed. The new catalysts coming from laboratories go to pilot plants, which produce samples that indicate the changes to be made in the laboratories and so on.

Various studies were undertaken in the research centre of the CER chemical company to understand how knowledge is created, shared and transferred ([7]).

On the research side, given the uncertainty of the final product, the challenge is to perform the greatest number of trials (experiments) in the shortest time. The research process is innovative in that it merges the phase of invention of new chemical components with the phase of experimenting with new technological solutions for the production of the components themselves.

The key elements that make such merging possible are the pilot plants, where experiments to find new chemical recipes are run directly. Thus, once a new catalyst has been found the technology to produce it becomes available immediately. Such methods allow the centre to develop a market for its innovations in a short time. This speed and efficiency gives it a clear advantage over its competitors. Finally, at the level of human resource management, a very high level of flexibility is attained. This has been achieved through the adoption of semi autonomous teams, internal mobility (both horizontal and vertical), 24-hour activity cycles and role integration. Such practices (associated with a high degree of participation, union-management joint decisions and a policy of retaining in-house knowledge at all levels) have resulted in a very flexible use of internal resources, with the possibility of modifying activities very quickly, concerning market opportunities and day-to-day results.

2.3. Work process knowledge and corporate restructuring

We refer to the concept of work process knowledge as a view of the work process in its entirety, that is, knowledge that encompasses more than an individual's single position/role and covers the different parts of work activity (Kruse, 1986).

The link between work process knowledge and corporate restructuring is

([7]) The site has been a world-leader in polyolefin research and innovation for 40 years. Its core activities include production, research and added value services for customers (codesign, piloting, computer-aided design, compliance testing, and so on).

apparent when we consider the recent changes made in many organisations. 'Multi-skilling', the wide scale introduction of information and communication technologies (ICTs) and the integration of different parts of the work process demand work process knowledge.

Multi-skilling has been widely adopted in the chemical sector. While 20 years ago, approximately 20 different professional profiles were necessary to operate a plant, at present most of these competences have been integrated in one multi-skilled (*polivalente*) operator who can play the role of external operator, process driver and process assistant as illustrated by the following excerpt from an interview with the planning and control manager at CER:

> 'I need the competences of each worker and each team of workers to be as homogeneous as possible. This allows me to plan the activity of the different pilots as a function of the real needs of the process. I know exactly how many people are needed to conduct a certain process inside a certain plant. Once the pattern of activities has been defined, I need to move people from one plant to another and from one position to another. Such mobility is only possible if I have people with enough training and experience'.

In the modern workplace everyone should be aware of the different aspects of work so that they can correctly interpret results and practices and be an active part of the process.

ICT in the workplace allows increased integration between different phases and aspects of the work process and holds the potential to reduce temporal barriers to knowledge sharing. The introduction of modern control panels has allowed the operator of chemical plants to monitor the whole work process at a glance. This was not possible with the old panels comprising hundreds of single indicators.

Integration of different parts of the work process can be seen in maintenance. In the past this focused on adjusting parts of the plants that broke often as a consequence of modifications introduced by engineers. Recently, this function has been broadened under the heading of 'maintenance and technology'. This means that instead of waiting for the consequences of the designers' work, maintenance and design now relate to a common practice. In such a way, two levels of experience were combined (see Figures 1 and 2), namely, knowledge of the history of the plant (maintenance people) and knowledge of the desired new design (engineers).

Figure 1: **Maintenance as a residual activity**

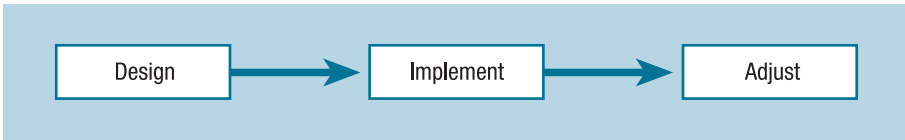
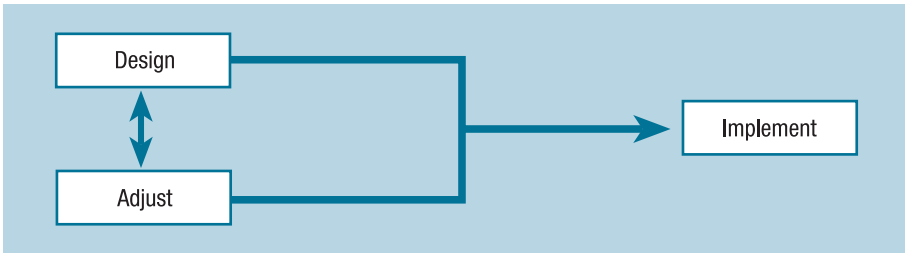


Figure 2: **Maintenance as an integrated activity**



2.4. Learning experiences and work process knowledge creation

To provide a high level of flexibility and readiness during the work process, access to knowledge of the activities and practices of both departments (manufacturing and technological research) is considered of paramount importance at CER. Various authors have ascertained that practice is one of the most efficient means of learning. For example, Miller and Gildea (1987) compared learning words through everyday conversation with trying to learn vocabulary from dictionaries. They noted the following:

- on average 17 year-olds learned vocabulary at a rate of 5 000 words per year, learning both what these words mean and how to use them;
- when learning from abstract definitions and sentences from dictionaries, young people acquired between 100 and 200 words per year, with much of this learning useless in practice.

From research in a different domain, ethnographers Lave and Wenger (1991) have shown how organisations can be seen as 'communities of practice' where learning effectively occurs as people participate at the work process ('legitimate peripheral learning').

At CER, practices are regarded as valuable repositories of work process knowledge that can be accessed through participation and experience. Practices, when shared, are the primary resources for organisational learning and corporate restructuring. We give the following five examples:

(a) rotating between roles and plants;
(b) integrating work process knowledge in the applied research laboratory of polymerisation and control;
(c) training temporary workers;
(d) joint attendance at training courses;
(e) teaching newcomers;
(f) temporary workers' training as a chance for knowledge renewal.

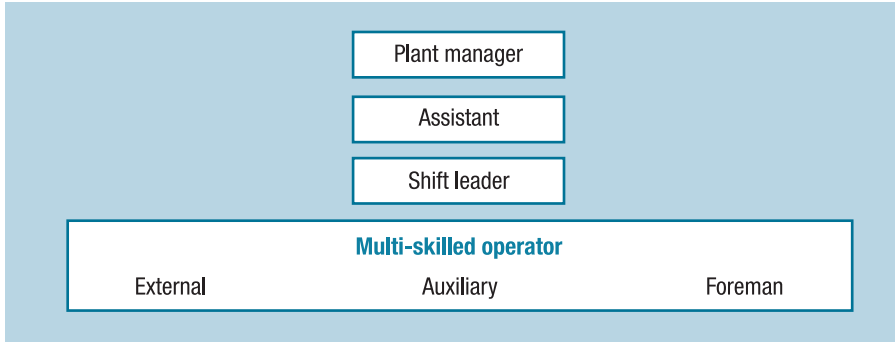
Each of these five examples is elaborated on below.

2.4.1. Rotating between roles and plants

Pilot plants are operated by teams working on a continuous 24-hour basis ([8]). Four basic roles can be identified (see Figure 3) ([9]):

(a) plant/division manager,
(b) plant manager's assistant,
(c) shift leader,
(d) multi-skilled operator (*operatore polivalente di impianto*).

Figure 3: **The different roles in a pilot plant**



Plant managers hold the most complete knowledge of a plant. They interact with the researchers with whom they undertake planning. They also coordinate and decide the shift rotation. The plant managers' assistants aid the plant managers and replace them when they are not at the plant. The shift leader coordinates the shift and oversees micro variations of the

([8]) Three shifts of 8 hours each (06.00hrs-14.00hrs; 14.00hrs-22.00hrs; 22.00hrs-06.00hrs).
([9]) A sample pilot plant can have approximately 20 employees. Both the number and the competences of the people who constitute a team can change depending on the complexity and intensity of the process, to maximise both efficacy and efficiency. For example, each plant can have one or more lines of production. Pilots with more than one line activated at the same time need teamwork-oriented operators.

process. The multi-skilled operator ([10]) can play three different roles:

- external operator,
- auxiliary operator,
- foreman (*quadrista*).

In the role of foreman, the operator monitors the plant's functioning and oversees the process, following specific instructions given by the researcher and the plant manager. The foreman also keeps track of the results of ongoing plant activities. As an 'external', the operator charges the plant with the different materials (for example, additives). He/she also operates the valves and pumps that cannot be activated from the internal control room. As an 'auxiliary', the operator supports the team when necessary. In addition, being at the plant during dayshift, multi-skilled operators learn about the different peripheral activities that are performed to run the installation (e. g. keeping contact with the materials department, maintenance, laboratories, and so on.).

No one is hired to be, for example, a shift leader. On the contrary, everybody starts as an external operator, following the scheme in Figure 4.

Figure 4: **Sequence of positions for learning in pilot plants** ([11])

Once operators have learned the basic skills of three roles (external, auxiliary, foreman), they are frequently rotated to learn about the plant itself and the different tasks involved.

As well as rotating within teams, operators can be rotated between teams of the same plant and even different plants.

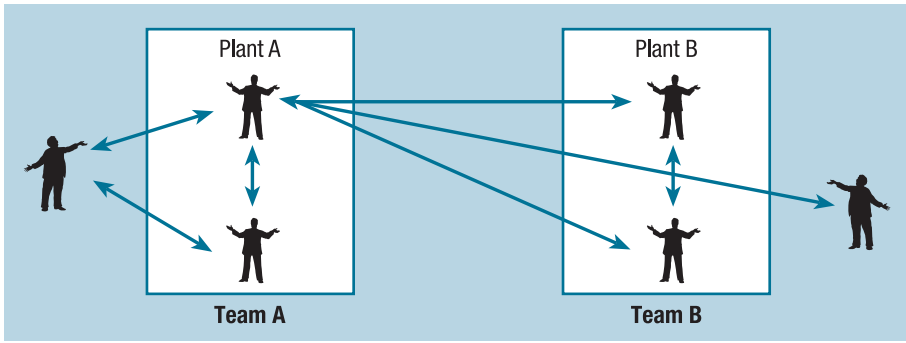
> 'The meeting scheduled was concerned with team organisational problems. Team leaders discussed some ways of improving team skill levels and proposals were made for moving individuals from one plant to another, to improve their experience and knowledge of the work process' (planning and control manager).

([10]) The same multi-skilling also holds for technicians in the laboratories: 'With our system of training, a technician learns all the operations (more that 40) that are performed in my laboratory, so that I am free to place them in one shift or another, depending on the need of the programmes' (APRC manager assistant).

([11]) Within the site it is quite normal that even engineers and researchers spend their initial training inside pilot plants, rotating as the operators do, to get hands-on experience of the details of the process they will design later on.

Although 20 years ago about 20 different professional profiles were necessary to operate a plant, at present most of these competences have been condensed into one multi-skilled (*polivalente*) operator. Such operators are continuously rotated between teams and pilot plants as necessary (see Figure 5), learning different practices directly.

Figure 5: **Role rotation**



When rotating between teams and plants, employees learn different ways of behaving. Frequently they have different ways of performing a similar operation and so they cross check and improve each other's routines and procedures, leading to a transfer of experience between the different communities of practices:

> 'Each team is like a different family. The way in which work is accomplished and people cooperate depends to a great extent on the shift leader' (planning and control manager).

2.4.2. Integrating work process knowledge in the applied research laboratory for polymerisation and control

The applied research laboratory for polymerisation and control (ARPC) is the biggest in the world, with 18 autoclaves (small reactors), approximately 10 of which are active in each shift. It is devoted to 'polytesting' the process of obtaining polymers by a chemical reaction between a monomer (coming from another site) and a catalyst ([12]). Polytests are performed for different reasons:

(a) research, both for new products and for developing existing ones;
(b) quality controls for production plants;

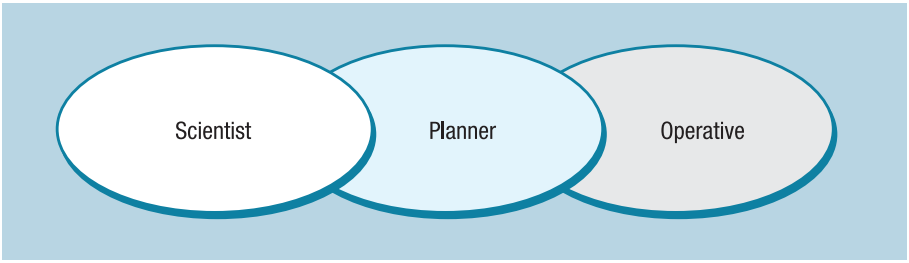
([12]) Using bread making as a metaphor, monomers can be regarded as flour, catalysts as yeast, reactors as the oven, and polymers as the bread, the final product.

(c) analysis for pilot plants;
(d) others (services for licensee plants, and so on).

ARPC employs approximately 54 workers in three teams that resemble teams in pilot plants:
(a) plant manager,
(b) plant manager's assistant,
(c) shift leader,
(d) technicians (five in each shift).

The retirement of one key member of personnel within the autoclaves division led to a restructuring of the work process. Prior to this employee's retirement, work was carried out as a 'three actor process' (see Figure 6).

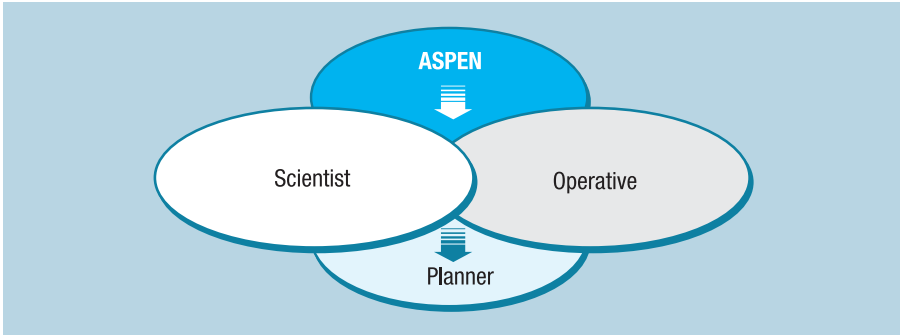
Figure 6: **Work as a three-actor process**



The division has many researchers and technicians, while the planner (a former researcher) was the only person able to write the 'recipes' (non-standard, innovative) for the test. Such a situation created a rigid workflow that caused delays and inefficiencies. As soon as the planner retired, the management did not replace him, deciding to introduce a new system called 'ASPEN' that could support planning (see Figure 7). They decided to train scientists and operatives together in four (60-70 hours) courses in one year. The training enabled employees both to acquire technical competences related to the system itself, and to get the two major actors of the work process (i.e. scientists and operatives) to work together on common ground and learn each other's practices. Such an approach led to a mutual learning process that was successful in understanding the needs and language of both groups.

> 'As a consequence, the planning function was successfully abolished. This meant that we succeeded in enhancing the degree of flexibility within the system: now there are two groups who cooperate in planning, without any dedicated role'. (Excerpt from an interview with planning and control manager).

Figure 7: **The new work process in autoclaves**



The planner who retired had knowledge of the tools (reactors) and laboratory methods, as well as the skills of the researchers. Therefore, it was relatively easy for him to provide the formula. However, due to his unique profile neither the researchers nor the technicians had the opportunity to learn his job. The three roles in the autoclaves division were thus separated by boundaries of role and competence. The restructuring and training that took place following the retirement of the planner lead to the following outcomes:

(a) researchers are able to provide ideas that are closer to the constraints of the tools;
(b) technicians are able to interpret the researchers' ideas;
(c) there are no more 'bottlenecks' in the process. Activity and knowledge are distributed throughout the system much more flexibly;
(d) the plant manager can distribute activities in more varied ways;
(e) the division has raised skill levels and knowledge of internal culture.

2.4.3. Training temporary workers

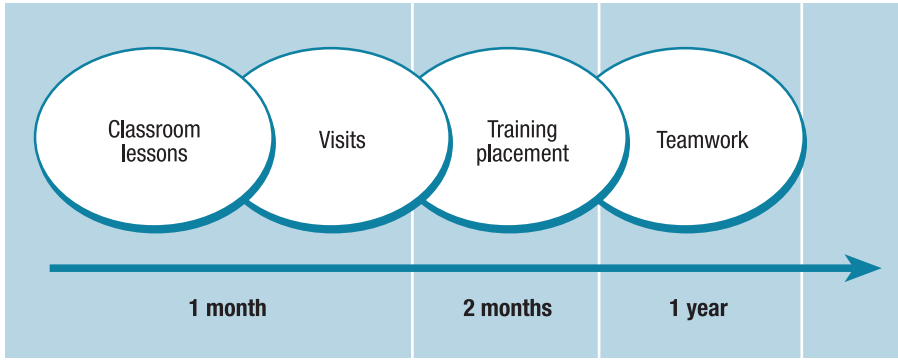
Additionally, the idea of 'key users' was adopted to promote internal learning. This means that whenever a training course on a new technology takes place (such as the aforementioned ASPEN system), not all personnel concerned with the technology will attend the initial lessons (normally taught by external experts/consultants). Instead, only a limited number of 'key users' are selected from among the group. These 'key users' attend the lessons and, as soon as the technology's characteristics are learned, they become teachers for the rest of the group.

> 'In choosing 'key users' we enforce in people the attitude of being both good learners and good teachers'. (Excerpt from an interview with the maintenance manager.)

2.4.4. Teaching newcomers

As soon as the opportunity arose, CER hired temporary workers. It saw the employment of temporary workers as a way in which to increase flexibility, for example making it possible to instigate a number of additional, short-term exploratory research projects. To exploit this new opportunity, CER had to overcome a serious problem. Two to three years' experience is required to become an effective chemical plant operator. It was difficult to see how temporary staff, employed on a one-year contract could be usefully employed. This difficulty was overcome by placing temporary workers inside well-established processes managed by expert teams. This created an extremely effective training process. It became possible to move one expert operator from each team to create new groups that would work on new advanced processes. The whole training process is structured along two axes: from theoretical knowledge to work process knowledge and from a general view of the company to participating in a unit team (see Figure 8).

Figure 8: **The process of training newcomers**



Once selected ([13]), novices attend a one-month period of instruction, tutored by expert technicians. The morning is devoted to classes on theoretical subjects, the application of which is discussed in the afternoon during guided tours of the site divisions. If, for example, a lesson is given in the morning concerning the principle of polymerisation, in the afternoon there is a visit to the laboratory where this principle is applied. In the first month novices are taught about all the different work processes that take place in all of the site's divisions (pilot, laboratories and production plants),

([13]) Novices are selected on the basis of a psycho-attitudinal test, an interview and their educational curriculum. The minimum requirement for attending the selection is the Italian middle school certificate.

irrespective of where the individual will be employed on their one-year contract.

Learning in teams begins with the repeated performance of a task. Once a basic skill is acquired, the typical process foresees the learning of another simple task directly linked to the first one. Training, therefore, follows the two basic principles stated by Vygotsky (1978):

(a) knowledge acquired by proximal development;
(b) full cognitive development requires social interaction.

From the company's point of view, such a method has the great advantage in that the starting points (i.e. the first basic operations) are not the same for everyone, but can be decided on as a function of the present needs of the company.

The integration of traditional classroom-based lessons and an apprenticeship within the community of practice (Lave and Wenger, 1991) represented by the team, allows for a quicker and more thorough socialisation of novices (Gustavsson and Ellström, 1998). Teams become:

> 'training contexts, setting an example for activities performed and the professional behaviour and orientation required [...] the novice learns how the organisation operates on the basis of cooperation and self-organisation' (Catino and Fasulo, 1998).

The effectiveness of this method is reflected in the fact that even employees without previous knowledge of the domain, become fully competent members of the operational teams after the training period.

2.4.5. Temporary worker training as an opportunity for knowledge renewal

Besides the primary goal of instigating several innovative, exploratory research programmes, the introduction of temporary workers was found to be very effective as a means of promoting knowledge renewal. Work practices, in fact, tend to be conservative and resistant to change. This phenomenon is even stronger if the social context remains the same for a long time. Within a company that can have a maximum turnover of two percent of workers per year, the introduction of temporary workers represented an effective way to refresh long-established work practices and skills.

> 'Always having to teach others increases our own level of professionalism. If we did not have to teach some of our plant's schemes to newcomers, we would not look at those schemes for months. In this way, we have to continuously refresh our knowledge'. (Excerpt from an interview with team operator.)

In teaching the newcomers, skilled workers have to describe their experience, transforming tacit into explicit knowledge (Nonaka and Takeuchi, 1995).

2.5. Conclusions

In-house knowledge and experience are seen by various authors as inhibiting innovation. However, as a consequence of the failure (or limited success) of change processes which attempted to start with a clean sheet – totally abandoning previous in-house know-how – companies are reassessing the value of in-house internal knowledge and experience. In examining the case of an advanced R&D centre of a chemical company we argue that internal knowledge, or work process knowledge, can be a valuable resource for companies attempting to improve efficiency and increase flexibility. Such a resource can be deployed by sharing knowledge, that is, by participating in a mutual learning processes mediated by a company's activities. Learning is speeded up by full participation in team activities. As Hutchins (1995) argues:

> 'The meanings of statements and questions are negotiated by the participants in the context of their understanding of the activities underway'.

Integration-times are reduced by immersion in the community, facilitating mastering of a common language (Oliveira, 1998), interpersonal sense making (Weick, 1995) and the development of personal competence (Nuutinen and Norros, 1998).

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CHAPTER 3

Local knowledge in activity systems: the socio-cultural perspective of knowledge development

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3.1. Introduction: focus and objectives

Phenomena such as 'knowing-how', 'experience' and 'tacit knowledge' are becoming key issues not only in vocational training, but also in other work disciplines and organisational sciences. They demonstrate that representing knowledge as information processing is far too simplistic a viewpoint. This is especially true when considering knowledge development and knowledge transfer. In fact, learning processes are simplified if they are described solely as the transportation of content from one mind to another.

An analysis of learning theory suggests that there is a process of transformation, whereby the carriers and the contents of knowledge are constantly changing. These transformations are embedded in physical and social situations and depend on local conditions and demands. Learning processes and the adaptation of knowledge, therefore, should be analysed in the context of the concrete workplace and real work processes. This ecological dimension of knowledge has to be taken into account when developing theoretical concepts of learning and knowledge.

This chapter highlights the importance of the 'local knowledge phenomenon', which is not the same as work process knowledge. It focuses on the local conditions and borders of knowledge development and draws attention to the fact that knowledge is held by local collectives (communities of practice). A theoretical framework for this perspective is provided by Engeström's socio-cultural activity theory (Engeström, 1987; Cole and Engeström, 1993). Our empirical approach examines the conceptual organisation of local knowledge. Because they are explicit carriers or signs of knowledge, 'verbal concepts' are crucial for exchanging experience as well as supporting instructional learning. We show that 'verbal concepts' are

sometimes restricted to local communities, that they play an important role in internal regulation and do not automatically fit the requirements of the coordination of the whole work process.

3.2. The challenges of knowledge development

The development of work-related knowledge requires a new understanding; many discussions about work-related knowledge have their common starting point in problems of daily work, in fields such as work organisation, technological innovation, or vocational education. There is a broad agreement in applied work-related disciplines that knowledge is related to action and practice. Therefore, knowledge at work is not only saved, stored and disposed of as an abstract resource but is exchanged and transferred in a continuous learning process. In knowledge development the following issues are central:

(a) the challenge of individual orientation;
(b) the challenge of organisational innovation;
(c) the theoretical challenge of the transformation of different types of knowledge.

3.2.1. **Knowledge development as an individual challenge**

Technological and economic demands for flexibility and incessant change impact on the skills and resources of employees. For example, the question of orientation can be seen as a consequence of accelerating technological change. The amount of information that has to be processed by individuals is increasing, as are the opportunities provided by new information and communication technologies. The ability to use the right information is meant to be a key qualification (Badura, 1989; Reetz, 1989; Breyde, 1995). Individuals need personal frames of reference when dealing with information. These provide criteria with which to evaluate information as relevant, useful or valuable. This affects not only short-term decisions in daily work situations but also long-term life decisions in a biographical frame (Heinz et al., this volume). The life course perspective (as well as strategic economic considerations) reveals that the properties of an individual are important in the sense of an individual's occupational capacity so that an employee becomes independent of a single company (von Krogh and Venzin, 1997; Willke, 2000). Companies no longer offer a lifelong guarantee of work but they can promote employees' capacities with regard to the labour market (Derboven et al., 1999).

3.2.2. Knowledge development as an organisational challenge

Demand-oriented markets and decreasing mass production make the improvement of quality a strategic goal in industrial enterprises. The new relationships between central planning and shop floor performance make quality an important issue. Both products and internal processes must be improved continuously. 'Quality circles', 'lean management' and 'Kaizen', as practised in Japanese organisations have permeated global work processes. Their central tenet is that the knowledge held by workers is valuable and profitable (Stahlmann, 1995; Howaldt and Minssen, 1993). Creativity and problem-solving methods are implemented in production settings and a general atmosphere conducive to innovation is cultivated. However, without sufficient gratification and participation of shop floor workers in central decision-making processes, these initiatives cannot fulfil their promises (Greifenstein et al., 1993; Derboven et al., 1996). Moreover, if the proposals for improvement are not pursued and the workers receive no feedback, their motivation fades. From this perspective, innovation is based on the knowledge of all employees and must be seen as a question of continuous cooperation between different social systems (Wehner and Endres, 1996; Waibel and Wehner, 1996; Wehner and Waibel, 1997).

3.2.3. Knowledge development as a theoretical challenge

Innovation in itself implies a process of learning. If initiated by the workers themselves, the creation of new methods or tools is a process of active construction. If initiated by external technological innovation then the workers must adapt. This adaptation to new production methods (e.g. CNC) means that the tacit character of expertise, experience and knowledge has to be confronted (Bromme, 1992, 1993; Böhle, 1992; Böhle and Rose, 1992; Malsch, 1987; Fischer, 1996). It has been shown that the automation and informatisation of industrial production has limitations and that workers are able to act and react in more flexible ways than any standardised procedure will allow, especially in cases of accident and disruption. Compensating for dissonance between plan and practice has to be carried out by workers in a precise fashion, tacitly and almost imperceptibly. Therefore, a great deal of attention must be paid to the differentiation between explicit knowledge (which is 'verbally available') and the tacit or implicit knowledge (skills, experience, knowing how) embedded in behaviours, routines and practices (Nonaka and Takeuchi, 1995). Any routine aspect of the work process bears this embedded character. The central question is how personal and tacit experience is transformed into 'verbal knowledge' that can be shared with others (Derboven et al., 2002).

This transformation cycle between the tacit and the explicit refers to the relationship between 'embedded' and 'cultural knowledge' and between the individual and the community perspectives of knowledge.

3.3. Knowledge: individual and socio-cultural perspectives

The relations between the explicit and tacit dimension, as well as those between the individual and their community or culture, require a dynamic concept of knowledge. This concept will be elaborated in two steps. First, we will distinguish between declarative and procedural knowledge based on a cognitive perspective. Second, we present the physically and socially embedded nature of knowledge that separates knowledge from the individual, and moves away from the cognitive paradigm.

3.3.1. **Cognitive perspective: knowledge as an individual representation**

The notion of the mind as an information processing system is the dominant theoretical perspective of cognitive psychology (Anderson, 1983; Norman and Rumelhart, 1975; Newell and Simon, 1972). Thinking and problem-solving are seen as formal operations applied to signals or data (critically: Herrmann, 1982). Subsequently, problems of knowledge in organisations are tackled logistically. Knowledge, like information, is a source of innovation and adaptation necessary to respond to technological and economic demands for flexibility and continual change. Classical views of knowledge, such as the cognitive view, have overlooked the complex reality of organisations – mainly because they conceptualised thinking and knowledge without consideration of action.

The division between 'acting' and 'knowing' is addressed by concepts such as 'procedural knowledge' or 'knowing how'. Opposed to the declarative knowledge of verbal representation ('knowing that'), 'procedural knowledge' refers to the tacit dimension of knowledge (Ryle, 1949; Polanyi, 1966; Dreyfus and Dreyfus, 1986; Neuweg, in this volume). Declarative knowledge is conscious and verbal; it refers to the representation of facts. Procedural knowledge refers to the more indistinct phenomena of skill, ability or expertise that can be represented physically, nonverbally and sometimes unconsciously. This is supported by experimental findings in cognitive psychology, where performance in problem solving tasks can be seen as independent of the ability to explain the actions that were performed (Berry and Broadbent, 1984; Broadbent et al., 1986; summarising:

Neuweg, 1999). Researchers acknowledge that sensory and motivational processes hold some value in the development of knowledge, but this explanation of intelligent behaviour is mostly based on individual representations of a priori cognitive structures. Procedural knowledge is seen as the result of the routine application of declarative knowledge, which precedes it. Therefore, acting (the tacit dimension) is still seen as an individual achievement, independent of its social and cultural conditions.

3.3.2. The socio-cultural perspective: knowledge is situated and distributed

The acknowledgement of tacit knowledge reflected in the concept of procedural knowledge still focuses too much on individual thinking and learning capabilities. The criticism of this position is formulated from a cultural perspective, which emphasises the social, historical, and physical aspects of knowledge, learning, and behaviour (Lave, 1988; Brown et al., 1989; Collins et al., 1989; Lave and Wenger, 1991; Resnick, 1991; Raeithel, 1992; Chong Law, 1994). According to these authors, the frame and conditions of knowledge and learning lie in everyday life, embedded in a natural context: they are situated. 'Situated cognition' and 'situated learning' are the paradigms that result mainly from anthropological (Lave and Wenger, 1991), organisational (Brown, 1991; Blackler, 1995; Spender, 1996) and learning theory research (Berryman, 1991; Perkins, 1993; Engeström, 1999). Situated theories of knowledge acquisition argue that learning, as it normally occurs, is a function of the activity, context and culture in which it takes place.

Knowledge development can be seen as a social and organisational matter, with social interaction being a critical component. Learners become involved in a community of practice, which embodies certain values, beliefs, and behaviours that are to be adopted. As newcomers move from the periphery of a community to its centre, they become more actively engaged in the culture and are permitted to deal with issues and tasks more central to the culture. Situated learning is usually unintentional rather than deliberate. Lave and Wenger (1991) call this the process of 'legitimate peripheral participation'. They have based their empirical analysis on many different settings (Yucatec midwives, native tailors, navy quartermasters, meat cutters and alcoholics). In all cases, there was a gradual acquisition of knowledge and skills, as novices learned from experts in the context of everyday activities. Suchman (1988) explores the situated learning framework in the context of artificial intelligence. Orr (1990, 1996) describes the use of stories – for example in maintenance settings – as a collective

memory with practical relevance. Brown et al. (1989) propose the idea of cognitive apprenticeship, where students are enabled to acquire, develop and use cognitive tools in authentic domain activities.

Learning advances through social collaboration and the construction of meaning. Therefore, a greater emphasis is placed on active perception rather than on concepts and representations. Further applications in work and educational environments may be found in the work of the cognition and technology group of Vanderbilt (1993), Engeström and Middleton (1996) or Clases et al. (1996).

3.3.3. The collective dimension of knowledge in practice

Learning and knowledge, in work and organisational practice, has not only a tacit but also a socio-cultural dimension. From this perspective we understand the physical, environmental, social and historical context of action as a complex and only partly conscious structure in which individual behaviour is located. The regulation of action is, therefore, based on the individual as well as on 'over-individual' processes. 'Over-individual' refers to the process of joint construction and collaboration in groups or communities, called 'shared cognition' (Resnick, 1991; Roschelle and Teasley, 1995). It results in 'distributed cognition'. This term illustrates that knowledge is not only transferred from one mind to another, but also through artefacts, signs, structures and rules. Tools, media and facilities are, therefore, carriers of knowledge (Hutchins, 1990; Raeithel, 1992; Pea, 1993; Tsoukas, 1996). In summary: 'People appear to think in conjunction or partnership with others and with the help of culturally provided tools and implements' (Salomon, 1993, p. xiii). From this perspective, knowledge does not result from an objective determination of facts but from a social negotiation of meanings. From the methodological standpoint of 'symbolic interactionism' (Blumer, 1969; Wilson, 1970) people act on things, events and other people based on their meaning, which is a product of social interaction. Social interaction transforms meaning continuously, for example, when events fail the expectations and anticipations of the actors. If meanings are generated, adopted and modified in social practice they are shared elements of knowledge.

This standpoint stresses the meaning of everyday practice. It challenges the traditional psychological point of view which sees the individual and their environment separately from each other, so that social and physical conditions can be treated as independent and controlled conditions of behaviour. Instead of this dualistic separation of an inner and outer world, we propose a holistic view, with individuals and their environment forming an

integrated unit. In this we are adopting not only a quintessentially phenomenological standpoint, but also a pragmatic one. In comparison, psychological analysis is said to reach for 'processes of the full situation of organism-environment' (Dewey and Bentley, 1946, p. 256; see Salomon, 1993, p. xv).

Our understanding of knowledge can now be summarised as follows (Waibel, 1997):

(a) knowledge is not a static copy of real life phenomena but includes dynamic structures that support the personal mastery of action demands. In a pragmatic sense this means the primacy of action and experience over cognitive representation;
(b) knowledge is not limited to individual memory but is also embedded in the physical and social conditions of a field of action. In this situated perspective, knowledge or knowing cannot be analysed purely as a structure independent of any contextual influence;
(c) individual knowledge is developed through participation in a socio-cultural practice. This concept of learning implies an interaction between individuals, between people and artefacts, and between individuals and the values, rules and institutions of social life.

Therefore, knowledge development occurs as a transformation of experience between action and reflection, between tacit (bodily) and explicit (verbal) representations and between individuals and communities of reference. Experience is bound to concrete rather than universal situations, to their spatial, temporal and social boundaries. In our memory the stream of consciousness is organised as situational episodes, so that knowledge is always related to the conditions of its grounding experience. These conditions – or boundaries – are responsible for the local character of knowledge. Its validity is limited to these experiential boundaries at first, but can be widened via several modes of practical testing or theoretical reasoning. However, there is no need for us to stretch validity beyond these borders when it serves routine accomplishment of local demands. For the phenomenon of knowledge remaining in local references, Waibel introduces the term 'local knowledge' (1987, p. 23).

Local knowledge is not the same as 'work process knowledge'. It refers to the place where knowledge is distributed and where its borders lie, while the concept of 'work process knowledge' refers to the content of knowledge, to what is 'known' (Kruse, 1986; Fischer, 2000; Fischer and Boreham, in this volume). Both of these concepts view knowledge as a construction of the individual that is culturally bound and socially negotiated. Both recognise that knowledge is often constructed in an ad hoc manner

and, therefore, possesses a preverbal, tacit quality. Both concepts also state that knowledge is bound to practice. However, there are important differences between these concepts: 'Local knowledge' has boundaries in which it is valid and useful but beyond these boundaries it may be invalid. It never applies to the work process as a whole, which is divided into different stages and bound to different communities. The work process as a whole consists of several domain places of local knowledge, separated for cultural, social, technical and structural reasons.

3.4. Local knowledge in activity systems

Despite their differing roots, there are striking similarities between the concept of work process knowledge and the socio-cultural perspective of knowledge as described above. Both directions point out that the phenomenon of knowledge has to be understood in terms of a 'knowing process' rather than as a static resource (Davenport and Prusak, 1998). If knowledge is a result (and condition) of everyday practice, it must be fluid and changeable on a daily basis and must undergo permanent revision. Knowing and acting are interlinked in practice:

> 'The concept of practice connotes doing ... in a historical and social context that gives structure and meaning to what we do. ... Such a concept of practice includes both the explicit and the tacit. It includes what is said and what is left unsaid; what is represented and what is assumed. It includes the language, tools, documents, images, symbols, well-defined roles, specified criteria, codified procedures, regulations, and contracts that various practices make explicit for a variety of purposes. But it also includes all the implicit relations, tacit conventions, subtle cues, untold rules of thumb, recognisable intuitions, specific perceptions, well-tuned sensitivities, embodied understandings, underlying assumptions, and shared world views' (Wenger, 1998, p. 47).

3.4.1. Communities of practice as collective units of analysis

Both local and work process knowledge emphasise the collective nature of knowledge, which is held not only by individuals but also by the culture of an organisation. However, mere recognition of the dimensions of individual versus collective knowledge provides a general theory without really reflecting the differences between an abstract social system (in the Luhmann sense), an organisational structure and a greater societal formation or a physically copresent group. To overcome such limitations, local boundaries

should be viewed in the manner in which they appear in organisations: under everyday conditions, be they spatial, temporal, social or cultural in origin.

Boundaries represent the physical and social aspects of knowledge. If specific qualities of knowledge reflect its local conditions, we can determine that the barriers and differences between units in an organisation reflect the local character of their knowledge (Bourdieu, 1990). Similarly Fleck (1980) observed that exchange of knowledge and common understanding is usually limited to esoteric exchange within a collective, whereas innovation and change are dependent on exoteric communication with other collectives.

If knowledge is viewed as both physically and socially located, the basic unit of analysis is no longer the individual. The focus of interest becomes local communities, constituting joint practices, rules, structures and artefacts, which are distributed along the work process and create differences between communities. The so-called communities of practice are more than just an aggregation of people. They represent an intermediate stage between the individual and society, characterised by a high level of apparently natural coherence among its members. Communities of practice can be characterised by the following criteria (Wenger, 1998; Waibel, 1997):

(a) mutual engagement of the participants (communication, cooperation, coordination);
(b) a joint enterprise (product);
(c) temporal continuity and a common tradition;
(d) a grown structure for reproduction, manifested in a shared repertoire (tools, signs, artefacts) and an enculturation practice;
(e) embedding in a broader social system.

All of these criteria are dependent on each other: the key issue is that participants cultivate their repertoire and resources while pursuing a joint enterprise. This cultivation means that they negotiate meanings in relation to each other. The process of cultivation, in turn, ultimately generates a tradition.

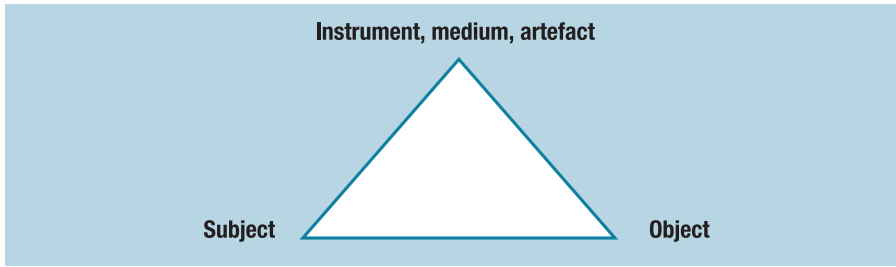
3.4.2. Theoretical roots of the model of the activity system

An appropriate theoretical framework for this concept can be found in the Russian tradition of the cultural-historic activity theory (Vygotsky, Leont'ev, Lurija). More recently, the central concepts of activity theory were recalled and worked out by different authors within the socio-cultural perspective (Engestöm, 1987; Valsiner, 1988; Raeithel, 1989, 1992; Wertsch, 1991; Cole and Engeström, 1993; Blackler, 1995; Waibel, 1997; Wehner et al., 2000). Activity theory centres on the concept of labour as the central sphere

of human encounter with the world. The development and division of labour has enabled us to anticipate goals, to transfer practices and principles, to cooperate and coordinate work and finally to release cultural and mental development from physical reproduction. It is remarkable that, following activity theory, individuals and social units build up a circular coevolution of natural and cultural elements of human constitution. This coevolution is a collective process: 'We may well speak of the activity of the individual, but never of individual activity; only actions are individual' (Engeström, 1987, p. 66).

'Cultural-historic activity theory' can be characterised by three basic concepts: objectivity; the hierarchical structure of human activity; and the cultural mediation of activity. Objectivity (German: *Gegenständlichkeit*) means that human acting is mediated via signs and tools: 'the simple stimulus-response process is replaced by a complex, mediated act' (Vygotsky, 1978, p. 40). This act implies responsiveness: not only do humans shape their environment but environmental processes shape humans as well: 'The sign also possesses the important characteristic of reverse action (that is, it operates on the individual, not the environment)' (loc. cit.; see Engeström, 1987, p. 58 et seq.). In a joint and continuous process, both the subject and the objects are transformed. Individuals appropriate objective structures and objectify (reify) subjective meanings. The relationship between subjects and objects is instrumental: in using tools and signs, human beings extend their potential and generalise functions. The basic unit of human activity – and its psychological analysis – is a triangle consisting of subject, object and instrument (Figure 1).

Figure 1: **The basic mediated unit of human activity (Leont'ev, 1981)**



Instruments, artefacts and media are functional and symbolic carriers of meaning. Signs, like language and verbal concepts, are special forms of tools (Vygotsky, 1978). They are bound to practice, not as secondary structures that are invented, used and modified independently, nor are they

simple images. This externalisation of practical meaning is the process of distributing knowledge. Conversely, individuals appropriate these cultural meanings and internalise external activity.

Human activity is hierarchically structured. At the highest level, it is driven by motives and regulated through social and cultural meanings. At the middle level, action is driven by goals and regulated through anticipation and control of situational interaction. The lower level of activity is the operation, driven by conditions and regulated by bodily interaction or incorporated skills (for a comparing overview between this and other psychological theories see Engeström, 1987, p. 154). The hierarchical structure of human activity allows us to set an empirical focus on any of these levels without losing sight of the respective frames of reference.

The cultural mediation of individual life suggests a close mutual relationship between the inner and the outer aspects of human activity. In this joint evolution, knowledge is distributed as symbols and artefacts. The idea of objectivity or reification refers to 'the process of giving form to our experience by producing objects that congeal this experience into "thingness"' (Wenger, 1998, p. 57 et seq.). The social aspect of joint evolution is concentrated in the concept of participation. It 'refers to a process of taking part and also to the relations with others that reflect this process. It suggests both action and connection' (op. cit., p. 55).

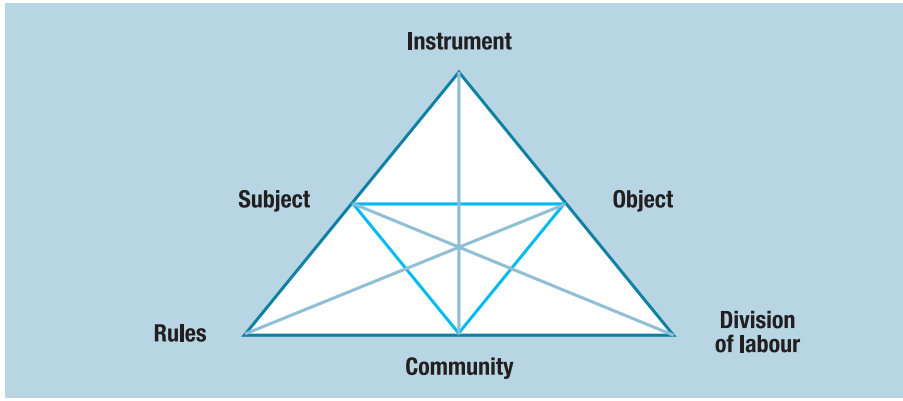
The division of labour is not merely a functional enterprise but also has a social and cultural framework. In reference to this theoretical framework, our central statement can be formulated as follows. The knowledge of any community is distributed over a so-called activity system. Individual knowledge is part of this system and does not exist independently of it. It is generated, preserved, developed, and shared via participation in common activities.

3.4.3. The model: major dimensions of activity systems

The term 'activity system' was elaborated by Engeström (1987). He described the basic factors of human activity in a model, which allows the systematic analysis of relationships within the basic triangular structure of activity (subject – instrument – object). This central triangle is accomplished by the culturally mediated structures, i. e. cooperation within a community, coordination by rules and the division of labour (Figure 2). Each triangle is an independent unit of analysis but each field of practice must be analysed in terms of all of them. With the help of this model, human activity is no longer seen as an individual enterprise but as a system that is collectively organised by cultural traditions.

Transcending the basic triangle (Figure 1) individuals are seen as parts of a local community. The relationship between the subject and the community is mediated by rules and by 'the full collection of mediating artefacts' (Cole and Engeström, 1993, p. 7). The distribution of tasks and the legitimated participation of members in a community lead to a division of labour, which, in turn, is affected by the product of the activity system. Activity systems – for example a school class, a supermarket, a group of scientists, or an industrial assembly department – can be viewed as a complex composition of different structures in mutual regulation (Figure 2).

Figure 2: **Loci of knowledge distribution in an activity system (Engeström, 1987)**



The illustration in Figure 2 displays the relationship between these dimensions. Along these dimensions we now introduce the activity system of our empirical studies, conducted in an automobile factory, specifically in the department where cable harnesses for electrical equipment are installed (Waibel, 1997).

The object of an activity system represents the common point of reference for each individual action. Its representation can be physical or ideal. The object of a learning group, for instance, may be a special audit and the solution of its tasks. In our empirical field, the object is the assembly of cable harnesses as part of the electrical equipment of an automobile.

The mediating artefacts of a community of practice are tools and signs, organised in a manner characteristic of the culture in which they are embedded. The hall of the assembly department has a specific architecture that reflects the assembly process in its entirety. Signs represent the organisation of work. In our example, an overall visible time display

represents control mechanisms. Tools like a screwdriver or other mechanical devices represent single steps of the assembly process, but also, in its strictest sense, the technical development and the broader frame of technology and culture.

The verbal concepts used in an activity system, for the regulation and coordination of actions, can be considered as a special type of signs. They are a relevant part of the knowledge distributed in the activity system. In many cases these concepts are indexical, i.e. understood only by members of the inner community (in the form of sub cultural symbols). Moreover, these concepts are used in a vague and ambiguous way, so that individuals from other communities are often unable to deduce the related knowledge.

The division of labour, tasks and responsibilities is constitutional for the whole and closely related to the object of the common activity. To discuss a school class, for example, we at least need to determine the roles of teacher and pupils. The division of labour implies a vertical and a horizontal dimension. Formal criteria of the vertical division in our empirical field are the ranks of a manager, superior and worker. Informal criteria are the duration of membership or the perceived expertise of an individual. Horizontally the group decided who had to work on which part of the car (left or right, front or rear). There are central and peripheral roles and functions in an activity system, which influence the prominence of those who hold them. In our case, experienced senior workers were in charge of coaching and inducting novices.

While division of labour links the community to the object of the system, rules organise the communication and interaction of the subjects among themselves and the community. Rules have to be understood as standards and sanctions that are applied to perceived and anticipated actions and interactions. Rules determine what behaviour is appropriate for which situation. They can exist as official directives, formal instructions, implied control mechanisms or self-evident signals. Traffic laws are a common example of such rules. In our case, rules guide how an assembly group acts in case of a disruption (e.g. missing assembly parts).

Finally, the individuals give the activity system the dynamic that is necessary for continual reproduction and development. Only by the subjective interpretation of their roles as experts or novices, as metalworkers or electricians is the division of labour, the use of instruments and the following of rules, realised. Individual knowledge and abilities form the basis for the interpretation of roles, tasks and functions. Historically, shared cultural meanings flow within individual structures of knowledge and give them an ‘over-individual’ continuity over time.

Activity systems are embedded in superior structures. They have an organisational and a cultural environment. They are specialist entities, the degree of their specialism increasing with technological progress and diversity. The more diversified these systems become, the more necessary it is to coordinate between them. The cost of coordination may rise with the technological standard of systems but the cost of missed coordination can get out of control in the case of an accident. We argue that coordination problems arise from not only social issues, such as claims to power or divergent interests, but also that coordination problems are due to different tasks and representations of knowledge. Members of an activity system refer to shared meanings which are self-evident in common practice. Coordination between different systems is based on symbolically organised cooperation. Only those parts of the local knowledge have to be transformed to superior levels that serve the orientation on the object, which the diverse activity systems have in common. This transformation makes tacit knowledge explicit and combines different local perspectives to provide an overall perspective of the whole work process. This new perspective and quality of knowledge have to be re-situated in other activity systems and local contexts; this requires further transformations.

3.5. The collective use of local concepts: empirical observations

The following empirical studies are directed at the relatively new topic of the differences between local and superior coordinative knowledge. The aim was to reconstruct local concepts and their relationship with concepts that serve the coordination between different communities. We considered local concepts as mediating signs or tools that serve the internal regulation of common action. Verbal concepts represent shared meanings of procedures and artefacts and are a central locus of knowledge. Furthermore, we wish to show that situated verbal concepts of participants are able to reveal the borders of the activity system or community. In consequence, the empirical reconstruction of verbal concepts can reveal structures and boundaries of local knowledge in an activity system (Waibel, 1997).

The empirical field is an assembly department in the automobile industry, where cable harnesses for electrical equipment are installed. At the time of our research, the case study area had just changed from an assembly line to group work in boxes consisting of three to four workers each, organised into two shifts. The two shifts allowed us to examine different communities under

similar physical and organisational conditions (instrument, division of labour and objects) so that the influence of the group on the use of concepts could be visualised. The construction department provided us with official manufacturing plans (*Fertigungspläne*), which could be compared with the use of 'local concepts' of manufacturing. The organisational hierarchy provided the embeddedness of the research community in a broader social system.

One research scientist spent two weeks working in the assembly department. An understanding of the whole work process could be acquired through participation-observation and structured interviews. To reconstruct the local concepts and their embedding in subjective meanings, 48 semi-structured interviews with workers were carried out. Three examples should illustrate the existence and collective property of 'local knowledge'; they are taken from a detailed and complete report by Waibel (1997). They show that:

(a) concepts, as an instrument of internal regulation, are acquired locally;
(b) local and coordinative concepts differ;
(c) the community's 'personality' influences the development of local concepts.

3.5.1. Concepts, as an instrument of internal regulation, are acquired locally

First, we considered which instruments were used to regulate the assembly process. The official media of orientation consisted of a construction pattern card (*Baumusterkarte*) and a time display. The construction pattern card was designed to give the workers detailed information of upcoming assembly tasks (chassis). The time display was intended as an additional means of control. Observations of the assembly groups over the two-week period and semi-structured interviews with the workers showed that the construction pattern card was used very rarely and not even understood by many of the workers. Instead, the time display was the most important subjective means of orientation.

The official rule of the planners was: 'pick up the construction pattern card, look what you have to do, and use the time display to monitor how much time you have left'. Instead, the workers looked at the time display and the ensuing task and used special visible features to make a precis, if necessary. There was a deviation from the official default, even though the time display contained no detailed information of the upcoming coachwork. There was even a reduction in the number of subjective interpretations of the displayed time proposals. While the display provided approximately 32 different time categories between 11 and 42 minutes, the workers only paid attention to two

of the categories, namely, 'big' and 'small' (car). This conceptual difference was sufficient to fulfil most of the assembly tasks. If more information were necessary, it was gleaned by the workers from visible physical aspects, such as the side on which the steering wheel was found or certain cables hanging from the chassis. All visible features were combined into special categorising concepts. The *Ami* was a name given for a combination exported to the US in most, but not in all, cases. *Rechtslenker* (steering wheel on the right) was a rather unfamiliar combination. *Normaler Europäer*' (usual European) covered the most frequent combination and *ganz kleine Karosse* (very small coachwork) meant that there was no special equipment to install. It could be shown that these action-guiding concepts were not shared or understood outside of the local communities (by planners for instance).

The first study shows that local actors acquire an own-orientation and regulation of activity, which is independent of official and planned media. To regulate routine actions the workers rely on relatively vague concepts (like 'big' and 'small') that reduce the complexity of the whole task to a currently necessary degree. Language is one, but not the only, carrier of this knowledge. We can also assume that the physical and visible aspects of the situation in their entirety maintain a tacit quality.

3.5.2. **Local and coordinative concepts differ**

Second, a systematic comparison was conducted between the concepts used for local regulation and those used for coordination across the group's borders. Local concepts were determined by applying the 'thinking aloud' method (*lautes Denken*). Workers were asked to articulate a complete series of self-instructions as used by them during manufacturing. Manufacturing plans were analysed to determine the coordinative concepts. The plans were divided into sequences that represented the individual steps taken during manufacturing. A comparative content analysis was conducted between the official sequences and those generated by the workers. In addition to their description, a quantitative analysis of the frequency with which operational sequences referred either to the operation, or the location, or the object of assembly, was undertaken.

The comparison showed that the workers generated fewer sequences than the official documents included and that their sequences were less detailed. The concepts articulated by the workers to describe the sequences were vague and not uniform. For example workers used terms such as the abbreviation ZV (*Zentralverriegelung* = central locking), an overgeneralisation for the complete cable-harness including backlights. The same term was used without discrimination for only one cable of the whole unit as well. The

analysis showed different classification and aggregation strategies. Official plans referred to products, objects and operations significantly more than the sequences generated by the workers. Most of the workers used criteria related to the time and location of an operation: they classified chronologically during the assembly process. However, workers are able to understand each other. In interaction with the physical and social conditions of a situation, the semantically vague concepts become precise and sufficient for the manufacturing task. These results resemble Vygotsky's (1978) findings regarding inner speech, which is both fragmented and dynamic at the same time. The flexibility of inner concepts makes them suitable for self-control and self-regulation. However, the comprehension of inner and local concepts terminates at the boundaries of the actual system, be it the individual or the community.

In summary, we can conclude that local concepts are refined to ensure the continuity of the local action process, and that the official plans are more detailed and refined for the purpose of object-related coordination. The variety and the precision of the concepts varied with their purpose.

3.5.3. Community 'personality' and the development of local concepts

To examine social differences in the conceptual organisation of local knowledge we used a quasi-experimental design in the natural context of the assembly unit. Constant physical and material conditions were given for the two shifts: only the inner social structures (the loci 'rules' and 'community') differed. A comparison of the concepts generated by the two local communities, via content analysis, displayed some characteristic differences. The concepts in one shift were more explicit, more precise and were related to their function in the whole assembly process. This group also generated increasingly detailed sequences to describe the whole assembly process. Another striking difference – likely to cause misunderstandings and disturbances – was only apparent after close examination: The local concept for a complete assembly stage (*außen links* = outside left) was used in a different manner by the two shifts. One shift referred to the doors on the left (front and rear) and the other referred to the rear doors on both sides (left and right). The concept of *außen links* was originally determined by the planners, however the communities redefined it, in stages according to their own interpretation. The differences were due to the relationship between the subjects and the communities, mediated by rules. Because there is no evidence for a dominance of socially motivated discrimination between them, the explanation for the different use of the same concept lies in the diverse internal practices of both communities.

This gives us empirical evidence to support the hypothesis that membership of a community of practice determines which concepts are developed, how they are used and which meanings are shared. It also shows that communication and understanding between horizontal or vertical groups (between planners and workers or between shifts) cannot rely on verbal concepts alone. The situation in its entirety, with all visible and invisible, verbal and tacit features, provides the background for understanding.

Group-related differences highlight the boundaries in the use of concepts and therefore confirm that knowledge is held and developed collectively within an activity system. The transfer and exchange of knowledge between different activity systems can develop further knowledge, as perspectives on daily practices are changed and self-evident tools, signs, procedures, and artefacts become visible.

3.6. Conclusions: carriers and the transformation of knowledge

The studies in an automobile assembly department provided us with insights into the practices of local communities and the challenges of knowledge development. Local concepts and other tools are refined in accordance with their function in a practice and are, therefore, only valid within its borders. The consequences of this for individuals, organisations and theory are elaborated briefly below.

3.6.1. Implications for individuals

Regarding the question of orientation, we have to supplement the requirements of information use. Not only must the right information be acquired, but it also must be used in a proper manner. Information is a non-contextual form of knowledge that has to be resituated. The exchange of knowledge should communicate not only a concept in itself but also its local frame of reference or, if possible, its preverbal supplements. Professional self-assessment and reflection are essential to developing a higher occupational capability. It is crucial to be able to explicate and evaluate tacit parts of ‘own knowledge’. This can be supported by activities at the border of an individual’s own community of practice, where ‘own concepts’ are questioned by members of other communities (Clases and Wehner, this volume). Also, the importance of coaching and supervision as components of further education increases. Finally, we have gained a greater insight into

the knowledge development process and our findings challenge traditional understanding and evaluation of knowledge. It would appear that a considerable proportion of knowledge is attained collectively, not individually.

3.6.2. Implications on the organisational level

The boundaries of local knowledge are determined by social and physical conditions as they are theoretically described from the activity system's perspective. We found locally specified rules (use of time display) and tools or signs (verbal concepts). It could be argued that the division of labour (instructing tasks) and the community (two shifts) influenced the conceptual organisation of local knowledge. According to our theoretical considerations, these empirical results confirm that the process of knowledge development is embedded in a physical, social, and cultural environment. The agent of learning is not just the individual: knowledge should be valued as a collective asset. The suitable unit of analysis and design is the activity system, with its six loci of distribution. Learning environments, knowledge management, vocational education and training, work process design and similar programmes should consider the activity system as a whole, including its subsystems, as the carrier of knowledge. Knowledge and innovation are created via a process of collective mediation and construction in, as well as between, activity systems.

3.6.3. Theoretical implications

Local knowledge is useful as a form of internal regulation of a community's practice. The vague character of its conceptual organisation is useful both for action regulation and cooperation. Physical, bodily and social meanings are necessary complements of concepts, which give the verbally vague concepts situational precision. However, such vagueness is not recommended if we are attempting to coordinate between different production stage communities. Some of the above examples show that an attempt to relate between shifts based on local concepts would be detrimental to coordinating intentions: the denotations of the used concepts were different (e. g. '*außen links*', 'ZV'). Therefore, local knowledge is not inevitably useful to understand the work process as a whole. Local knowledge must be distinguished from work process knowledge, even if it may be a part of it. Local knowledge provides regulation at a local level; however, work process knowledge aims at superior understanding and coordination between communities. Both imply explicit as well as tacit aspects of knowledge and both use embedded concepts.

If we distinguish local knowledge and work process knowledge as two important, yet different, phenomena, the question of the level of interaction and transformation between them arises. It leads us to the challenge of analysing and designing the transformation between the types of knowledge already mentioned: between the local and the coordinating as well as between the explicit and the tacit, between individuals and communities. The transformation processes of explication, reification, and appropriation are crucial agents of knowledge development. The reconstruction of local knowledge is one part of it and can use the model of the activity system as a heuristic device. Further research in the application of this model is necessary, to clarify the model, increase its analytical capability, or suggest future research interventions.

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CHAPTER 4

Cooperation for knowledge development: a work psychology perspective

Christoph Clases, Theo Wehner

4.1. Knowledge as the object of cooperation

In the early stages of the industrial revolution, company founders were well aware that their theoretical knowledge of the production processes had to be supplemented and informed by the workers' practical experience, gained from everyday practice. On an organisational level these insights first found their expression in the introduction of suggestion systems (*Betriebliches Vorschlagswesen*) at the end of the 19th century, e. g. in the steel industry and bulb production.

In contrast, the Taylorist doctrine of production introduced in the 1920s explicitly opposed this approach. Instead it postulated a conceptual division between planning activities and the operative accomplishment of production tasks by decontextualised workers. Variations in practices and process-related knowledge were looked upon as disturbing variables, rather than fruitful resources for the adaptation of planning processes. Even today it may be observed that some departments in charge of research, development and planning base their activities on the assumption that most of the knowledge relevant for production planning and innovation is more or less directly accessible in documents and databases, which presents facts and figures in a decontextualised form.

However, various forms of knowledge manifest themselves in everyday practices that cannot be reduced to decontextualised and codified units of information as highly standardised artefacts. Various scholars have shown that knowledge is both bound to cognitive structures (Argyris, 1993; Senge, 1990) and bodily experiences (Scribner, 1986; Zuboff, 1988). Furthermore, knowledge is embedded and partly institutionalised in specific local routines, habits and artefacts (Granovetter, 1985).

The notion of the 'situatedness' of knowledge refers to findings which demonstrate that knowledge is shared (Resnick et al., 1991) and

distributed, both in and across, communities of practice (Lave and Wenger, 1991; Wenger, 1998). Despite conceptual differences, these various approaches have one factor in common, the notion that knowledge is grounded in action and bound to experiences in specific local practices.

Discourse on knowledge management (e.g., Nonaka and Takeuchi, 1995; Davenport and Prusak, 1998; Tuomi, 1999), has continued for almost a decade to drew attention to knowledge as a new integrative focus for management activities in an emerging 'knowledge society' (Drucker, 1993). A review of the existing literature and practical examples of knowledge management (Wehner et al., 1999) lead us to the following conclusions:

(a) knowledge management is a new challenge that we face in dealing with the old problem of determining the relationship between theory and practice;
(b) knowledge management calls for both a trans-disciplinary perspective and a clarification of the unique contributions made by various disciplines;
(c) in the discourse on knowledge management, issues of (micro) political relevance (power relations, trust, etc.) and their social implications (education, forms of socialisation, democratisation of access to knowledge) are often underestimated or simply neglected;
(d) knowledge management literature addresses the embodied features of cognition, the social character of knowledge, the context relatedness of experience and the mainly unconscious process of intuition that enables expert action. However, these issues are only partly addressed and there is little analytic reflection. These shortcomings become obvious when the objective of knowledge management (to make the right knowledge available, at the right time, for the right person by transferring all relevant knowledge in databases) is confronted;
(e) knowledge management is primarily understood as a new value-adding factor and mainly associated with questions of management and leadership. We miss an understanding of knowledge management as a participative social process needing dialogue and cooperation.

As it is not the aim of this paper to give an overview of knowledge management literature, we will focus on discussing the implications of knowledge management from the point of view of work psychology. To clarify the substantial contributions to be made from our perspective, we will approach the issue by discussing the notion of 'knowledge-oriented cooperation', i. e. we will put into perspective questions that arise when knowledge becomes the object of cooperation in the workplace, characterised by a specific division of labour.

Because knowledge management, in general, may be looked upon as the challenge of systematically understanding and designing the way in which social systems (institutions, companies, strategic networks, etc.) deal with the knowledge involved in their production and service processes, it is more than plausible that the analytical perspective must go beyond the scope of the knowledgeable individual. It must focus on processes in which knowledge is collectively constructed, generated, transformed, disseminated and used. All of these processes concern various forms of joint activity (Cole, 1996) that are realised in the collaboration between people, groups, organisational units, boundary-crossing networks, etc. In terms of work psychology, these processes should be looked upon as 'cooperative actor constellations', in which the 'object of cooperation' becomes the 'knowledge needed for both the reproduction and the innovation of everyday practice'. Therefore, the concept of knowledge-oriented cooperation stresses those processes in the shared accomplishment of work tasks and the collaborative production of products that lead to the cooperative generation and exchange of knowledge.

Starting from this assumption, the issue of knowledge management at a theoretical level has to do with the 'figure-ground-constellation' (*Figur-Grund-Beziehung*): the relationship between knowledge and action. The focal interest of work psychological research (i. e., its 'figure') has for a long time primarily been the analysis of actions based on qualifications acquired in or outside the workplace (as its 'ground'). This relationship is inverted, when we focus on knowledge-oriented cooperation, i. e. when we choose the generation and exchange of knowledge as the focal objects of our analysis ('figure'). Taking this perspective, we have to acknowledge that actions leading to the accomplishment of specific work tasks not only rely on ready available knowledge, but must also lead to the cooperative generation of new knowledge. Therefore, a core feature of knowledge management should be a new organisational awareness of the dual structure of knowledge-oriented cooperation.

The cooperative exchange of knowledge is not only a functional (or necessary) means of achieving successful reproduction of predefined work tasks. It is also a crucial precondition for organisational innovation, which may only be realised when new knowledge generated on a local level could have organisational consequences, i. e. when it has an impact on changes in the overall organisation of joint activity. The ways in which organisations deal with experience and process-related knowledge (integral and tacit ground of value adding work performance) is a new and important area of analysis with significant practical relevance.

The work-psychology analysis of knowledge-oriented cooperation calls

for a metaperspective on options for both individual knowledge generation and the collective accumulation of knowledge resources in joint activity (Clases, 2003). Therefore, from our perspective, knowledge management concerns the analysis and design of organisational, technological and social frame conditions that support knowledge-oriented cooperation. The basic assumptions put forward so far call for a conceptual understanding of the process of cooperation itself: which conceptual tools should we use when the object of analysis is cooperation?

In this chapter we present a conceptual framework that highlights various modes of joint activity and relates the notion of cooperation to issues of organisational development. We will discuss the implications of our framework for a deeper understanding of processes in which knowledge becomes the object of cooperation.

4.2. Cooperation as the object of analysis

In organisational theory, as well as in organisational practice, increasing importance is attached to the concept of cooperation. However, an overemphasis of the term's positive connotations can be identified in the discourse on cooperation. We will argue for a more differentiated perspective, taking into account the inter-subjective dimension of cooperation and its subjective efforts. Based on activity theory a conceptual framework for analysing cooperation as a situated process will be presented, highlighting cooperation, coordination and coconstruction as different modes of joint activity. In our examination of the concept of cooperation, we would like to start by pointing out three level-specific perspectives: the social, the organisational, and the action perspective.

On a social level, we generally see cooperation as a historically prevailing principle within the division of labour. The functionality of cooperation is emphasised, in view of the restrictions of individual resources. From the Aristotelian notion of the coherence of the community, to Durkheim's (1977) work on the social division of labour, cooperation is associated with a quasi-natural division of labour as the basic rationale of social differentiation and mutual dependence.

On an organisational level, cooperation is perceived as an efficient principle for the local optimisation of joint work processes. From this perspective, cooperation is associated with benefits to operating performance. The practical significance of cooperation, in terms of efficiency, has been discussed since the age of enlightenment. Diderot was

one of the first to investigate these processes and to describe an increase in the speed of work-performance and the perfection of products via cooperative action (Sandkühler, 1990).

This paper investigates cooperation at the action level. We understand the concept of cooperation as a goal-directed and process-related joint activity (Wehner et al., 1996, p. 96). This perspective takes into account that cooperative action is both situated in an historically evolving division and coordination of labour (formal organisational rules, job descriptions, predefined tasks, etc.) and is influenced by the subjective redefinition of these formal regulations in the face of contingent, unexpected events that arise in everyday practice. Our specific interest in the action level brings into focus the actual social processes and dynamics of cooperation related to phenomena such as goal orientation, motivation, trust, competition, conflict, strategies of coping with failure and situational and organisational preconditions for the emergence of cooperative action.

In presenting our theoretical conceptualisation of cooperation, we introduce three basic modes of joint activity – cooperation, coordination, and joint construction – that highlight structurally different forms of working together. These different modes of joint activity will be integrated into a conceptual framework that reflect the significance of unexpected events triggering a need for cooperation, as well as processes of transition between the various activity modes.

4.2.1. 'Initial coordinatedness' as a frame of reference

The initial level of actor coordination introduces a conceptual link between the analysis of cooperation on the action level and its preconditions and consequences in relation to the division of labour and further organisational regulations that structure joint activity. Inspired by activity theory (Leont'ev, 1978; Vygotsky, 1978), the theory of situated action and learning (Rogoff, 1996), and structuration theory (Giddens, 1984), we have become accustomed to broadening the scope of investigation beyond the perspective of individual reasoning, motivation and action, or the situational contingent interaction between actors at work. Therefore, the historical formation of an activity system (Engeström, 1987) and its structural features embedded in everyday action become a crucial issue.

Due to the division of labour, the interrelated differentiation of organisational roles and the high degree of diversification of tasks, actor relations at work may be characterised by specific practices of coordinating (boundary-crossing) activities. This is what we call the initial coordinatedness within and between workplaces, departments, and organisations. In the

context of a specific division of labour, actors in the field are mutually related by shared means of production and communication. They are also mutually related because they share overlapping tasks. With reference to Giddens' (1984) concept of the 'duality of structure', we hold that the initial coordinatedness of an organisation is an integral part of the joint activity between actors, as its precondition as well as its product. To learn more of the actual dynamics of cooperative action and boundary-crossing relations, in or between organisations, we should not neglect the investigation of the prevailing forms of coordinatedness that have evolved historically.

4.2.2. The logic of unexpected events

Our research on inter-organisational relationships in the German automobile industry (Endres and Wehner, 1995) considered the inter-personal and inter-organisational dynamics triggered by unexpected events in everyday work. The emerging interactive and socially embedded strategies used to cope with unexpected events may be used as evidence for the (psycho-) logic of cooperation. By analysing the logic of unexpected events, chances, barriers, the consequences and limits of joint activity may come into view. Technical breakdowns, decreases in product quality, unacceptable delays in delivery, false purchase orders, etc. lead to discontinuities in everyday activity and interrupt the coordinated sequences of interaction based on plans or explicit commitments.

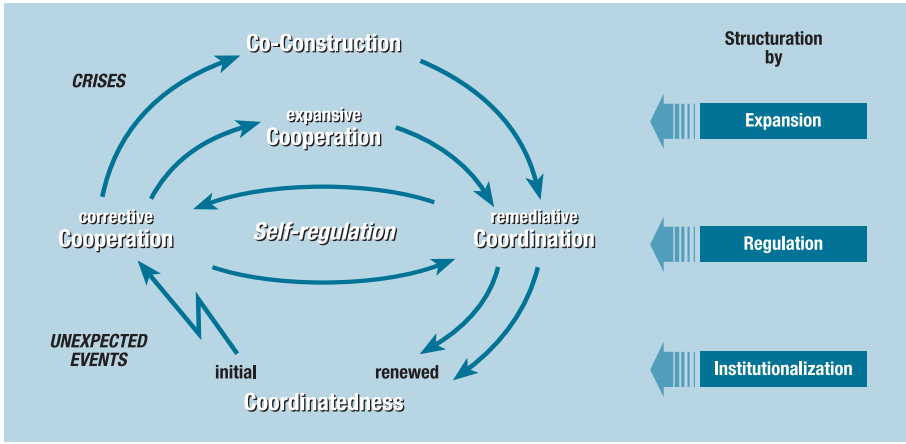
Coping with unexpected events cooperatively within a given initial coordinatedness is a secondary task (Schönpflug, 1985). Unexpected events are often not widely communicated or reflected on, not least because of time pressure, social taboos, the fear of showing personal failures, or a lack of trust (Clases et al., 2003). Unexpected events in everyday work processes reflect the complex interplay between the anticipation and realisation of work tasks, between planning and operative activities.

Based on our empirical findings from in-depth field studies, we have been able to show ways of designing inter-organisational relationships that account for the dynamics of unexpected events and turn the notion of failure into a productive element (Endres and Wehner, 1995). If evaluating experiences gained in cooperative activities, driven by unexpected events, leads to organisational change in relation to the coordinatedness of actors, accomplishing primary tasks may be supported. In this case, the outcome of cooperation would be more than simply a solitary solution for a specific problem. Additionally, a more comprehensive perspective would envisage changes in the initial coordinatedness of actors informed by local experiences.

4.2.3. Understanding the interplay of cooperation and coordination at work

The three modes of joint activity already highlighted in the introductory part of this chapter are integrated into our conceptual framework of cooperation analysis (Figure 1). It should be stressed that this framework should not be looked upon as a stage model, i. e. it does not suggest certain paths from any lower to any higher form of joint activity. Furthermore, it is not meant to be prescriptive, but should provide us with a frame of reference within which to conduct field research. The concepts of cooperation, coordination, and coconstruction (or 'joint construction') serve as analytical tools that describe interrelated, but specific processes in joint activity.

Figure 1: **Framework for the analysis of the dynamics of joint activity (Wehner et al., 2000)**



The planned division of labour in work and the expected patterns of interaction, as formulated at managerial level (in form of explicit contracts or even more fluid commitments), are necessarily vague and overdetermined compared with the concrete work processes they refer to. In consequence, a (necessary) mismatch may be observed in practice between formal demands and their actual accomplishment. Unexpected events have to be dealt with in various situations: for example an unexpected fall in product quality, fluctuations in procurement, misdirected orders, and so on. They reveal the abstractions of formal regulations with respect to unique cases that trigger cooperation.

These types of event may be identified as crucial factors triggering corrective cooperation; the actors involved need to leave the expected path

of interaction. We use the term corrective cooperation if, in the course of coping with events that deviate from the expected flow of activities, the common object of work or the problem that has to be solved remains the focus of attention. Corrective cooperation leads to additional efforts, as actors simultaneously strive to maintain the production process. In the case of unexpected events, the challenge is to develop a common understanding of the problem and common coping strategies. The solution developed in corrective cooperation is a solution for the single case. In this sense, we refer to corrective cooperation as a secondary work task (Schönpflug, 1985). Even if the malfunction reflects problematic forms with regard to the initial coordinatedness of actors, these aspects are not dealt with in corrective cooperation.

Coordination may be characterised by the use of routines and well-known patterns of interaction based on the initial coordinatedness of actors. The benefits of coordination result from its functionality in reducing the complexity of everyday life. Actors are freed from the need to constantly debate and reflect on the basic rules and patterns of joint activity. Coordination should be looked upon as an outcome as well as a resource for cooperation. Coordinated activities emerge due to an often implicit mutual understanding that develops in everyday practice over time. In this respect coordination is a mode, which provides a relief from the strain of repeatedly negotiating the way in which common tasks should be performed.

If the interplay of cooperation and coordination in everyday practice is not reflected from an organisational perspective, the experiences made may not lead to structural changes in the initial coordinatedness of actors. Nevertheless, the self-regulating interplay between corrective cooperation and coordination (Figure 1) may lead to gradual shifts in the actual performance of a joint activity. Step-by-step modifications may become relevant in strategies for coping with unexpected events, as corrective cooperation may locally broaden the scope for anticipation. However, if experiences in corrective cooperation are not evaluated and transferred on an organisational level, the gulf between explicit regulations and their actual practice may widen.

4.2.4. Expansive cooperation, coconstruction, and remediative coordination: transcending the initial coordinatedness

In our conceptual approach we emphasise expansive cooperation as a specific form of joint activity. The main characteristic of expansive cooperation is that the structural aspects of joint activity are explicitly

questioned. Expansive cooperation may, for example, become obvious while searching for new partners or while explicitly searching for new ways of organising and structuring joint activities. While triggering factors for corrective cooperation may be identified in various deviations from expected developments in practice, we found in our empirical research that stages of expansive cooperation were motivated by a crisis in joint activity. One or more of the actors involved can formulate these crises. This is because the systematic occurrence of failures, or delays, leads to unacceptable secondary task efforts or, an inferior product quality.

While the objective of corrective cooperation is the immediate solution of an actual problem, in joint construction an attempt is made to generate organisational solutions that explicitly transcend the single case. Joint construction, as a specific form of expansive cooperation, differing in its underlying structure from coordination and cooperation because the focus of attention lies in redefining roles, work objectives and patterns of interaction. Not only may the different points of view on common work objects and tasks be exchanged, but also the rituals of everyday life, its formal procedures and its often unwritten rules. The objective of joint construction is to reflect on, and to envision changes in, the initial coordinatedness of actors.

We found that stages of joint construction are rare and must, as primary tasks, be explicitly designed and planned. Time and space are needed outside the constraints of everyday working life. Relevant actors needed for the development of new ideas must be identified. Joint construction may take place in different forums as, for example, project or changeover teams and interorganisational workshop circles. In forums of joint construction, perspectives may be exchanged to create a new common understanding of mutual dependencies and to determine options for structural improvements. Scenarios for modifying current coordinatedness may be calculated, based on the exchange of experiences and perspectives. Therefore, joint activity may serve as a source for new innovative solutions at the organisational level.

Scenarios determined via joint construction may point to a future form of coordinatedness. However, they will still have to be remediated in practice. In joint construction, new possibilities may only be envisioned. These possibilities must be practically generalised, a process we call ‘remediated coordination’. In practice, the products of coconstruction may be encountered in the form of rules and regulations, or as new frame conditions that open up new possibilities for managing unexpected events. To build up trust in both the cooperation partner and in the new forms of

coordinatedness, the outcomes of joint construction have to be communicated to those actors who did not personally participate in the forums but are nevertheless affected by their outcomes. A successful remediation of the possibilities worked out in joint construction results in a renewed form of coordinatedness on the organisational level.

This renewed form of coordinatedness will form the basis from which the dynamics of the relationship between cooperation and coordination will again unfold. It should be pointed out that our conceptual framework of analysing cooperation does not imply that joint construction will always lead to improvements in organising joint activity. The remediation of possibilities calculated in joint construction may fail in practice or the forum of joint construction may itself fail to achieve viable scenarios. Personal conflicts and a lack of trusting relationships resulting, e.g. from the underlying crisis or diverging interest and motivations to participate in the forum, may represent serious barriers. Forums of joint construction are always a field for micropolitical activities, which reflect power relations in a practical manner.

4.2.5. **Summary of our conceptual framework**

In summary, we would like to argue for a broader understanding of cooperation by considering that the structuring of joint activity is realised via the following processes (Figure 1):

(a) institutionalisation (initial and renewed coordinatedness);
(b) regulation (interplay between corrective cooperation and coordination);
(c) expansion (expansive cooperation, joint construction, remediative coordination).

Processes of transition between different modes of joint activity are of central interest in our conceptual approach. The inter-relationship between coordination and cooperation at work needs to be analysed and reflected in an attempt to design and improve joint activity at work. There can be no understanding of cooperation without an analysis of coordination and no analysis of coordination without an understanding of the logic of cooperation, as triggered by unexpected events in the framework of a specific form of coordinatedness. In this sense, the analysis of cooperation and coordination represents a figure-ground constellation. For an understanding of this constellation, the investigation into the initial coordinatedness of actors is a necessary starting point. As unexpected events occur, they may destabilise current forms of coordinatedness and tell us a great deal about the tensions in the initial coordinatedness itself. That is why they may be looked on as sources of innovation.

4.3. Encountering knowledge-oriented cooperation in practice: the supplier relationship

In this section we will illustrate our theoretical approach by depicting the trajectory of the inter-organisational relationship between an automobile manufacturer and one of its just-in-time suppliers ([14]). Responsibility for the preassembly of the frame floor assembly, which contains the tail light cable set, among others, was transferred to the supplier shortly before our investigation: previously, the final manufacturer had undertaken the preassembly of cables. The new supplier relationship could be characterised as highly sensitive, logistically speaking, as the subsequent replacement of a defective cable set takes several hours and involves great follow-up costs.

The three-month planning phase of the supplier relationship was short. This was accounted for by the fact that the preassembly of cable sets can only be 'learned' in practice and the supplying concept would have to be 'planned'. In this sense, 'new ground' was being broken with the supplier, which conformed to the upper management's strategy of 'redefining supplier projects', although this was characterised by the middle management as a 'rush job'. The planning took place in a project group, whereby new problem areas, knowledge and discussion partners had to be considered and involved in the process, so that expansive knowledge-oriented cooperation could take place to help establish the initial coordinatedness between the partners.

Interestingly, on the side of the final manufacturer, there was a consensus among those responsible for production to treat the suppliers 'like our own preassembly'. This was the basis of the initial coordinatedness. (Due to its own previous production logistics the final manufacturer had also been divided into an assembly and a preassembly area.) The patterns of interaction that were developed here proved to be sufficient and no fundamental changes were expected with regard to the collaboration between preassembly and assembly for the new supplier relationship. It was thus implicitly assumed that cooperation partners could be 'exchanged' and that this would not endanger the coordinatedness of activities. The final manufacturer counted on confidence in the established coordinatedness without explicitly formulating this.

When the new collaboration was put into practice, the relationship was characterised as 'close and open'. During mutual visits of several days' duration, totally new methods for inter-firm cooperation were applied. The

([14]) We base our account on a total of 116 expert interviews. All passages in quotation marks, even if they are only individual words, are literal statements from our research partners.

usefulness of this was made apparent as disruptions (faulty instructions, defective preassemblies, etc.) occurred. This required corrective cooperation, which had to account for experience-based knowledge from all participants, at different levels. Contact between the manufacturer and supplier took place between supervisors and one 'shift coordinator'. Even after six months, 'breaks of quality' and 'faulty deliveries' were still answered by the final manufacturer with 'patience and understanding' and a decision was made to reconsider or delay a planned reorganisation of production.

However, despite this amiable start, massive disruptions led to the first crisis after nine months. A change in the model led to documentation problems and the shift coordinator at the supplier was ill, leading to the lack of a contact partner who 'could get things done' when disruptions arose. The workers in the final assembly spoke henceforth of a 'chaos shop' and insisted that the supplier should deal with the disruptions unilaterally, by referring to the initial framework for coordinatedness and its rules.

However, an attempt was made to avoid quality defects by developing a sample cable set with maximal equipment for demonstration purposes. In addition to the production workers, representatives from the planning areas of the final manufacturer also took part. This makes it clear that we are no longer speaking of cooperation to secure production, but about expansive knowledge-oriented cooperation. This means that what was initially considered as a secondary task (compensating for quality defects in the production process) is now declared the main task, the exchange of knowledge between various actors to assemble the sample cable set adequately.

Those who participated in the process referred to this time as the 'phase of standardisation' and the 'creation of commitment'. It again illustrates the goal of attaining confidence in the initial coordinatedness and avoiding the need for corrective cooperation. This found its organisational expression in the supplier hiring a second shift coordinator and initiating mutual 'visits' with subsequent documentation.

The number of corrective cooperation events increased again (due to unforeseen events) six months after the intervention phase described above and made the 'relationship appear very negative'. The reason for the quality problems was the changeover to foam technology while production was running. The disruptions now led directly to a joint construction, which can be described as innovative in the inter-firm area: an inter-firm quality circle was considered as a 'last attempt at building up the trust relationship again'. The participants worked on improving the sample cable sets. In the process, they increasingly deviated from planning standards and constructed the

samples according to their knowledge of the problems that arose. The joint construction led to an officially revised and renewed coordinatedness: the attempts at achieving a 'regulation and systematisation of the production sequences' characterised by the supplier relationship.

Three months later a further crisis arose; corrective cooperation opportunities were not taken up by the final assembly plant and disturbances were passed on directly to the level of the production manager. This was both an expression of resignation and disappointment that led to the characteristic key phrase: 'We have done a lot in the production area, but too little comes back from the suppliers'. Actors on the final manufacturer's side insisted on holding to the already-established coordinatedness that had been negotiated. Those responsible for production demanded a unilateral accommodation to the remediated coordinatedness.

For the further duration of the relationship, the supplier only used the shift coordinators for coordinating its internal production process and 'identified ' an additional person who could be seen as a contact partner for corrective cooperation and as a possible initiator of expansive cooperation. One of the ways in which he fulfilled the latter function was that after three months in office he put together a second quality circle dealing with the issue of 'problems with the foam-filled frame floor assembly'. In knowledge-oriented joint construction, task instructions were prepared, whereby a test manual for specific problem areas was drawn up to codify the knowledge that had been exchanged. After the workshop circle, the supplier agreed to take unilateral steps beyond the negotiated coordination structure in the form of a six-minute quality discussion per shift, to better preempt breaks in quality or to catch them even earlier, before delivery. The successes that were achieved were described in almost euphoric terms, half a year later. The relationship, and therefore the corrective cooperation, (which was still necessary) was characterised as 'very good' and 'the smoothest time of all'.

The adjustment of the supplier relationship to the revised initial coordinatedness appeared to have been successful but it was decided, at the strategic level, to end it after three years. The ordering of so-called 'compact sets' (a bundling of equipment segments) was considered to be more reliable. If we look at the supplier relationship as a whole, the crises that arose point towards a hidden crisis of the coordinatedness that was established in the planning stage. At that time, the sensitivity of the new relationship was underestimated and existing confidence overestimated. The simple transfer of existing forms of the internal company coordinatedness to the inter-organisational relationship failed. Those critics who spoke of a 'rush job' turned out to be correct.

4.4. When cooperation becomes the focus of process design

Based on both our theoretical framework of cooperation and our empirical research, we propose three areas for process design:
(a) exchange of employees;
(b) an inter-area manager;
(c) inter-firm workshop circle.

We have encountered examples of all three areas when reconstructing the lifeline of the inter-organisational supplier relationship: the mutual 'visits' as the germ cell of the exchange of employees; the quality circles behave as inter-firm workshops; and the 'shift coordinators' act as representatives of inter-area managers, between final manufacturer and supplier ([15]).

In Figure 2 we provide an overview for each area concerning the events that typically trigger activities, intended goals and the cognitive and organisational, effects that are aspired to.

Figure 2: **Areas for process design based on the model of joint activity**

Type of process design	Triggering situation	Intended goals	Cognitive effects	Organisational effects
(1) Exchange of employees	expected problem areas	generating knowledge on current coordinatedness	generating an increased capacity of anticipation	generating options for expansive cooperation
(2) Inter-area activity manager	emergent unexpected events	solving unique cases in corrective cooperation	context-sensitive problem solving competence	bridging communities / flexible use of process related knowledge
(3) Inter-firm workshop circle	systematic sources of critical incidents	developing comprehensive solutions	making visible variance in locally embedded knowledge	perspective taking / joint construction of new possibilities

([15]) A detailed description of all three areas for process design is to be found in Endres and Wehner (1996). Further references may also be found in the contribution of Waibel, Dick and Wehner in this book.

When discussing the concept of cooperation, in relation to the issue of knowledge, our framework guides us to the conclusion that process-related knowledge is very much generated in collaborative settings. In the case of unexpected events triggering corrective cooperation, we often overlook opportunities to examine critically the possibilities of options to generalise from certain experiences that, for the time being, are bound to unique events. The interplay between knowledge generated in process-related cooperation and its generalisation and transformation – into a new coordinatedness of actors – forms the starting point for areas of process design.

We formulated all three areas with the objective of covering both an individual and an organisational perspective of knowledge-generation, maintenance and expansion. While acknowledging that knowledge is meaningless when presented in a non-contextual manner, we should also stress that knowledge is not exclusively bound to a single, unique event. On the contrary, knowledge also represents the human capacity to abstract to a viable degree from the immediate circumstances of an experience. The question we must pose is how can we assure that knowledge generated in one context may be applied to another? Taking this perspective, knowledge-oriented cooperation is very much concerned with the issue of recontextualisation. All three areas for process design are meant to provide collaborative settings in which this very process of recontextualisation of knowledge may take place. The cognitive and organisational effects that we aim for, such as context-sensitive problem solving competences, visualisation of similarities, variance in locally embedded knowledge, an increase in our capacity for preemption, perspective taking, etc. all adhere to a common idea, namely that we can share knowledge by supporting its collaborative recontextualisation. This sometimes leads to actual organisational development, in terms of changes in the initial coordinatedness of actors.

This leads us into a discussion of the relationship between our work psychological framework of cooperation and knowledge management, a topic heavily debated in the organisation and information sciences since the early 1990s.

4.5. When knowledge-oriented cooperation becomes the object of knowledge management

Knowledge management cannot start from first principles. While it may be a new perspective in management, the notion of knowledge-oriented cooperation points to practices that have been in place ever since organised forms of production evolved making for a specific division of labour.

In the final stage of our argument, we will discuss issues that arise when, as proposed in the opening section of this paper, knowledge-oriented cooperation becomes the object or focus of knowledge management. In doing so, knowledge management has to overcome the analysis, evaluation and design of single work tasks. It also has to reflect upon individual and collective capabilities of generating, transforming and using knowledge. More specifically, it has to account for joint activities in which the locally generated knowledge necessary to perform specific tasks is mediated between actors, work places, departments, organisations and networks. Our framework informs us that these processes of mediation will find their structural counterpart in the initial coordinatedness of actors, with respect to the knowledge embedded in everyday practice. That is why the initial coordinatedness of actors concerning their options to generate, communicate, and access knowledge must first be understood. Furthermore, our conceptual framework provides us with a means of differentiating between various forms of knowledge-oriented cooperation.

In situations in which knowledge becomes the object of corrective cooperation, unexpected events trigger joint activities to cover a certain lack of knowledge necessary for the performance of a specific task. The ways in which actors cope with such a problematic situation may tell us a great deal about their perception of partners, that may help them to access adequate knowledge resources. The need to cooperate in search of knowledge, together with examples of unsuccessful search paths, may provide clues for analysing and supporting knowledge-oriented cooperation. They may hint at frictions in the division of labour that do not take into account the need to transform knowledge across established organisational boundaries.

Furthermore, the need for corrective cooperation may reveal a need to acquire knowledge that might not be available within the initial coordinatedness of the organisation itself. This does not necessarily mean that the relevant knowledge is not available within the organisation. However, it is at least a sign that the initial coordinatedness does not allow a specific actor to access cooperation partners or other knowledge

resources that provide the necessary knowledge. The initial coordinatedness, therefore, has produced a state of need which may not be satisfied within the frame conditions of the actual coordinatedness of the organisation. In this specific form of a crisis (the inability of actors to access or create relevant knowledge) the involvement of new collaborators or tools not yet available represents an emerging form of expansive cooperation (Clases and Wehner, 2001). In expansive knowledge-oriented cooperation, actors try to find new partners to deal with the insufficiencies in the initial coordinatedness of a joint activity.

Methodologies that systematically support the process of joint construction have been proven to enable the formulation of requirements for new tools in knowledge management (Clases, 2001).

Local strategies for expansive knowledge-oriented cooperation may be seen as germ cells for a more generalised reflection on the initial coordinatedness of knowledge-oriented cooperation in forums for joint construction. The objective of joint construction is to initiate a comprehensive discourse on innovative forms, to organise the initial coordinatedness. Based on experiences in corrective and expansive cooperation, forums of joint construction are dedicated to the overall objective of formulating new ways of designing the coordinatedness of actors in a manner that alleviates new knowledge-oriented cooperation and supports the coordination of knowledge in everyday practice. However, only a successful remediation and transfer of the scenarios determined in joint construction, will lead to a renewed coordinatedness of actors encouraging new forms of knowledge-oriented cooperation.

From the framework proposed in this paper, it should be obvious that we do not share the objective of some writers in knowledge management literature. From our perspective, this literature neglects the socially distributed and situated character of knowledge and, in the end, represents a new kind of chimera in the discourse on knowledge management. In contrast, the analysis and the design of knowledge-oriented cooperation should account for the fact that unexpected events, malfunctions, crises and tensions, concerning the availability of knowledge at the workplace, are driving forces and important clues for changes in the design of the initial coordinatedness of actors. In this sense, successful knowledge-oriented cooperation finds its expression both in the generation of new knowledge in dynamic environments and its transformation into renewed forms of knowledge-oriented coordinatedness.

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CHAPTER 5

Organisational learning in the European chemical industry: concepts and cases

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5.1. Introduction

Many definitions of organisational learning emphasise that individual learning processes are a precondition for organisational learning. However, they also emphasise that learning in a company is different from, and should be regarded as more than, the sum of individual learning processes (see Probst and Büchel, 1998, p. 19; Senge, 1997, p. 171; Sonntag, 1996, p. 67). This paradox has led to a controversial discussion of the learning organisation in Germany. Some authors view organisational learning as pure ideology or myth (Geissler and Orthey, 1996), while others see it as a revolution in the culture of learning with fundamental implications for the system of vocational education and training (Dybowski, 2002).

What do companies really do, when they claim to be learning organisations or learning companies? To answer this question, it is necessary to relate empirical findings to theoretical considerations. Terms like 'organisational learning' and 'the learning company' do not make much sense if they only mean a collection of learning individuals. Thus, it was necessary to develop a conceptual framework for organisational learning if it was to be seriously investigated in a project concerned with ways of organisational learning in the chemical industry and the impact on vocational education and training) ([16]). The conceptual framework attempts to address the question of how organisational learning can be differentiated from pure individual learning (see Fischer, 2003).

One of the early answers to this question was given by Chris Argyris and Donald Schön (1978). According to them, we speak of a learning organisation if it engages in processes of double-loop and deutero learning.

([16]) The acronym for this project, which was funded by the 5th research framework programme of the European Union, is OrgLearn.

This means that the individual not only receives feedback concerning unsuccessful efforts at work in avoiding future mistakes (single-loop learning) but implies that an organisation has created a structure through which individual learning is permanently stimulated, documented and evaluated through double-loop or deutero learning. It is this that differentiates organisational learning from pure individual learning. Such a structure is put into practice when organisational learning is not just a formal entity but a cultural phenomenon. This is an idea developed by Edgar Schein (1992, 1995, 1996) who conceptualises culture as 'a pattern of shared basic assumptions that a group learned as it solved its problems of external adaptation and internal integration, and 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 can a culture of organisational learning be implemented? Peter Senge (1997; see also Senge et al., 1996) gives an answer to this question by describing the elements of a systemic interventionist management practice. All of these concepts claim to point beyond the individual learning of the employees. They share a focus on the company's practice of systemic reflection and the development of company culture towards learning. This can go so far as to consider the relationship between enterprise and society, as Harald Geissler (1996) pointed out.

If we integrate these concepts, then the need for empirical research into organisational learning becomes important. The main question is how companies transform their current culture of learning, which contains elements of 'a refusal to learn', and individual and organisational learning, into a culture of learning which stimulates individual learning processes and derives benefits from them on a organisational level. The most relevant criteria for this are:

(a) organisational work routines are evaluated and improved.
Indicators: constant review and revision of standard operating procedures, communicating improved performance, etc.;

(b) formal and informal learning processes are evaluated and improved.
Indicators: inquiries to identify learning deficiencies and to draw conclusions from them. Learning processes are stimulated, supported, evaluated and results disseminated, etc.;

(c) transformations occur in the culture of the organisation.
Indicators: staff feel personally committed and empowered to closing the gap between the organisation's current standards (what they ought to be). There is a readiness to introduce and improve instruments and artefacts to increase learning opportunities. There are feedback loops in

place to evaluate interventions aimed at achieving change in response to external challenges, etc.;

(d) knowledge is being created within the organisation, at different levels (not only by managers/scientists) and is shared within the organisation.
Indicators: knowledge (including informal knowledge) creation projects are officially sponsored throughout the organisation. Systems and structures are in place to code and store knowledge and to make it available to those who need and use it, etc.;

(e) learning from the environment is encouraged and systematically evaluated. The results are assimilated and accommodated to the company's objectives in accordance with local constraints and opportunities.
Indicators: inter-company learning is an accepted part of the company's overall policy including the use of practical approaches such as 'boundary crossing workers', external audits, systems and procedures for acquiring and sharing information from outside the company, etc.

It is clear that if a systemic learning culture is to be created in the company, the work processes and the views of management must change. The manner through which such change can be observed is discussed by means of two case studies from the UK and Germany.

5.2. Problem solving groups and organisational learning: a case study from the UK

The concept of a learning organisation makes significant assumptions about the nature of the work process, and the way in which knowledge is created and distributed within the company. To explore these issues in detail, a case study was carried out in a company which has recently made major efforts to turn itself into a learning organisation. The site where the research was conducted is an oil refinery in which crude oil is processed into a range of petrochemical products, such as petroleum, waxes and bitumen. While some of the products are sold directly to the consumer, the majority are sold to other chemical companies which process them further into a wide range of chemical products.

In response to global challenges to the oil and chemical industry, the parent company considered closing the refinery altogether and basing its operations in refineries elsewhere in Europe. However, a new site manager was appointed who reorganised the UK refinery along the lines of a learning organisation. Consequently, it has improved its performance to such an

extent that it remains one of the most productive refineries in Europe. When the new manager took over, the refinery was a bureaucratic organisation with a hierarchical command-and-control structure. The operatives followed fixed procedures under the direction of supervisors and middle management. Since then, the company has undergone many changes including delayering, the introduction of self-directing teams (SDTs), reduction in vertical and horizontal demarcations, more functional flexibility, downsizing to less than half the original number of employees, outsourcing of support functions such as buildings maintenance, more openness in communication and more sharing of information in top-down, bottom-up and lateral directions. Above all, employees at all levels are required to participate proactively in the process of learning from past experiences and constructing new knowledge about how to improve performance in the future.

In this section, we focus on the introduction of self-directing teams (SDTs). The concept of the SDT can best be understood by contrasting it with the way work is organised in the traditional Taylorist factory, that is by strict division of labour, hierarchical command-and-control and expectation that operatives will follow fixed procedures under fairly close supervision. In contrast, SDTs are multi-functional and the team assumes much of the decision-making responsibility previously held by managers. Appelbaum and Batt (1994) trace the growth of SDTs to the impact of the sociotechnical systems theory of the 1950s, which replaced the concept of work as a collection of individuals performing separate tasks with the idea of a person-machine system in which workers form a collective and are integrated with a set of tools to form an indivisible, self-regulating unit. Appelbaum and Batt define SDTs as work groups which operate autonomously without shift supervisors, design their own training (typically training their members for as many as four semi-skilled jobs within the team), and rotate team members around these jobs. Work is not coordinated by an external boss, but through collective activity. The roles of supervisor and middle manager largely disappear; any remaining middle managers become the facilitators of the SDTs (for example, the training manager will provide courses and learning support in response to the team's identification of its learning needs).

In the company concerned, operations are based on a five-year plan drawn up by senior management. A 'site plan' is produced in the form of a booklet which is issued to all members of staff, and which specifies performance objectives with respect to safety, reliability of production, environmental protection, etc. All employees are expected to possess a copy of the site plan and understand it. They are expected to take the

initiative in directing their own work activities towards achieving the performance targets outlined in the plan. In this context, the SDTs are not regarded by the company only as production units, but also as learning cells continuously engaged in creating knowledge about the work process. Each team is required to hold meetings to identify ways in which it can contribute to the performance targets specified in the site plan. The company recognises that this implies that the team must engage in continuous learning in the workplace. Thus, an important part of the work of each SDT is to reflect on its own performance and plan its own future learning. This is done in line with the following procedures laid down by management:

(a) when asked to do so by a message circulated on the company intranet, the SDT identifies tasks and targets, i. e. how to contribute to the goals specified in the site plan;
(b) learning and development needs are identified through peer appraisal within the team (about half the employees have been trained by the company to carry out appraisal);
(c) collectively, the teams devise a personal development plan (PDP) for each employee in the team, to give them the skills needed to achieve their targets;
(d) each team has a training budget, and goes to the company's training department with requests for courses to meet the learning needs specified in the PDPs.

The company encourages the SDTs to carry out projects designed to solve production problems. Through this practice, work process knowledge is continuously being generated by the workforce. The importance attached to promoting the problem-solving capability of the SDTs is reflected in the size of the company's training budget, and the fact that training is now part of the overall business plan. On average, each employee receives eight days' formal training per year, about four of which are required by legislation (e. g. health and safety), and about four of which focus on 'soft skills' such as leadership, communication skills and report writing. Much of the training in soft skills is designed to facilitate the problem-solving capacity of the SDTs. It typically includes a significant amount of coaching in collective activity, such as team building, human relations training and improving internal communication. A recent initiative designed to develop the team's problem-solving provided each SDT with a four-day team-building course which focused on their ability to manage their own learning and conduct effective meetings. This was backed up by the provision of on-site training facilitators, who carry out back-up training for the teams. Most of the training provision is bought in from outside the company.

5.3. The development and use of a plant manual as a subject of organisational learning: a case study from Germany

This section features a case study on organisational learning in a large German chemical company. Research was conducted into the involvement of personnel in producing and using a plant manual on the functioning of the steam cracker, a large chemical plant.

The steam cracker is one of the 350 plants on a large site and consists of two subplants (steam cracker 1 and 2). A steam cracker produces many different products, such as ethylene and propylene.

5.3.1. **Work organisation**

The boundary conditions under which the organisational processes in the steam cracker can be evaluated and refined are greatly influenced by the specific characteristics of these large-scale chemical plants. The steam cracker is the starting point for a chain of chemical production stages and its outputs are the first intermediate products (mainly ethylene and propylene) which 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.

The various activities performed at the steam cracker can be classified along horizontal and vertical lines in relation to different line organisations or levels of hierarchy, respectively (see Figure 1).

The workforce comprises a plant manager, two deputy plant managers, two plant assistants, six-day shift foremen and ten other day-shift workers. There are three shifts, each with its own shift manager responsible for the plant. Each shift comprises two groups, one for each plant. Each shift is led by a foreman and his deputy. At each plant, in addition to the shift manager and his deputy, there are also four workers per shift who are viewed as managerial staff. Each shift comprises different numbers of operators ([17])

([17]) An 'operator' at this company is someone who has successfully completed the first half of his or her *Meister* training. In other companies, the term operator refers to a normal shift worker working with the process control system (control room operator) or in the plant itself (field operator). The company analysed does not have this division of labour: every shift worker is supposed to be skilled in both areas.

(O), foremen (FM) and first man (FW). In total, there are 164 workers, of whom six are apprentices.

Figure 1: **Hierarchy and responsibilities**

Level of hierarchy - operations	Main responsibilities - operations	Level of hierarchy	Main responsibilities - plant engineering
Plant manager	Compliance with financial targets, integration at section level, supervising day foremen and shift foremen; plant optimisation	Plant engineer	Detail planning and realisation of plant modifications, supervising implementation
Day-shift foreman (DF)	Availability of production plant: planning and organising activities to maintain, improve or restore operation of the production plant	Foremen in the various specialisations e.g. Mechanics/Process Engineering; Control Engineering	In consultation with the day foremen: planning and organisation of detail measures on the production plant (e.g. pump changes); procurement of spare parts; coordination of external contractors
Shift (workers and shift foremen (SF))	Operating the production plant: running the plant; tracing and reporting faults, decommissioning parts for repair and re-commissioning after repair, instructing trades persons	Craft trades persons in the various specialisations	Implementation of measures (e.g. dismantling and installing pumps)

5.3.2. Learning in the steam cracker: producing the operations manual

An important learning project in the steam cracker was the participative production of an operations manual. The plant had faced the challenge of promoting job cuts using early retirement arrangements, which resulted in a loss of experience and know-how in the shift teams. To counteract this, a

project was launched in 1998 in collaboration with the training division to produce an operations manual for all the processes within the steam cracker. The operations manual became a kind of organisational memory for a major portion of the know-how essential for operating the steam cracker. It became the central basis of a qualification system and was linked to the pay system.

Drafting and editing the operations manual for the steam cracker was organisationally controlled. At regular intervals, a team comprising one beginner, an experienced worker and a moderator met in a room near the workplace to draft the description for a particular process stage. Normally every team had three to four weeks to write their chapter. The manual explains how each process stage functions, how it is operated and the safety instructions to be followed. The team is also responsible for producing sample questions for each qualification level (linked with the wage system). The whole operation manual consists of 30 or 35 single folders, each containing a chapter.

The team started its work with the collection of all relevant material (i. e. technical drawings, flow charts, list of devices) and information about the stage in the process and then drafted the text together. When they had finished writing a section of the manual, they gave it to the shifts for comments and corrections. By the next meeting, the team tried to clarify anything it did not know by talking to colleagues on the shift, the shift foremen, the day foremen and the works management. During this work there was intensive discussion about the function and operation of the plant.

Producing the operations manual tended to be more popular among younger workers. Older workers considered this a waste of effort. The greatest learning effect arose in joint discussions within the manual team and in discussions with experienced workers on the shift. The shift foreman did not usually send the most experienced workers to the container where the manual was produced, because there were only a few such workers on the shift. Direct participation of shift workers ensured that the manual was easy to understand.

> 'It is easy to understand because you yourself are doing the writing and there are not many complicated words in it.' (Shift worker interview)

Employees who were not involved in producing the manual also confirm that the text was readable.

The learning that occurred when writing the operations manual was, without doubt, intensive. The very act of writing compels the workers to think very carefully and precisely about what actually occurs in a particular processing unit. Most workers realise very quickly how a processing unit is

operated or what its most important functions are. However, during continuous operations there is often little cause to think about the plant in any depth. Writing the operations manual provides such an occasion.

5.3.3. Using the operations manual

The strong training effect of producing the operations manual was quite remarkable. In the empirical investigation we also focused on its everyday use. Novices, in particular, use this manual intensively and were motivated by the link between learning and the salary system. Because of the work-oriented content of the operations manual, it is frequently used whenever employees take on a new assignment. As it describes exactly how a process unit is structured, and how it has to be operated in particular situations, novices are able to prepare their activities well.

In case questions arose concerning the use of the manual, users often contacted the authors responsible for the description of a particular process unit. If mistakes in the manual were detected and amendments needed, then a master (*Meister*) with responsibility for the section concerned did the update.

5.3.4. Link to wage system

Novices with vocational qualifications from outside the chemical industry receive lower wages when engaged by the company. The difference between this primary wage group and a skilled chemical worker is four to five wage bands. Since the operations manual was introduced, novices have been given the opportunity to rise one salary band if they pass an examination (an oral examination on technical issues). They are able to prepare for this very effectively using the operations manual as it contains sample questions (similar to the examination questions). The rise in salary used to be dependent on a judgement by shift and day masters. Today, workers may choose to be examined independently.

Each wage group is linked to a qualification level which is related to a taxonomy of training goals (see Figure 2). The beginner uses the operations manual to obtain a general overview of the plant. The first part of the text gives an overview of the function of a particular piece of equipment related to basic knowledge.

Figure 2: **Taxonomy of training goals at different qualification levels**

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

5.3.5. Interpretation as organisational learning

Producing and updating the operations manual, as well as integrating it into the process of training workers, is a process of organisational learning. Previously, the process of training shift workers depended primarily on the initiative of shift foremen and experienced shift workers. The organisational process of preparing and updating the operations manual means that an important part of the employees' knowledge base is added to the organisation's 'memory'. The training system, linked as it is to the payment system, provides organisational processes for distributing knowledge stored

in the operations manual.

The process of writing and using the plant manual not only matches our second criterion of organisational learning (formal and informal learning processes are being evaluated and improved), but can also be understood as a process of knowledge management in the vocational area (criterion 4).

The construction and use of the manual generates knowledge about the plant which goes beyond that which is needed for direct operations. This occurs during the writing process when operators need to take a systematic overview, and also when the manual is reviewed as a whole. The participation of the shift workers in preparing the plant manual provides access to all the information sources of the company. Previously there were hardly any opportunities for the workers to contact the planning and documentation department, but now need access to it during the preparation of the plant manual.

In correcting the texts written by the teams, the workers from a certain shift are stimulated to discuss the controlling and driving of the plant and the connectivity of the various functions. Previously these matters were explained to the novices by the master (or experienced workers) and they had no option but to accept these explanations as fact. But in writing or reviewing the operations manual, the workers had to search for and find explanations for themselves. This led to a form of debate among workers that did not take place previously.

Every team that prepared a section of the plant manual comprised workers from all the shifts. During the discussions about the correct version of a text, the workers became aware that every shift has its own way of running the plant. Previously, there used to be little communication among the shifts, so the workers from one shift considered their way to run the plant as the only possible one.

The shift workers and the master had ‘mental models’ of the plant, concerning the way it should operate, that changed through the process of preparing and using the operations manual. Notions about the role of workers in the work organisation changed, too. The female moderator of the team reported in an interview, for example, that at the beginning of the project angry shift masters came to her to complain about shift workers being sent to join the teams. The main point of the complaint was the awakened self-consciousness of the workers who were making themselves independent of the master’s control of the information flow.

Organisational learning in the sense of double-loop and deutero learning implies that the organisation creates a structure through which individual learning is permanently stimulated, documented and evaluated. The

individual learning processes of novices in the steam cracker used to happen quasi naturally. If novices were motivated to learn, then masters answered their questions and encouraged them to continue learning if time and opportunities were appropriate. The transformation of this quasi-natural training into a structured knowledge development process for running the steam cracker is organisational learning. Of particular importance is the link to the wage system, which led to a taxonomy of training goals and a guide on how the manual could be used as tutorial material. An oral examination test is used and there is no certification. A learner has successfully passed the examination if he or she can respond correctly to at least 80 % of the questions. Whoever surmounts this hurdle is promoted to the next wage band. To prepare for the examination, examinees are informed about what is expected of them. For this reason, a discussion about what parts of the manual need to be studied takes place within the steam cracker. There used to be no need for such a discussion. Every master decided who would be promoted within his shift based on his own criteria. The present examination system has changed this to a more objective and participatory system.

5.4. Conclusions

Learning in a learning organisation has an element of ambiguity. Learning extends to all spheres of the company. Demanding and varied tasks are created that are carried out under conditions of partial self-organisation. Direct feedback on the consequences of one's own actions becomes possible, as well as an exchange of experience and knowledge. The development and use of knowledge within a company has always been a cause for dispute regarding who gains benefits – the individual or the company. The concept of the learning organisation revives this controversy (see Ostendorf, 1998). Our findings lead to the following preliminary conclusions:

(a) both the UK and German cases presented here meet the organisational learning criteria 1-4 presented earlier:
  (i) organisational work routines are being evaluated and improved;
  (ii) formal and informal learning processes are being evaluated and improved;
  (iii) transformations are occurring in the culture of the organisation;
  (iv) knowledge is being created within the organisation, at different levels (not only by the managers/scientists) and it is being shared within the organisation;

(b) in both case studies the main emphasis is on the provision of an organisational structure for knowledge creation and knowledge sharing. In one case, this is a system for rewriting the plant manual, in the other case it is a system for organising work in 'self directing teams' (SDTs). The knowledge being created and shared is what we call work process knowledge: knowledge about the whole labour process within the organisation, including reflection on practical and theoretical knowledge that might be useful for work;

(c) there is an increase in self-directed learning and a reduction in the extent to which learning processes are controlled by masters and foremen. Learning processes, on the one hand, are more independent from personal control (by middle managers), and on the other hand are more objectified through manuals, standard operating procedures, appraisal systems and regulations, while 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 externally-imposed job descriptions such as are defined by the German *Beruf* concept;

(d) in both case studies, processes of organisational learning are a response to a major reduction in manpower and in particular the loss of experienced workers. In one sense, organisational learning can be regarded as an attempt to compensate for the loss of know-how caused by this. 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 also through artefacts in which knowledge is stored in the organisation's 'memory'. It is not yet clear to what extent organisational learning may support a hire-and-fire policy or an out-sourcing and in-sourcing policy, and to what extent the individual worker benefits from processes of organisational learning.

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SECTION III

Explicit and implicit learning at work

CHAPTER 6

Tacit knowing and implicit learning

Georg Hans Neuweg

6.1. Introduction

It is tempting to ask about the proportion of tacit, as opposed to explicit, work process knowledge that an individual (or group) acquires in modern economic life; what is the correct blend of the two and is the importance of tacit knowledge in working life increasing nowadays.

Although these questions cannot be answered from a 'tacit knowing perspective', nevertheless, some people attempt to provide answers. A business economist estimated that the percentage of tacit (personal) knowledge in companies is in the region of 20 % to 30 % (Böhnisch, 1999). Several criticisms can be made of such a proposition:

(a) it is not possible to quantify knowledge in such a manner. For example, how are we to measure explicit knowledge: by analysing the words used? How is the knowledge to be measured: by counting or by weighing? But, most importantly, what constitutes tacit knowledge in the first place?

(b) not much knowledge is purely tacit since speech allows us to comment in some way on nearly everything we do and explicate almost everything we know. However, the question of whether a certain kind of knowledge is describable must always refer to a particular purpose in a particular context, for which a description may or may not be adequate/exhaustive;

(c) the economist's assertion fails to account for the fact that pure explicit knowledge does not exist in a raw state. Symbols, words, and sentences by themselves do not contain any knowledge. They become meaningful through a tacit act of 'sense-reading', performed by someone who sees *beyond* the symbols to that which they refer (and who may soon forget the words while still keeping their content in mind);

(d) last but not least, the economist's proposition misses the point of the 'tacit knowing' debate, as do the questions outlined above. The debate is not about a particular *kind of knowledge* that is to be distinguished

from and added to explicit knowledge; it is about a different *view of knowledge* in general ([18]).

This paper begins by presenting a brief overview of the 'tacit knowing' view and questions the intellectualist and objectivist view of knowledge (Section 6.2). It continues by distinguishing different meanings of the term 'tacit' and refers to different types of tacit knowledge (Section 6.3). Finally, some implications for the acquisition of knowledge are discussed (Section 6.4) ([19]).

6.2. Work process knowledge as a substance?

Talking about 'knowledge' (as distinct from competence, skill, mastery of an art, understanding, ability, judgement, etc.) is a way of identifying the invisible cognitive repertoires that underlie competent behaviour: that is, a hidden mental substance (in the form of propositions, programmes, rules, algorithms, theories) as well as mental processes dealing with that substance. However, in ascribing 'work process knowledge' to workers, we impute to them not mentally stored knowledge, but the ability to perceive, to think, and to act skilfully, to *do* certain things in an expert-like way. We are interested in *knowledge in use* rather than *knowledge as a state*. That is why a theory of tacit knowing ought to come into play if we are interested in work-process 'knowledge'.

The tacit knowing view:

(a) concerns know*ing*, not in the sense of storage places and their contents, but processes (e.g. perception, judgement, action, thought, discernment, contrivance) and underlying human dispositions ([20]);
(b) focuses on the relationship between knowing and its articulated counterpart;
(c) argues that 'we know more than we can tell'. This proposition has one or both of the following meanings:

([18]) For a brief exposition of the main differences between the tacit knowing view and the cognitive view see the table in Neuweg (2001, pp. 22, 23).

([19]) For a closer look at the tacit knowing view, we particularly recommend the following works : Michael Polanyi (1969, 1975 and 1962); Gilbert Ryle's brilliant analysis in *The concept of mind* (1949); the taxonomy of levels of human skill, and the taxonomy's philosophical basis in the works of Dreyfus and Dreyfus (e.g. 1986); summaries and discussions of empirical results on implicit learning, such as in Reber (1993) or Berry and Dienes (1993), and, for German readers, the comprehensive exposition in Neuweg (2001).

([20]) For this reason, the tacit knowing debate is less concerned with the acquisition of knowledge of facts.

(i) some human dispositions are 'unformalisable'. In this case, to 'tell' can be seen to mean programming a computer so that, by means of rules, it simulates a knowing person with regard to a particular disposition;

(ii) some human dispositions are 'unteachable' solely by means of verbal instruction. In this case, to 'tell' means instructing learners verbally in such a way that they follow in the teacher's footsteps with regards to a particular disposition (that is, so that they understand and replicate the teacher without having first-hand experience or a demonstration).

Both meanings are informed by the conviction that it is dangerous to believe that knowledge of propositions, rules, or theories is a sufficient condition for knowing and that it is even dangerous to believe that such knowledge is always a necessary condition for knowing. Furthermore, an important corollary is the assertion that all (even the most academic) professions have a practical (craft) side, which, once learned, is not detachable from the knowing person.

Such a view stands in opposition to traditional thinking on human insight and action. From the intellectualist or cognitive viewpoint ([21]) knowledge is essentially propositional. This means that everything we do is seen as derived from propositions in our head and from thought processes dealing with these propositions. From this perspective, to do something intelligently is to employ both theory and practice, but practice is seen as nothing more than applied theory. (This view admits that we are often unable to articulate how we proceed in carrying out a task. However, this is said to indicate the proceduralisation of previously conscious rules into procedures, the execution of which is now mere routine.) From this viewpoint teaching is merely the transfer of information, and learning is nothing more than the storage of information.

The acceptance of this view implying the existence of conscious and unconscious 'mental' rules and schemata that 'cause' intelligent behaviour, has important consequences. For the scientist, it means that in order to detect the causes of skilful action, research in work process knowledge has to focus on the mind and its content and architecture, rather than on observable behaviour over time. It also means that the elicitation and codification of an expert's knowledge is of theoretical as well as practical importance.

([21]) For a detailed critique of the cognitive view see Ryle (1949) and Neuweg (2000).

To view knowledge as a mass of conscious and unconscious propositions suggests that it is more or less easily detachable from knowing subjects. This would have important practical benefits. For example, externalising 'the substance' hidden in an expert's brain would enable us to shorten a beginner's learning process. Indeed, if all we knew were transposable into words and detachable, we could impart many years of experience to a learner in just a few weeks ([22]). Furthermore, if people's knowledge is seen in terms of rules and external procedures, these are replaceable, either by machines/technology or by other people.

Educationalists as well as business economists are not the only ones to find the idea of 'objective' knowledge attractive. Famous proponents have already been seduced. Popper (1972, pp. 107, 108) for example, argues for the existence of a so-called 'world 3' of objective thoughts, existing independently of and in addition to the (physical) 'world 1' and 'world 2' (the world of states of consciousness, mental states or dispositions to act). Imagine, he says, that some catastrophe destroyed our machines and tools together with our subjective knowledge of their use, while libraries, as well as our capacity to learn from books, survived. He argues that we would not have difficulty in rebuilding our civilisation.

But, is this the case? In the late 1960s, a Canadian research laboratory succeeded in constructing a special device – the so-called TEA laser. Collins (1985) studied attempts by British laboratories to build copies of the device along the lines of Popper. The findings outlined below strongly challenge his thoughts:

(a) no scientist succeeded in building the laser by using only the information found in written sources; a crucial component of knowledge was acquired through personal contact;
(b) no scientist succeeded in building the laser when the informant was a 'middle man' who had not built the device himself;
(c) even where the informant had built the device himself, the learner was unlikely to succeed without some extended period of contact with the informant;
(d) the flow of knowledge was partly obscured, so that scientists did not know whether they had the relevant expertise until they put it into practice.

([22]) In the German weekly newspaper *Die Zeit*, for example, Niki Lauda dreams of 'how wonderful it would be if I could transmit the rich store of my experience, my knowledge, to my sons Lucas and Matthias. Just take a modem or an adapter, suddenly a flow of data would start its journey' (Lauda, 2001, translation G. N.).

Collins concluded that tacit knowledge is a crucial component in laser building and that, therefore, written information alone is inadequate.

From the intellectualist point of view, such findings are surprising. Given that intelligent action is the outcome of deliberation and knowledge, why are experts unable to express all that they are able to do in words?

On the contrary, it would appear that practice is not always 'a client' of theory. First, there is empirical evidence challenging the intellectualist viewpoint. If knowing and deliberating are *necessary* conditions for skilful action, then what about the skilled expert who can perform tasks intuitively? Following Polanyi (1962, p. 49) 'the aim of a skilful performance is achieved by the observance of a set of rules which are not known as such to the person following them.' Although, for example, the cyclist knows how to ride a bicycle, he is unable to state the rule – to compensate for a given angle of imbalance we must take a curve on the side of the imbalance, of which the radius should be proportional to the square of the velocity over the imbalance. On the other hand, if knowing and deliberating were *sufficient* conditions for intelligent action, then what about theorists who are unable to do what they know? In an experiment conducted by Renkl et al. (1994), for example, it was shown that graduate students of economics were less successful than laymen in controlling a computer-based economic simulation, perhaps not in spite of, but because of, their broader base of explicit knowledge. It is also well known that expert performance can break down if subjects try to focus on specific components of a skill and attempt to govern execution according to strict rules (see for example Masters, 1992).

Second, there is a strong logical argument against the intellectualist point of view. If action is the result of deliberation, intelligent action presupposes intelligent deliberation. Following the intellectualist construction, deliberation must be the result of further instruction about being intelligent. To avoid an infinite regression, the intellectualist must suppose deliberation to be intelligent in itself. Such a supposition is not just wrong – people may deliberate very unintelligently – but it is also inconsistent. If there are second-order acts that are intelligent per se, why should there not also be first-order acts that are intelligent in the same manner?

6.3. The concept of tacit knowledge

It is a fact that people need not necessarily think before acting intelligently: consider intelligent speakers who talk fluently because they do *not* contemplate about the words to use before they speak. Also, people cannot prescribe all their intelligent behaviour: infinite regression would mean one could never start acting at all. In what sense, then, are we allowed to ascribe 'knowledge' to people?

It is important to distinguish carefully between knowledge in the psychological sense (first person knowledge) and knowledge constructed from the observer's point of view (third person's knowledge). According to the 'intellectualist' viewpoint, the intuitive actor has propositional knowledge 'in mind', albeit unconsciously. Ryle (1949) has shown that this point of view is subject to a category mistake. The ascribed knowledge base merely functions as a construction to describe, explain and predict behaviour. The only objective mode of existence for this knowledge is behaviour over time, or, as Ryle (1949, p. 57) puts it: 'Overt intelligent performances are not clues to the workings of minds; they are those workings.' People behave as they do not because they have unconscious rules in mind but, at best, as if they had such rules in mind. In this sense, tacit knowledge is essentially implicit in one's behaviour and does not consist of internally represented rules (although it can be partly reconstructed and symbolised, either by the subject or by the observer). Memory is not a storage place of symbolic representations but rather is 'the name we give to the capability of behaving in similar ways in similar situations' (Clancey, 1990, p. 61).

This is not to say that the relationship between know-how and explicit knowledge is just one of practice to its description; it is also one of practice to its intrinsic or extrinsic instruction. But the question, 'what knowledge does the expert unconsciously apply?' should be replaced by two totally different and more fruitful questions:

(a) to what extent does third person knowledge *describe* the knowledge of the first person? Or, to put this in another way, to what extent can explicit 'know-that' simulate 'know-how'?
(b) to what extent is explicit knowledge suited for *instructing* 'know-how'?

6.3.1. Meanings of the term 'tacit'

We are now ready to look at three different – though interrelated – meanings of the term 'tacit', which appear in the debate.

First, tacit knowing often means doing something intelligently in an intuitive manner. Experienced workers ordinarily reveal a kind of 'knowledge'

that does not stem from a prior act of deliberation. Although somebody might be able to articulate corresponding rules before or afterwards, there need not be any self-instruction during the course of an action. (In some sense, every kind of acting is intuitive as it is impossible to do something and to reflect upon one's own action at the same time.) Consequently, '"thinking what I am doing" does not connote "both thinking what to do and doing it". When I do something intelligently, i.e. thinking what I am doing, I am doing one thing and not two. My performance has a special procedure or manner, not special antecedents.' (Ryle, 1949, p. 32);

Second, by reflecting on our actions we can try to make descriptions of the knowing that is implicit in them. Knowing-in-action becomes knowledge-in-action. It is important to note that the term knowing refers to a dynamic quality whereas facts, rules or theories are static. Therefore, descriptions of knowing-in-action are always constructions; that is, 'attempts to put into explicit, symbolic form a kind of intelligence that begins by being tacit and spontaneous' (Schön, 1987, p. 25). This leads to the second meaning of tacit knowing as the residue left unsaid by a defective articulation. In this stronger sense, tacit knowledge means that 'we can know more than we can tell' (Polanyi, 1983, p. 4): somebody is able to judge or act skilfully without being able to articulate what it is that he knows or, at least, able to articulate it appropriately. The workaday life of the professional, Schön argues, depends heavily on this kind of knowing:

> 'Every competent practitioner can recognise phenomena – families of symptoms associated with a particular disease, peculiarities of a certain kind of building site, irregularities of materials and structures – for which he cannot give a reasonably accurate or complete description. In his day-to-day practice he makes innumerable judgements of quality for which he cannot state adequate criteria, and he displays skills for which he cannot state the rules and procedures. Even when he makes conscious use of research-based theories and techniques, he is dependent on tacit recognitions, judgements, and skilful performances' (Schön, 1983, pp. 49-50).

Even if the actor is unable to fully articulate what it is that he knows, this need not impair our ability to detach knowledge from people. The third person analysis may reveal the first person knowledge. In a third and still stronger sense tacit knowledge means that even the third person is unable to describe intelligent action in terms of rules. This is a crucial point. Some psychologists think of tacit knowledge as the collective unconscious rules computed by an actor in a way that careful analysis reveals. It may well be that, in some cases, this view is correct. However, are these cases pertinent

when we consider the ill-structured domains of human expertise and their environmental complexities? Rules are abstract and standardised, whereas an expert has to deal with concrete cases and their variations. As no general proposition can fit every detail of a particular state of affairs, the expert must be sensible. However, if we view his good sense as a product of the acknowledgement of further general principles, we end up in an infinite regression of rules and principles. To put it another way, 'To a partly novel situation the response is necessarily partly novel, else it is not a response' (Ryle, 1976, p. 125). Note that the point here is not that skilful acting is intuitive; it may well be highly conscious, but it does not follow strict and formalisable rules. It is creative. This is Ryle's point against the reduction of thinking to mere computation:

> 'When considering abstract questions about the intellect we are apt to treat arithmetical computation as its most typical exercises – as if the best thinkers in their best moments are doing in their heads the sort of things that computing machines do, only much faster, in their complex insides. I don't know where this superstition comes from. Computation is, though very important, so low a form of thinking that a well-trained cashier can do lengthy and complex computations while thinking about something else. Moreover, pure computation tasks offer no scope whatsoever for originality, talent, flair, horse sense, taste, judiciousness in the weighing of evidence, or constructiveness in the building up of chains of argumentation' (Ryle, 1979, p. 52).

We sometimes refer to tacit knowledge of this kind as 'common sense'. To deepen our insight into this meaning of tacit, it is helpful to distinguish between two kinds of action (see Collins and Kusch, 1998). On the one hand, mimeomorphic actions maintain routines. Examples include a production-line type action such as that portrayed by Charlie Chaplin in his *Modern Times* film; the standard golf-swing; or simple arithmetical operations. Anyone or anything that can follow the set of rules describing the behaviour can, in effect, reproduce the act. Hence these acts are machinelike and mechanisable.

Polymorphic actions, on the other hand, are those in which the same action can and must be instantiated by an indefinite number of different behaviours, depending on the context at hand. Although this kind of acting is usually 'rule following' and sometimes 'rule establishing', it is very difficult to describe the rules that we follow when we are performing polymorphic actions. Collins (1995) gives an instructive example:

> '(It) is clear that there are rules applying to my actions as a pedestrian because I will get into trouble if I break them – perhaps by walking too

> close to the single person on an otherwise deserted beach, or by trying to keep too far away from others in a crowded street – but I cannot encapsulate all that I know about the proper way to walk in a formula. The little bits of rule that I can provide – such as those in the previous sentence – are full of undefined terms. I have not defined "close", "distant", nor "crowded", nor can I define all my terms on pain of regress. What is more, what counts as following the rule varies from society to society and situation to situation. A set recipe for walking will be found wanting on the first occasion of its use in unanticipated circumstances; perhaps the next people on the beach will be actors in a perfume advertisement playing out the mysterious attractiveness of a particular aroma, while the next people in the street will be living in the time of a contagious epidemic disease!'

Note that to act skilfully in working life, we mostly have to act with insight and not machinelike. A common and effective form of industrial disruption is to act too uniformly: to 'work to rule.' This point becomes important, in particular where bureaucratic work systems are replaced by individual and organisational flexibility.

6.3.2. Three different types of tacit knowledge

It should be pointed out that use of the term tacit knowledge transcends the realm of action. This is apparent when we distinguish between three different types of tacit knowledge.

6.3.2.1. *Tacit knowing-how*

Whenever we speak of art, e.g. the art of cooking, the art of teaching, or the art of managing, we refer to 'tacit knowing-how', the tacit side of expertise that is more than, or different from, the application of theory. Tacit knowing-how comprises all dispositions to judge or act and forms what Polanyi (1962, p. 87) has called the 'ineffable domain'. Polanyi emphatically invites us to accredit 'skills and connoisseurship as valid, indispensable, and definitive forms of knowledge' (1975, pp. 32, 33), not least because of the need to bring the theoretical body of science to bear on experience:

> 'Students of chemistry, biology, and medicine [...] seek to bridge the gap between the printed text of their books and the facts of experience. They are training their eyes, their ears, and their sense of touch to recognise the things to which their textbooks and theories refer. But they are not doing so by studying further textbooks. They are acquiring the skills for testing by their own bodily senses the objects of which their textbooks speak. [...] Textbooks of chemistry, biology, and medicine are so much empty talk in the absence of personal, tacit knowledge of their subject matter. The

> excellence of a distinguished medical consultant or surgeon is due not to his more diligent reading of textbooks but to his skill as a diagnostician and healer – a personal skill acquired through practical experience. His professional distinction therefore lies in a massive body of personal knowledge.' (1975, pp. 31, 32).

The tacit component in connoisseurship and skills is easy to see if we consider motor skills and impressionistic knowledge. It is difficult to explain how to juggle five balls, how to class cotton or how to diagnose a patient by interpreting his facies. Typically the expert will refer to the 'right feel'. But it is important to see that there is a tacit component to even the most abstract forms of judgement and action. Take, for example, our ability to reason correctly without considering the rules of logic, the art of applying theories in a context-sensitive way, or maintaining intelligent practices for which there are no written rules at all, e.g., the practice of invention.

6.3.2.2. *Tacit knowing-that*

In our behaviour we also exhibit an abundance of 'tacit knowing-that', which is difficult, if not impossible, to describe. This is 'knowledge taken for granted'; knowledge based on our cognitive background, interpretative frameworks, viewpoints, paradigms, mental models and beliefs. Once more, Polanyi (1983, pp. 64, 65) gives us an instructive example of the way tacit knowing-that functions. He refers to a letter published by *Nature*, the author of which

> 'had observed that the average gestation period of different animals ranging from rabbits to cows was an integer multiple of the number π. The evidence he produced was ample, the agreement good. Yet the acceptance of this contribution by the journal was meant only as a joke. No amount of evidence would convince a modern biologist that gestation periods are equal to integer multiples of π. Our conception of the nature of things tells us that such a relationship is absurd, but cannot prescribe how one could prove this.'

Following Searle (1983, Ch. 5), it would be a hopeless endeavour to specify all our tacit beliefs, not only because a great number of them are submerged in the subconscious but also for two further reasons. First, they are not individuated: we do not know, for example, how to count them. Second, in trying to explicate our tacit beliefs we would encounter states that are too fundamental to be called beliefs or elements of 'know-that', for example, 'objects that offer resistance to touch': whatever one does with objects, one does not in addition think subconsciously that they offer resistance to touch.

6.3.2.3. *Tacit roots of explicit knowledge*

If we use the prevalent signs for representing knowledge – e.g. the spoken sentence, the textbook or the database – are we really talking about knowledge? Clearly we are not. Sound waves, printing ink, and magnetic disks are just physical objects, not knowledge, until somebody understands what they mean. Knowledge is a psychological phenomenon, not a physical one. Consequently, tacit knowledge may also refer to the tacit roots of all our explicit knowledge, i.e. to its semantic and pragmatic basis. 'There is a possibility of knowledge only if one *understands the concepts* used and the contexts in which the sentences are normally used, and that is not the same as having the ability to repeat the sentences parrot-fashion' (Molander, 1992, p. 14). Furthermore, as it is meaning that constitutes knowledge, 'a *wholly* explicit knowledge is unthinkable' (Polanyi, 1969, p. 144). All knowledge is fundamentally tacit, because deprived of their tacit coefficients, all spoken or written words would be meaningless; explicit knowledge must rely on being tacitly understood and applied to be knowledge at all.

6.4. Transmitting and acquiring tacit knowledge

It is widely acknowledged that the acquisition of practical knowledge requires learning by doing. 'We learn *how* by practice, schooled indeed by criticism and example, but often quite unaided by any lessons in the theory' (Ryle, 1949, p. 41). Indeed, shifting the emphasis from 'expertise in verbalising' to 'expertise in doing' supports the view that 'what we need is not so much theories, articles, books, and other conceptual matters, but, first and foremost, concrete situations to be perceived, experiences to be had, persons to be met, plans to be exerted, and their consequences to be reflected upon' (Kessels and Korthagen, 1996, p. 21).

Given that experts always know more than they can tell and even more than anyone could ever formalise, it seems clear that expert knowledge cannot be transmitted by prescription alone. Hence, tacit knowledge, at least if we consider the strong sense of the term, has to be learned implicitly: 'An art which cannot be specified in detail cannot be transmitted by prescription, since no prescription for it exists' (Polanyi, 1962, p. 53). Some authors even define the concept of tacit knowledge by its didactic implications, as does Molander (1992, p. 11):

> 'Knowledge transmitted through models or exemplars – through exemplary action, as in the master-apprentice relationship – and knowledge which is attained through training and personal experience may be called 'tacit knowledge'. This is a good label because the core of such knowledge does not consist of verbal or mathematical formulations, it consists of abilities to make judgements and to do things in practice, skilfully and with insight.'

Although tacit knowledge is not teachable, it is coachable. What must be left unspoken is attained through personal experience and transmitted within master-apprentice relationships and cultures of expert practice. Polanyi's analysis of tacit knowledge leads him to advocate apprenticeship as indispensable for the acquisition of tacit knowledge. He emphasises that skills, whether practical or intellectual, can be passed on only by example from master to apprentice: 'By watching the master and emulating his efforts in the presence of his example, the apprentice unconsciously picks up the rules of the art, including those which are not explicitly known to the master himself' (Polanyi, 1962, p. 53). Because the range of diffusion is restricted to that of personal contact, traditions of how to act skilfully may be lost if they fall into disuse for the period of a generation. Polanyi gives the example of violin-making (1954, p. 387): 'It is pathetic to watch the endless efforts, equipped with microscopes and chemistry, with mathematics and electronics, to reproduce a single violin of the kind that the half literate Stradivarius turned out as a matter of routine more than 200 years ago.' Furthermore, Polanyi argued that this apprenticeship must be an uncritical one. The more hidden the rules, the more the apprentice must surrender himself uncritically to the imitation of the master and the more he has to be convinced that there is something important to learn. Indeed, the paradox of learning a new competence lies in the fact that 'a student cannot at first understand what he needs to learn, can learn it only by educating himself, and can educate himself only by beginning to do what he does not yet understand' (Schön, 1987, p. 93).

Within the realm of tacit knowledge, Polanyi pays special attention to connoisseurship. This faculty has to be trained in a 'case-based manner' ([23]). Schools and universities often teach what to do in situations of a certain type, representing these situations as verbal vignettes. However, in reality, we have to react to situations, not words. To choose a particular course of action requires a correct subsumption of the concrete situation in general

([23]) The importance of case-based instruction can be exemplified by the practice of Common Law (Polanyi, 1962, pp. 53, 54). Courts follow precedents considered in other courts, for they see the rules of law embodied in prior decisions. In doing so, they recognise that practical wisdom is more truly embodied in action than in expressed rules of action.

terms. This faculty of judgement and discrimination is essential for applying the appropriate rules if there are any. But it cannot be developed simply by laying down further rules; for we must learn to recognise a situational pattern in which the elements may vary and we have to consider that the meaning of a specific situation is always context-related (see Neuweg, 2001, Ch. 12, for more details on expertise and pattern recognition).

Beyond these more or less obvious didactic ideas, further hints can be derived from studying Polanyi's concept of tacit knowledge more closely. The concept basically rests on analysis of the architecture and workings of human consciousness. Within this framework, learning appears as a process of 'interiorisation', of making things function as if they were part of our body (see Neuweg, 1998). The learning process aims to instrumentalise elements, objects, actions, theories, in the service of some purpose. Therefore, the master ought to encourage learners to direct their attention primarily to the object under consideration, and only in a 'subsidiary' manner to the theoretical and practical means applied.

To establish relationships between parts and wholes and between means and ends, in effect to endow parts and means with meaning, the learner must concentrate on the 'distal' (Polanyi), the situation's 'back-talk' (Schön) and the overall context or purpose. By doing so, the learner becomes aware of elements, objects and actions not in themselves but as tools; in terms of operational results achieved through their use ([24]). If learners experience their actions

> 'only subsidiarily, in terms of an achievement to which they contribute, its performance may select from them those which the performer finds helpful, without ever knowing these as they would appear to him when considered in themselves. [...] hence the practical discovery of a wide range of not consciously known rules of skill and connoisseurship which comprise important technical processes that can rarely be completely specified, and even then only as a result of extensive scientific research' (Polanyi, 1962, p. 62).

Polanyi would have agreed strongly with Schön (1987, p. 158) when he said that the learner needs to grasp a skill 'as a whole to grasp it at all [...]; for the pieces tend to interact with one another and to derive their meanings and characters from the whole process in which they are embedded.' This is not to say that all tacitly learned pieces are unspecifiable; merely that drawing attention to them would cause a deterioration in performance and deprive them of their meaning.

([24]) The importance of looking at outcomes can be seen in a simple example. In learning to steer a large and slow-moving boat, it is very helpful to pick a distant point to aim for. Then the details of turns and corrections take care of themselves (personal note from D. Schmitt).

6.5. Caveats and qualifications

Parts of the tacit knowing debate tend to overemphasise the difference between theoretical and experiential knowledge, and to overlook the benefits of critical reflection (this being the reason for Fischer, 2000, to prefer the term 'work process knowledge' to experiential or tacit knowledge.) The following four remarks therefore should be made.

(a) Much of what we learn is picked up incidentally, and often one's learning is far more effective if the mind does not interfere with analysis and focusing on rules. However, even if work process knowledge is considered largely to be tacit knowledge, this does not imply that it has to be learned wholly implicitly, i.e. without explicit instruction and without conscious attempts to detect underlying rules. In most cases learning involves some balance or oscillation between relatively controlled, analytical processes and more spontaneous, integrative ones, the right blend of processes depending on the person and the subject matter being learned. In particular, it is sometimes necessary to draw the learner's 'focal' attention (Polanyi) to the details and to formulate pedagogically helpful rules. For this reason, a master is not necessarily a good teacher for beginners.

Although Polanyi argued that 'an unbridled lucidity can destroy our understanding of complex matters' (1983, p. 18), he was fully aware of the benefits of analysis, and thought that 'an oscillation of detailing and integrating' is 'the royal road for deepening our understanding of any comprehensive entity' (1997, p. 333). A continual journey back and forth between analysis and synthesis is highly desirable, provided that analysis helps to render more of the tacit components focally known, without causing irreparable disintegration in our central focal meaning. Polanyi gives the example of motion studies, which tend to paralyse a skill, but improve it when followed up with practice. In cases of this kind, 'the detailing of particulars, which by itself would destroy meaning, serves as a guide to their subsequent integration and thus establishes a more secure and more accurate meaning of them' (Polanyi, 1983, p. 19). Furthermore, in many cases the destructive effects of analysis can be counteracted by explicitly stating the relation between the particulars. 'Where such explicit integration is feasible', says Polanyi (1983, p. 19), 'it goes far beyond the range of tacit integration.' ([25]).

([25]) Nevertheless, one must see that an explicit integration cannot replace its tacit counterpart. The skill of a driver cannot be replaced by schooling in the theory of the motorcar, nor are the rules of rhyme or prosody necessary conditions for enjoying a poem and indeed, can lessen enjoyment.

(b) Polanyi's idea of a see-saw balance between experience, analysis, reflection, and integration is closely related to the more elaborate concept of reflection to be found in the work of Schön (1983, 1987). If a practitioner reflects in the midst of action, he focuses 'interactively on the outcomes of action, the action itself, and the intuitive knowing implicit in the action' (Schön, 1983, p. 56), always attending to the peculiarities of the situation at hand. This is what Schön calls 'reflection-in-action'. He makes clear that it would be a mistake to view the alternation between analysis and integration as nothing more than an intermediary state in the process of becoming an expert. The very practice that leads to expertise also endangers it: tacit knowledge is often tacit blindness. Therefore, the question, 'how could one combine a critical stance towards knowledge with the protection and cultivation of 'tacit' aspects of knowledge, if this is at all possible', has rightly been identified as 'a key problem concerning "unarticulated knowledge"' (Molander, 1992, p. 10). The expert is not only a person who acts intuitively, but also someone who continues to study in his or her field.

(c) In many domains the emphasis on tacit knowledge should not seduce us into underestimating the need for a broad theoretical understanding for skilful action. Take the example of medical diagnosis, to which Polanyi often refers. The identification of a specific disorder surely requires a massive experiential background; but the expert's ability to perceive significant patterns of illness is also dependent upon his knowledge of medical theory. In general, the relationship between tacit knowing and the professional knowledge taught in schools should be treated as an open question, the answer to which is task-dependent.

What remains tacit and has to be learned experientially, however, is the knowledge of how to apply theory to phenomena. Application can never build on a theory of application. Furthermore, what might become tacit in the course of time are the details of theory in its propositional form. The expert may be aware of the theory only in terms of the phenomena that are seen in its light. To understand a situation, one does not need to be fully conscious of what one has studied to use it interpretively: Polanyi argues that 'a theory is like a pair of spectacles; you examine things by it, and your knowledge of it lies in this very use of it. You dwell in it as you dwell in your own body and in the tools by which you amplify the powers of your body' (Polanyi, 1975, p. 37; see also Broudy, 1970, for an analysis of 'tacit knowing with').

(d) Given that instruction and theoretical studies form an essential part of a curriculum, what role do they play exactly? Remembering that all explicit

knowledge has, and must have, tacit roots, it is clear that not only do we sometimes need a great deal of instruction to understand experience, but we also need a great deal of experience to understand the meaning of a theory or what is contained in the instruction we are receiving. What learners see is largely dependent on what they hear the master say; yet the meaningfulness of what they hear is in itself dependent on their capacity to see what the words indicate. That is why Schön (1987, p. 103) pleads for instructions in the context of the student's doing: 'Instructions are always and inevitably incomplete. Unless we already know how to do the thing in question, there is always a gap between the instruction and the action it describes – a gap we are unlikely to detect, except when we listen in the mode of operative attention.' Polanyi strongly agrees that rules should be observed within the context of skilful performance, as 'the premises of a skill cannot be [...] understood if explicitly stated by others, before we ourselves have experienced its performance, whether by watching it or engaging in it ourselves.' (1962, p. 162).

Both theoretical and experiential learning may, therefore, be enhanced if connected in parallel. If we synchronise language and objects, we always find a dual movement of comprehension; if the two fall apart we risk the danger of a lack of comprehension in both realms. To illustrate this dual act of sense reading, Polanyi uses the vivid example of a medical student attending a course in X-ray diagnosis of pulmonary diseases. He watches shadowy traces on a fluorescent screen and hears the radiologist commenting to his assistants. At first he can see nothing that is talked about nor does he understand the language used. But as he goes on listening for a few weeks the pictures begin to make sense – and so do the comments made about them:

> 'Thus, at the very moment when he has learned the language of pulmonary radiology, the student will also have learned to understand pulmonary radiograms. The two can only happen together. Both halves of the problem set to us by an unintelligible text, referring to an unintelligible subject, jointly guide our efforts to solve them, and they are solved eventually together by discovering a conception which comprises a joint understanding of both the words and the things.' (Polanyi, 1962, p. 101, emphasis by the author)

From this we can learn a lot about the proper relationship between 'theory' and 'practice'.

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CHAPTER 7

The role of metaphors in acquiring and transmitting knowledge

Karin S. Moser

7.1. Introduction

In a world of work where services are increasingly replacing industrial production, employee knowledge is becoming increasingly important. Knowledge is frequently the main means of production and knowledge is the product being sold (Nonaka and Takeuchi, 1995; Probst et al., 1997). Organisations are adopting more flexible work structures and, more than ever before, employees in various departments of an organisation must now work together, for restricted periods of time, in project groups that are frequently distributed across various sites (Boos, 1996; Tschan, 2000; Turner, 2001). This places high demands on employees with respect to cooperation and communication (Moser, 2002; Moser et al., 2000).

People with varying qualifications and different tasks and roles now have to communicate with each other in person, by telephone and electronically to contribute their knowledge to the work process. Knowledge cooperation in interdisciplinary work groups requires a high level of understanding of the entire work process. It demands the ability to perceive a product from a variety of perspectives and the ability to articulate one's own perspective in such a way that it is easily understood (Moser, 2003a; Thompson et al., 1999).

The concept of 'work process knowledge' describes an essential component of these new work demands: it refers to knowledge of how work processes (production, sales, development, and so on) are organised (Fischer, 2000; 2001). This knowledge comprises academic/technical knowledge of the specific field, knowledge of the required machines and facilities, knowledge of the customer base and the market and also knowledge of the culture of the organisation, that is, the way in which projects are usually processed in a specific organisation.

Important components of work process knowledge are acquired via experience and they usually remain tacit. New working methods are now making it necessary for organisations to make this implicit knowledge explicit to a certain extent. Explicit knowledge is required so that knowledge can be exchanged in interdisciplinary groups and so that mutually produced goods can be developed and sold.

If we wish to make implicit knowledge explicit, language is of crucial importance. For one thing, language is the medium in which various implicit perspectives of the same object and implicit knowledge of this object are represented. In knowledge management projects, implicit knowledge has to be captured largely via analysis of actor-specific language. First, techniques of communication and language analysis are core methods of knowledge management. Second, language is the main medium for representing implicit knowledge as well as the medium for reflecting upon and discussing the meaning of this implicit knowledge.

A possible method of capturing and representing implicit knowledge in language is via metaphor analysis (Moser, 2000a, 2000b, 2001, 2003b). Taking the example of knowledge management, this paper sets out to demonstrate how metaphors can be used to explicate the implicit understanding various actors have as well as to create a mutual basis for communication and knowledge in interdisciplinary work groups. The fundamental issue we must address is the question of how knowledge is represented to allow a sufficient degree of understanding to serve as the basis for action in decision-making, planning, and problem solving (Moser, 2003a).

7.2. The metaphorical representation of knowledge

Metaphors are analogies that project a so-called 'source domain' (the water cycle, for example) onto a 'target domain' (money, for example). In this mapping process, the cognitive structural template of the source domain with its slots is projected onto the target domain. The process of building metaphors using analogies can be illustrated using the example of the metaphor model 'money is water'. In this metaphor model, 'water' is the source domain, and 'money' is the target domain ([26]). The source domain 'water' has the following structuring:

([26]) The domain 'money' can be structured cognitively using other source domains, as well. Language often offers alternative possibilities, as the other examples of metaphors in the domain 'knowledge management' that are presented here will show.

Cognitive structuring of the source domain ‘water’:
Source – River – Ocean
Cognitive structuring of ‘water’ transposed onto the target domain ‘money’:
Money source – Flow of money –

The three slots of the source domain are transposed onto the target domain, which allows the abstract concept of ‘money’ to be structured cognitively and understood in analogy to the water cycle. As this example shows, it is not necessary that every slot of the source domain be filled in the target domain as well. In German, for example, there is no metaphor ‘ocean of money’. However, based on the underlying metaphorical cognitive model of money = water, the expression ‘ocean of money’ is understandable all the same. Inverted, however, in the transposition process no new slots can be created in the target domain that are not given for the source domain. This would destroy the basic analogy between the source and target domains.

In the German language, the metaphor model ‘money is water’ has led to the creation of a great number of metaphorical expressions. The same is true of English, as the following examples show: ‘source of income’; ‘flow of money’; ‘capital flow’; money ‘circulates; money can ‘pour in; money goes ‘down the drain’; money sources can ‘run dry’; money runs through your hands ‘like water’; you can ‘swim in money’; you can be ‘solvent’; assets can be ‘liquidated’ or ‘frozen’, and many more.

As the above examples show, our concern is with lexical metaphors or conventional metaphorical expressions that are commonly used in any particular language. Such metaphors are learned during language acquisition. We do not include metaphors that are constructed deliberately for literary texts, for example, or for advertising or politics.

This understanding of metaphors is based on the metaphor theory of cognitive linguistics first formulated by Lakoff and Johnson in 1980 in ‘Metaphors we live by’ (Lakoff and Johnson, 1980). The theoretical assumptions presented in that publication led to a new understanding of metaphors and triggered a large body of empirical research and literature in the fields of cognitive linguistics and the cognitive sciences, particularly in the English-speaking world (Ortony, 1993). Since then, Lakoff and Johnson have undertaken several revisions and further specifications of their original theses (Johnson, 1987; Lakoff, 1987 and 1993). The metaphor theory in cognitive linguistics following Lakoff and Johnson starts out from the following assumptions (Moser, 2000b, 2003b): when a metaphor is created, experience that was originally sensory (for example, the experience of water

that we drink or that we swim in) is transposed onto abstract contents (such as money, electric current) according to the principle of analogy building. Metaphorical transposing, therefore, transmits a sensory quality as well as being an aid towards cognitive structuring that make abstract concepts comprehensible, 'tangible', and accessible. With this, metaphors can reduce complexity and establish meaningful references to known experience.

The models that underlie metaphors are not an expression of language, but an expression of thought. These models are an indication of the cognitive structuring of experience, that in turn determines actions and thinking.

Metaphorical expressions cannot be generated and combined arbitrarily. Cultural and social conventions determine whether a metaphor is comprehensible and socially acceptable in a particular language culture. These conventions are reflected in the lexical metaphor stock of the language and they even undergo historical development (for example, the development of the automobile and the computer has given rise to new metaphors, such as 'change gears', 'improve team interfaces', and so on).

Lexical metaphors have several characteristics that are pertinent to the investigation of work process knowledge.

The use of conventional metaphors is necessary both in everyday and technical language. It is virtually impossible to construct a sentence that does not contain lexical metaphors. This means that access to implicit knowledge is possible by means of metaphor analysis of practically any language material, whether in oral, written, or electronic form.

Metaphors and their correct use are learned implicitly via imitation during language acquisition. Later they are further differentiated and expanded through experience, such as, for example, in the context of work and professional socialisation and through the acquisition of a specific technical language. This means that a person's specific metaphor use shows individual and idiosyncratic features that have arisen from a specific experience and activity context. These features are characteristic of a particular organisation culture within an enterprise.

The use of lexical metaphors is not normally conscious and it is just as automatic as the use of correct grammar and syntax rules. People usually only become conscious of the thinking models that underlie metaphors and their importance for the understanding of complex and abstract concepts when they learn a foreign language or receive special training (such as, for example, the metaphor workshop that will be described below). For this reason, conventional metaphors are rarely (or only to a minor extent) used deliberately as strategies for self-presentation. This means that metaphors

give us a relatively 'unadulterated' access to implicit knowledge.

Despite these important characteristics of metaphors for representing experience and investigating implicit learning processes, the cognitive metaphor theory has not received much attention in psychology as a whole and in work research in particular. The theory not only relates to the concept of 'work process knowledge', but also to central theoretical approaches in psychology, particularly to the theory of mental models (Gentner et al., 1989; Gentner and Stevens, 1983), to research on analogous reasoning and problem solving (Vosniadou and Ortony, 1989) and to the concept of schema in cognitive psychology (Anderson, 1996). An overview of the psychological literature on the significance and function of metaphors is presented by Moser (2001, 2003b).

7.3. The function of metaphors for work process knowledge

Current projects under way in innumerable enterprises and organisations under the catchword 'knowledge management' aim to visualise the knowledge of individuals involved in the work process to better support the exchange of knowledge, the documentation of available knowledge and the generation of new knowledge in the work process (Nonaka and Takeuchi, 1995; Probst et al., 1997).

As central aspects of work process knowledge, the knowledge that employees have, in particular their implicit knowledge and experience, is one of the most important resources of an enterprise and critical to its long-term success (Clases et al., 2002; Moser and Schaffner, 2003). The ultimate hope of the enterprise is that knowledge management will result in economic gain. If more effective knowledge exchange and improved explication of existing knowledge leads to a minimisation of knowledge loss, then disastrous and costly misunderstandings can be avoided (Moser, 2003a).

In many organisations, work takes place more and more frequently in interdisciplinary teams with team members in different workplaces at various sites, primary communication being electronic. This places increasingly higher demands on the communication and cooperation abilities of individual employees (Moser, 2002). One of the greatest challenges for successful knowledge management concerns employees' so-called 'implicit knowledge', the kind of knowledge that is represented in metaphors.

Implicit knowledge refers to that part of knowledge that can only to a very small extent be put into words and tapped directly as 'fact knowledge'

(Neuweg, 1999) Instead, implicit knowledge is expressed much more in the way and the manner in which a person structures and solves a problem. In everyday language, the way that implicit knowledge works is often called the result of 'experience' or 'intuition'. Even qualified experts find it very difficult to say how they reached precisely that particular solution to a problem or to describe the details of how they went about solving it. This is because these processes are usually implicit and automatic.

The following passage aims to sketch out how it is that metaphors can be used to explicate implicit knowledge. Metaphor analysis has advantages over other language analytical techniques, in that it can be complemented and easily supported via graphical representation (Moser, 2003a, 2003b). For the analysis of work process knowledge in particular, there are several further reasons why metaphor analysis is interesting:

(a) metaphor creation is one of the most important strategies used for the representation of complex and abstract concepts in technical and everyday language. This is also particularly valid for such abstract concepts as the experience and knowledge that knowledge management projects attempt to capture. Precisely because these concepts are so abstract, metaphors are a central means of reducing their complexity and making them tangible and accessible;

(b) creating analogies in general and, more specifically, creating metaphors is a central aspect of acquiring new knowledge. By forming analogies we can structure and understand new and unfamiliar knowledge along the lines of the familiar. This is indispensable if we are to remain capable of making decisions and acting in uncertain and new situations. Familiar metaphorical models of thought are applied to new knowledge and the new knowledge basis can be structured according to the newly generated metaphors;

(c) each metaphor model emphasises particular possibilities and eliminates others. For example, the 'money is water' metaphor model determines all the things that can be done with money (let it flow, freeze it), where it comes from (fed from a source), and so on. In addition to the representation of declarative as well as procedural knowledge of money, the metaphor model 'money is water' also implies, at the experience-oriented level, that money and money circulation are things as natural as rain and snow and that they follow natural laws. It is reasonable to assume, therefore, that metaphor models direct our attention selectively to particular aspects and thus serve as potential guidelines for action (for a discussion of the relation between cognition and action, compare Moser, 2003b; 2003).

In connection with knowledge management projects and the processes of knowledge exchange and knowledge cooperation, it is important (Moser, 2002) that the use of metaphors truly clarifies the subject or problem, and also significantly increases its communicability and transferability.

Finally, the importance of the emotional content of metaphors should not be underestimated. As the examples of metaphor models of knowledge management outlined below will show, the emotional content of metaphors varies widely and this emotional content has a central motivating or demotivating function.

7.4. Explication of implicit knowledge via metaphor analysis

Let us examine how metaphors can be implemented in the framework of knowledge management projects to explicate implicit knowledge. The following examples of metaphor models illustrate some of the various ways that people responsible for knowledge management in their companies conceptualise and understand knowledge management metaphorically. We will see what effects these different understandings can have on knowledge management.

Examples have been taken from a knowledge management workshop held for heads of knowledge management from 15 different companies. As the basis for metaphor analysis, the participants wrote texts on the core problems in their own knowledge management projects in their companies. At the workshop, they were given instruction on how to identify the metaphors in their own texts, assign their metaphors to a metaphor category (such as water, war, and so on) and create graphical representations of their main metaphor models (for details on the method of metaphor analysis, see Moser, 2003b; 2003). The various metaphor models and their implications for knowledge management were then discussed and alternative metaphor-models were sought. The main crux of the discussion centred on the differing perspectives that the various metaphor models transmit, the resulting potential misunderstandings in team communication that can arise from them, the motivational potential of these models and their heuristic value for knowledge transfer in the framework of work-related cooperation (Moser, 2002).

The ‘metaphor workshop’ aimed, on the one hand, to reveal the different implicit perspectives and their possible resulting consequences for knowledge cooperation. On the other hand, the workshop aimed generally to increase sensitivity to the fact that implicit knowledge is significant.

Determining the congruencies and divergences in the participants' implicit knowledge and encouraging participants to look consciously at varying concepts of knowledge management are crucial to the success of knowledge management projects. Both of these aims can be achieved via metaphor analysis. The overall goal of the 'metaphor workshop' was to improve knowledge cooperation among the participants, or to facilitate such cooperation. In addition, in the course of a workshop new knowledge is generated continuously. This new knowledge basis is of great value for further cooperation, because it arises from socially shared mental models. Last but not least, the recognitions gained in 'metaphor workshops' can serve as the basis for further knowledge management strategies, such as the design of tools, databases, and so on (Dutke, 1994; Mambrey and Trepper, 1996).

7.5. Metaphor models of knowledge management

The following presents three different metaphor models identified by the workshop participants and then represented graphically. While this paper cannot go into the details of identifying metaphor models on the basis of individual metaphorical expressions and statements and illustrating them graphically, further information on the method of metaphor analysis can be found in Moser (2003b).

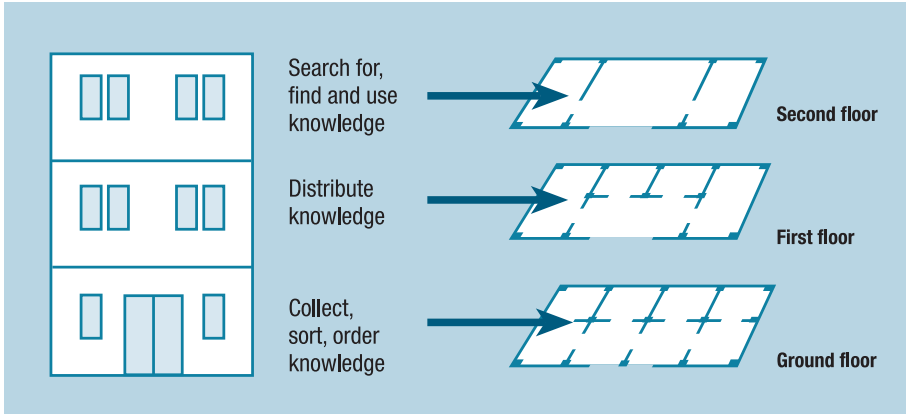
7.5.1. 'Knowledge management using the metaphor of a library

One metaphor model that was often used for an understanding of knowledge management was to imagine knowledge management as a library (see Figure 1). The central aspects of this metaphor model are the sorting and classification of knowledge and the accessibility of knowledge that, thanks to careful cataloguing and ordering, can be found and used. The underlying metaphor model is a building with several floors, doors, stairways and rooms that allow knowledge to be arranged precisely. With a good map, the catalogued knowledge can be found, checked out, and used.

The 'library' metaphor-model of knowledge management implies that the knowledge should be accessible to all who have entry to the building and its individual rooms. In contrast to the second model below, 'knowledge management as contested treasure' (see Figure 2), there are no 'owners' of the knowledge and no others that fight to obtain possession of that knowledge. Instead, the available knowledge is equally accessible to all who have a key to the building and its rooms. One aspect missing from this model, however, in contrast to the third metaphor model shown further

below in Figure 3, is the fact that knowledge is also dynamic and thus can change. There are other missing aspects, namely that some knowledge is superfluous or unimportant and should not be collected and that knowledge can be bound to persons or situations. In the library metaphor mode of thinking, knowledge is something that is static and has no context, it is basically always valuable and should therefore be collated and stored.

Figure 1: **Knowledge management using the metaphor model of a library**



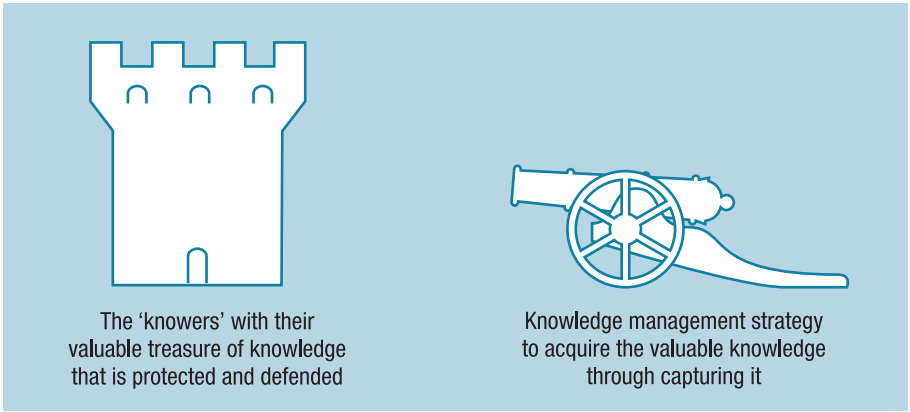
The library metaphor model is therefore, not a conception of knowledge management that deals with the management of knowledge, but one that instead focuses on the management of information. This model does not consider some core aspects of knowledge, such as context-dependency and reference to action (Moser et al., 2000).

7.5.2. Knowledge management using the contested treasure metaphor model

A very different understanding of knowledge was revealed in a metaphor model that sees knowledge as a contested treasure (see Figure 2).

Just as with the aforementioned conception of money in analogy to the water cycle, the way that knowledge is understood also has very specific effects on cognitive structuring. A metaphor-model that views knowledge as a contested treasure focuses on the aspects of value and possession of knowledge. In this model, knowledge is unquestioned and always valuable. There is no qualification concerning important versus unimportant or lack of knowledge. Just like money, knowledge is something that you can have or not. This model is not interested in what 'currency' the knowledge is in, how it is used, what its significance is, and so on.

Figure 2: **Knowledge management using the contested treasure metaphor model**



The idea that someone may well have valuable knowledge, but that the knowledge might be completely irrelevant and worthless to someone else or in another context, cannot be represented in this cognitive model. This leads directly to another important aspect: according to this understanding, knowledge is a valuable possession that must be protected and defended and therefore, captured or bought. As knowledge is of unquestionable value, it is not simply disseminated or donated generously; it is hidden behind defensive barriers.

Due to the non-reflected valuation of all knowledge and bearers of knowledge in this model, knowledge is bound inseparably to power. He or she who has knowledge, has the power and will therefore protect all they know and strive to gain even more knowledge. A criticism of this model is its failure to consider the idea that knowledge can also be something dynamic, something that arises only in the exchange between persons and, with this, is also perhaps fleeting, transitory, and – metaphorically speaking – not something that can be buried within the 'castle walls'. The 'half-life' of knowledge, one of today's common metaphors, could not be applied in this metaphor model, nor the context-bound nature of knowledge.

The analysis of this metaphor model leads us to an important insight: the treasure metaphor model of knowledge, no more than the library metaphor model, is a mental model not of knowledge but of information ([27]). The contested treasure comprises important pieces of information that are not relinquished, but hoarded. They are not pieces of information that become

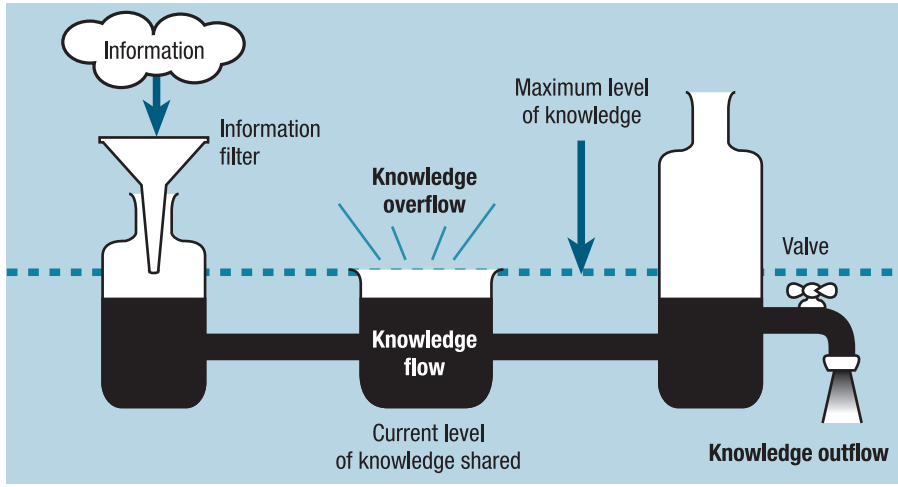
([27]) On the distinction between knowledge and information, see Moser et al., 2000.

visible and attainable only in application, that is, in exchange in concrete situations. Managers that hold this metaphor model of knowledge, whether consciously or not, will never conduct true knowledge management; at best it will conduct good information management. The contested treasure metaphor model of knowledge leaves unconsidered the core characteristics of knowledge, namely its context-bound nature, its reference to action and its relatively transitory nature. These characteristics are removed from our field of attention; they are 'in hiding', as the cognitive linguists would say, and they have no chance to serve as guidelines for action in the management of knowledge.

7.5.3. Knowledge management using a canalisation system metaphor model

The third example reveals a completely different understanding of knowledge and knowledge management (Figure 3). In this metaphor model, knowledge is seen as something that is as dynamic and transitory as the water cycle. Relevant pieces of information are filtered out by the company and funnelled into a canalisation system that brings all employees to the same level of knowledge, since the information flows everywhere. Finally, after successfully flowing through the system, information leads to the company's know-how outflow (product). In this model, the employees are represented metaphorically as containers that take up and filter information and are themselves built into the company's own information channels.

Figure 3: **Knowledge management using a canalisation system metaphor model**



The knowledge management as canalisation system metaphor model makes several implicit assumptions about knowledge. In this perspective, not every bit of information is relevant, only current knowledge. There can be too much knowledge, so an overflow tank exists to protect against a flood of knowledge and it is essential that all employees have the same level of knowledge, and potentially the same knowledge, at their disposal. What this dynamic model of knowledge management leaves out of consideration is the role of experience and the role of existing knowledge that, to follow the metaphor, could be imagined as built-up sediment at the bottom of the system. Instead, the permanent flow of new information continually flushes existing stores of knowledge right out of the system. Although there is always room for new information, existing knowledge cannot accumulate.

7.6. Revealing varying actor perspectives through analysis of metaphors

The above examples show that the analysis of metaphors allows us not only to explicate implicit knowledge, but also reveals the differing perspectives on the same object, with their peculiar advantages and disadvantages. Both of these are central aspects of work process knowledge. It is important to remember that at the level of metaphor analysis, there is no right or wrong understanding of knowledge management. What analysis reveals are the varying perspectives that each emphasise different features and, depending on the goals of knowledge management, serve the purpose for better or worse.

Analysis of metaphor models allows access to varying perspectives of thinking and discussion and explicates previous implicit knowledge. Everyone involved in the analysis, such as the members of a work group, can profit from the different perspectives of the others and learn from the way that experts structure the problem cognitively. Most importantly, however, analysis of the underlying mental models brings a deeper, shared understanding of the cooperation partners, because it goes beyond mere understanding of facts to encompass conceptual thinking.

This conceptual level is essential for an understanding of whole work processes. It supports knowledge cooperation in flexible organisation structures (Moser, 2002). Understanding how others conceive of an object makes individual and group-specific views of self and the world visible. At last we gain access to these central components of company culture that are probably much more frequently the cause of communication problems

than missing information or lack of knowledge of certain facts or technical terms.

When we concentrate on pure information, the essential characteristics of knowledge are lost: the context and action references, as well as individual and social perspectives that make information knowledge, cannot be represented. In contrast, the central characteristics of knowledge can be captured very well in metaphor models, for they exhibit precisely these characteristics of context-reference and give representation not only to structures, but also to processes. This is particularly important for cooperation in interdisciplinary teams, whose members have formed very different mental models during the course of work and professional socialisation. Here, it is essential to create a new, common basis of understanding that builds on a shared mental model. Taking our example of knowledge management in companies, this means that a new knowledge management tool should be based conceptually on central metaphor models that ideally represent the common denominator of a shared understanding of knowledge, or one's own work activity. This central metaphor model should be extendable and amenable to further differentiation, so that specific applications, perspectives and needs can have a place without losing the shared basis for communication.

The richness of the metaphor model is essential to the flexibility and developmental capability of the chosen knowledge management strategy. Incongruence in the conceptual understanding of an object alerts, triggers curiosity and serves to motivate team members, while noting congruencies can result in a fundamental expansion of knowledge.

Finally, we should not forget that different metaphor models vary in emotional content, as illustrated by the metaphor model examples: 'knowledge management as library', 'knowledge management as contested treasure', and 'knowledge management as canalisation system'. The implicit intentions communicated in knowledge management projects via the use of metaphors have a considerable motivating or demotivating effect on employees.

The present contribution has attempted to show that metaphor analysis is a method of linguistic analysis that is well suited to capturing central aspects of work process knowledge. It is also well suited to tracking down the underlying cognitive processes in representing experience and implicit actor perspectives.

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SECTION IV

Learning at work: obstacles and opportunities

CHAPTER 8

The division of labour and its impact on learning at work

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> 'The cliché that workers know their jobs better than anyone else is undoubtedly true under any production system. What's different about lean production is its goal of developing a broader contextual knowledge in the workforce about the production system, so that a worker's deep, often tacit knowledge of one specific task becomes linked to an understanding of how the overall system works, and how one's piece of it relates to other upstream and downstream tasks. Also different is the deliberate organisation of work to encourage workers' ideas to be surfaced, specified, and legitimised as an input to making changes in the production process – the process known as kaizen.' (MacDuffie, 1995, p. 55)

8.1. Learning opportunities of jobs are rooted in the division of labour

Work is a social process and should therefore be judged also on its social – not merely individual – merits. Irrespective of whether people like to carry responsibilities, to participate in consultation, to learn and develop themselves, there is a social stake in using human potential in such a way that it contributes to social development. Outside of the workplace, compulsory education exists based on the view that it has social importance. There is no logical reason why this view should stop at the gates of workplaces.

But the 'learning potential' of an organisation depends on the interplay of different dimensions (Onstenk, 1994, p. 18). It is related to:

(a) the qualifications of workers, their experience and education;
(b) the willingness of workers to learn, their motivation and obstacles to learning;
(c) the learning opportunities in the job, both in its features and the working environment;

(d) the training provided at the job, the learning opportunities and participation in innovation.

In this paper, we focus on the learning opportunities in the job. This is learning not structured by a specific professional and pedagogic intervention, but by the work practice itself in which learning takes place. Learning is a side-product of working, but potentially it is an important and powerful learning resource. Too often organisational problems are tackled with additional training for workers, while an improvement of learning opportunities in the work practice itself may be a better option. It is also a source of growing importance for organisations as the life span of qualifications diminishes and organisations find it increasingly difficult to take workers from their jobs to receive training. Off-the-job training is inevitably restricted to short periods and can only fulfil a supporting function for learning on the job. This is especially the case for SMEs having fewer opportunities to provide formal training. In addition, the effectiveness of learning on the job is greater as the application through experience is assured, keeping in mind that the transfer of qualifications acquired in formal training to daily practice can be problematic.

But, learning opportunities in the job also influence other sources of learning in organisations. The experience of being able to learn in and through work enhances the motivation to learn. Also, because jobs have a broad range of activities, the difference between formal and non-formal learning diminishes when learning is integrated in the job, e.g. work consultation, meetings, project groups, etc. The confrontation with other work domains arouses interest in expanding one's qualifications, including participation in formal training.

However, to provide learning opportunities, a job must fulfil certain conditions with respect to the activities covered. The range and nature of activities integrated in jobs is a consequence of the way work is divided in an organisation. Therefore, investigating the learning opportunities of jobs means analysing how labour is divided in an organisation. This covers the way in which executive and regulatory capacities in an organisation are divided between workers, influencing their chances to deal with problems and to solve these autonomously or in collaboration with others, and consequently their ability to learn from working.

In this paper we investigate the conditions that must be met by jobs to boost their potential to offer learning opportunities. This will be done by means of an illustration from the car assembly industry, which for decades served as the ideal model for a traditional Tayloristic division of labour in which learning opportunities for workers were almost nil. However, in the last decade the industry claims to have transformed division of labour on a broad

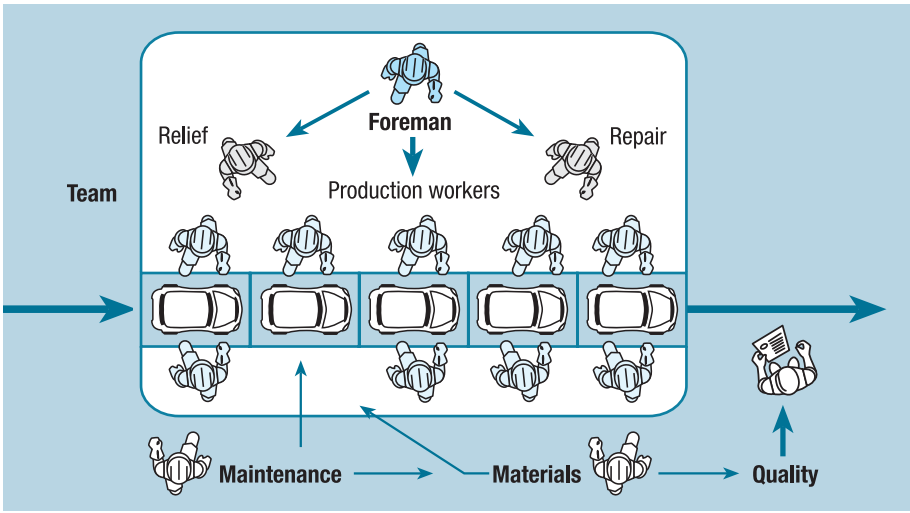
scale to enhance the participation of front-line workers in improving production. During the 1990s 'lean production' dominated the discussion of work organisation in the car assembly industry. This entailed a strengthening of learning opportunities for those workers on the line to add value to the car, a major objective of lean production. However, we question whether lean production sufficiently transforms the structure of the division of labour to meet the necessary conditions for jobs to provide learning opportunities. This investigation is based on case studies featuring the division of labour in Belgian car assembly plants (Huys, 2000). These cases offer a variety of structures, some of which are in line with the prescriptions of lean production, but with others following an alternative path which may serve as an inspiration to stimulate the learning opportunities of jobs.

8.2. A traditional division of labour: why learning opportunities are lacking

The traditional work organisation at an assembly line is illustrated in Figure 1. It shows several jobs at the assembly line which are short-cycled, strictly paced, strictly standardised and exclusively executive in nature. There are separate relief workers on the line to provide breaks for individuals. Repair workers correct the mistakes made in the execution of work by the group. The foremen take care of coordination within the group, with other production groups and supporting services, and monitor whether work remains in line with the norms that have been set. To do its work, the group receives extensive support from separate specialised functions outside the group from the staff departments dealing with quality control, maintenance and material handling. This general description is still valid for many car assembly plants, including aspects of the cases we researched in Belgium.

In a line structure, work is simple and repetitive due to the short cycle times. Consequently, the possibilities to do work in different ways, e.g. to adapt work to changing circumstances, is severely restricted. Workers are tied to a predetermined workplace and work pace. This leaves almost no room for 'internal regulatory capacity' in the job. Internal regulatory capacity means that a job is designed in such a way that it allows disturbances, changes, problems in the execution of work to be solved, thereby enabling workers to maintain stable exchange relations with other jobs in the organisation. The internal regulatory capacity enables the worker to keep the input and output of his work in line with expectations, despite disturbances. This ability to solve problems is precisely what reduces the risk of *stress*.

Figure 1: **Traditional division of labour on the assembly line**



Due to the absence of an internal regulatory capacity in the traditional division of labour, workers on the line can only perform effectively when the product they receive corresponds to specified standards. As disturbances cannot be tackled by workers themselves, any deviation in the process must be avoided. The absence of an internal regulatory capacity on the line also explains the absence of external regulatory capacity. External regulatory capacity means a job is designed in such a way that the exchange relations with the environment can be modified. It refers not to a change in the way work is done, but to a change in work itself. This entails that the expectations related to orders, materials, information that one receives from, or delivers to others, are brought under discussion. Often some margins are tolerated in the exchanges with other jobs. If work is allowed to vary within such margins, this does not, as such, require consultation between workers, although communication will often increase to inform or warn others of deviations. This can be described as 'routine tuning' between jobs. If work must be changed beyond the margins, then the exchange network itself is brought under discussion. This is 'non-routine tuning' and requires consultation as the normative structure of the exchange relations between partners in an exchange network is at stake. Therefore, external regulatory capacity has a major social dimension and reduces the risks of alienation at the workplace.

As the jobs at the assembly line have little internal regulatory capacity, their external regulatory capacity is restricted as well. To coordinate one's

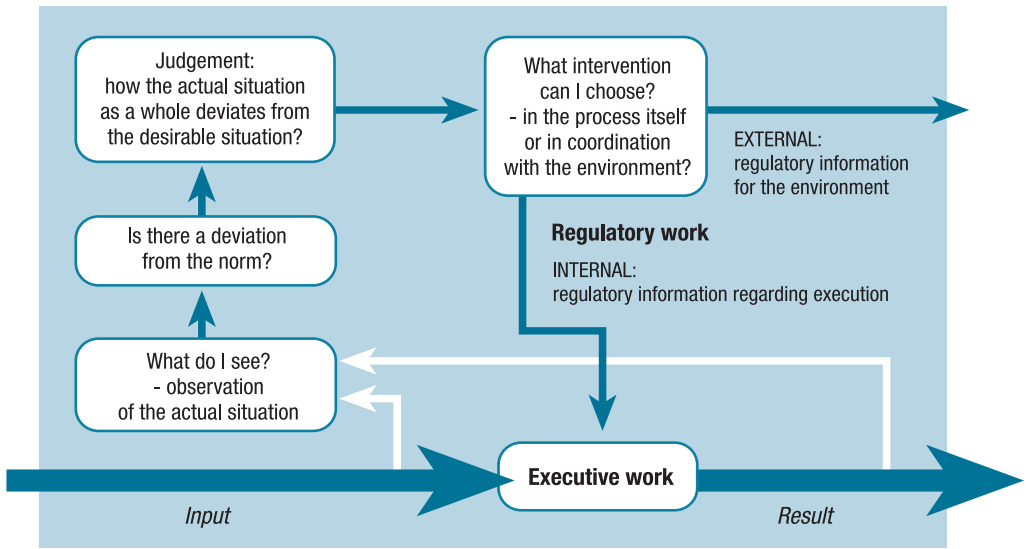
work with that of others (external regulation) requires that choices are available in the way work is done (internal regulation). Moreover in a line structure, jobs are composed of separate work tasks which are added until the work cycle is completed, but do not lead to a significant part of the product. Logically and functionally coherent work is broken down into separate unrelated and meaningless 'atoms'. Such jobs lack an overview of the process and the possibility to participate in external regulation leading to meaningful solutions.

Intuitively, we are aware that such jobs offer few learning opportunities. In applying sociotechnical terminology and 'guidelines' we aim to pinpoint the underlying causes more precisely (de Sitter, 2000). Four guidelines are presented below.

8.2.1. Guideline 1: work must involve multiple executive tasks which entail internal regulatory capacity

'Multiple' refers to the number and nature of tasks integrated in the job. As the chain of mutually related different tasks in a job grows, ever more steps need to be coordinated that gives rise to the need for an internal regulatory capacity. A larger number of operations in a job entails more possibilities to vary the sequence, the timing and the nature of operations and the ability to adapt work to changing circumstances. Broader jobs enhance the internal regulatory capacity.

Figure 2: **The regulation cycle (de Sitter, 2000, p. 92)**



This internal regulatory capacity provides learning opportunities. If we look at the steps involved in the regulation cycle (Figure 2), the similarity with the learning cycle is striking: observation, comparison with expectations, evaluation of deviations, thinking about solutions, implementation of solutions, etc. after which the cycle starts again. Learning involves regulation and therefore only jobs designed with an internal regulatory capacity provide learning opportunities. Conversely, if the composition of executive tasks is such that it inhibits regulatory work, learning opportunities are restricted. Due to the narrowness of jobs, this is precisely what happens in the traditional division of labour on the assembly line.

8.2.2. Guideline 2: opportunities must be build into jobs to learn in a product-oriented way

The second requirement is related to the coherency in the composition of executive work. If work is a composition of separate unrelated activities, one is only able to learn in an additive way. This is a very hard way to learn as it is based on the limited capabilities of short-term memory. People are only capable of keeping a small number of unrelated items in their mind at the same time. As tasks are fragmented into meaningless 'atoms', learning is 'atomistic' and predominantly concerned with speed in the execution of work. In such 'atomistic' learning it is impossible to understand how people can accumulate the required skills to assemble a whole part of a car, even a whole car, as was demonstrated in Volvo-Uddevalla (Berggren, 1992). Learning requires a composition of executive work that has a clearly identifiable function in the production process and tasks that are logically coherent. Then learning can employ the capability of long-term memory. In such 'holistic' learning, tasks are placed meaningfully within a whole which allows one to learn very complex and broad tasks and acquire occupational qualifications. Indeed, it is only under this condition, that 'job enlargement' (see guideline 1) makes sense. But this requires a systematic approach that is absent in the quantitatively oriented work analysis and balancing methods typical of the traditional division of labour on the assembly line.

8.2.3. Guideline 3: the execution of work must involve the coordination of one's own responsibilities with that of others (external regulatory capacity)

Workers do not learn merely from a combination of their own executive and internal regulatory work. An essential feature of working in organisations is that one learns from others as well as from one's exchanges with others. The need to coordinate work with that of others is a practical expression of

external regulation. It prevents work being isolated and alienating. In such exchanges learning about one's own work is strengthened, as work can be placed within the context of the broader exchange network in the organisation, thereby giving sense and a deeper understanding of one's work.

In addition to occupational skills in learning to perform executive work, external regulation allows workers to acquire social, communicative, negotiation, representational and organisational skills. These are transitional skills which are useful for any workplace. Irrespective of the complexity and the level of qualifications required to perform executive tasks, external regulatory capacity improves learning opportunities within jobs.

Such external regulatory capacities are minimal in the traditional division of labour on the assembly line. Indeed, there is no need for external regulation as the executive tasks – even those of people in the same group – are not related to one another. The concept of 'group' is hollow from a division of labour point of view as the work of people within the group is no more related to one another than it is related to the work of people outside the group. A group is merely an – arbitrary – organisational criterion referring to several people who just happen to be geographically close to one another and under the supervision of the same group leader. Inevitably, regulation must take place. But as workers are unable to regulate themselves, the necessary regulation is either 'automated' (e.g. the work pace of all jobs is determined by the speed of the assembly belt) or comes 'from above' (e. g. the predetermined standards that have to be adhered to blindly).

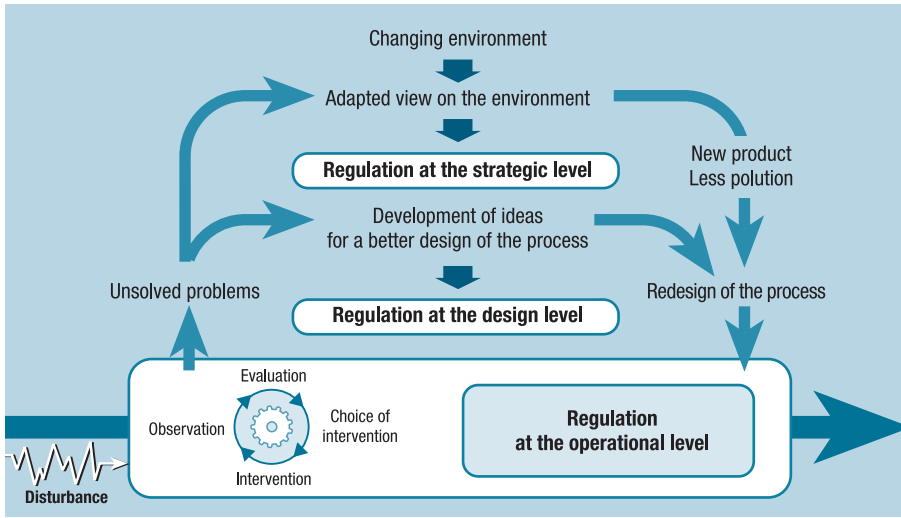
8.2.4. Guideline 4: the composition of executive work by means of integrating related preparatory, supporting and production tasks enhances the non-routine external regulatory capacities of a job.

The external regulation of workers is not merely concerned with coordinating work within certain margins. It is also concerned with bringing the exchange relationship itself under discussion. At this point, the regulation cycle goes to a higher level as well as the learning opportunities that are offered (Figure 3).

Thus far, we have merely been concerned with regulation at the operational level: this is regulation within the existing division of labour structure. The process remains controlled by existing norms specifying who does what and when and how things are regulated by means of which norms. But if problems persist and do not seem to be soluble by existing routines, these routines themselves can be reviewed. This is another kind of regulation as it is no longer based on given operational norms (norms with regard to observation, judgement, intervention, etc.), but rather targeted at

changing them. This is regulation at the design level. Finally, one can question whether changes have occurred in the environment: is the market demanding another product; does it specify new ecological demands; are there new demands with regard to the organisation of work, etc. This is strategic regulation dealing with adaptations to changing environmental conditions and their consequences for the internal structure of the organisation.

Figure 3: **The regulation cycle at three levels (de Sitter, 2000, p. 103)**



Regulation at the design or strategic level requires consultation about improvement and innovation. It enables critical-reflective skills to be developed, resulting in 'double-loop' learning. This no longer deals with learning to perform work as it is designed (by others), but with learning how work can be adapted. This can be seen as a potent cure for 'experience concentration', i.e. when learning is only done on the job, an argument often put forward in favour of formal off-the-job training. Indeed, the learning involved here in 'double-loop' learning is so different, that the label 'development opportunities' may be more appropriate. Through external, non-routine regulation, workers are able to change the framework in which they work and engage into other work domains. In dealing with such changes, they are better prepared for (structural) changes.

Once again, however, non-routine external regulation demands appropriate job design. In addition to the above-mentioned guidelines, attention should be paid to integrating related preparatory and supporting

tasks in the composition of executive work. To engage in a substantial way in external non-routine regulation, contact with existing production jobs is insufficient; attention must be paid to preparatory and supporting functions in the production process. This can only be achieved when such preparatory and supporting activities are included in one's own job and these are linked with the external environment. Such task integration enhances the opportunities for variation in the job. The increase in interdisciplinary knowledge brings about an exponential increase in the amount of possible knowledge combinations.

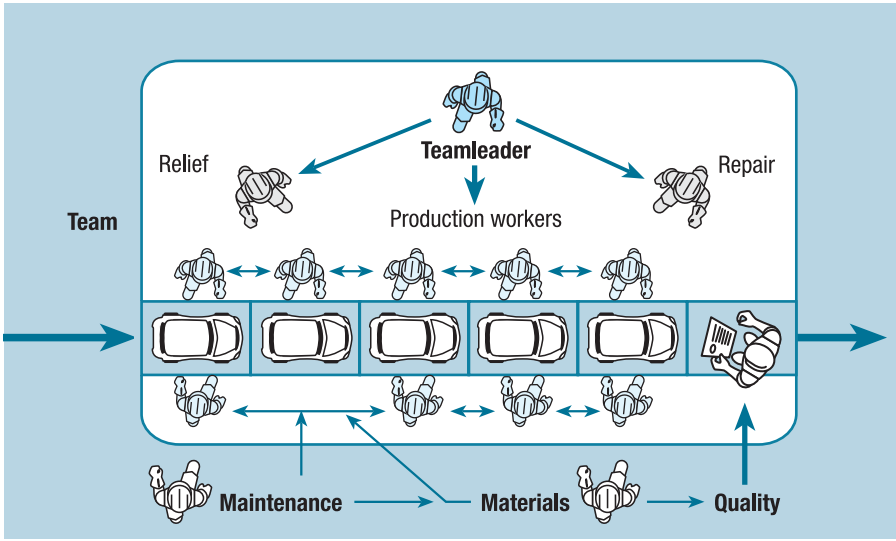
In short, jobs in a traditional division of labour setting offer few learning opportunities because they do not demand an internal or external regulatory capacity as a consequence of the atomised, fragmented and merely productive nature of the tasks involved.

8.3. Opel-Antwerp: lean production as the vehicle to enhance participation of front-line workers

How does the division of labour transform under lean production? How does it enhance learning opportunities for front-line workers on the assembly line? Lean production refers to an 'ideal type' based on the practice of Toyota-plants in Japan. In our case studies of Belgian car assembly plants, this model is best matched by the practice of the Opel-plant in Antwerp. While the plant does not match the ideal model, it provides Belgian cases that have the most characteristic features of lean production. The plant is clearly inspired by the practice of the NUMMI plant in the US – a joint-venture between General Motors and Toyota – which passes as the shining example of lean production in the Western world (Adler and Cole, 1993; Krafcik, 1986).

The division of labour on the assembly line in the plant is illustrated by Figure 4. Several deviations from the organisation under a traditional division of labour (Figure 1) are apparent. First, the arrows between the production workers refer to the flexible allocation of the workers to the jobs on the assembly line. Workers perform different jobs on a regular basis by means of rotation. Second, the scope of the 'team' is broadened significantly. The separate functions, previously belonging to staff departments – quality control, material handling or maintenance – are integrated within the domain of the production team. This means that the production team is no longer merely concerned with output but has to take care of its own support services. The team has to become more 'self-supporting'.

Figure 4: **Division of labour on the assembly line under lean production**



In addition, work organisation on the assembly line in this plant, has some distinct 'lean production' features not represented in Figure 4.

Andon-cord: The assembly line is equipped with an 'Andon-cord' that the workers can pull when they are unable to perform their tasks within the allotted time. This signals the need for assistance, first from the team leader and, if necessary, also from supporting workers. In case the problem cannot be solved, a line stop takes place. To prevent the line stops generating a plant shutdown, the assembly line is converted to 'mini-lines', referring to the buffer capacity between segments of the production.

Suggestion scheme: The plant has a long tradition of an elaborated suggestion scheme. While good ideas are welcomed in all car assembly plants, Opel-Antwerp has a well-established procedure to receive, evaluate and implement suggestions delivered by front-line workers, either as individual or collective 'team' proposals. Specifically, the plant rewards implemented improvements financially, up to 10 % (net) of the returns brought about by the improvement during the first year after implementation.

Team meetings: The production line is halted twice each shift for five minutes to free workers from the work pace of the assembly line and allow them to meet and discuss the progress of production and difficulties occurring. During the first stop, team members meet with the team leader. During the second stop, different teams meet under the supervision of the section head.

***Kaizen-workshops*:** On a yearly basis, each team engages in a Kaizen-workshop lasting seven weeks with a meeting each week. These workshops aim to improve the potential of the suggestion scheme, with a focus on detecting 'waste' in the process. The teams apply specific improvement techniques such as brainstorming, fishbone-diagram, five 'whys', statistical analysis, etc., to rationalise their workplaces. The improvements suggested by the workshops are subsequently submitted as a collective team proposal in the framework of the suggestion scheme (see above) and are eligible for financial awards.

What do these transformations of the traditional division of labour on the assembly line mean when viewed from the perspective of the above-mentioned guidelines to enhancing learning opportunities of jobs? The following points can be made.

Obviously, the rotation of workers broadens their range of activities. It also facilitates mutual understanding as workers become acquainted with each other's job. The main restriction, however, is that the broader overview of the process is based on a loose sum of unrelated and predetermined tasks. The sum of jobs with no internal regulatory capacity does not suddenly add up to much internal regulation. Job enlargement based on broader jobs (e. g. by means of 'drift work' in which workers follow the product on an assembly line over several workplaces), would enhance internal regulatory capacity to a larger extent ([28]). This also explains why workers often resist job rotation, although for an outsider a change of work routine may seem preferable. Job rotation adds little to regulation capacity but presents an obstacle to the acquisition of speed. Instead, job rotation adds to the regulation capacity of line management, as the possibility to allocate workers flexibly facilitates work planning and offers a solution to unforeseen problems such as absenteeism.

Integrating supporting and preparatory tasks into teamwork domains demands extensive organisational restructuring, aiming to bring related production, preparative and supporting tasks within one area of responsibility and thus improve mutual coordination. Support staff find their responsibilities transferred to the production department. The team leader is no longer merely concerned with attaining production targets, but also responsible for delivering good quality, for maintaining machinery and

([28]) Suppose a worker rotates over four jobs which each contain three separate tasks. Then there are merely seven possible combinations ($2^n - 1$) within each job and 4 x 7 or 28 combinations by means of rotation. If, on the other hand, we combine the tasks within one broader job, we compose a job containing 4 x 3 or 12 separate tasks which allow for 4095 possible combinations and therefore much more internal regulatory capacity.

equipment and for the delivery of material.

However, Figure 4 clearly shows that this integration tendency falls short of including the individual front-line workers in adding value to the car at the line. This points to the essential, but often neglected – not least in claims made by lean-production – distinction between the responsibility of teams versus that of individual team members. Jobs on the line remain unaffected by these changes, although communication with the integrated staff functions can be improved. Again, this transformation offers significant changes for the team leader, enhancing his regulation capacity to solve problems in the execution of work in his area. But, for the production workers on the line, such integration of preparatory and supporting tasks does not take place and therefore the structural basis – see guideline 4 – is lacking for participation in substantial external regulation.

Similar remarks could be made with regard to the specific 'lean production' style additions to work organisation as described above. What these measures have in common is a strategy to engage – some might say coerce – workers into non-routine external regulation. Stopping the line at regular intervals (meetings) or in case of problems (andon), encouraging workers to engage in improvement activities (suggestion scheme, kaizen-workshops) are all intended at external regulation on the design-level.

This should improve learning and even development opportunities for workers on the line. What the sociotechnical guidelines cited above emphasise, is that external regulatory capacity is not to be seen as something floating up in the air waiting to be captured, but that certain structural conditions must be met with regard to the division of labour. The structural conditions related to lean production fail to deliver because executive jobs remain short-cycled, strictly paced and standardised, lacking substantial preparatory and supporting tasks and with limited internal regulatory capacity. In short, lean production claims to design jobs having a combination of reduced internal regulation capacity with extended external – especially non-routine – regulation capacity. From a system theoretical point of view this is quite improbable, as more internal regulatory capacity induces external regulatory capacity. A rigid labour process in which work can only be done in one standardised and prescribed way implies that workers are forced to rely completely on their environment for coordination problems.

This effect can be seen straight away if we look at the level of participation of workers in external regulation in the plant under review. Workers have the potential to 'request help' by pulling the andon-cord; the foreman and other supporting functions will give assistance to solve the problem. Although lean

production claims that the work pace is no longer machine-paced but worker-paced as it can be influenced by workers, if workers have no internal regulatory capacity whatsoever – especially since lean production aims to banish internal regulatory capacity through reinforced standardisation, including 'subterranean' capacity – all one can do is cry for help. Similarly, workers are encouraged by financial rewards to come up with improvement proposals, but are neither able nor entitled to implement them. In the framework of Kaizen-workshops, workers are taught about improvement techniques, but only the team leader and supporting functions are actually involved in these meetings as the collective absence from the assembly line of front-line workers for such a long time is considered too costly and insufficiently 'productive'. Illustrative of the piecemeal approach is the suspension of Kaizen-workshops after a new model is introduced. Also, team meetings are so short that members are, at best, able to draw attention to occurring problems, though not to solve them through mutual consultation. It is no wonder that – contrary to popular belief – lean production requires a heavy hierarchy and extensive preparatory and supporting structure.

The external regulatory capacity of front-line workers under lean production is essentially concerned with pointing out problems, disturbances and deviations. This explains the importance of visual management techniques under lean production and the strategy to reduce the possibility of workers to solve problems by eliminating internal regulatory capacity. As the realm of standardisation is continuously expanded on the one hand and the tolerated margins to vary relationships within the exchange network are tightened on the other, lean production thrives on 'insoluble problems for workers. As this matches stress risk criteria, lean production has appropriately been labelled as 'management by stress' (Parker and Slaughter, 1995).

The logic behind this strategy is that of 'organisational learning'. Lean production is based on the belief that only when problems are forced to the surface by making them insoluble for front-line workers, will the organisation be concerned with improving standards. This is a bureaucratic way of 'organisational learning', hence the qualification of lean production as a 'learning bureaucracy' (Adler, 1992). From a sociotechnical perspective, the starting point lies in appropriate division of labour to involve workers in renewal and improvement, thus mobilising all available knowledge and experience for development and innovation. In this perspective, the lean production organisational learning approach undercuts the very source (participating workers) through which innovation takes place.

It is fruitful to recall the views of Taylor and Ford about organisational learning. Both emphatically repeat that there is 'no one best way' or, more precisely, no 'one best way forever'. The best way to do work is always a temporary one. It is the best we can think of at the current moment, but one that should be superseded by a better one as quickly as possible. But to come up with a better way of doing work, work has to be standardised as much as possible as standards provide the basis for improvement (Taylor, 1911/1972, 118; Ford, 1926/1988, 82). Taylor stressed that workers themselves should contribute to finding such a better way. He urges management to listen to suggestions from workers and when it leads to a more efficient way of working, Taylor advises management to pay a cash premium for their 'ingenuity'. In this way, Taylor asserts that 'the true initiative of the workmen is better attained under scientific management than under the old individual plan' (Taylor, 1911/1972, 128).

In later industrial practice, Taylor's advice to involve workers in regulation at the design level has been grossly neglected. This is what the development of lean production suggests. Is the lean production approach then a repetition of history in as much as it attempts to revive participation of workers but is not prepared to provide for the necessary structural basis in the division of labour? Rather participation is promoted through personnel measures, that is: a strong internal labour market ('lifetime-imprisonment'); extensive variable pay based on one's participation.

Whatever the merits of lean production with regard to organisational learning, job design certainly does not sufficiently meet the sociotechnical guidelines put forward to strengthen the learning opportunities of jobs.

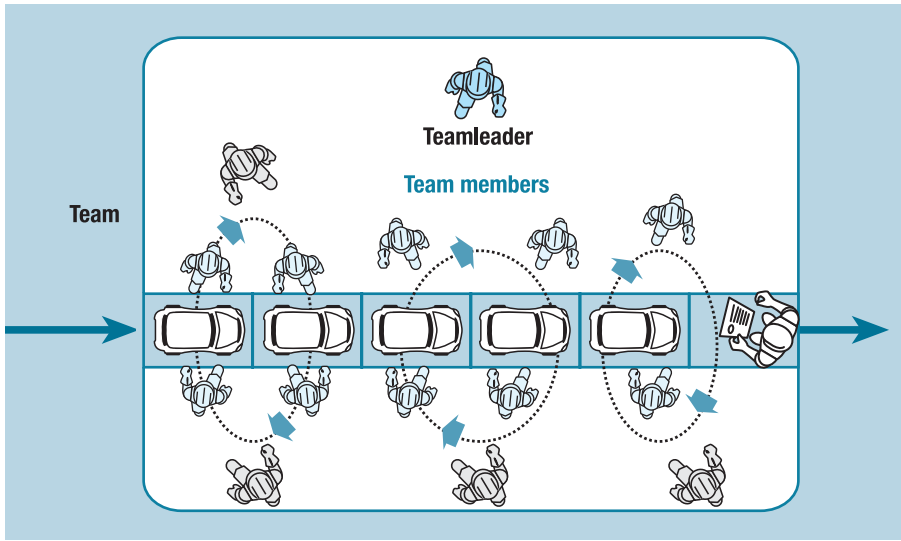
8.4. Volvo-Ghent: moving learning opportunities on a line structure at a higher level

If one wishes to enhance the learning opportunities of jobs beyond the limited possibilities under lean production, inspiration may be sought in the approach of Volvo-Ghent. As is shown in Figure 5, the work organisation on the assembly line has strong similarities with 'lean production'. A distinct feature however, as illustrated by the oval moving arrows, is the rotation of workers between jobs, not merely on the line but off the line as well, thereby integrating preparatory and supporting tasks.

This allocated measure is in accordance with sociotechnical guideline 4, stressing the need to combine productive work with related preparatory and supporting tasks. This provides a more solid basis for workers to engage in

regulation at the design and strategic level. Although the executive work cycle on the line is short, the job rotation applied makes it possible to integrate more substantial supporting tasks.

Figure 5: **Task integration by means of allocation of workers to jobs on and off the line**



The implementation of this allocation mechanism in the plant was done gradually. It started over a decade ago by rotating people first to jobs on the line and subsequently getting them off the line periodically to perform 'indirect' tasks such as providing support for other team members. This trend increased during subsequent years, as workers received training and acquired sufficiently knowledge about additional indirect tasks. Gradually, a substantial proportion of the indirect tasks previously performed by specialised staff was transferred to front-line workers.

During the first stage, all workers had to learn all indirect tasks that the team members were responsible for. Later on, other additional indirect work packages were transferred according to the interest and qualifications of different workers within the team. Thus different team members can act as a contact person for the team with regard to specialised tasks.

Through the allocation of off-line jobs, workers became aware of the indirect tasks related to their production work, inducing a broader overview and understanding of their work. This also provided a solid basis for workers on the line to have more substantial and enduring participation in regulation

at the design and strategic levels. In comparison to Opel-Antwerp, Volvo-Ghent did not resort to 'coercive' measures to 'achieve' participation from front-line workers. There is an elaborate suggestion scheme, but with no financial rewards attached. This is perceived as unnecessary, as coming up with improvements is a 'normal' task related to taking the time off from the line. For example workers, who are involved in quality control, can use the time off from the line to analyse quality data, identify causes of deviations, and devise solutions. Similarly there are no 'separate' Kaizen-workshops at Volvo-Ghent in which team leaders are suddenly drawn away from their work in order 'to think' about improvements. This 'thinking' is part of the core task as they are freed from daily routine tasks now dealt with by team members themselves. Volvo-Ghent also stops the production line to hold a team meeting. Although these are restricted to once a fortnight, they last for half an hour allowing for real discussion rather than merely identifying the problems of the current day.

Even though the transformation of the division of labour remains modest at Volvo-Ghent, it is important because, in contrast to lean production, workers on the line take on additional tasks and responsibilities in their work. This gives them broader skills related to different work domains that can be applied as a source of regulation at the design and strategic level.

In this work organisation formal 'off-the-job' training and learning on the job gets increasingly blurred as learning moments occur during team meetings and working off-line. Equally, both kinds of learning are mutually reinforcing, as the execution of indirect tasks often requires some formal training.

8.5. A glimpse of how the division of labour could/should be

Although it is a step on the way to providing a structural basis for learning opportunities through work, the work organisation of Volvo-Ghent still suffers from severe deficiencies as far the maximisation of learning opportunities of work is concerned. In the first place, executive work is still based on fragmenting jobs into short-cycled, strictly standardised and paced work. To remedy these obstacles to learning, a mere redesign at the job or even the team level is insufficient. A more fundamental restructuring is required in the structure of the execution of work. This inevitably calls for a break up of the line structure in the assembly of cars. In a line structure, the regulation capacity of workers and teams is severely restricted due to

their rigid coupling. A team has little decision-making autonomy since most of its decisions have immediate consequences for all other teams on the line. As an obvious example, teams have no decision-making power about work pace as this affects the work of other teams. As Figure 6 shows, this requires setting up parallel lines in which teams are not merely linked in a segmented way one after the other, but next to each other allowing for more decision power. The rigid relationship with other teams must be loosened, while the relationship between jobs within the team must be strengthened. Workers on the line must primarily be related to other workers in the team through the content of the work itself, instead of relating to workers outside of the team.

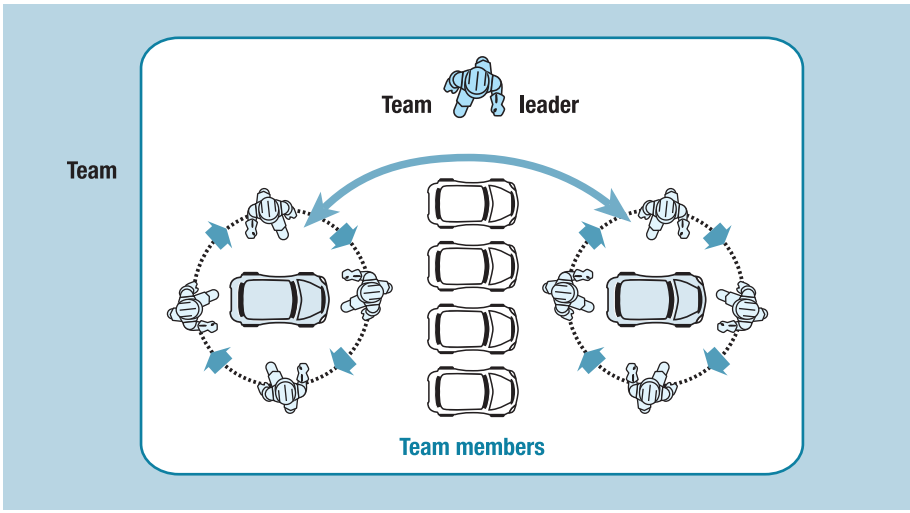
A way to achieve intensive mutual relationships within teams is to include a meaningful and functional part of the product within the work domain of the teams. When teams are responsible for a meaningful part of the product, more regulation capacity can be assigned to them. The potential participation in regulation in the design or strategic level is raised substantially when, for instance, a team is responsible for the assembly of the cockpit of the car. An overview of such an integrated part within the team allows the team not merely to engage in the improvement of its fragmented tasks, but also in the improvement of the whole product. Quality control performed by the team is no longer confined to the control of unrelated tasks, but involves quality control of the product as a whole; engineering performed by the team is no longer confined to banishing 'wasteful movement' in partial tasks, but participation in the design of the product.

Such a reconfiguration of the structure of execution largely matches the sociotechnical guidelines for the learning opportunities of jobs. Due to setting up the line parallel with each other, cycle times increased and jobs were broadened (guideline 1). Due to the allocation of a meaningful part of the process to the teams, the workers involved have the opportunity to learn in a product-oriented way (guideline 2). The break up of the line reduces regulation 'from above' and requires more coordination between jobs (guideline 3). Finally, as the work domain covering a meaningful part, more preparatory and supporting tasks can be assigned to the team, providing a solid basis for regulation capacity at the design and strategic levels (guideline 4).

In a sociotechnical perspective, the reorganisation of the structure of execution is a starting point for the (re)design of the organisation. It is not merely out of 'human concern' that these guidelines are prescribed, but equally out of a concern for the performance of organisations. The manageability of a process is better assured from a sociotechnical

perspective when workers are able to adapt their work by themselves or through consultation with others. Allocating the capacity to adapt to workers, allows the process to be flexible and to respond to changing demands in an increasingly volatile environment. This is a perspective diametrically opposed to the assumption of lean production – but equally of traditional division of labour – in which the manageability of the process is assured only to a strict control of workers' activities.

Figure 6: **A division of labour maximising the learning opportunities of jobs**



Unfortunately, however, as the research in the Belgian car assembly plants has revealed (Huys, 2000), the line structure is still dominant in car assembly. Even worse, it is intensified, as more workers are tied to the assembly line than ever before; cycle times are shortened; the line is tightened through the removal of a buffer capacity, standardisation is increased. There is an increased tendency in car assembly towards modular production in which subassemblies of the cockpit, doors or motor are assembled separately and then inserted into the car.

8.6. Increasing the learning opportunities of jobs: contribution to labour market policy

When structural changes occur in the economy, demand for labour changes as well. Governments attempt to reduce frictions in the labour market by means of (re)training programmes. Instead of mediation between demand and supply, mediation occurs between the allocation of the unemployed to 'suitable' training programmes.

Why are workers not able to adapt themselves? This is partly because too often work is divided in such a way that the execution of tasks does not require coordination with other work activities and therefore there is a lack of opportunity to learn about the overall work system. An improvement of learning and development opportunities in work would enhance workers' abilities to adapt to change and enhance their labour market potential. In addition, these learning opportunities contribute to a flexible labour market and social innovation.

In contrast to machines, people do not merely add value to a product or service through their activities, they also add value to the activities which give rise to these products or services. As machines are not able to learn, they depreciate very quickly to be replaced by better and smarter ones. But as workers live for many decades, it is essential that they learn through carrying out their work. It costs nothing for an organisation to promote learning, provided that an appropriate division of labour is in place (de Sitter, 2000, p. 313).

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CHAPTER 9

Promoting learning at the workplace: challenges in shaping the work environment

Georg Spöttl

9.1. Introduction

Learning at the workplace is assuming increasing importance in operational practices and also in public discussions. Enterprises cherish the hope that much of the knowledge and skills required for coping with new work tasks can be acquired on the job. But, they deliberately or unknowingly assume that 'learning through working' is an unorganised, non-supported way of learning. Formal and intentional learning is clearly different from learning through one's work (see Livingstone, 1999, p. 65 et seq.). The recognition of this is a first step towards facing up to the reality of the 'learning enterprise', allowing us to examine learning and working behaviour more closely. Staudt and Kriegesmann's Mythos Weiterbildung (1999) show that developing a seminar-based (or course-based) further training scheme is not always the best approach ([29]). The following reasons are given to explain the lack of participation in seminar-based training:

(a) 50 % of the interviewees indicated lack of time;
(b) 40 % felt that the seminars/courses took place at inconvenient times;
(c) 40 % indicated family duties;
(d) one third complained that the courses were too expensive (see Livingstone, 1999, p. 76).

Learning at the workplace (assuming that it is successful) has the decisive advantage of taking place alongside one's work. It does not require special arrangements associated with conducting seminars (teachers, instruction rooms, learning infrastructure and so on).

([29]) Staudt et al. (1999) and a number of American surveys point out that just 10 % of all seminars qualify their participants for better job performance. In the United States it is estimated that this figure amounts to a loss of approximately USD 90 billion.

9.2. The importance of learning at the workplace

Learning at the workplace implies that work and the work environment are organised in a way to provide support for workers in solving their problems for themselves. This also means that companies trust their employees and provide a work environment that not only permits but promotes learning. Once these requirements are met, there is an increased chance of employees acquiring new knowledge during the work process. Furthermore, when such work and learning processes are initiated in a company, it is likely that learning will accompany and respond to changes in work demands. This will allow workers to cope with the challenges provided by new technologies. In fact, technologies may be designed and introduced in order to integrate learning and work. This allows continuing development for employees and the company, and enables both parties to attain the skill level required for coping with work tasks and safeguarding their future.

9.2.1. Development of competence via learning at the workplace

Learning at the workplace is associated with developing competence. This has become a crucial issue in establishing a smart workforce to achieve competitive success and calls for 'efficient ways to manage training and development in organisations' (Sandberg, 2000, p. 48). However, managers firstly need to understand what constitutes human competence at work.

Dreyfus and Dreyfus (1986) investigated the acquisition of competence by aircraft pilots, chess players and others. 'A central finding from their study was that the attributes needed for work are not context-free, but are bound to particular types of work situations, no matter what the level of competence required. Results showed that as soon as workers gain experience of a particular type of work they begin to acquire knowledge and skills that are not context-free but, rather, are situational or context-dependent' (Sandberg, 2000, p. 51).

A number of studies of workplace practice point out that the ways people actually work usually differ fundamentally from the way organisations describe their work in manuals, training programmes, job descriptions and so on. Work always has a tacit dimension that requires practical competence and professional artistry.

When workers undertake their work, they 'do not select methods that are separate from their experience. Instead, they frame and set the problem situations through their experience of work' (Sandberg, 2000, p. 52). This underpins the context-dependent nature of competence. Thus, descriptions

of competence arising from a decontextualised approach are incomplete and consequently misleading as a basis for managing competence development in organisations.

Based on this on the above assumption and the Dreyfus and Dreyfus model of skill acquisition and competence development, a high level of performance may be attained via learning at the workplace. The highest level of competence in the Dreyfus model is that of the 'expert'. The expert does not have to rely on rules and procedures to link an understanding of a situation to an appropriate action.

Learning at the workplace has many advantages but requires organisational improvements to facilitate workplace-learning environments and cohesive, interactive work teams. Organisations must take risks in their learning and display a willingness to undertake organisational improvements.

9.2.2. **Forms of learning at the workplace**

As part of ADAPT ([30]) European Community Initiative of the European Social Fund, the author carried out a survey on the Learning of employees while accomplishing operational tasks within companies. The topic of the survey was focused not just on learning during working or learning by working. Rather it set out to identify as many facets of learning at the workplace as possible (see Becker and Spöttl, 2000). The survey concentrated on the daily learning processes in a company related to the successful accomplishment of important work task. The challenge is to learn something new at the workplace, often informally:

(a) using well-known learning on-the-job approaches;
(b) based on learning on demand;
(c) learning by means of manuals;
(d) learning with reference to databases, the Internet and so on.

There is no single valid approach for learning during work or learning at the workplace. Many approaches can be used depending on the individual and company-specific situation.

A survey of micro-companies (with less than 10 people), carried out in Ireland in the contest of the ADAPT programme, revealed that lifelong

([30]) The ADAPT programme whose full title is 'Adaptation to industrial change' promoted the core ideas of the European Commission Green Paper 'Partnership for a new work organisation of work'. The main premise in the Green Paper is that a better organisation of work based on skill, trust and quality, as well as a high level of involvement of workers, can make a valuable contribution to the competitiveness of European firms. This can also improve the quality of working life and the employability of the workforce. A new approach to organising work implies replacing hierarchical and rigid structures with innovative and flexible ones (Mora et al., 2000, p. 5).

learning (in a sense of learning at the workplace) takes place in such companies. Up to twelve different ways of learning at the workplace were indicated:

- periodicals,
- work plans,
- Internet,
- videos,
- manuals,
- problem-solving together with colleagues,
- coping with difficult tasks,
- receiving advice from experts,
- learning from experience,
- practising with new equipment,
- dealing with non-routine tasks,
- receiving support from management.

(see van den Tillaart et al., 1998, p. 47).

These methods for learning at the workplace are mainly observed in small enterprises and are applied in very specific situations. Thus, situation-oriented use of selected measures can contribute considerably to the further development of an employee's competence.

> 'The most important thing is the desire for constant personal improvement. If the worker does not believe in the necessity of training then no kind of formal or informal training has an effect. Training is comprised of seminars on new technology, importer-distributor training about new machines. Team training is an important component of learning, manuals and books play only a supplementary role.' (van den Tillaart et al., 1998, p. 47).

The list of methods outlined above highlights the fact that approaches differ. However, they have one thing in common: they are linked to corporate practice and are seen to be relevant by both employees and employers.

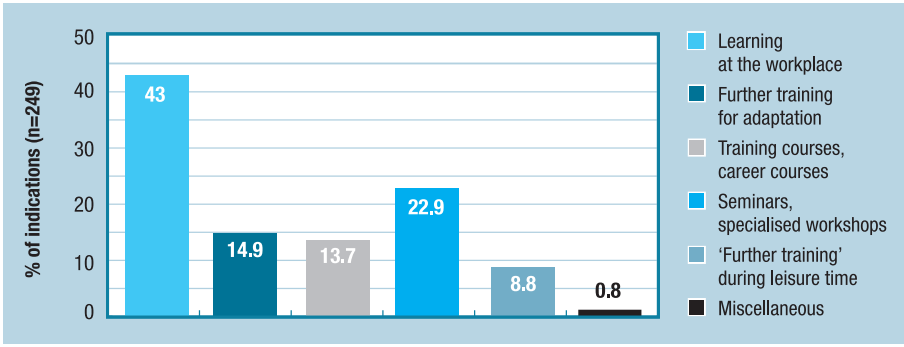
The importance of learning at the workplace, with regard to small enterprises, is also underpinned by a survey carried out in an economically weak region in Germany (see Figure 1). Learning in the workplace was found to be dominant (43 %), whereas seminars and conferences accounted for only 22 %. Learning by other means did not have significant effect (see Büchter et al., 1998).

Learning at the workplace is not only preferred by small enterprises; large companies consider this form of training to be increasingly important. Automobile manufacturers, for example, are currently changing their continuing training concepts and replacing theoretically-oriented seminars with further qualification measures that are carried out in production. One of

the car manufacturers surveyed turned the company's further training concept upside down between 1993 and 1998. Within just five years, prior emphasis on seminars (80 % of all training in 1993) was transformed into training predominantly occurring in the workplace (80 % of all training in 1998).

However, training courses and seminars continue to be widely used in further training (see Figure 1). Holistic further training philosophies seem to thrive in exceptionally innovative enterprises. In these cases there is usually a direct link between employees' qualifications and remuneration system (see Spöttl et al., 2003).

Figure 1: **Forms of further training in companies**



9.3. The European ADAPT programme: paving the way for learning at the workplace

Learning at the workplace occurs in various operational contexts, as seen in 250 out of the 657 German ADAPT projects that dealt extensively with the topic. Approximately 40 such projects focused specifically on this topic (see Becker and Spöttl, 2000). However, only one of the 40 participating enterprise projects employed more than 60 people. All the other companies had a staff of less than 60, the majority employing between 5 and 20 people.

9.3.1. Requirements for learning at the workplace

As frequently observed during discussion in the ADAPT project, successful approaches to learning at the workplace still run the risk of not being recognised as learning. Approaches to learning in the workplace are constantly confused with activities such as product-oriented briefings. The following criteria for effective learning at the workplace can be identified:

(a) learning at the workplace must be clearly differentiated from the traditional seminar system;
(b) there must be a link between learning and work processes;
(c) learning concepts related to learning at the workplace must be clearly articulated;
(d) there must be a clear connection between organisational and personnel development;
(e) learning in groups and cooperative learning must be supported;
(f) applied new technologies/media must support learning at the workplace;
(g) innovative models must be devised to the involvement of companies and their employees.

Persuading companies to follow these criteria entails a considerable amount of effort and motivation.

It is understandable that small enterprises will only engage in experimentation if there is a likelihood of success. When learning at workplace is seen to hamper the business processes, companies reject this approach and try to solve their problems in another way.

9.3.2. Advantages and disadvantages of learning at the workplace

The arguments for and against learning at the workplace are manifold and often affected by personal learning experiences. Figure 2 presents the 'for' and 'against' positions of the 40 company partners of the ADAPT project. The companies' greatest fear is that learning might take over – 'companies are not schools' – and productive work would suffer.

Current organisational structures are not aligned with the idea of a learning organisation. Therefore, it is important to pursue learning at the workplace as it provides us with an acceptable means of integrating learning and work processes.

In this context work organisation has to be considered in its entirety. Human capital is a key competitiveness factor for modern companies. It is widely accepted that companies are unable to create long-term value if they do not manage and organise their staff in a suitable manner, taking into consideration matters such as salaries, training, loyalty and working conditions.

Learning at the workplace, in the sense of an integration of learning and working, must therefore be given serious consideration. This must be in line with the corporate culture, in order to ensure a high level of acceptance. In this regard work organisation structures, remuneration systems and working conditions must be adapted accordingly.

Figure 2: **Arguments for and against learning at the workplace**

Arguments against learning at the workplace	Arguments for learning at the workplace
1. No systematic learning. 2. No control over the transfer. 3. Every day work prohibits learning. 4. Acquired knowledge cannot be verified. 5. Certification is impossible. 6. Lack of certification prevents promotion to higher salary levels for employees. 7. Learning inhibits productive work. 8. There is a lack of didactical teaching aids.	1. Employees stay at the company. 2. Learning takes place by means of problem solving. 3. Knowledge is renewed; problematic work situations can yield successful learning. 4. Acquired knowledge can be applied immediately. 5. Training costs are low; no travel expenses; staff are not away from the workplace. 6. New technologies, working procedures become the subject of learning. 7. Learning is integrated into the organisation of the company. 8. Learning 'on demand' and 'just in time' become possible. 9. Learning and operational/organisational cultures are aligned.

The following points in particular must be taken into consideration:

(a) employees should be introduced to new process in a step-by-step manner by learning during work and contributing to the shaping of the work environment. In the event of the introduction of entirely new technologies and forms of work organisation, old competences are obsolete and no longer adequate for dealing with new work processes;

(b) competences acquired at work are often not documented and therefore cannot be communicated in the event of an employee changing company. Qualifications acquired in-house are often downgraded in the case of a forced change of workplace. This is a long-standing problem which became apparent with the structural crises in important branches (e.g. steel industry) and the related forced changes of workplaces (Bosch, 2000, p. 16).

9.4. Variety of 'workplace learning approaches'

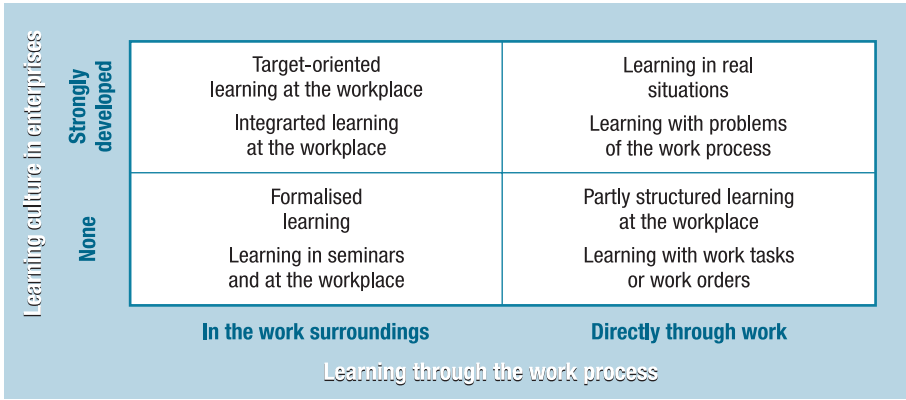
Figure 3: **Trends in learning at the workplace**

Trend	Target	Didactics/methods	Instruments
Observation, learning, comprehension.	Comprehension and understanding of processes. Acquisition of documentation and knowledge on stipulations, standards etc.	Learning with the aid of real work tasks via handling regulating theory.	Aids for problem solving such as hardcopy or multimedia, manuals.
Problem-solving at the workplace.	Development of situation-oriented competences for problem solving. Efficient accomplishment of real, problem-based work tasks.	Learning on demand in case of problems. Context-oriented support via flexible methods (learning by doing).	Help with problem solving via the Internet, hotlines etc. Cooperation with colleagues.
Learning during breaks.	Acquisition of context-oriented knowledge.	Communication-oriented learning using various instruments.	The Internet as a knowledge platform; use of databases.
Learning in various operational situations at workplace.	Coping with a variety of tasks in different situations.	Application of various learning forms from seminars to breakdown of work processes.	Learning tasks taken from the company; a multitude of problem-oriented materials.
Individualised, situation-related learning	Solving complex situation-specific tasks. 'Learn only what is needed'.	Individualised learning with various learning forms.	Operational situations, colleagues, study corners.

These trends underline a variety of different learning approaches that become practice in mixed forms. It has to be stressed that we cannot use present learning theory to define learning at the workplace; it needs to develop its own paradigms. This means taking a step towards ways of learning suitable for different corporate cultures that no longer adhere to traditional systematic rules. Every company, every form of work organisation, every personnel development challenge, requires a specific response at the workplace level.

Nevertheless, it is possible to detect a common trend running through all of the trends (see Figure 4). Learning in real situations is closely adapted to corporate cultures, highly context-dependent and linked closely to work processes. This way of learning can hardly – if ever – be formalised. However, it provides great advantages for the company, provided that the supporting instruments are easy to handle. The opposite form of training is formalised learning which is often carried out away from the workplace. This kind of training is generally well structured but often does not necessarily provide answers to the requirements of the target groups.

Figure 4: **Characterisation of learning at the workplace**



Target-oriented learning at the workplace is based on integration of learning and working and involves the application of different methods and instruments. It represents the best compromise between systematic training and learning in real situations. Partly structured learning at the workplace has the advantage of being linked with the work process. This can be partly formalised. The most important aim is to maintain a balance between work process orientation and formalisation, in order to be able to assess the success of the learning process with regards to accomplishing tasks.

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CHAPTER 10

A life-course perspective on work-related learning

Walter R. Heinz, Thomas Kühn, Andreas Witzel

10.1. Introduction

In this paper we analyse apprenticeship as an important transition institution from education to skilled employment from the point of view of young adults in Germany. How do they adjust to the gap between vocational education and training (VET) and employment? To what extent are structural changes in their work experiences anticipated in their career decisions?

To understand the biographical meaning of education and work experience during apprenticeship and beyond, in a period of accelerated social change, we followed a cohort of young skilled apprentices born around 1970 in Bremen and Munich. They started their vocational education and training in the second half of the 1980s, receiving their skilled worker certificates in 1989. They pursued different transition pathways afterwards, motivated by efforts to strike a balance between their work experiences and career expectations on the one hand, and labour market changes and organisational opportunities on the other (see Heinz, 1999).

To understand the importance of VET for qualifying and socialising young people, not just for employment but for the entire life-course in Germany, a short overview of the apprenticeship or the dual system is necessary. Occupations are usually grouped as production and service jobs. Sometimes a more elaborate distinction is made between crafts; technical; administrative; educational and service occupations ([31]). In Germany, young people can enter 360 occupations with a training period of three years via the dual system. The term 'dual' refers to the fact that theoretical education is offered by public vocational schools and training is provided by employers. Furthermore, there are 120 (mostly 'female') occupations that are offered at vocational colleges. The dual system, however, is not an equal

([31]) Such distinctions may be justified in societies such as the USA or Canada where vocational education and training is not institutionalised and teenage employment, on-the-job training and broad college qualifications shape the school-to-work process.

opportunity training institution as it implicitly discriminates against women with access to occupations with good career prospects rather limited. Thus, the range of occupations is more restricted for young women than for young men as the former are channelled into vocational schools and colleges that have little connection with the labour market (see Krüger, 1999).

Although an increasing number of young people have been entering academic post-secondary education (polytechnics or universities) the majority of school leavers (approximately two thirds) still pass through the VET dual system. This occurs despite a less predictable transition from training to work and a growing mismatch between occupational certificates and employment careers and prospects (see Heinz, 1997).

With working life organisations being restructured, many labour market experts and education researchers predict that the notion of occupation (*Beruf* in German) will lose its importance as a mechanism of social integration and as a biographical signpost. Thus, job entrants who come from the apprenticeship VET dual system may be increasingly confronted with the risk of reduced income levels and job security, unstable work conditions and declining opportunities for advancement to a management or *Meister* (master) position. This insecurity conflicts with young people's expectations, aspirations and orientations which they developed via processes of pre-vocational socialisation. However, in the framework of the German occupational culture, vocational choice is still embedded in the VET transition system which mediates individual interests, work content and work conditions. Because of the restructuring of work and changing transitions in the labour force, higher levels of competence in self-management skills are required in addition to occupational qualifications.

Our study attempts to shed some light on the orientations and decisions of skilled young adults concerning their experiences in the transition from apprenticeship to employment and their career development actions.

10.2. Theoretical framework: self-socialisation and biographical agency

Before presenting some selected results from our longitudinal study, some concepts are outlined. We see life-course transitions as linked to processes of self-socialisation (see Heinz and Witzel, 1995; Heinz, 1988, 2000, 2001) which translate experiences related to vocational choice, occupational options, work conditions and careers into biographical action orientations and further decision making. Self-socialisation refers to the microdynamics

of individual agency in varying social contexts across time.

To what extent do labour market structures, job tasks and work experiences influence personality socialisation? What role do self-initiated adaptations and job changes play in shaping a person's employment biography? Research suggests that there is a bidirectional or reciprocal relationship between personality and work activities that may be explained either by individual preferences (self-selection or personal agency) or by reference to structural contexts and socialisation (social learning and internalisation of norms and values). This distinction, however, is not very helpful in the light of recent theories in developmental and personality psychology (see Brandtstädter and Lerner, 1999; Schallberger, 2000) and socialisation research (see Grundmann, 1999).

Correlative studies of work dimensions and individual orientations are not conclusive concerning the interaction of personality and work experiences over time and cannot take into account the changing organisational context of work. Therefore, longitudinal studies are employed to ascertain how the interaction between personality and work has socialising effects and to what extent these are moderated by the degree of fit between biography and the work context.

Our study goes beyond the conceptual and methodological approaches that normally inform research on vocational behaviour and career development. First, we focus on the horizontal or contextual differentiation of job activities, work tasks, promotion and learning opportunities regarding specific occupations. Research on work and socialisation in the tradition of Kohn (Kohn and Schooler, 1983) focused, in contrast, on vertical or status aspects, such as self-direction, prestige, income and rank, without specifying the characteristics of employment conditions and work settings. Second, we translate the general 'personality-environment-fit' concept into a time-related concept of biographical action in work contexts. Therefore, it is possible to extend our understanding of the interaction between socialisation and career development in the world of work by developing a typology of biographical action orientations that go beyond the basic distinction between extrinsic and intrinsic orientations towards work (see Vroom, 1964).

We suggest that training and work do not directly influence people's beliefs about their competence (self-efficacy or self-esteem, see Bandura, 1997) and their expectations concerning job conditions and career prospects. Instead, it is the way people match their education, training and employment biography with the work contexts and work options. This matching process is mediated by action-orientations that relate to selected

aspects of work in specific ways and provide personal guidelines for job-related activities. Therefore, transition biographies are neither determined by action contexts or by social class, instead they are individually constructed in the course of a person's training and work history.

How does the 'training-to-work' transition influence this reciprocal adaptation of work and personality over time? Does self-selection direct this process or does socialisation guide it? The self-socialisation notion proposes to integrate these two processes into one linking mechanism (see Elder and O'Rand, 1995). In this framework, 'career process learning' is a personal accomplishment that is derived from self-initiated actions which maintain employment continuity or respond to occupational discontinuity.

A flexible labour market and restructured organisations shape individual work experiences by requiring people to construct and assess their job experiences and transitions in response to frequent discontinuities and multiple options. In the context of our study, occupations, work experiences and organisations constitute the social contexts for intentional self-development. In this sense they are the substance for the mental representation of material and symbolic realities related to the individual construction of early work career orientations. Furthermore, we argue that individuals develop different strategies for coming to terms with the intended and unintended consequences of their educational and occupational decisions. By introducing self-socialisation as a core concept for analysing work experiences and transitions, we not only take into account social contexts and actor-driven developmental processes but also the institutional and temporal aspects of life-course sequences. Since the contexts of work and careers change over time and differ according to economic and cultural conditions, the mechanisms that mediate social structure and personality development must be specified. It is evident that the possibility of self-initiated actions and participation in work organisations is important for an individual's belief in their competence across life stages. Combined with agency, self-socialisation also directs our attention to the biographical consequences of actions that cause the person to reflect on their intentions and the range of options available to them. This view is also consistent with the statement from Elder and O'Rand (1995: p. 457): 'Despite the empirical evidence on links between life transitions, the agency of individuals and their life choices ensure some degree of loose coupling between social transitions and stages.'

Self-socialisation therefore, conceptualises life-course transitions as biographical accomplishments in the sense of an active process of meaningful integration between occupational pathways and work

experiences over time. Self-socialisation implies biographical reflexivity *vis-à-vis* social contexts. Work and status sequences are understood not only from the perspective of work conditions, opportunities and career contingencies, but also in relation to self-initiated or enforced actions that influence the shape and direction of one's life course.

Life-course transitions and developmental sequences require us to make decisions about pathways that are compatible with our past experiences and future aspirations. In this sense, biography is a person's reflexive arrangement with the circumstances and contingencies of their life course which is socially structured by constraints and opportunities. Social origin, gender and education circumscribe the range of biographical options in the world of work. These are translated into experiences that shape biographical agency via processes of self-socialisation. Modes of biographical agency are, therefore, not sediments of work settings but cumulative reinterpretations of experiences. These modes, in turn, are resources of individual actions and decisions that structure and restructure people's sense of place and identity across their life course.

The extent to which employment careers are continuous or interrupted constitutes a social framework for adjusting occupational self-concepts, goals and action strategies in a process of career learning. An individual career path, however, does not just result from an adaptation to labour market opportunities and compliance with social norms, but also from the individual's interpretation and selection of employment, career or educational alternatives. Therefore, our study asks how young people manage to come to terms with the outcomes of training and their participation in the labour market as well as with their experiences of different work conditions.

Self-socialisation theory proposes that transition experiences and the consequences of work and career-related actions lead to differences in the individual processing or monitoring of employment options. Therefore, we expect to find differences within, as well as between, occupations resulting from the specific 'person-work-fit' or the extent of 'biography-career-match'. Specifically, we expect that skilled young people respond to work circumstances according to their respective mode of biographical agency; occupation and biographical agency interact in skilled young people's self-initiated or enforced career process learning. We also expect that gender differences in modes of biographical agency interact with specific occupations.

In order to provide exploratory evidence for these assumptions, we will first introduce our typology of modes of biographical agency and then look

at the relationship between work experience, career process learning and action strategies, before finally examining these strategies in the light of the modes of biographical agency.

10.3. The Bremen/Munich transition study: methods and data

We conducted a quantitative and qualitative panel study with young skilled female and male workers in six major occupations in Bremen and Munich between 1989 and 1997 ([32]). The macro-panel (N = 2 230, first phase) consists of the complete cohort of young adults who received their skilled worker certificates in one of six major occupations in the city state of Bremen and a sample of a third of the young skilled workers in the same occupations in the capital of Bavaria, Munich, in 1989. The choice of the two cities was based on labour market data over a period of time that documented Bremen as a depressed and Munich as a booming training and labour market. The six occupations selected are among the most popular ones in Germany: bank clerks, office clerks, engine fitters, car repair mechanics, hairdressers and sales clerks. Due to the gendered structure of the apprenticeship system, we focused on male-type (engine fitters, car repair), female-type (office clerks, hairdressers) and mixed occupations (bank and sales clerks). The occupations also represented different status-related employment opportunities: bank clerks being on top and hairdressers at the bottom (see Figure 1).

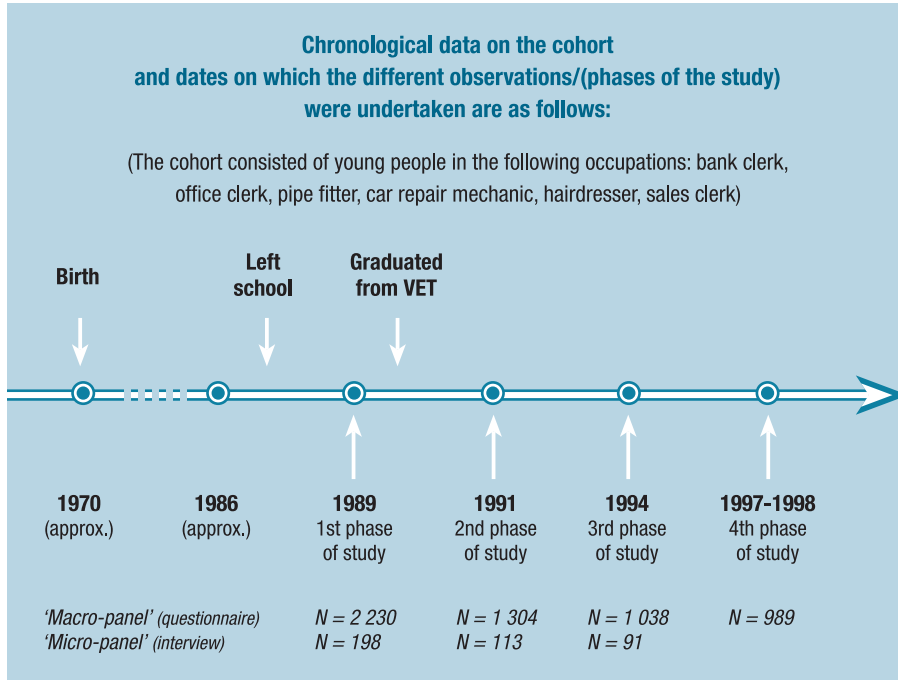
The respondents completed the first standardised questionnaire in their classrooms shortly before leaving their vocational school. The questionnaire queried the respondents with regards to their social background, their educational and training pathways, vocational interest, training experiences and occupational aspiration.

A micro-panel was constructed from a theoretical sampling strategy (Strauss, 1987) through grouping the respondents according to a direct/immediate versus indirect/time-lagged entry into an apprenticeship and by gender, education level and occupation. Altogether we started with

([32]) In this study of the DFG-Sfb 186 (Special Collaborative Research Center, funded by the German National Research Foundation) *Status passages and risks in the life course*, we collaborated with Udo Kelle, Joachim Mowitz-Lambert, Hilde Schaeper and Jens Zinn (see Heinz et al., 1998; Heinz, 1999; Schaeper/Witzel 2001; Schaeper/Kühn/Witzel, 2000; Witzel/Kühn, 2000, 2001; Witzel/Mowitz-Lambert/Heinz, 2001).

15 cases in six occupations in the two regions and some special cases (N = 198); over the three waves of qualitative interviewing we retained 91 cases. Micro-panel data were collected by problem-centred interviews (Witzel, 2000), a method that combines focused with narrative techniques. Coding and interpretative analysis of the interview transcripts followed the procedures suggested by Strauss and Corbin (1990) in the context of grounded theory. The interviews lasted between one and two hours and were recorded and completely transcribed. The transcripts were put on a text file that could be structured by computer-aided text analysis (program NUDIST – see Kühn and Witzel, 2000a/b). The comparison and analysis of 30 cases, based on the interview guide, provided a system of categories that permitted us to structure the remaining 168 cases. This interpretative work was done with continuous 'case-conferences' in our research team which led to a step-by-step development of core categories that could be applied to classify all cases into one of the six types of biographical agency (for details consult Witzel and Kühn, 2000). The data design of the macro- and micro-panels is presented in Figure 1.

Figure 1: **Information on the study of the cohort – undertaken in Bremen and Munich between 1989 and 1998**



The degree of discontinuity and differentiation of job-entry careers over a period of eight years was analysed with standardised panel data in relation, first, to the timing of transitions, second, the duration of job tenure and non-employment episodes and, third, the sequences of work-related events and positions.

As our sequence-pattern analysis of employment careers (Schaeper et al., 2000) shows, a 'normal' uninterrupted course of employment is rarely found in our sample. Therefore, we expect that occupational continuity has been losing ground as a guideline for life-course planning for the job-start cohorts of the 1990s. Below, we discuss the findings from the qualitative panel study which was conducted between 1990 and 1995.

10.4. Findings

10.4.1. Modes of biographical agency

In the course of analysing the interviews that were conducted over a period of six years, we constructed an empirically grounded typology. This typology distinguishes six patterns of action orientations or modes of biographical agency *vis-à-vis* work and career (for details on this see Witzel and Kühn, 2000).

Figure 2: **Typology of modes of biographical agency (based on micro-panel interviews n=91)**

Status arrangement	Company identification Wage-worker habitus	26 21
Advancement ambition	Career orientation Optimising chances	19 15
Autonomy gain	Personality growth Self-employed habitus	6 4
	TOTAL	**n=91**

When comparing the individual aspirations, actions and appraisals of occupational consequences – with a focus on stocktaking – we found that young skilled workers and employees differ in the way they combine criteria for the evaluation of experiences in training and occupational contexts:

these criteria are content/conditions of work, qualifications (skills and knowledge), career opportunities, income and the company's culture.

We regard the modes of biographical agency as specific ways of constructing a fit between the person and the context of work. They have their roots in prevocational socialisation and work experiences, and vary according to the contingencies of careers: they generate patterns of career decisions and actions and stretch across different work situations.

Our typology of modes of biographical agency (see Figure 2) is a heuristic device for reconstructing decisions, actions and meanings related to training pathways, work settings and career outcomes. That is, the ways through which individuals contribute to the shaping of their transitions in the employment system.

The typology distinguishes between six modes of biographical agency:

1. Company identification: The firm is regarded as a kind of home; interpersonal relations at work are highly valued; social support and recognition are expected in exchange for trust and loyalty, even when income is moderate.
2. Wage-worker habitus: Employment is regarded as a necessity and sometimes even as a burden. To improve income and working conditions, jobs and employers are changed. Most highly valued aspects are job security and employment continuity.
3. Career orientation: A career in a company and promotion up the ranks is favoured over occupational alternatives. In order to advance to a higher level position much time is devoted to further education.
4. Optimising chances: Gaining advancement through having a wide scope for shaping one's work history is most important; this is addressed through keeping open as many occupational paths as possible and by gaining additional qualifications.
5. Personality growth: An occupation is seen to be a space for fulfilling personal interests; conditions at work, promotion and income are evaluated in relation to furthering autonomy/self-direction.
6. Self-employment habitus: Freedom in economic and business activities is highly valued; risks are taken in order to become an independent actor concerning work goals and work which are regarded as pre-requisites for business success.

These empirically grounded modes of biographical agency result from processes of self-socialisation in the changing social contexts of the transition from a company in which one received training or a vocational school to the labour market. They generate relatively stable action strategies, which are rooted in a person's appraisal of the consequences of

his actions with regards to opportunities and constraints in the world of work. The typology is a promising differentiation of formal or general concepts, such as 'self-efficacy' (Bandura, 1997), 'intentional self-development' (Brandtstädter and Lerner, 1999) or the 'action-phase model of developmental regulation' (Heckhausen, 1999) in the field of vocational development and career theory.

However, there is no doubt that our respondents are developing and applying biographical agency in a system of socially structured inequality. Access to secondary schools is still influenced by social origin and the school level attained predefines the range of occupational choice and career development options. Social inequality is a central feature of life-course options in Germany (see Mayer and Blossfield, 1990) as in other modern stratified societies (Shavit and Müller, 1998). The same holds true for gender in the social selection processes in the transition to employment. Krüger (1999) has shown that the German VET-system puts women in a disadvantaged position by restricting access to occupations providing long-term employment and good career prospects.

In this context, we wished to determine how education and training and work experiences were converted into career process learning via biographical agency. To understand how biographical agency mediates between occupational and career development, we compared our cases systematically.

10.4.2. Work process knowledge and career process learning

We postulate that work process knowledge is implied in career process learning. Personal goals, interests and motivations concerning work result from processes of self-socialisation in training and work. We define work process knowledge according to the recent publication of Pahl et al. (2000) as a type of knowledge that is related to the entire work process and includes more than practical knowledge or experiential learning; it also entails the integration of theoretical knowledge. In fact, this kind of knowledge is at the intersection of practical and theoretical knowledge. Career process learning is based on socialisation experiences connected to work experiences that result in different modes of biographical agency.

Within our framework of biographical agency, the dimensions 'work activity' and 'qualification' are particularly related to different methods of how persons acquire work process knowledge. Statements belonging to those dimensions show a certain duality: on the one hand, the acquisition of work process knowledge is influenced by occupational options and organisational requirements in the reality of work (see Figure 3 for

distribution of various modes of biographical agency across occupations). On the other hand, the extent to which young employees use or demand work entailing self-directed learning depends on their particular mode of biographical agency. Therefore, it is necessary to understand not only the external working conditions but also (internal) personal motives and reasons for developing work process knowledge in the context of organisational and occupational circumstances.

Figure 3: **The distribution of different modes of biographical agency across occupations**

	Occupation						
Mode of biographical agency	**Bank**	**Office**	**Industrial mecha-nics**	**Car mecha-nics**	**Hair-dressing**	**Sales**	**Total**
Company identification	3	10	5	1	6	1	**26**
Wage worker habitus	0	0	6	8	2	5	**21**
Carreer orientation	8	2	0	4	2	3	**19**
Optimising chances	4	4	3	1	0	3	**15**
Personal autonomy	1	2	0	1	0	2	**6**
Self-employed habitus	1	0	0	1	2	0	**4**
Total	17	18	14	16	12	14	**91**

Young skilled workers in crafts, manufacturing and service jobs, who experienced less successful learning processes in school and in different training contexts, tend to develop modes of biographical agency that focus on ‘status arrangement’. Their school career was restricted to the lower or intermediate level schools (*Haupt- or Realschule*) associated with a lack of theoretical knowledge and a corresponding strength in more practical aptitudes which guide or channel these young people into manual occupations (see Heinz et al., 1987: p. 138). Therefore, we found that workers in the mode ‘company identification’ or the mode ‘wage-worker habitus’ share the preference for acquiring experience-based knowledge. In

their view there is a big distinction between practical and theoretical matters concerning work-related learning. Theoretical learning, required in education, is more or less rejected by them because they see their strengths lying in manual skills. To rely on theoretical reasoning is regarded even as an impediment in the successful performance of work. There is a kind of self-confident rejection of theoretical knowledge that explains why the allocation to less intellectually demanding work does not necessarily lead to a feeling that they have failed in theoretical disciplines.

Despite similar assessments of the relationship between theory and practice in the context of 'individual status arrangement', young skilled workers acquire knowledge in different ways when they are confronted with the qualification demands of companies. Actors belonging to the mode of 'company identification' socialise themselves to accept the learning requirements in a restricted range of job-related tasks. This corresponds to a relatively narrow occupational profile and to a low level of subjective claims concerning the content of work. These respondents resort to compliance to gain employment continuity and attempt to arrange themselves with the job conditions by emphasising good interpersonal relations. 'Company identification' corresponds with a degree of hesitation concerning further learning requirements and with the belief that acquiring more theoretical knowledge will not be necessary for working life. Complying with further learning requirements means that learning processes and their results remain more or less on a formal level; what counts is that participating in further learning will be regarded positively by their supervisors. Young workers with this mode of biographical action orientation believe that it is better to learn the tricks of the trade from more experienced workers because they know how to do a job in an efficient way.

A similar assessment of qualification demands can be found among young skilled workers belonging to the mode 'wage–oriented work attitude' who restrict their interest in work process knowledge to immediate job requirements. The importance of having a job and earning money is emphasised and learning does not extend the scope of a given work place. This orientation changes, however, when there is a clearly defined set of qualifications that appear to be directly useful for improving work conditions and income level. In the latter case, we found that these young skilled workers approach learning options that go beyond experiential learning; they expect to get less stressful and less boring work and to move into jobs where working conditions are more satisfying due to a greater degree of variety in work assignments. Such work experience sets the stage for acquiring some work process knowledge that leads to knowledge about the

work organisation and creates greater expectations about increased responsibility in decision-making at work. Such workers still reject the idea of theoretical learning but have begun to develop some insights into the organisational distribution of job-tasks, which require greater knowledge of alternative procedures. Although there is no explicit preference for further learning, there is a tendency that young workers with the mode of 'wage–oriented work attitude' try to acquire work process knowledge. This behaviour is guided by practical job experience and can be seen as a consequence of a long period of job tenure.

Despite adopting a sceptical attitude to theoretical learning, young skilled workers whose biographical orientations focus on 'status preservation' attempt to acquire work-related knowledge to some extent. However, this is restricted to immediately useful and useable knowledge about their job activities. Their willingness to acquire theoretical knowledge is motivated by practical reasons connected to job conditions, social recognition and employment continuity. It is rarely linked to an intention to accumulate knowledge for promotion or a more complete understanding of the politics or structures shaping the work place.

It is quite different for the modes of 'optimising chances' and 'career orientation', which are linked to another kind of assessment about the acquisition of knowledge: accumulating work process knowledge serves the purpose of occupational advancements. Young skilled workers with a strong career orientation actively engage in regular further occupational development activities. This corresponds, for instance, with the occupational culture of banking which offers opportunities for status advancement based on a demonstration of personal achievement. Here, one's occupational biography is shaped by acquiring knowledge that provides the opportunity to work on a broader variety of job tasks that require theoretical knowledge and insight about a range of tasks and jobs around the business process. Work experiences and interest in one's own occupational skills create career process learning which transcends the work place and takes into account work organisation in the context of the economy. This mode of biographical action orientation may improve access to differing job assignments, prepare for collaboration in teams and projects and open pathways to different divisions within the company.

For those who belong to the modes of 'optimising changes' and 'career orientation', theory and practice are not seen as mutually exclusive. The work organisation of the company and the nature of their jobs require an overview of, and an insight into, the whole work process of the organisation. This demands theoretical knowledge concerning different job tasks. We

found an interest in acquiring work process knowledge mainly in bank clerks who prefer the 'career orientation' mode of biographical agency. They wish to acquire knowledge that extends beyond task-specific requirements in order to increase flexibility in dealing with the various job demands of the organisation.

A similar orientation can be found among those car repair mechanics who succeeded in gaining employment in line with their skill levels and are confronted with rapid technological changes in their occupation. They wish to stay abreast of new developments in their occupational field in order to understand the new technologies related to their repair jobs.

Young skilled workers with the mode 'optimising chances' do not relate their career process knowledge to firm-specific promotion, but rather wish to develop a broad range of competences that will give them multiple occupational options. Having acquired work process knowledge through combining job-related experiences with a series of training seminars, for instance in a bank, they tend to criticise these seminars for being related to work processes that are too specific and restricted to limited tasks. This critical stance often gives rise to decisions to opt for a career move by enrolling in academic studies. They wish to learn theoretical knowledge because they intend to combine work experience (providing organisation specific knowledge) with the acquisition of a higher level of competence, surpassing immediate occupational usefulness.

While bank clerks plan a return to higher education as an element in a long-term career strategy, industrial mechanics – who do not have university entrance qualifications – tend to change careers due to disappointing work experiences that do not recognise their skills. They argue that their biographical decision to acquire higher educational credentials will provide them with more theoretical knowledge making them less dependent on manual skills. The preference for acquiring theoretical knowledge is related to an ambition to improve their occupational status, which in turn provides them with a more independent and rewarding work life.

Among office workers within the mode 'optimising chances', we found the emergence of experiential career process learning, stemming from a change in jobs, provided them with a variety of challenging work process experiences. This group mainly comprises women with an intermediate level of schooling who decided to make the best use of their vocational skills. They do not change their career through wishing to take academic studies, but rather through changing jobs and companies in order to accumulate work process knowledge. This improves their employment opportunities and keeps open several occupational paths.

Skilled young workers within the mode of 'personal autonomy' value further learning highly because they see acquiring theoretical knowledge as a means of personal development. Having the opportunity for continued learning means an increase in the quality of life, especially if this is related to academic studies and the autonomy linked to this lifestyle. These skilled workers see themselves as actively shaping their own biographies and regard studies not so much as an instrument for a career but as a very satisfying personal development period. They do not regard their field of study from the perspective of practical utility but as a way of nurturing their personal growth.

When jobs and employment offers are assessed from the intrinsic perspective of enlarging one's knowledge, however, finding a job that satisfies the claim of being 'intellectually challenging' is quite difficult. Since employment should also be socially meaningful, very few skilled workers within the mode 'personal autonomy' succeed in realising their claims. Thus, they tend to accept compromises by combining part-time work for earning money and academic studies in order to satisfy their interest in acquiring theoretical knowledge. A compromise is also possible by accepting a job that provides work process knowledge for a temporary period without giving up a biographical project to take further academic studies.

Finally, the young skilled workers who have developed the mode of 'self-employment habitus' engage in work process learning not for personal development but in order to optimise business success. Through learning from their experiences and the experiences of others they develop a deeper understanding of business practices. They accept theoretically oriented courses only if convinced that the content is relevant for their business plans. Moreover, multiple and wide-ranging business activities are seen as sources of knowledge, together with involvement in further education. This 'career-process learning' is embedded in a strategy of professionalisation to improve business opportunities in the context of competition. In contrast to the biographical mode 'personal autonomy', the mode of 'self-employment habitus', leads to learning activities that are a prerequisite for business success. The aim is not to acquire general knowledge but to obtain a certificate, diploma or a degree that is formally required in order to run a business or can be used as a status symbol to enhance their reputation.

10.5. Discussion and conclusions

Our qualitative analysis of work experience and career-related learning has shown that the knowledge acquisition processes described above are not independent of trainees' and young workers' occupations (*Berufe*). We found that self-initiated work process learning is most often associated with bank clerks and engine fitters, while a passive compliance with learning demands is more characteristic of hairdressers, sales clerks and car-repair workers.

'Transition research' is concerned with determining the adaptive skills that mediate between social, structural and organisational conditions and job-entry pathways (see Reitzle and Silbereisen, 2000). Personality characteristics such as risk-taking, planning or self-confidence tend to be mediating factors having an impact on different patterns of timing, sequencing and completing transitions.

Our analysis suggests that there is not only variation between, but also within occupations in dealing with the learning constellations and employment conditions. However, our results are not conclusive because this exploratory study only focuses on six occupations and one job-start cohort. Therefore, we cannot generalise for other occupations and cohorts. However, there are indications that the relative importance of practical and/or theoretical learning and knowing is associated with the respective modes of biographical agency that young skilled workers develop during their occupational self-socialisation.

Success and failure in translating one's work process knowledge into career process learning is closely linked to efforts to maintain or improve one's biography-work-fit. Life-course learning is not totally path-dependent because skilled young people in particular have the opportunity to select or choose different transition pathways, leading to a diversity of early employment trajectories.

We have argued that restructuring work leads to the destabilisation of career patterns and an increase in interruptions at the job entry phase. This may threaten the occupation as a mechanism of social integration, but not as an institutionalised framework for acquiring work process skills and biographical action orientations. An experience of discontinuity can come in different constellations and initiate a decline in work orientation for a minority of young people. This triggers a search for improving or maintaining a biography-work-fit when skilled young workers take up career learning objectives.

We have shown that, in Germany, the concept of occupation (*Beruf*) and its career orientation provides a context for self-socialisation that guides young skilled workers in adapting to discontinuity in employment. Our qualitative data analysis suggests that there is an association between occupation, gender and modes of biographical agency and a correspondence, though not a perfect one, between the modes of biographical agency and the way skilled young people acquire work process knowledge and engage in career process learning. Although the German dual education and training system structures the transition from education to work via vocational education and training, personal career options still vary in accordance with gender, social origin and the opportunities existing within specific occupation contexts.

The experiences of our respondents since they entered into an apprenticeship – up to eight years in the labour market, an observation window of more than ten years – show that the concept of occupation (*Beruf*) is not in decline as a socialisation framework and social institution for career process learning. It is remarkable that only a small number of our respondents lowered their aspirations, resigned themselves to becoming 'deskilled' or withdrawing from employment. It seems that most of the young people interviewed in our study managed to translate their training and work experiences into relatively stable patterns of biographical agency and found personally meaningful ways of dealing with work settings and career requirements.

We can conclude that, despite substantial career changes, only a few of the young skilled employees lost the identification with their occupation (*Beruf*) as a guidepost for shaping their careers. However, when frequent attempts to match their skill profile with satisfactory job requirements fail, a loss of trust in this biographical perspective is likely. It must be mentioned that most of our respondents use their work experiences as a challenge to convert their basic occupational skill profiles into a construction of new pathways or bridges to a more self-directed employment career. Again, such an attitude reveals that work-related learning and the acquisition of work process knowledge cannot be seen to be independent of career aspirations (and realisation) and the different modes of biographical agency that people adopt throughout their life-course.

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SECTION V

Analysis of work process knowledge for teaching and learning

CHAPTER 11

Psychological analysis of complex work environments

Janine Rogalski

11.1. Introduction

Complex work environments exert strong demands on actors, whatever their position in a work organisation. The competences needed to confront challenges in a dynamic professional world may be developed by combinations of training and activity in the context of work itself. Psychological work analysis is needed both for identifying the possible developmental impact of professional activity and for defining constructive properties of work or training situations to cope with complexity in technological and organisational changes. In this chapter, the author presents a framework for a global dynamic work analysis. This includes the twofold control loop of activity in work situations, developed from the schema of activity-regulation proposed by Leplat (1997) and a model of competence based on a structural model of operational knowledge, KEOPS, proposed by Rogalski (1995b). The '(work) situation view' concerns the work process as a whole over time. Therefore, the twofold loop is concerned with several spatial, temporal and organisational spans. Professional competence is one of the key components in the 'individual (competence) view' determinants. The issues of training for work process knowledge and competence development are discussed in terms of transposition of work situations, that is, designing 'situation components' in a way that enables expected changes to be attained in regard to the 'individual component' through actors' activity in simulated situations.

11.2. A framework for work psychological analysis

The term 'work process knowledge' was proposed to account for 'knowledge of both the labour and the production process' (Boreham, 2002). The underlying conceptualisation was developed against a previously dominant conception of vocational competence as knowledge required for

performing a given task, defined in a Taylorist manner (and in the context of Taylorist work organisations). In fact, the notions of 'operational knowledge' and 'professional competence', developed in the French community of work psychology and professional didactics (Leplat and de Montmollin, 2001) are compatible with the conceptual approach of work process knowledge.

In a historical review of psychological work analysis, Leplat showed how the field of work was extended. New approaches were developed, with 'systemic and macro-organisational perspectives increasing in importance and placing an emphasis on the way the set of conditions are organised in activity [at work]' (a translation by the author, Leplat, 2000, p. 90). He also underlines another evolution: subjective aspects, such as internal operator's conditions, skills and competences with regard to not only a well-defined task but also a work field. Goals adopted by actors in relation to their activity were increasingly taken into account. In this evolutionary process, an interest in collective activity was also developing. However, it was noted that work activity is not only oriented toward production but also toward the development of professional knowledge and efficiency (that was sometimes called 'metafunctional activities'). The twofold control-loop we propose above for analysing activity in work situations takes such factors into account.

11.2.1. The twofold control-loop of activity in work situations

The framework we propose for psychological work analysis is centred on consideration of individual activity. We differentiate between task and activity: the task is what has to be performed concerning the world to be acted on. Initially defined by Leontiev (1975, 1978), a task is 'a goal under given conditions'. In work situations, when individuals are performing a task, their activity is not only what they develop in order to reach the target-state defined in the task, given the conditions, but also what is oriented towards their personal motives. In summary: ' task is on the side of the objects of the world to be acted on, while activity is on the side of the individual subjects, or groups as self-active systems ([33]). Tasks can be considered both from the point of view of the prescriber (eventually a system) and from the point of

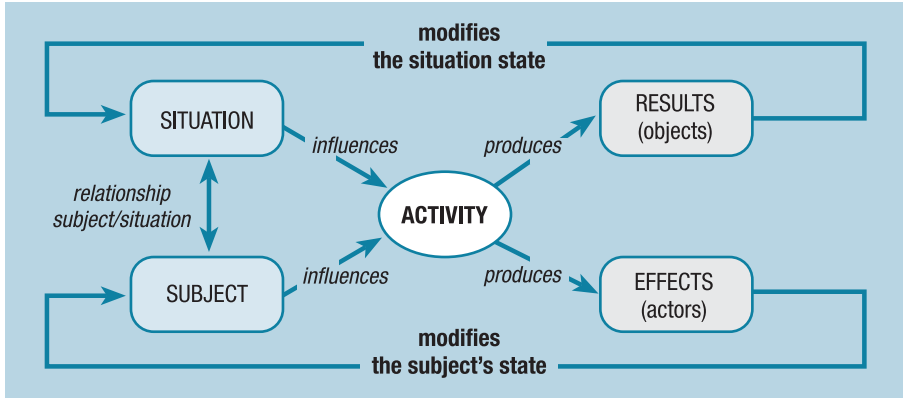
([33]) The notion of a group as a self-active system was developed by von Cranach et al. (1986). The framework will be widened with the notion of virtual operator: a virtual operator is a sub-system of actors to whom a given task (or mission) is allocated. Frameworks and methods developed to analyse individual activity or competence can then be used for the analysis of activity and competence of any sub-systems considered as a whole. For instance, interactions between pilots and air-traffic controllers can be generalised to interactions between the 'cockpit' and the 'air traffic control'. In fact, this reflects the way pilots and controllers interact. Similarly, in crisis management, or in production management, a productive way of analysing a commander's or a manager's activity was to consider that he was interacting with virtual operators (subordinates, hierarchy, actors in other firms).

view of the performer (individual, team, or virtual operator, which may all be considered as systems). The approach developed in the French community of work psychology (or ergonomics) converges with those reported by Röben (in this volume) about the definition of the concept of the work task.

There is an important difference between a task – a goal to be achieved under given conditions – and activity, that is, what a subject develops and controls (cognitive operations, perceptions and actions) when performing a task (Leplat, 1997). Activity goes beyond work performance in that it also involves actions oriented towards self-management and possibly unaccomplished goals and actions.

Both technical-organisational demands and the individual's properties determine activity and they are informed and modified by activity. A schema of the twofold control loop of actors' activity in work situations is presented in Figure 1. As work process knowledge is a component of the individual's determinants, the model of twofold regulation expresses that work process knowledge (WPK) is both a prerequisite and a result of activity, as underlined by Röben. In fact, the twofold regulation presented in Figure1 is the same whatever is considered to be the level of the 'subject' of activity. It may concern an individual actor, a team of actors (e.g., the crew piloting an aircraft, the team in the control room of a nuclear power plant), or a more complex collective organisation, involved in a common mission (such as an intervention unit in forest-fire fighting, involving 18 fire fighters, or a coordinating group in concurrent design).

Figure 1: **Schema of the twofold regulation of activity in a work situation.**



(Comment on figure: the subject's activity is determined both by 'external' variables of the work situation and by 'internal' variables, depending on the subject. Similarly, activity both affects situation and subject through the results on the objects of the situation and through the effects on the subject.)

The 'coupling' between the situation and the subject is in itself dependent on *a priori* factors linked to the position of the subject with regards to the work situation. It is also dependent on *a posteriori* factors due to the subject's activity itself. We will not develop this point, despite its importance. It is less an issue of knowledge than a point of articulation between the individual psychic perspective, as analysed by Clot et al. (2002) in the 'clinic of activity' and the collective social perspective, involving the notion of contract as analysed by Reynaud. The latter author insists on the necessary uncertainty and 'incompletion' of the work contract involving authority, exchanges and a continuous process of imbalance and re-equilibration (1997, p. 150), before analysing social conditions for organisational learning (the social counterpart of individual competence development).

11.2.2. Forward and backward analysis in the control-loop

This loop may be used in a forward and backward manner in order to tackle various issues concerning the situational and the individual point of view.

In a forward analysis, one can look at (a) the effect on work activity of variables either in work situations or in actors' properties (or both). If we look at (b) we can see the feedback effects of such variables on task performance, or on actors' state.

Through this two-fold regulation model, one may also analyse the process of adaptation to various changes. The issues and the results may concern changes in the system of resources and constraints (Reynaud, 1997) and may include both the tools – including externalised shared knowledge – and the modification of the work process itself, together with possible changes concerning goals themselves.

Considering the 'individual's view', one may analyse the process of individual competence development and the development of collective competence from two perspectives: first, taking work units as entities and second, considering individual competence for collective work. The latter approach may be crucial when considering situations where the operational device and/or the relative positions of individuals within the operational device may differ depending on the situation (it is the case for piloting civil aircraft, or for fire-fighting, two types of situations for which our approach was developed. It may also be the case in project management, or more generally in flexible work).

Backtracking in the control loop is mainly concerned with two aims: inferring actors' competences from an analysis of their activity (and its effects) in performing tasks in various situations; and designing training

situations to provoke specific competence development. Inferring competence calls for a variety of methods we will not develop here ([34]).

11.2.3. **The notion of operational device**

The situational determinants involve a detailed definition of the notion of 'task'. First, we developed the notion introduced by Leontiev in expanding what is 'a goal to be reached under given conditions', by expanding his definition along teleological (goals and motives), axiological (criteria and values) and technical dimensions (constraints and resources) (Rogalski, 1995b). A task can be seen as a target state for the objects of the world of action, to be reached through a system of resources and constraints. This target state is reached according to a system of criteria and values concerning the action in context. For instance, the task of air traffic control aims to achieve safety and movement in air traffic, through a system of regulations (constraints) and a set of operative tools (resources). The criteria are companies' interests as well as safety limitations. These may be conflicting (even if safety becomes an increasing collective social value). Work-to-rule may be adopted in, for example, the event of an accident where controllers were implicated.

Second, we extend the notion of task in considering three points:

(a) any task can be seen as a node in a net of tasks (for a given actor);
(b) any actor occupies a position in a net of actors involved in a common global task or mission, through a vertical and horizontal organisation;
(c) the nets of tasks and of actors are evolving over time: in short-term activity some tasks are achieved and some enter the agenda. In long-term activity wider changes may appear.

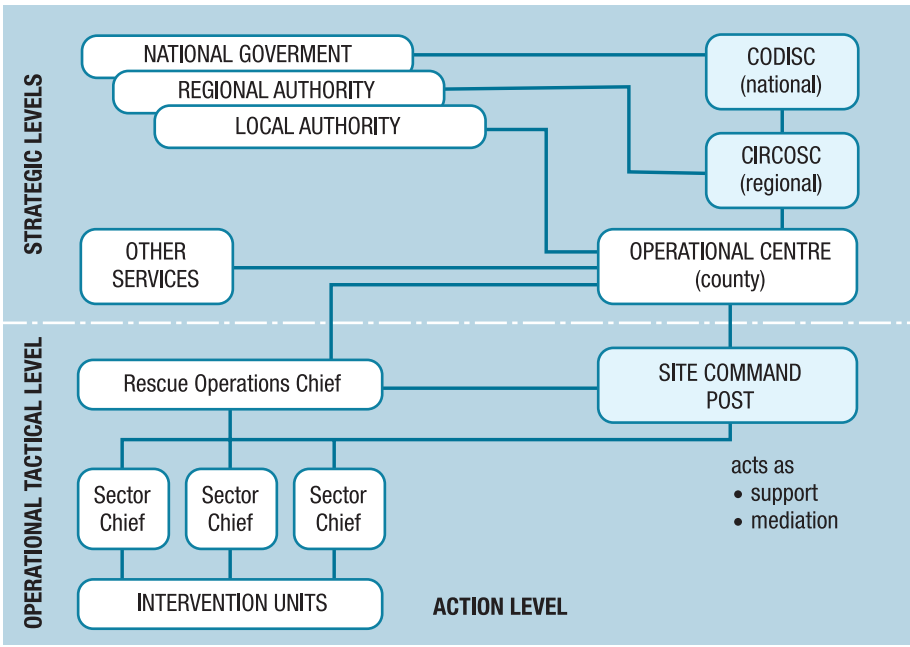
The management of large-scale emergency situations was taken as a paradigm for defining and analysing how the net of tasks and the net of actors are intertwined with the notion of operational device (Rogalski, 1991).

Beyond the organisation of tasks and actors intending to perform a mission, the notion of operational device entails the flow of information, matter and energy within this organisation. It is defined from an operational point of view for a particular purpose and it can differ from the hierarchical permanent organisation in a given system. Figure 2 sketches the virtual

([34]) The issue of activity analysis has been developed for instance in: Amalberti, R. (1990). Activity analysis in field studies. *In*: J. Rasmussen, A. Pejtersen & K. Schmidt (Ed.) *Models of human activities in work context. taxonomy for analysis of work domains. First MOHAWC Workshop*, 2 (pp. 19-32). Liège, and Amalberti, R. and Hoc, J.-M. (1998) Analyse des activités cognitives en situation dynamique: Pour quels buts? Comment? *Le Travail Humain*. A wide overview can be found in Vicente (1999).

operational device for crisis management (large emergency situations, managed within the frame of public safety). It articulates strategic, tactical and physical levels (Cdt Bonjour, 1998). The operational tactical level has to be considered as an entity, under the operational responsibility of the rescue operational chief (ROC) who is a high-ranking fire fighter officer. Each actor needs to know his position in this unit, implying duties, space of freedom and regulations in the communication flow.

Figure 2: **The operational device in the case of large-scale emergency situations.**



(Comment on figure: depending on the severity of the situation and the adapted means for action, this can involve one or more strategic levels (CODISC and CIRCOSC are strategic operational centres respectively acting at regional and national level).

The notion of operational device departs from sociological approaches where collective activity is considered as a form of node or sub-system in a global system; it is centred on purposeful activity. It also departs from the notion of 'activity system' developed by Engeström (1995). The notion of operational device aims at articulating different levels in work activity and tries both to maintain the level of individual subject's activity and to take into account the organisational level in the development of competences.

Elsewhere, the notion enables analysis within the same conceptual and methodological framework, contexts where 'occupational work' is concerned (Röben, this volume) and contexts where actors are involved in a particular mission, which is specified in content, organisation, time and space. Examples are presented in the appendix of the emergency operations procedures manual for fire fighters and incident management in a nuclear power plant, where the operational device extends beyond current work organisation within the control room.

11.3. Competence in a work domain: a multidimensional organisation

The notions of 'operational knowledge' and 'professional competence' were developed in the French community of work psychology and professional didactics. They are compatible with the conceptual approach proposed by the theory of work process knowledge. As with WPK, operational knowledge concerns the world to be acted on, the organisation to be worked in and the processes performed at other locations in the organisation. It articulates knowledge about the world to be acted on and knowledge about the system of actors and the flow of work.

We define competence as a multidimensional organisation, which expresses the potentialities of an actor to cope with work situations. Competence is not observable: it has to be inferred from activities developed by the actor under various circumstances. It may be analysed from three points of view, or along three axes: a) operational knowledge, b) schemes of action and c) actor's qualities (*Eigenschaften*) that are available, or may be mobilised, in a class of situations within a work domain ([35]).

11.3.1. **A model of operational knowledge**

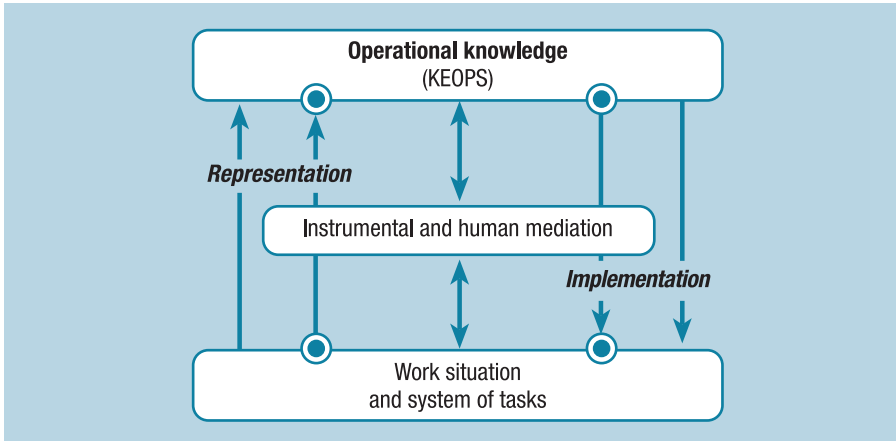
A model of operational competence was proposed (Rogalski, 1995a), as an extension of the notion of 'conceptual field' G. Vergnaud proposed for analysing student learning in mathematics and other fields of knowledge (Vergnaud, 1991). This model, KEOPS, has four dimensions: knowledge (K), experience (E), operative cognitive tools (O) and problems and solutions

([35]) We depart from the definition generally adopted in cognitive ergonomics for competence as a 'system of knowledge which will enable activity to be generated to meet the requirements of tasks of a given class' (Leplat, 1991). This focus on the cognitive dimension was probably motivated by the issue of cognitive task analysis in domains mainly involving information processing (human-computer interaction).

(PS). Beyond these dimensions, meta-knowledge for an individual consists of knowledge of knowledge itself (epistemic reflexivity) and in knowledge of our own competence.

Operational knowledge, as described through this model is defined at the representational level of what is conceived about the world of action in the individual's activity. Various methodologies can be used to infer the properties of KEOPS for actors in a work domain. As it concerns a representational level, it can be reached through verbalisations. This level has to be linked to the physical level of 'what is perceived and acted on', that is, the level of the 'objects of the world of action' (OWA). Figure 3 presents a schema of the relationship between the representational level and the physical level.

Figure 3: **Schema of the core of an integrated model articulating operational knowledge (representational level) and activity in work situations (functional level).**



(Comment on figure: the cognitive processes of representation and implementation link the contextual and temporally situated action on the 'present objects of the world' (Gegenstände) to the (more) stable and non-contextual level of 'conceptualised work entities'. The existence of human and/or instrumental mediation requires interpretation processes for human mediation or specific schemes of use.)

There are two key processes involved. Representation comes from a conceptualisation process, defining a conceptual field within K, categorising the situation in terms of PS, activating episodic knowledge in E and orienting toward the elements in O. Implementation is the reverse process. Activity involves, but cannot be reduced to, the complex including the two types of processes that relate KEOPS to the world of the objects of action and the various cognitive processes, which develop at the representational level.

11.3.2. Schemes of action

Following the Piagetian notion, further developed by Vergnaud (1998), we define schemes of action as invariant organisations of activity in a given class of situations. These can be considered from the point of view of a professional community: they are common, regular 'ways of doing' and are partly expressed via work procedures. They are components of shared operational knowledge when collective work is involved. They can also be considered from the point of view of the individual, as their own regularities in action, which enable more fluent action, requiring a lower level of control and enabling them to exert a wider power of influence on their posture, with regards to the work situation. Such 'ways of doing' have been theorised by Clot et al. as 'genre' when collective and 'style' when individual, from a transposition of Bakhtin's notions (Clot et al., 2002). Schemes and instrumented action organisers are components of competence development, as exemplified in the case of electrical maintenance (Samurçay and Vidal-Gomel, 2002).

11.3.3. Work process knowledge in professional competence

Work process knowledge concerns both what is processed (the objects of the world of action) and through whose activity is it processed (the operational device through the activity of which production is ensured). This could be seen as an extension of the analysis Bainbridge made of cognitive requirements for managing dynamic situations: it requires a model of dynamics of the world and a model of the operator's actions on this world (Bainbridge, 1988). In the case of collective work, the requirement for the first model is unchanged, while the model of the operator's own action is split into two models: a model of the action of the team considered as an entity (virtual operators' action model) and a model of the articulation of individual operator actions into team's action (articulation model). This can be extended to activity in an operational device.

In fact, operational knowledge involves two types of representations (*Vorstellungen*). These two types of representations concern, first, properties of what is processed (technical professional knowledge) and second, the properties of the operational device (in an analysis of collective training in dynamic environments – Rogalski at al., 2002 – we call it doctrinal knowledge). Technical knowledge is required for identifying what the state of the world to be acted on enables us to do, while doctrinal knowledge concerns what the work organisation allows a given actor (or any acting entity) to perform. Work process knowledge may be considered as articulating the two points of view.

Within KEOPS, work process knowledge does not only concern general knowledge (on the K-PS axis): it also involves the 'apex' E. The role of 'experiential knowledge' arising from work episodes was illuminated in a study by Baerentsen, in a highly automated power plant. He showed that 'a considerable amount of knowledge based on experience [circulated] among operators and that this circulation of informal knowledge [provided] a potential for development and maintenance of qualifications, general knowledge and motivation' (Baerentsen, 1996, p. 318). The role of accident scenarios was similarly underlined in the case of traffic safety (Stoop, 1997). The importance of experience as an element of WPK was extensively analysed by Fischer (2002). With the exception of the limitation of visual images, we agree with the multiple statements Fischer makes about the nature of experience and its relationships with a variety of notions involved in the general issue of WPK. His introduction of a 'dialectic term of experience as an act of reception and an act of production' enables us to understand the strong link between the representational level (which is stressed in KEOPS) and the perceived and enacted level, at which the potential of professional competence becomes effective in 'action performance'. It also enables us to account for the fact that 'experience of the ancients becomes knowledge of the beginners' as expressed by an expert firefighter officer (both as a chief of rescue operations and as a trainer). However, we argue that there exists an 'envelope' of professional situations within which actors may learn from experience, under conditions of collective support and allotted time resources. This envelope may be seen as a 'zone of proximal development' (Vygotsky, 1985) for the case of professional competence. Outside this zone, specific training-situations would be needed.

11.4. Work analysis for identifying competence and designing training situations in complex work environments

The methods of work analysis developed in work psychology (Amalberti, 1990; Amalberti and Hoc, 1998; Vicente, 1999) may be used in a dialectical manner: first, analyses of real situations parallel with the design of training situations (simulations); second, simulated situations may be used for analysing actors' activity and for inferring competence requirements for the target situation. This requires fields of operational knowledge to be related to a typology of situations (such a relation could then be used for analysing possible transfer).

There are two main processes that may be implemented in order to design training situations within the zone of proximal professional development: cutting-out sub-tasks and uncoupling sub-systems. Beyond these processes, the development of work process knowledge sufficient to deal with complex cases requires the range of the training situations to be expanded.

11.4.1. Typology of situations and hierarchical fields of operational knowledge

The first process in the transposition or 'fitting out' of work situations for didactical purposes is the use of a typology of situations ([36]) which will serve as a basis for inferring competences and designing training situations. If S1 and S2 belong to the same type S, or share near key parameters, then competences expressed in S1 on dimensions that are shared within S are also competences for S2. The issues of controlling the complexity of training situations (with regards to target work situations) and the questions of transfer are directly linked to such use of typologies.

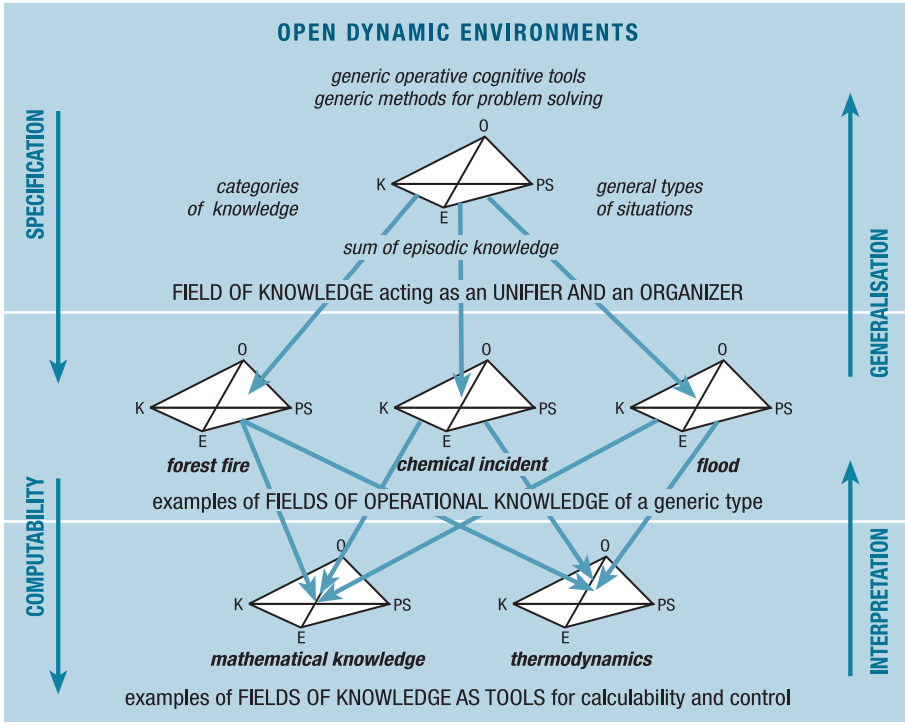
Our claim is supported by considering an extended version of the KEOPS model into a model of hierarchical KEOPS. Such a model (presented in Figure 4), for the case of open dynamic environments management, relate specific fields of operational knowledge in various domains of work to two other levels of operational knowledge. First, at the upper level, a field of operational knowledge acts as a unifier and an organiser; it is constructed via a process of generalisation and is then relevant for a class of work domains. Second, various fields of operational knowledge, depending on the scientific or technical domains, play the role of tools with regards to operational knowledge processing. They are used in modelling the production process – wherever possible – in ensuring computability when necessary and in controlling the validity of pragmatic concepts and techniques.

Two types of processes exist that relate these fields of knowledge: a twofold process of generalisation/specification relates specifics to general operational knowledge, while a twofold process of computability/interpretation links specific KEOPS to technical operational knowledge. Both

([36]) A typology of process-control situations has been developed by Hoc (1993) in the case of industrial processes. Baron et al. (1989) proposed a more complex multi-dimensional typology, articulating – among others – the level of physical parameters of the environment to be managed, the level of modelisation of the dynamic world and of the actions on it, the level of foreseen operational organisation (operational device and means) and the variety of services and organisations involved.

are concerned with analysing the potential transfer from a (training) situation to another one.

Figure 4: **Schema of hierarchy of fields of operational knowledge in the case of open dynamic environment management.**



11.4.2. Cutting out subtasks and uncoupling subsystems

As outlined in the presentation of the twofold control loop model, work situations can be analysed into components in order to reduce complexity both for inferring competence and for designing training situations. Experts can be interviewed and their activity observed in order to link situational components and specific competence subsets. In particular, critical tasks in the situation are deconstructed into subtasks, via a hierarchical task analysis. Objects of action and systems of control-command are analysed in a parallel manner. If a situation S has T as a critical task and if T requires us to perform two subtasks T1 and T2, a cognitive task analysis of T1 and T2 is developed for inferring two competence subsets. This analysis is then used for defining a 'part-whole training' approach. A further step takes into account the interdependence between the objects of action, the actors

involved and the actions required for performing the subtasks T1 and T2. In the field of aviation, problems due to the integration of specific subtasks in the global flight task led to the concept of line-oriented flight training, in full-size simulator training sessions.

When transposing a real work situation for training purposes it is impossible to tackle the work system as a whole. Subsystems have to be defined, that are supposed to be the main determinants of the activity, which consequently lead to competence requirements. These subsystems are used as inputs for individual or collective activity, to develop competence through practice. Competences linked to secondary determinants are allotted to further steps in training, or to further real work situations. Defining the level and the spatial-temporal delimitation of such subsystems requires previously developed activity analysis in a work situation, for various types of actors. Delimiting subsystems raises the issue of uncoupling a subsystem from higher-level systems. (The same is true for risk analysis, as was stressed by Rasmussen, 1997.)

In real situations of command (for example, dealing with forest fires) we have observed decisions being taken for immediate action at the expense of taking into account a serious risk. These decisions were not determined by an underestimation of risk: they were due to the authorities' expected reaction, or that of the media (in newspapers and TV) with regards to the duty to act required of fire and rescue services. In such cases, operational competence includes the ability to anticipate how to defend their decisions. The 'cut-out' of a subsystem nearest the present tasks and objects of action would exclude the possibility of a didactical intervention at this point.

11.4.3. Expanding the scope of training situations

Technical dimensions of competence may be developed through training situations centred on a well-defined task or set of tasks, involving an actor or a limited team of actors. For instance, this is the case, with respect to initial training, for pilots learning to fly a new model of aircraft, in controlling a nuclear power plant, or fighting against a limited fire.

In non-routine situations, such as critical incidents, it is often the case that the operational device stands at a distance from the current 'local' organisation. In such situations, there exists a strong interdependence between actors participating at various positions in a complex operational device. Actors not only need to know the system of dependencies but they must also be able to manage them in real time, under pressure, according to the novelty of the situation and according to the possible risks involved in its development. Designing training situations for this purpose must reflect the

system of interdependencies, through involving actors at different places of the operational device in the same training unit.

The issue of training for shared mental models (or shared operational representations) has been identified as a key point in training for collective competence, even in the case of small teams (Rouse et al., 1992; Stout et al., 1999). Such shared knowledge involves representations of how the world of action can be perceived and acted upon from different locations in the operational device. The notion of cross training was introduced as a step in this direction and was proven to be efficient, concerning the training of relatively small teams (Cannon-Bowers et al., 1998).

A training simulation organised with the whole set of actors at all levels was found to achieve better work relationships in a large power plant. Critical incidents were played in such a way that any actors might identify the set of constraints on the others and may discuss their respective points of view in the operational device (Jansens et al., 1989).

Our own studies of fire fighter officer training led us to similar conclusions. In particular, training officers using staff-methods to manage complex operations had to position them clearly as actors in a site command post (CP) acting as ROC's support system. In effect, a first series of training sessions, strictly centred on CP activity, showed an unavoidable difficulty in acting at the appropriate tactical level and a tendency to take charge of tasks devoted to other action systems (operational centre, ROC and sector chiefs, Figure 2). At the same time, allocation of tasks within CP was relatively unstable (mainly due to the fact that the flow of communication with CP 'outside' was undifferentiated). Conversely, when OC and ROC roles were played by trainees themselves (Rogalski et al., 2002), responsibilities were better distributed within CP. The simulation ran more smoothly and was more positively evaluated by trainers and trainees.

However, two types of professional competence cannot be developed via training situations, whatever the quality of a simulation. The first is related to qualities involved in the activity of perception/action on the real world. The second type is the ability to be aware of, and play with, the 'coupling space' between individuals and the situation. An important case of this is identifying situations where it is possible to violate general rules, or to relate to higher-level rules (for ethical or safety reasons, for instance). Rules are not only procedural, oriented toward the objects of action (action procedures) or the actors themselves (safety rules): they may also be communication rules (who has/is allowed to communicate with whom and through what medium), or rules for task allocation (who is required/allowed to do what). This implies first that the individual knows the meaning of the rules and not only the letter,

their reasons and the consequences of departing of them, and, second, that they identify the type of situation they are involved in. This can only be done in real world situations and calls for well-designed experience feedback (taking into account the whole twofold regulation system of work activity).

11.5. Conclusion

A framework for cognitive work analysis has been proposed which encompasses the complexity of work from the point of view of subjective individual activity. It is organised around three main concepts developed from French work psychology:

(a) activity is analysed as the core of a twofold regulation loop (Figure 1);
(b) work performance is seen as resulting from distributed activity between actors in an operational device (Figure 2);
(c) activity is dependent upon competence which articulates three dimensions: operational knowledge – including work process knowledge – schemes of action and instrumental activity organisers.

It is also dependent upon the individual's properties concerning their relationship with the 'objects of the world of action' (including themselves and other actors [Figure 3 and 4]). The dynamics expressed by the double regulation concerns all components: work situations, actor competences and the 'coupling space' between human subjects and situations.

Work process knowledge enters into this at two levels. First, emphasis is placed on knowledge (defined at the level of 'what is conceived'). Second, emphasis is placed on the organisation of the activity in a given field of action ('related to the world being acted on'). We developed the notion of 'operational knowledge' from consideration of the first of these: it was defined as a network articulating four perspectives:

(a) conceptual and factual knowledge (including scientific, technical, and pragmatic concepts);
(b) types of situations to be handled and classes of solutions to these situations;
(c) operative cognitive tools;
(d) episodic knowledge (coming from experienced situations, that is fairly contextually based and personalised knowledge).

From the second point of view, professional competence includes operational knowledge but is not limited to it. Beyond the level of operational knowledge (what is conceived), the operator's properties related to perception and action are components of their professional competence (what is perceived and acted). Also, apart from the somehow structural –

hence static – definition of operational knowledge, competence also involves a dynamic dimension, related to the organisation of the operator's activity, including schemes and repertories of actions.

The proposed frame may be used to analyse either situations – as enabling or not the development of work process knowledge and individual competences – or actors' competences and positions, with regards to work situations. It may also be used for intervention. We gave some examples of such an approach being used for designing training situations. Methods for implementing such an analytic approach were beyond the scope of this paper. They are, however, as important as the conceptual framework itself.

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CHAPTER 12

Work analysis and curriculum based on the *Beruf* concept [37]

Felix Rauner

12.1. The vocational research contribution to qualification research and curriculum development in Germany

Vocational training cannot be planned without taking account of trainees' ability to cope with occupational working tasks. As Robinson observes, 'education equips people to handle life situations' (Robinson, 1967, p. 45), and this has particular relevance to the design of learning and teaching in vocational training. The determination of qualification requirements has been afforded particular importance in the development of dual vocational training since the 1920s. The most diverse procedures in the empirical analysis of vocational activities and tasks have tried to identify the practical vocational substantive elements of training which are then assembled in a training framework plan (see Stratmann, 1975; Benner, 1977; Heidegger et al., 1991). In this connection an underlying guiding principle has been that of keeping the temporal separation between technical evolution and changes in both work systems and the content of the training as short as possible. The German Vocational Training Act (BBiG) states in paragraph 25 that occupational training regulations need 'to be adapted to technical,

[37] Even though the term 'occupation' is normally used to translate the German term '*Beruf*', it does not capture its real meaning. Whereas the word 'occupation' connotates a more utilitarian perspective on work – an occupation is a job one does to earn a living – the term '*Beruf*' has the meaning of committing oneself to the mission of a group (community) to carry out special tasks in a societal and political context. As Max Weber (1920) pointed out in 'The Protestant Ethic and the Spirit of Capitalism', it even had a religious meaning – one has a 'calling' to carry out certain social tasks to a high standard of excellence. Thus, the English word 'vocation' (calling) is perhaps a more accurate literal translation of *'Beruf'*. The term 'profession' in its classical meaning of publicly declaring one's commitment to a mission is also perhaps a better translation of *'Beruf'*. However, today, due to shifts in language and current translation practices *'Beruf'* is normally translated as 'occupation'. In this chapter the reader should keep in mind, that with the view to capturing the real meaning of the concept of*'Beruf',* the following different terms - 'occupational profile', 'vocational profile', 'professional profile' - are used interchangeably.

economic and social demands'. Within the tradition of occupational training regulation research, as it is affirmed by the *Deutscher Ausschuß für das Technische Schulwesen* (DATSCH) and endorsed by the *Arbeitsstelle für betriebliche Berufsausbildung* (ABB) and the *Bundesinstitut für Berufsbildung* (BIBB) that vocational training is construed as a process of adapting the content of training (and also employees) to existing and evolving structures of work.

There is some debate even now about the importance that should be attached to qualification research for the development of vocational curricula. When it comes to the legitimisation and formulation of teaching/learning content, three approaches have been differentiated in the discussion on vocational education (see also Reetz and Seyd, 1995). These are discussed in the next section.

12.2. Vocational education approaches in curriculum development

12.2.1. **Curriculum based on scientific/technological knowledge**

This assumes that an occupation is a given, and fits into a vocational tradition which already features countless vocational profiles in a specialist and scientific systematic way. A large number of commercial/technical industrial jobs contain specific technology as a central defining feature, so fitting the system of academic disciplines ([38]). This suggests selecting and arranging the teaching content for these vocations in line with the system of the relevant scientific spheres. This tradition of 'specialist' occupations corresponds with the concept of the didactic simplification of scientific content and its composition into course plans arranged in a scientific systematic (or preliminary scientific) way as well as the concepts of 'vocational basic training' and 'vocational fields'. Basic training spanning the vocational field is generally defined by means of a teaching content derived from the specific individual vocational tasks. Given that the descriptions of vocational fields and sciences are identical in many cases (electrotechnical and the vocational field of electrical engineering, civil engineering and the vocational field of civil engineering, etc.) curricula are built up in a scientific systematic way. The fact that the actual content of these curricula often has only an indirect connection to the world of work or the occupational tasks to be learned is taken into account (see Zabeck, 1995). It is assumed that the

([38]) This applies, for example, in the case of industrial electrical occupations.

scientific-based curriculum represents a theoretical foundation for the occupation to be learned or the vocational field as a whole. This line of argument can be supported by reference to arguments of social science qualification research, which with a view to technical change sees the switch in vocational training policies towards strengthening workforce mobility as a desirable outcome. As Kern and Schumann said as long ago as 1970 in the debate on flexibility, vocational training policies which take into consideration the conditions of technical change 'need to focus primarily on the promotion and maintenance of the necessary basic premises in science and the social sciences, turning in only a secondary way to the passing on of the knowledge and skills specific to particular activities' (Kern and Schumann, 1970, vol. 1. p. 281). In contrast, Gustav Grüner raised the question of whether 'a theory of vocation' as the foundation for the development of vocational curricula has a completely different perspective (Grüner, 1981).

12.2.2. Curriculum based on a theory of learning

In a vocational curriculum which rests upon a theory of learning or personality development, it is assumed that occupations are a given, just as in the concept of a scientific systematic curriculum. The legitimisation and selection of the content to be taught is accorded secondary importance, as the development of 'personality' or the shaping of curricula and training based on the theory of learning is the priority. In learning and personality theory terms, there is less focus on content to be taught: in many cases they are mutually interchangeable. Training objectives focus primarily, and in quite general terms, on stages of cognitive development, behavioural regulation or personality development. Cognitive interest based on the theory of learning and associated didactic behaviour is directed towards effectively shaping the learning process, rather than to the substantiation of teaching content subject matter. The latter is perceived as a matter of normative decisions to be clarified in a non-scientific way. Thus there is no need for scientifically founded qualification research.

12.2.3. Curriculum based on the *Beruf* concept

If vocational training is construed as a qualification for work processes based on occupational profiles, then the key issue is to analyse vocational work processes and vocational activities in order to reveal a detailed picture of qualification requirements. These then form a basis for vocational curricula. This form of vocational training research, with its focus on occupational training regulation research, draws on a long tradition. Work

analysis investigations were carried out originally for the purposes of performance appraisal and wage differentiation (see Riedel, 1957; Nutzhorn, 1964). The subject of the work analysis was recording and evaluating operational work processes in a Tayloristic organisation of work processes. Particular importance is attached to labour and activity analysis in constructing occupational training regulations, for it is assumed that it is possible to determine the elementary building blocks of vocational work behaviour by reference to the types of activities and the jobs performed. In the 1960s, Molle (1965), drawing on the work analyses, was a primary figure in developing an array of instruments for vocational analysis.

In the 1960s, the *Arbeitsstelle für betriebliche Berufsausbildung* (ABB) took up these considerations, but clearly restricted Molle's vocational pedagogy considerations on occupational characteristics (*Beruflichkeit*) by means of the analytical instruments developed by Pfeuffer for the further regulation of industrial electrical occupations. These occupations, regulated in 1972, are based on a method developed further by the ABB for activity and vocational analysis; a list of standardised elementary activities, complex skills and fields of activity was used to examine qualification requirements (Pfeuffer, 1972). The problem underlying this analysis and development method is illustrated in the development of the stage-based occupational training regulations for the industrial electrical occupations from 1972. On the basis of his empirical findings, Pfeuffer formulates, for the first stage of the occupations, the overall training objective of 'the ability to carry out simple occupational working tasks planned in detail, following equally detailed instructions and examples'.

These occupations and training framework plans, which evolved in the tradition of occupational training regulation research by the DATSCH and the ABB, are not only profoundly rooted in the tradition of scientific management and the highly fragmented work structures resulting from it, but they also reduce vocational training to an adjustment qualification, which limits vocational activities to abstract, skill-related performances ([39]).

Vocational curricula/regulatory methods in this research tradition are primarily the result of interest-led negotiation. Hermann Schmidt, the former Director of BIBB, calls this 'a type of application-oriented action research' (Schmidt, 1995). Vocational training research accompanies negotiating the targets and content of vocational training by the social partners more or less intensively through research projects. The number of occupations needing further regulation naturally exceeds the possibilities of occupational training

([39]) Regarding the criticism, see Stratmann, 1975 and Heidegger et al., 1991.

regulation research at the BIBB that would accompany each of the individual regulatory procedures on an occupation-specific or occupational scientific basis. In fact, this could only be undertaken by a research network that would include university vocational qualification research personnel. In his seminal contribution to curriculum development in the field of vocational training, Stratmann refers to the significance of investigations based on vocational science (VS). According to Stratmann, the usual superficial analyses are not adequate to identify the content of vocational basic training. 'In this case, the VS research analyses need to be applied in a much more highly differentiated way if we are to overcome the narrow relational boundaries of a vocational group' (Stratmann, 1975, p. 341). He argues in a quite similar vein when it comes to his critique of the 1971 eradication of some 100 occupations in line with the criteria of the upper limit of 20 apprentices in the federal territory and not on the basis of employment or VS research findings on the technological conditions of the individual occupations (ibid, p. 339). The demand for vocational qualification research was taken up only after countless, expensive detours in the investigation of the knowledge incorporated in the VS work by vocational research in the 1990s (see inter alia Rauner and Zeymer, 1991; Bannwitz and Rauner, 1993; Pahl and Rauner, 1998; Fischer, 2000; Storz and Fries, 1997; Drescher, 1996; Niethammer, 1995 etc).

12.3. Social science qualification research

Social science qualification research grew out of the foundation of the *Max-Planck Institut für Bildungsforschung* (1963), the *Institut für Arbeitsmarkt- und Berufsforschung* (1967) and, above all, the foundation of the *Bundesinstitut für Berufsbildungsforschung* – BBF (1970). The BBF continues the tradition of the activity and vocational analyses (occupational training regulation research) of the DATSCH and the ABB, while the foundation of its major department of structural research provided the impetus behind qualification research from a social-science angle. A review of qualification research by the BIBB on 'the current state of the discussion on qualification research' (Grünewald et al., 1979) shows that occupational training regulation research was not taken into consideration in that case, although this could rest on a long tradition of relevant analyses. Occupational training regulation research does not feature prominently in this assessment. Conversely, social science qualification research has not achieved any appreciable access to the (new) regulation of occupations

supported by occupational training regulation research. This is a surprising phenomenon insofar as ergonomic qualification research as represented by the likes of Volpert and Sonntag makes the claim of using behavioural and task structure analyses 'to formulate activity characteristics in such a way that they can stand directly as learning objectives without transformation' (Volpert, 1974, p. 72). Volpert proposes a 7-step concept:

(a) presentation of the task-specific behaviour;
(b) description of the task content and place and function of the task within the overall structure of work;
(c) presentation of the external task structure as well as the decision-making points and objective degrees of freedom;
(d) analysis of the internal (hierarchical) task structure;
(e) presentation of the subjective reflection of the task structure in the executors;
(f) partiality analysis;
(g) formulation of the task-specific learning objective hierarchy.

His considerations are taken up by ergonomic research. Since then, the determination of qualification requirements and content for the development of vocational curricula has become accepted as one of the purposes of industrial psychology work analysis (Frieling, 1995).

However, if we draw up an assessment of ergonomic qualifications research and underpin it with the claim developed by Volpert in 1974, then a sobering picture emerges. Ergonomic qualification research has not made a significant contribution to developing vocational curricula. The main reason for this is perceived as being that standardised task analyses (see also Sonntag, 1987; Frieling and Sonntag, 1987) can really serve only as an organisational aid for systematic exploration of salient aspects of working activities. However, when it comes to actual work content and its significance in shaping vocational training plans, these standardised instruments are seriously overvalued (Lamnek, 1988; Frieling, 1995; Rauner, 1998).

At the macro level, social science qualification research tends primarily to focus on the origin and causes of structural change in employment in the uneasy relationship with education. The many findings in this qualification research have served over a decade to fuel the disqualification debate touched off by Bravermann (1977). At the heart of this debate stands the question of whether technical change and the logic of capitalisation, as defined by capitalist production relationships, lead to higher (*Projektgruppe Automation und Qualifikation,* 1975-1981), lower or polarised qualification requirements (Baethge et al., 1975). The vehemence of the discussion

around the development of the level of qualification requirements in the wake of the advancing modernisation of industrial production until the mid-1980s reflects the idea that technological change and the capitalisation process determine qualification levels (technological and economic determinism). With work and technology research as well as with the concept of shaping-oriented vocational training, we see the emergence at the beginning of the 1980s of a fundamental change in outlook in qualification research as well (Lutz, 1988; Rauner, 1988b; Baethge and Baethge-Kinsky, 1995).

Social science qualification research in the 1970s and 1980s uncovered many results for developing the skilled industrial worker, which has contributed to the stereotyping of industrial skilled labour (see Mickler, 1986). The waning in interest in such research in the 1990s is caused primarily by the fact that the issues of the actual content of vocational training, which are so crucial for vocational development, the development of vocational training regulations and curricula, as well as vocational training concepts, largely escape social science qualification research. The position after three decades of qualification research shows that the contribution to vocational development and to the development of vocational curricula was correspondingly minor. The review of qualification research put forward by the BIBB (Grünewald et al., 1979) also documents that training research, curriculum development and social science qualification research have taken precious little account of each other.

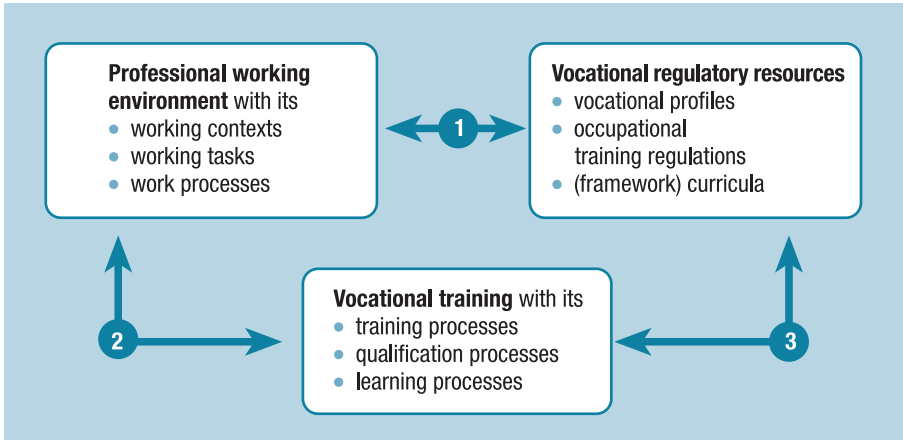
12.4. Vocational qualification research

Vocational science (VS) research concerns itself with the actual content and forms of expert work in established and emerging occupations and occupational spheres, with the vocational and vocational-sphere-specific learning processes for the world of work and with implicit and explicit learning in the working process. In analysing, shaping and evaluating vocational training processes, plus learning-promoting work processes, the connection needs to be established between the working processes of vocational working reality, learning and training processes and the vocational regulatory resources.

The common notion according to which analysis of working reality can be used to deliver a linear derivation of the content and forms of vocational expert work, and thus vocational regulatory resources, disappears. This supposed linear relationship makes way, in vocational research, for a

differentiated, non-deterministic investigation into reciprocal relationships between the three poles of the connection: technical aspects, work and training. It is primarily here that the investigations and development work for a shaping-oriented type of vocational training should be set (see Rauner, 1988a; Heidegger et al., 1991).

Figure1: **The connection between vocational work and training processes**



There are three principal tasks facing the vocational qualification researcher:

(a) from the shaping-oriented point of view, the criteria for developing occupational profiles and clusters need to be identified and developed;
(b) the vocational research task analyses explore the question of what vocational tasks are to be carried out for current and future vocational development, and what learning content results from them in terms of the development of vocational training planning;
(c) the vocational research work process studies refer to the questions already formulated by other research traditions about the knowledge of working processes of skilled workers and skilled employees and investigate the knowledge incorporated into practical vocational work.

VS research analyses are faced with the problem of contributing to an empirical foundation of vocational profiles which are already assumed to be a necessary investigative framework for the analysis. Industrial/cultural research has made some wider-ranging contributions (Ruth, 1995; Laske, 1995; Demes and Georg, 1994; Rasmussen and Rauner, 1996) to a deeper understanding of this dilemma and the options for escaping it. According to

this, occupations are to a large extent anchored in the industrial/cultural particularities of countries and regions. Accordingly there is a need, given the conditions of accelerating structural change in all employment sectors, for establishing criteria for a modern *Beruflichkeit* anchored in a broad vocational training dialogue.

VS research task analyses encompass the following:

(a) identifying the working contexts characterising a vocational profile and qualification requirements: the vocational profile;
(b) identifying the occupational working tasks encompassing the vocational profile. A distinction needs to be made here according to the core tasks, the fields of tasks specific to the sector and application;
(c) differentiating the occupational working tasks according to the categories:
    (i) subject of the expert work;
    (ii) methods, tools and organisation of the expert work;
    (iii) requirements placed upon the subjects and forms of the expert work.

12.4.1. Vocational profiles and occupational tasks as determined by German legislation

The main committee of the BIBB only laid down criteria in decisions dated 17 September 1980 and 17 May 1990 for formulating training vocational profiles that 'this must, in a concentrated and generally comprehensible form, describe the subject of the vocational training in the sense of the end context to be achieved'. This definition offers no clues on formulating quality standards in the occupations to be developed. Any job tasks and activities put together in a rather arbitrary way might be classed as an 'occupation' for the sake of the end context to be achieved. Occupations regulated in line with the Vocational Training Act and the decisions by the main committee also present, in terms of their qualifying, forming, identity and career building functions, as a starting point for vocational further training and in terms of their roots in social consciousness, an extremely varied quality. While industrial occupations are mainly regulated according to areas of expertise or technical science, or specific working job performances, and therefore frequently detached from the real employment contexts, the determining feature of occupations regulated as part of the craft tradition, such as a goldsmith or a roofer, and state health or education professions, is a working context anchored in social consciousness and in the employment system.

Thanks to a close orientation of activities in occupational training regulations, the industrial occupations newly regulated in accordance with

the 1969 Vocational Training Act (BBiG) in the 1980s are increasingly contrary to the flat operational organisation structures induced by international quality competition and a participative operational organisation development demanded by both management and the workers' organisations. Business process-oriented organisational concepts, with their higher expectations in terms of the responsibility and motivation of employees (see Ganguin, 1993) open the way for modern – open, dynamic – vocational profiles (see below). However, at the same time they harbour the risk of eroding occupational concepts, primarily in industrial and trade sectors. The concept of a potential-oriented organisational development as proposed by Staudt (1995) points in this direction.

12.4.2. Criteria of modern *Beruflichkeit*

Holding on to the occupational form of (expert) work will not be justified afresh here (see in this connection Rauner, 1998). It is far more a question of the constituent moments and quality features for a concept of modern *Beruflichkeit* and a regulatory procedure directed towards it for vocational training planning. There is a significant need here for research, development and discussion. The following four criteria for modern *Beruflichkeit* are based on a string of relevant research projects (Heidegger et al., 1991; Drescher et al., 1995; Heidegger and Rauner, 1997; Laur-Ernst et al., 1992).

1. *The working context*
   Developing occupations on the basis of working contexts and an understanding of context (Laur-Ernst et al., 1992) as complementary objective and subjective aspects of occupational type work, releases the occupational structures from the surface of technical change and, at the same time, raises the quality for vocational orientation and identification potential for school leavers, trainees and employees as well as a stronger anchoring of occupational profiles in social consciousness. As a working context here, we should infer, by reference to a craft-based occupational understanding, a definable field of work made up of comprehensive and connected occupational working tasks and demonstrating a clearly identifiable and contextualised work subject within a context of social division of labour. This criterion suggests taking back the level of horizontal task distribution.
2. *Abandoning horizontal specialisation by introducing core occupations* ([40]).
   The high level of task distribution and rigid division of job tasks which accompanies a function-oriented organisation of labour is reflected in

([40]) See Heidegger and Rauner, 1997.

countless occupations in production and maintenance. The superimposition and decreasing importance of function-oriented divisions of labour by business process oriented organisational structures suggests a clear reduction in the number of occupations and their merging into core occupations. The number of occupations in production and maintenance could be more than halved by the introduction of core occupations.

However, core occupations are not basic training occupations in the sense of traditional vocational basic training. The reference to abstract basic knowledge, drawn from the relevant scientific or engineering disciplines, acts more as a barrier to vocational activity and shaping competence. Neither can core occupations be described by means of a concept of context-free key qualifications. On the contrary, the reference point for core occupations lies in the concrete work context and the work process knowledge contained therein. Core occupations cannot be realised as 'shortened training occupations' below skilled worker level because, in the scope of their training, they usually cover more than a traditional occupation. The extension of the vocational foundation places high requirements on the qualification for demanding occupational skilled work. Core occupations thereby represent a broader starting point for the vocational career. They form a new basis for a close linkage with modularised training and further training which leads to certified further training occupations.

3. *The life cycle of an occupation*

The rooting of vocational profiles in social consciousness, their suitability for orientation in the case of the choice of occupation and the identity-building potential of an occupation for trainees and employees depend decisively upon the stability of the occupations. Vocational profiles with a lifespan of no more than 15 years, such as the electrical occupations, are quite definitely misconstrued from this point of view. Technological and economic change harbours both chances for the development of new occupations and the disappearance of old ones.

The foundation of new vocational profiles according to working contexts makes a decisive contribution to the stability of the occupations. Accordingly we may distinguish four classes of occupations in terms of decreasing orientation to the work context:

(a) 'timeless' and long-lived occupations (e.g. doctor, pilot, teacher) as well as a large number of craft occupations;
(b) technologically induced occupations (e.g. electrical and chemical occupations);

(c) technology-linked occupations (e.g. process control electronics);
(d) performance-oriented occupations (e.g. lathe operator).

Technology-linked and performance-oriented occupations are particularly susceptible to relatively short life cycles. They lack virtually all the characteristics of modern professionalism. The occupation of a compositor is an example of a performance-oriented occupation and at the same time one linked to a special technology. The activity of the compositor is increasingly being squeezed out by the use of modern computer programmes. The work context of 'wording of a text' could certainly have prevented the devaluation of the compositor's job. In addition, the specific competence of the compositor would be underscored by such a vocational profile.

A central element in the development of modern occupations with a long life cycle as well as the assurance of their quality is the concept of open, dynamic vocational profiles and core occupations. The argument that accelerated technological change pulls the rug out from under the realisation of long-term occupations can be countered with the example of the profession of doctor. The profession of a doctor is not linked to medical technology, but to the medical art.

4. *Open, dynamic vocational profiles (Heidegger and Rauner, 1997)*
The concept of open, dynamic *Beruflichkeit* continues to assume a particular work context.

However, *Beruflichkeit* must:

(a) be able to be experienced in adequate qualification and training processes as exemplary for the occupational capability of the skilled workers;
(b) be able to expand as work, work organisation and technology, and thus task patterns, are jointly shaped in a responsible way;
(c) be able to evolve into new tasks which go beyond the occupation: self-management instead of putting up with modernisation and simply being tossed back and forth.

12.4.3. Determining occupational working tasks: expert skilled worker workshops

Occupational working tasks do not arise from aggregation of elementary, abstract basic skills and basic knowledge, as they are assumed to be the smallest units in the microanalysis of work activities. Conversely, the primary, meaning-imparting working contexts with their identity-building potential become the starting point for identifying the occupational working tasks constituting the occupation. In the case of an occupation calling for

something like three years of training, our experience with the development of core occupations to date indicates that we can expect around 15 to 20 vocational tasks, which satisfy the criteria for vocational working contexts ([41]). A differentiation of each of these occupational working tasks into its constituent tasks is eminently sensible in the sense of getting some precision, contextualisation and operationalisation of the occupational working tasks, although it is not necessary as a starting point for the task analysis. As occupational working tasks here, we should interpret those which can be formulated in an action-oriented way and as part of operational value-added activities. Occupational working tasks have widely differing qualities in terms of the professional experience required, the degree to which they can be routinised and the amount and level of theoretical knowledge required for their mastery. While some vocational tasks can be mastered safely and effectively only after a long period of professional experience, other tasks can be carried out by beginners without this needing to mean that these tasks are accorded less value in terms of their qualification requirements. Because all occupational working tasks are acquired in the course of the time spent learning the occupation according to the novice-expert paradigm, it is obvious that occupational working tasks should be regulated as a starting point for developing vocational training plans in such a way that they support vocational training and qualification on the way towards reflective mastery ([42]).

The concept of the expert skilled worker workshops ([43]) on the identification of occupational working tasks rests upon the DACUM procedure and task analysis tested in the LEONARDO 'car mechatronic' project. A two-day expert skilled worker workshop is the core component in this procedure.

Approximately 10 to 12 expert skilled workers are selected for the workshop. Expert skilled workers are people who:

(a) already represent the occupation to be (further) developed in vocational and biographical terms. Even new occupations exist already as empirical occupations, even if they are not regulated;
(b) are in a position to describe their current (occupational) expert work from

([41]) This figure has been confirmed in a comprehensive examination involving the industrial electrical and metal-working occupations as well as the occupation of industrial clerk, accompanied by 25 expert skilled worker workshops. A comparable assessment is made by Bob Norton in his writing on the procedure developed by Canadian vocational training researchers (see Glendinning, 1995) for the development of vocational curricula: *Design a Curriculum* (DACUM).

([42]) On the concept of the structuring of vocational training plans in line with the logic of development, see Rauner 1996 and 1999.

([43]) See also chapters of Röben and Bremer in this book.

a perspective point of view and competently, to evaluate it and systematise it according to work task areas; and

(c) are in a position to reflect their own training and further training in connection with the change in occupational working tasks.

Figure 2: **Structuring learning tasks and learning areas according to the novice-expert-paradigm**

Learning areas			Learning tasks	Methods for problem-solving
Specialised and advanced knowledge	How things can be explained in the logic of the subject area and how problems can be solved contextually		Unpredictable work-based problems	Experience guided (non-deterministic) problem-solving
Detailed and functional knowledge	What is important for skilled work and how things function		Problem-based special work tasks	Theory guided (non-deterministic) problem-solving
Holistic knowledge	How and why things are connected		Systematic work tasks	Systematic rule-based problem-solving
Orientation and overview knowledge	What is the main content of the occupation		Carreer guiding work tasks	Guided (deterministic) problem-solving

Approximately three quarters of the expert skilled workers should be actively engaged in carrying out the expert activity being examined, and one quarter should derive from the indirect area and be working as foremen, trainers or technicians or performing other leading roles in the vocational task area to be analysed.

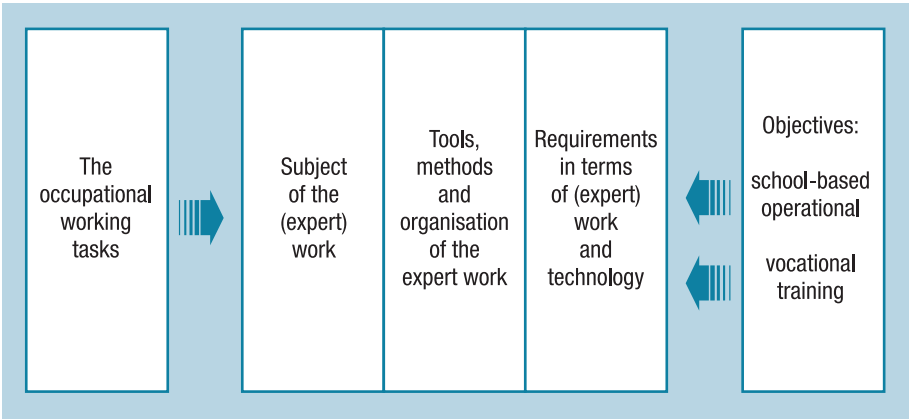
Interpretation and re-evaluation of operational work processes and tasks assumes consideration of the interpretation patterns emerging in the context of communities of practice. Wehner et al introduce the concept of 'local patterns of interpretation' here. These are imbued, on the one hand, with social significance structures yet, on the other, they reveal themselves only in the places where communities of practice are acting (ibid, p. 79). In qualification research, this means that researchers have to unravel the

working processes in their situatedness as the interplay of working subjects, tools and methods as well as work organisation regarding the shaping of its technological and social dimensions.

Identifying and formulating the content of training occurs from two angles at the same time:

(a) the occupational working tasks and the qualification requirements resulting from them;
(b) the qualification and training objectives and thus the question of the training relevance of the content of the work from a shaping-oriented perspective.

Figure 3: **Identifying and determining the training-teaching content from the point of view of vocational qualification requirements and training objectives**



Both criteria can lead to various types of training/teaching content, between which some reconciliation then has to be found. This requires corrections and amplifications. The pattern is suited to developing work and shaping-oriented vocational training plans, because it encourages the formulation of the content in a work-related way from the perspective of operational occupational working tasks. At the same time, the pattern is arranged in such a way that it can be interpreted from left to right as steps of increasing reflectivity and shaping-orientation. In the column headed Requirements in terms of work and technology, the requirements from the point of view of businesses, the legislator, the public, employees etc are laid down, so that both the subject of the work and the organisation and forms of work can be interpreted and learned as being factors in their situation

characterised through the various requirements and the compromises resulting from them. In a further stage, the reflection possibilities implicitly set out in this column are explicitly also included in the form of the objectively laid down action and shaping options and scope for the vocational work world in the column for the qualification and training objectives. This development pattern for integrated and work-related vocational training plans then feeds into the training task for vocational training, namely to enable the trainees to play their part in shaping the world of work and society in a socially and ecologically responsible way (agreement of the KMK on vocational school 1991). A detailed example of this development procedure for vocational training plans was put forward by Rauner et al. (1997). A vocational training plan laid out in this way represents an occupation as a supra-company institution and, at the same time, refers to the concrete conditions of operational organisation development.

12.5. Concluding observations

Vocational research into work processes covers task analyses in the sense in which they are necessary for the further development of vocational profiles and corresponding vocational training plans, plus work process analyses for determining knowledge and skills incorporated into practical vocational activity. This being so, the operational/economic, technological/organisational, normative and industrial/cultural contexts constituting the work are taken into consideration. Occupational working tasks become the subject of analysis, the vocational development and the shaping of vocational training processes, not merely in terms of their current content and methods and as an expression of specific forms of work organisation, but also in their genesis and their possible and desirable developments (development scenarios).

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CHAPTER 13

Identifying work process knowledge in accordance with characteristic occupational tasks

Peter Röben

13.1. Introduction

For some years, efforts have been made in Germany to link vocational training curricula more closely to occupational work processes (Pahl et al., 2000). These efforts must be seen in the context of three different kinds of research findings which raise three different types of problems:

(a) results obtained to date from research on skill requirements (e.g. Kern and Schumann, 1984; Schumann et al., 1994) are too unspecific for curricular purposes and focus inadequately on the specific content of work in particular occupations. Moreover, they are usually very general and contain few references to sectoral or regional specificities that play a significant role in the design of particular curricula. This problem is one of discrepancy between the theoretical and real content of work;

(b) recent findings regarding the importance of experiential knowledge (Böhle and Rose, 1992) and above all work process knowledge ([44]) are documented with separate case studies (Fischer and Röben, 1997; Boreham, 1992; Drescher, 1996) and do not enable the details of present-day occupational work essential for designing occupational curricula to be extracted. This problem relates to the narrow empirical basis of current skills research;

(c) on the one hand, reference to occupational work must be as specific as possible for curricular purposes, so that the competences acquired in vocational training can be put to direct use as far as possible when working in that occupation; on the other hand, the concept of

([44]) See the results of the network entitled Work process knowledge in technological and organisational development, Boreham et al. (2002).

'occupational profile' exists in Germany for all sectors and for many types of enterprise. The latter fact renders it imperative to abstract from the work performed in a particular enterprise in a particular sector, and from its embeddedness in enterprise- and sector-specific contexts. This problem is one of finding a balance in the curriculum between actual work and its description as an 'occupational profile'.

The aim of GAB pilot project ([45]) is to develop integrated occupational curricula for five German occupations. This means that the framework training plan of the participating companies and the framework curriculum of the vocational training schools must be related to each other in such a way that the goal of the pilot project – namely to establish an intensive link to occupational work and business processes – is achieved. In this paper, we will show how the link to occupational work in the respective occupations is established using the instrument of expert-skilled worker workshops (ESWWs) and how the three problems outlined above are dealt with. The integration of 'workshop output' in the curriculum and the presentation of the underlying development theories are treated by Felix Rauner and Rainer Bremer in this volume.

In order to demonstrate the connecting link between the expert-skilled worker workshops and work process knowledge, the link between work process knowledge, occupation and occupational tasks need to be established in the first place.

13.2. Work process knowledge as occupational work process knowledge

The concept of work process knowledge, especially in European debates, does not relate exclusively to work in recognised trades or professions but applies in principle to any kind of work. According to Fischer (2000a), one can specify three aspects of work process knowledge that demarcate it from the concept of work experience:

(a) work process knowledge is the result of merging work experience and training/skilling;
(b) work process knowledge includes knowledge about the purpose and the process of the industrial work process in its totality;

([45]) GAB: *Geschäfts- und arbeitsprozeßbezogene, dualkooperative Ausbildung in ausgewählten Industrieberufen mit optionaler Fachhochschulreife* (Business and work process-related, dual cooperative training in selected industrial occupations with optional eligibility for tertiary-level technical education). Home page: www.gab.uni-bremen.de

(c) work process knowledge is accumulated above all in problematic situations (Fischer 2000, p. 119).

We use the term 'occupational work' to refer first of all to work within recognised trades and professions, for which vocational training is necessary ([46]). On that basis, vocational work process knowledge can be defined as follows:

(a) occupational work process knowledge is the result of merging work experience from occupationally organised work ([47]) and the knowledge acquired in initial and continuing training;

(b) occupational work process knowledge includes knowledge about the purpose and the process of the industrial work process in its totality and the organisation of the occupational work incorporated within that process;

(c) occupational work process knowledge is accumulated primarily in problematic situations that can result from technical, organisational or skill-related factors.

To ensure that this definition does not degenerate into a pleonasm (occupational work equals work performed by a worker who has trained for an occupation), it is necessary to find an objective definition for the specific aspect of occupational work that distinguishes this kind of work from non-occupational work. However, this endeavour will lead to a debate that has been conducted among vocational training researchers and industrial sociologists in Germany since the 1970s at least (see Beck and Brater, 1977) and which has still not been settled. The dominant strands in the debate are, first, the viewpoint which says that occupations, as a construct, are an obstacle to organisational development and must therefore be superseded (e.g. Kern and Sabel, 1994), and, second, the view that sees the construct of occupation as having future viability, albeit in some other

([46]) The necessity of having an occupation in order to do certain tasks is part of industrial culture and in Germany is not only traditional, but often prescribed as mandatory by laws, statutes and regulations. These regulations, which have mostly been administered and handled in a strict manner, have been diluted in recent years; in the young IT industry, in particular, little consideration has been given to occupational traditions. And yet, while occupations have been progressively defined and established in this field, the traditional structure has also become more fluid. For example, chemical operators have recently been allowed to perform simple mechanical maintenance work that was previously reserved for industrial mechanics only due to provisions in the water resources management act. Similarly, the strict demarcation from electrical occupations has been softened, such that chemical operators are now permitted to carry out simple electrical repairs themselves.

([47]) Once again, it is trained occupations that are meant. In one electrical workshop at VW, for example, power electricians, radio and TV technicians and communications electricians all perform the same functions. Whereas different trained occupations in an occupational field (here within the broader field of electrical engineering) can substitute for each other, this is not the case for occupations in other fields. The divisions between occupational fields is traditionally very rigorous.

than today's conventional form (e.g. Rauner, 1998). The new occupations in the field of information technology, as well as reorganised occupations ([48]) such as chemical technicians, exhibit many features that may help the construct of occupation to survive.

Whatever way occupations develop in Germany, and whatever standpoints are adopted in the debate over the occupational form of work, there is one aspect that remains constant; skilling needs will not decrease in the future, but will increase substantially. All current empirical analyses of work refer in virtually every occupational field to significant growth in training needs (e.g. Schumann et al., 1994; Lutz et al., 2000), also for skilled workers who have trained for a particular occupation. If one can also discuss the occupational focus of this skilling, the discussion cannot centre on the increasing amount of skilling that is necessary for highly skilled work.

Two old notions of occupational work have been eroding for several decades: the notion of confining vocational learning to the narrow time corridor of vocational education and training; and the notion of occupation as lifelong identification with a particular profile of activities that once used to exist due to the specific way that work was organised in enterprises.

Any modern concept of occupation must provide answers to the demands of lifelong learning and ensure that occupational identification is not exclusively associated with material activities and operations, techniques and forms of organisation whose future existence may be questionable.

We are convinced that the concept of occupational tasks presented in the following is one element of occupations in the modern world. Vocational identification is not primarily linked to changing techniques, activities and operations, but to the purposes and objectives that are pursued with technical objects as well as occupational activities and operations. The extent to which purposes and objectives of skilled occupational work are linked to the business process of the enterprise is heavily influenced by the organisational definition of fields of work. The transfer of responsibilities to the skilled worker level, observable in recent years, leads to a broadening of the purposes and objectives pursued by the individual skilled worker. In addition to the objectives and purposes relating to the performance of his material activity, the skilled worker must pursue additional purposes and objectives relating to the planning, organisation and quality of his work within the overall work process.

([48]) Information about these occupations is found on the English-language pages of the Bundesinstitut für Berufsbildung (Federal Institute for Vocational Training), BIBB, at http://www.bibb.de/en/welcome.htm.

13.3. Work process knowledge: the prerequisite and result of handling work tasks

In order to characterise the content of occupational work, we pursue an approach that describes the potential range of work performed within a particular occupation in terms of a collection of characteristic occupational tasks (Bremer et al., 2001b). The number of occupational tasks is set to 15–20, whereby this specified range determines the descriptive level in respect of tasks performed, on the one hand, and is itself determined by curricular purposes, on the other (see the contribution by Felix Rauner in this collection). This form of work analysis is, therefore, combined from the outset with goals of curriculum development. The curriculum itself consists of four learning areas (*Lernbereiche*) which are in accordance with a development theory of Felix Rauner (1999):

(a) orientation and overview knowledge;
(b) holistic knowledge (*Zusammenhangswissen*);
(c) detailed and functional knowledge;
(d) specialised and advanced knowledge.

The set of the occupational tasks is distributed to each of the learning areas where they are the one half of four to five 'areas of learning subjects' (*Lernfelder*) (see for an example Figure 1). The other half is a set of requirements which should be matched at the end of the learning process. This 'learning subject area' (*Lernfeld*) is the starting point for the teachers and the trainers to organise their lessons.

The description of work in the form of occupational tasks requires a more precise definition of what is meant by tasks of work:

> 'A task is when a subject mentally anticipates the achievement of an objective under certain conditions and is aware of the necessity of attaining that objective. This means one is seeing the task as the singular activity as viewed from its beginning and anticipating the objective in its unfolded form. In this sense, tasks are unfolded objectives.'(Seidel, 1976, p. 54, quoted from Fischer, 1995, p. 126)

Knowing the need to achieve the objectives is conditional on the subject being aware of the shortcomings of the existing state. Unfolding objectives means that the path to the final envisaged state is conceived of mentally using the means at one's disposal. These two aspects of the task make it a suitable concept for specifying occupational work in a form that persists even when the means used are constantly changing.

The concept of work task embraces two meanings that both play a major role in job analysis. In the quote from Seidel, it is the subjective side that is

emphasised – a task can thus be understood as bearing responsibility for something. The other meaning of task emphasises the objective side; the task as an order to get something done. The division of labour within an enterprise operates at the level of skilled work in the form of tasks that the incumbent of a particular job is expected to perform. Because of these two aspects, the work task is an interface between the technical and organisational demands of the company, on the one hand, and the skills and qualifications of the human worker, on the other (see Dunckel and Volpert, 1997).

A concrete example is provided by the task of maintenance ([49]). Regardless of how technology advances, the task of maintenance is hardly likely to disappear in the foreseeable future. Although the division of labour can change as a result of organisational development of in-company maintenance procedures, the pressure to perform maintenance work in an ever-shorter time is sure to increase due to the ever-increasing deployment of capital in automated plant and machinery. The disincorporation of corporate entities will also lead to greater use of outside contractors, yet these influences will only modify maintenance work, rather than cause it to disappear.

The work task is thus definable as an interface between the operational organisation of work (the aspect of job order and the demands of the enterprise) and the skilled worker who appropriates the task for himself, i.e. who takes responsibility for handling the task and for that reason derives the objectives and purpose of his work process from the task at hand. This relationship will now be examined with regard to the dynamics of work performance, to arrive at the relationship between work tasks and work process knowledge.

Work process knowledge relates to the task as a prerequisite, on the one hand, and as a result, one the other:

(a) work process knowledge is a precondition because it constitutes knowledge of the means to realise the objective of work in the inner-company context. The concept of 'means' is very broadly defined here and encompasses not only technical artefacts (tools and work equipment), but also work procedures (cooperation with others);

(b) work process knowledge is a result or outcome, because the handling of tasks, especially in modern forms of organisation and with highly automated means of production, frequently comes up against unforeseeable situations in which problems can arise. One key

([49]) Maintenance refers here to the broader field of maintenance, repair and inspection.

characteristic of work process knowledge – the fact that it is generated during work by solving problems – is therefore linked to the handling of a work task (and one that is non-problematic at the outset ([50]).

If the process by which a novice becomes an expert is understood as the accumulation of work process knowledge, then this development is fostered when, on the one hand, handling the task requires more work process knowledge than the performer possesses, and, on the other, when this difference or discrepancy can be surmounted during performance of the task by the performer himself. The apprentice, in particular, thus learns by performing tasks because he does not yet have a mastery of the means for performing said tasks. The skilled worker who is familiar with the means for performing a task also learns, however, when performing the task involves solving problems.

Occupational tasks that are supposed to characterise a particular occupation summarise occupational activities within the context of their work context. The skilled worker has a command of occupational tasks in the context of in-company business processes and can assess and specify their meaning within the company context. In our view, activities and operations such as turning, drilling, fitting, etc. are not occupational tasks but parts thereof, and viewing them in isolation can lead to knowledge of their ultimate purpose being lost. This situation is often encountered in fragmented Taylorist work, the purpose of which must be defined and ensured by organisational entities that are separated from the level of actual performance (e.g. job planning).

13.4. Experts/skilled workers workshops and DACUM

The expert-skilled worker workshops (Rauner, 1998) were designed with the aim of developing a work- and work process-related curriculum and involved grappling with the DACUM (designing a curriculum) procedure proposed by Bob Norton at CETE ([51]) (Norton, 1997). The DACUM process is used very

([50]) The notion of task is a basic interdisciplinary term, with a structure that resembles the term 'problem'. One speaks of tasks when at least the initial state, the anticipated result and steps of work are known to the performer (whereas the characteristic feature of a problem is that the methods for solving it are not known initially). Of course, problems are an integral part of the skilled worker's everyday labour. Problems are phenomena that can occur when performing the task of work, but they are not usually part of that task.

([51]) Center on Education and Training for Employment, c/o College of Education (Ohio State University, USA).

often in the USA for developing curricula. The DACUM Manual (Norton, 1997) lists about 60 agencies in the USA alone that conduct DACUM workshops, mostly in colleges. Industrial companies also use the process, although more for analysing jobs and processes than duties and tasks, which is what the process was actually designed for. There is a demand for such processes worldwide, as shown by the list of approximately 30 countries that have sent people to the USA to train as DACUM facilitators.

The starting point for DACUM is avoiding mistakes: 'There are two major types of errors you should be avoiding. The first, and most serious, is failing to teach what should be taught to keep your programme current with industry and real world needs. The second, the obverse of the first and almost as serious, is teaching what is no longer needed and relevant.' (Norton, 1997, p. 23).

At this level of generality, the starting point of the process can hardly be wrong. Certain questions are asked:

(a) what teaching is no longer relevant?
(b) what should be taught instead?
(c) how should one design the teaching programme so that it matches the needs and requirements of industry and the real environment?

The answers are by no means obvious. The process, developed in Canada and the USA in the 1980s and 1990s, attempts to provide answers in expert-skilled worker workshops. In such workshops, tasks are to be defined in the form of units (complex duties). The workshops are based on three premises:

(a) expert workers are better able than anyone else to describe their occupation;
(b) an occupation can be described effectively in terms of the tasks successful workers perform;
(c) successful task performance is directly related to the knowledge, skills, tools, and attitudes that workers must possess to perform the task correctly' (Norton, 1997, p. A-19).

There is therefore no distinction between the tasks documented at DACUM workshops and the task analyses we conducted with the help of expert-skilled worker workshops. One initial indication that 'duties' and 'tasks' are a narrow selection of what is actually a more far-reaching division of labour representation than our occupational tasks is provided by the recommendation in the DACUM Manual regarding the selection of workshop participants:

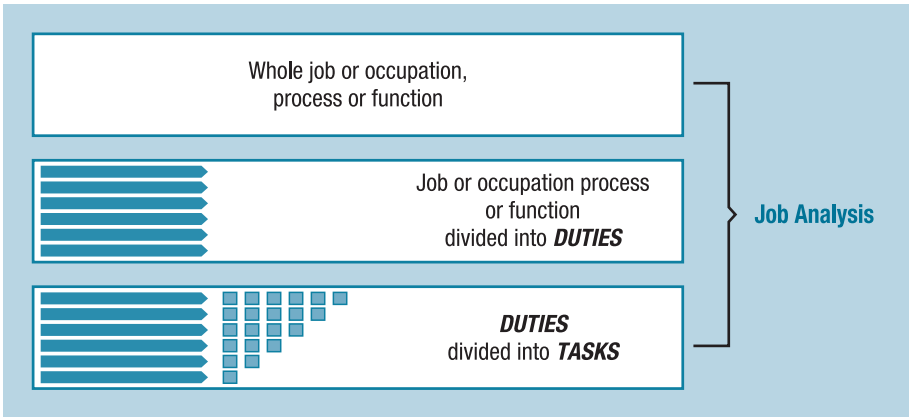
> 'For example, an analysis of the clerical field may include persons employed as mail clerks, file clerks, receptionists, typists, secretaries,

> medical secretaries, legal secretaries, and administrative assistants. Although employees in these jobs may perform similar tasks, the overall nature of the jobs varies so widely (!!) that to attempt an analysis of such broad occupational cluster through one DACUM would be unwieldy and probably inconclusive.' (Norton, 1997, p. C-1)

In other words, if a DACUM workshop comprising mail clerks, file clerks, etc. does not deliver any exploitable data because these are too widely scattered due to the mixture of workshop participants, and are therefore too indefinite for evaluation in the DACUM process, then it is probably safe to assume that the 'duties' in the DACUM process must be understood in Germany more as sub-tasks of an occupational task. This assumption is supported by the American system of occupational classification, which lists many more occupations than does the German classification system. The narrow definition of occupations in America sets preconditions that lead to different results when specifying duties and material tasks than is the case in Germany.

However, comparing the German and the American nomenclature is difficult because tasks are clearly activities: 'Task – A work activity that is discrete, observable, performed within a limited period of time, and that leads to a product, service or decision.' (Norton, 1997, Appendix C, p. 4). 'Decisions', as results of an activity, do not quite fit into the same framework as products or services, it should be noted. However, 'duty' is not simply a task in the course of which the activities for achieving the task objective are performed. In DACUM, duties are a 'cluster of related tasks from a broad work area or general area of responsibility (area of competence)' (Norton, 1997, Appendix C, p. 2).

Figure 1: **The matrix structure of duties and tasks in the DACUM process**



In DACUM, duties are seen as collective entities that are used for sorting similar and related tasks. As the diagram in Figure 1 suggests, work analysis consists of sorting the tasks that comprise a job and placing them within a matrix. With this structure, combined with the knowledge necessary for the tasks and the competences required for performing those tasks, all of which is documented in DACUM workshops, the DACUM curriculum is virtually completed. 'By using the Develop A Curriculum (DACUM) approach to job analysis, a complete job profile (including prioritised tasks) can be developed in only two days.' (http://www.dacum.com)

The notion of tasks on which job analysis in expert/skilled worker workshops is based is different from the DACUM concept of duties. The output from ESWWs – a collection of characteristic occupational tasks – is intended as a target variable for the learning and work tasks performed during training for a core occupation. Occupational tasks are always associated with objectives of occupational action that guide the reasoned deployment of material activities. These activities are initiated by virtue of the defined objective associated with the task and are geared to accomplishing the respective aim of the task. Tasks and material activities or operations are connected as ends and means. In this interpretation of activity, it makes little sense to array unrelated activities alongside each other and to summarise them subsequently on the basis of similarities. By virtue of the task's objective, activities or operations become a meaningful dimension of a work process. Handling a task is thus associated with a work process. Within the work process, an objective is pursued by the skilled worker, with tools, work equipment and objects of work acting as elements of the work process ([52]). Specialised knowledge and experience possessed by the skilled worker operate throughout every phase and at every moment of the work process. The work process determines the tasks, objectives and activities or means for achieving that objective.

If tasks and activities or operations are viewed in isolation from their role within the work process, the result is confusion between the differing levels at which work is regulated. However, the regulation level for the simplest activities and operations within a strict division of labour is only a minor constituent of the regulatory requirements in respect of modern-day skilled labour. Such confusion would arise, for example, if fitting headlamps onto a car on the assembly line were conceived of as an occupational task. In our concept, this is a material activity.

([52]) See Röben (2000) and Fischer and Röben (2002) regarding the idea of interpreting objectives, tools, working equipment and objects of work as parts of the work process.

The risk of confusing occupational tasks and operations is particularly rife when workshops are attended by skilled workers from the various departments and shops of an enterprise in which work organisation is still heavily influenced by Taylorist principles. The objective of a Taylorist division of labour consists precisely in the elimination of the individual skilled worker as the active carrier of work process objectives and in reducing him to a mere performer. According to this ideal, the 'spirit' of the work process resides in job planning, whereas production workers merely execute what job planners dictate.

13.5. The participative analysis of tasks that characterise an occupation

13.5.1. Basic concept of participative analysis

The novel aspects of job analysis with ESWWs are the manner in which occupational experts are involved in wording that part of the occupational profile described by the work tasks ([53]) and the up-to-date, occupation-specific way that analysis is carried out.

In the ESWW concept, the work process of skilled workers is analysed not only by researchers, but also by the workers themselves; one key task that participants must perform is to draft a list of tasks that are characteristic for their occupational field and their actual work. The result is that participants are stimulated by the occupational researchers to reflect on the work they do. Understanding the concept of work task as it understood by industrial sociologists is no trivial aspect; in the workshops, independently of the various fields in which the participants worked, we identified a range of differences in the reception of the term task. Within that range, the maintenance technicians in the fields of electrical engineering and metalworking formed the one extreme. They found it difficult to think of other tasks besides their primary one, namely the maintenance of plant and machinery. At the other extreme were the toolmakers, who immediately understood every single tool they built as a separate task, and for that reason could think of hundreds, even thousands of tasks they performed. The middle of the range was occupied by workshop employees who already possessed a cognitive framework for their work due to their experience with order processing procedures, finding it relatively easy to generalise typical

([53]) The complete image of a particular (training) occupation comprises, among other things, the specified knowledge, skills, capabilities and examination requirements.

tasks that they performed. Thus, during the workshop, there had to be a learning process on the part of skilled workers and the researchers. The skilled workers learned to describe their occupational practice in terms of characteristic tasks of work, whereas the researchers had to learn how to overcome lack of transparency in the task construct.

The expert-skilled worker workshops are a transitional phase that is characterised by Hacker (1996) as the transition from broaching concepts to more advanced concepts, and which is characteristic for design-oriented vocational training. In addition to researching work process knowledge, any modern and design-centred vocational training needs concepts that permit participation of work experts in designing their work, their work equipment (tools, techniques) and their own education and training.

The ESWWs are the attempt to solve the problem mentioned at the outset, namely the discrepancy between the theoretical and real content of work. The content of work is made accessible for training by the concept of characteristic tasks and by the participative definition of those tasks.

The problem of the narrow empirical knowledge-base in skilling research, mentioned at the beginning, is mitigated (but not solved) in the GAB pilot study by conducting ESWWs for every core occupation and for every company site, because the workshops still generate data that is specific to VW. The task lists for each occupation were validated by a national survey of experts. The fact that the ESWWs were conducted before the pilot project commenced ensures that the data material is up to date. Furthermore, an instrument was created in the pilot project with which teachers and trainers can obtain, at any time, a profile of the current reality in each occupational task (BAG) (‘*BAG erleben’* see Bremer et al., 2001a, p. 25)

13.5.1.1. *Criteria for selecting participants*

Experts and skilled workers are selected using a series of criteria derived from the aims of the method.

Due to their occupational biography, their occupational competences and their current tasks, expert skilled workers represent a background of experience and knowledge that can be put to good use to identify interrelationships at the workplace which provide an inkling of future trends. The expert/skilled workers should have progressed through some key stages in their careers in recent years, and should therefore know various departments of the company and have participated in innovative projects.

Thus, expert/skilled workers are not representatives formed by the existing occupational structure, but personify occupational practice that is innovative and suggestive of future trends in a particular occupational field

(prospectivity). Depending on the occupational field in question, the sectoral structures must be taken into consideration when selecting and deciding the number of expert/skilled workers such that the core and peripheral tasks of the particular occupation can be documented.

In practice, about 10 to 12 participants was found to be a good group size for ESWWs. At least two thirds of the participants should be from the skilled worker level and at most one third from the supervisor/foreman level. In this method, representatives of skilled workers who had been promoted to higher positions (as foremen, *Meister* and shop managers) are deemed to represent a work-centred management perspective. They, especially, are the ones who are able to assess occupational tasks as they relate to the organisation of tasks within the enterprise.

13.5.2. Conducting the workshops

A total of 23 workshops were conducted for five occupations in all, with involvement by approximately 230 participants. Each workshop was scheduled for eight hours and was conducted by two researchers, at least one of whom had vocational training in the respective occupational field (e.g. technical college teacher or engineer in the field of electrical engineering). A 'script' containing the following five points was developed for all workshops:

(a) welcome and introduction.
The goals we are pursuing were explained to the participants. For them, it was something entirely new to be involved in the process of designing vocational training. The aims being pursued in the workshop and with their contributions were also explained.

(b) introducing the researchers and participants (occupational biographies).
We used the round of introductions common at workshops to foster understanding of the task concept, in addition to getting to know each other. Our first step when introducing ourselves was to provide an initial introduction to the concept of occupational tasks. We characterised each stage in our own occupational biographies in terms of the key tasks, thereby explaining our conception of work tasks and illustrating this with specific examples. The participants were requested to name key occupational tasks at each step of their careers when presenting their own occupational biographies. This gave us an initial impression of whether our concept of task was shared by the participants.

When interviewing the skilled workers it is essential to realise that they do not necessarily distinguish in their awareness between their occupational tasks and the other tasks that they have to perform. The opposite may even be the case: something that appears particularly

important in the everyday work situation of the individual skilled worker need not play such a key role according to our concept; conversely, some occupational tasks that appear important to us were seen by the skilled workers as relatively insignificant, because they had possessed the expertise for these tasks for years already and the tasks themselves were mere routine for them.

The participants were requested to write their biographies on a transparency. We asked them to include a maximum of five stages in their careers and to specify three key occupational tasks for each of these stages. The transparencies were successively shown using the overhead projector and the participants introduced themselves by referring to this information. This method is a good way of getting the participants into a talkative mood, i.e. to recount their biography in their own words and without interruption, and to answer subsequent questions about the various periods in their biographies. We collected the transparencies when they had been used. During the workshop we kept a record of the comments made by participants, which often went far beyond what they had written on the transparency, and added to our written notes using the tape recordings that were also made.

(c) contrastive task analysis – collecting and analysing characteristic tasks. In the preliminary studies, we identified for the pilot workshops some of the occupational tasks that are typical for the occupation. From these preliminary studies, we created a list of tasks to which the participants could add further details or additional tasks. For each of the predefined tasks, the participants were to state in keywords the extent to which the task is typical of their work, in their own view, or whether they do not view the task as being in any way typical.

This method was used in the pilot workshops, i.e. in the first round of workshops. Following this first round, the workshops were assessed and the method evaluated. The result of that evaluation led to modification in workshop procedure; in particular, no prompting was given by the researchers in any of the subsequent workshops. The participants all too quickly 'approved' the lists shown to them, and the original idea of contrastive analysis proved inappropriate.

To obtain some indications for later work regarding the level of difficulty of each task, we asked the participants to state whether the task is suitable for a beginner (A), a skilled worker (S) or an expert (E). This work was initially carried out in small groups; later on, the results were presented to the large group and discussed.

The discussion in the large group about the various tasks and their classification along a progressive scale from easy to advanced was evaluated by us when preparing the collection of characteristic occupational tasks.

(d) development from novice to expert: milestones.
Each of the workshop participants had successfully advanced from the novice stage to being a skilled worker or expert, and we wanted to know how the skilled workers themselves had experienced this development. In order to prompt participants' memory of the various stages in this development, we gave them a questionnaire containing three questions for each stage, whereby each question was posed from a different perspective (beginner, skilled, expert).

This questionnaire was kept by the participants and collected later on so that it could be evaluated in conjunction with the subsequent discussion on the path from beginner to skilled worker. The participants were shown the questions from the questionnaire and, from the answers, the discussions and additions that followed, keywords were written down on cards by the joint moderator; these cards were then arranged along a progress scale by the moderator with the approval of the participants.

(e) assessment of apprentices and vocational training.
The participants were asked for their opinion about those positive and negative qualities of apprentices that are relevant for the occupation, and about the changes that, in their opinion, were urgently needed in vocational training. The results of this survey were also presented for group discussions at which the moderators provided feedback, in the form of keywords on the pinboard, on the assessments made by the participants and examined the extent to which this reformulated opinion was accepted by the participants.

Evaluation of this final part again included the (photographed) pinboard and the tape recordings made.

Evaluation of the original material was carried out in two steps. For each workshop, the moderators drafted a record of proceedings, in which key excerpts from the discussions and statements made in the workshop were put down in writing. The tape recordings of the workshop were listened to and all passages that might be significant for the workshop records were transcribed. In a second step, the project group decided on the specific data from the total body of material that should be used for further evaluation.

13.5.3. Selected results

A characteristic occupational task for toolmakers is reproduced here to show the kind of results obtained from ESWWs. The complete list can be found on the Internet at www.gab.uni-bremen.de.

Figure 2: **An example of a vocational task**
(*Lernfeld* is the term used for a 'learning subject area')

Objective: production of components

Tooling mechanics make tools, jigs and fixtures, or parts thereof, as a core task in their occupation. This is done using various production methods, both manual and machine driven or automated. Production is based on technical drawings, sketches or models that the toolmaker must translate into physical items. The specifications that the single part or component must meet in respect of functionality, quality (e.g. surface quality, tolerances in dimensions, shape and position) as well as the costs involved must be complied with and monitored. The decision as to whether a required part or assembly is made internally, or farmed out to an external contractor, or whether a standardised part (possibly modified) will perform this function is of key importance when performing this occupational task.

Content of work

- Production of components for tools, jigs and fixtures
- Inspection of functional reliability and quality of the single parts or assembly

Tools

- Technical drawings, part lists, work plan, operational diagrams and sketches
- Assembly diagrams, models, operating instructions, accident prevention regulations
- Standardised/special tools
- Machine tools
- Measurement, testing and inspection equipment
- Technical information systems
- Machine utilisation plans, job disposition, spare parts disposition

Methods/procedures

- Reading, editing and producing technical documents
- Executing a work plan for a production task
- Manual production methods
- Automated, machine-driven production methods
- Determining the production data and machine parameters with the help of tables, diagrams and manuals
- Testing and inspecting the finished components

Organisation of work

- Third-party contractors/internal order
- Machine utilisation
- Groupwork/individual work
- Centralised/decentralised labour management
- Organisation of job execution
- Workplace design and equipment
- Work organisation: materials and spare parts

Requirements to be met by work performed

- Execution of customer order in accordance with technical documents/models
- Safe and proper selection, handling and use of standard and specialised tools, as well as measuring, testing and inspection equipment
- Operating machine tools in accordance with safety regulations
- Modifying and designing the single parts and assemblies
- Compliance with stipulations regarding production times and expenses
- Efficient planning of machine utilisation and use of workshop capacities
- Environmental aspects and environmental protection regulations (Bremer et al. 2001).

The 'learning subject area' (*Lernfeld*) contains an occupational task and the requirements to be met by work performed in a way that teachers and trainers are able to construct educational and occupational tasks (*Lern- und Arbeitsaufgaben*) for the trainees. These tasks are carried out by the trainees in businesses, teaching workshops or in the laboratory and make a frame available for acquiring work process knowledge.

13.6. Conclusion

Expert-skilled worker workshops are an instrument for participative analysis of skilled work. Work process knowledge is the basis on which the participating skilled workers select occupational tasks that are representative of the work situation in their occupations. In workshops of this kind, occupational tasks are specified in a way that correlates closely with the actual content of work. To that extent they are a suitable means for reducing the problems mentioned at the outset. They link curriculum design to the actual content of work.

Because occupational tasks are specified in a form specific to the participating company, they broaden the empirical basis of skills research.

However, they have been carried out for only one company so far. Further workshops must follow if an empirical basis for nationally defined occupations is to be created. In the GAB pilot project, the specific design of curricula using empirical findings is followed up by an analysis of existing occupational images and a nationwide survey of experts.

The problem of locating the occupational curriculum in the context of actual work and its description as an occupational profile is solved by the fact that the occupational tasks are abstracted from concrete work, on the one hand, but provide many points of contact for specifying them in a particular work context, on the other hand. Experiencing occupational tasks provides a methodological guide that was also tested in the pilot project (Bremer et al., 2001a). With the help of this guide, teachers and trainers can evaluate the concrete work in a plant to gain a concrete image of an occupational task in every sense. After that, they are able to design work-based education for the trainees. Work process knowledge is the background to these abilities but it has become explicit only to a very low degree. Expert-skilled worker workshops are a method for transferring the knowledge of the workers to novices, without undertaking a detailed analysis of work process knowledge.

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SECTION VI

Design of curricula and work process knowledge

CHAPTER 14

Practice and learning: issues in connecting school and work based learning

Toni Griffiths, David Guile

14.1. Introduction

This chapter is written in the context of the developing knowledge economy and the changes arising from the twin challenge of globalisation and regionalisation. It advances the idea that learning from work experience placements has the potential to equip students with the habit of enquiry and the ability to make connections they will both need and benefit from – intellectually and emotionally – in the working environment of the 21st century. Too much, but also too little, has been claimed for work experience. Studies of its true learning potential have been neglected in favour of studies about the quality and precision of the attendant management arrangements.

The reflections which follow benefit from our research project conducted under the aegis of the EC Fourth Framework (Targeted Socio-Economic Research – TSER) entitled *Work experience as an education and training strategy: new approaches for the 21st century* (Griffiths et al., 2001). This research examined the processes of work experience in the light of developments in learning theory, changes in the European labour market and national policies and trends in workplace requirements and organisation. See also the related Cedefop publication entitled *Learning through work experience for the knowledge economy: issues for educational research and policy* (Griffiths and Guile, 2004.)

It is clear from this work that, whereas there is an emerging debate (Guile and Griffiths, 2001) arising from such ideas as 'situated learning' (Lave, 1993), there is also a need to resituate some of the major theoretical ideas (for example, the implications of activity theory) in the context of European vocational education and training policies.

14.2. Learning through work experience

This chapter draws upon our explorations of learning theory, in particular dealing with:

(a) the question of 'context', in the sense of the learning which occurs within and between different contexts of education and work;
(b) the issue of 'mediation', in particular, the process of mediation that can provide learners with the basis for connecting context-specific learning with ideas or practices originating outside those contexts;
(c) 'boundary crossing', in the sense explored by Engeström, et al. (1995) reexamining and reformulating questions about the boundary between education and work (see also Tuomi-Gröhn and Engeström, 2003);
(d) 'consequential transitions', an individual, developmental process involving the full person, not just the acquisition of another skill;
(e) the concept of connectivity, which has led us through the TSER project to develop a typology of learning through work experience.

Until recently, most models of work experience have either ignored the influence of context on learning or have approached this issue mechanistically. The concepts of context and practice are now, however, increasingly recognised as crucial to the emerging debates (Guile and Griffiths, 2001) about how students learn and develop through all forms of work-based activity. Through case studies we have explored how attributes of connectivity provide the basis for a productive and useful relationship between formal and informal learning and the learning which occurs within and between the different contexts of education and work. These and other explorations have developed and confirmed our typology of work experience, which includes the innovative connective model that is outlined below.

14.3. Practice and learning

The concept of practice is central to understanding the learning and development that occurs through work experience and this is illustrated in the typology. The idea of practice provides a way of analysing human cognition and development as an integral part of a larger system. It has a long and distinguished history in the social sciences (Bourdieu, 1977; Wenger, 1998) and is inextricably bound up with the idea of learning. Many accounts of the acquisition of expertise, that is, practice, emanating from

cognitive psychology have stressed that one of its central features is the cognitive ability to acquire knowledge, problem-solving strategies and metacognitive skills. Sociological accounts on the other hand have tended to stress immersion in *habitas,* that is, cultural codes and conventions (Bourdieu, 1977).

Recent work in socio-cultural learning theory, in particular, activity theory (Engeström, 2001) and situated learning (Lave, 1993) has suggested that it is helpful to view practice in relational terms. This avoids treating the concept of practice and the context in which the practice is situated separately and allows both the macro-structural and personal process of construction to be taken into account (Lave, 1993). Moreover, the development of practice is not simply a matter of solving problems through the application of cognitive skill; rather, it involves learning how to use the 'resources', which may reside in or be distributed across different individuals to develop understanding, identity, new knowledge and, ultimately, to transform practice (Hutchins, 1997).

By specifically eschewing the assumption that students engaged in different forms of work-based practice are 'containers' to be filled-up with relevant knowledge and skill (Lave, 1993), it is possible to avoid assuming that the social practice in which students partake, will automatically enable them either to assimilate relevant workplace knowledge, skills and attitudes or to internalise changes occurring in the workplace and adapt to the 'world of work' and/or develop new occupational identities (Guile and Griffiths, 2001).

In the light of these considerations and the insights of Engeström, Lave and Hutchins about practice, it is important to distinguish between the forms of practice, the meaning of practice and the historically constructed basis of practice. Forms of practice relate to the different types of vocational/professional practice (i.e. 'communities of practice') in which students might participate. These pedagogic practices support learning through work experience and the forms of practice associated with different activity systems, which in turn shape the division of labour and rules which students encounter in workplaces. The meaning of practice reflects the idea that any form of practice has to be meaningful in terms of the activity system in which the practice is situated and for the individuals who are engaged in the practice.

In the case of the historically constructed basis of practice, it is important to remain sensitive to the fact that all forms of practice are historically constructed activities which are constantly evolving and changing.

These distinctions illuminate the important relationship that exists

between the context of education and the context of work. Lave stresses that mastery of practice is acquired by participating in specific forms of practice. However, as Lemke (1997) has observed, sometimes even full participation in practice is insufficient by itself to achieve full membership and understanding of that practice. For example, participation in activities and/or rituals, do not necessarily reveal the meaning of a practice. People have to be schooled in the mysteries of practice through formal education in exploring significance of a practice in order both to be accepted as a member of a community of practice and to develop the confidence to perform as a member of that community.

We have suggested (Guile and Griffiths, 2001) that greater thought needs to be given in general education and in VET on how to support students in relating their 'vertical development' more readily to their 'horizontal development' (Beach and Vyas, 1998; Engeström, 1996). The concept of vertical development is located in ideas about intellectual development which have been the cornerstone of most cognitive development theories (Gick, 1995). This entails that:

(a) intellectual development consists of making progress through a hierarchy of knowledge and skills and away from the specifics of human practice (Beach and Vyas, 1998);
(b) that the movement towards greater levels of abstraction and decontextualisation constitutes the hallmark of developmental progress, distinguishing true 'development' from 'mere' learning (Gick, 1995);
(c) that intellectual development normally occurs through formal study in an educational context, such as a school or university.

By contrast, the concept of horizontal development, which arises from more recent developments in socio-cultural theory, refers to the process of change and development which occurs within an individual as s/he moves from one context (such as a school) to another (such as a workplace). Thus, at one level, it could refer to the changes in an individual's sense of identity as a result of the experience of working in a school, factory or community centre. At another level, it could refer to new mediating concepts that enable one to cope with the demands of working effectively in different organisational settings (Engeström et al., 1995).

Because practice involves learning how to perform in different contexts, it is also important to bear in mind the distinction between different interpretations of the concept of context in relation to work experience. One interpretation defines context as a given object or condition, or set of objects or conditions with three different aspects: the organisational context, the production context and the changes occurring within context. The other

interpretation reflects the idea that work and education are contexts through which students can learn and develop (Guile and Griffiths, 2001). This distinction can be used to help students appreciate that the meaningful actions in which people engage have what Lemke refers to as, 'meanings of relations to one another in terms of a cultural system'. In other words, membership of a community of practice involves not only learning how to perform in one context but also what this performance means and how it might relate to other aspects of social or cultural life.

14.4. Approaches to work experience: a typology

Our five-model typology of work experience (see Figure 1) provides a means of exploring within five broad models the following dimensions of work experience:

(a) the purpose of work experience and the reason for providing it;
(b) the assumptions about learning and development in workplaces;
(c) the practice of work experience and the extent to which it is seen as divorced from context;
(d) the role of the education and training provider, the pedagogic strategies employed to support students in learning;
(e) the outcome of the work experience, the form of knowledge, skill or broader capabilities that students have developed.

The first four of the five models reflect the influence of different economic, technological and social factors prevailing within European countries as well as different ideas about learning and development. Although the models may be specific to different periods of economic and technological development and reflect changing educational ideas about the process of learning, as the final TSER report (Griffiths et al., 2001) indicates, they coexist in different countries. They are analytical rather than descriptive: no specific work experience programme fits neatly into any of the models and some programmes may contain elements of more than one model. The fifth model displays innovatory features which are relevant to future approaches to effective learning through work experience and provides a basis for different explorations (Herlau et al., 2000). All the models are described in detail elsewhere (Guile and Griffiths, 2001; Griffiths and Guile, 2004). Here we will focus on the fourth (work process) and fifth (connective) models.

Figure 1: **A typology of work experience**

MODEL OF WORK EXPERIENCE	Traditional Model 1	Experiential Model 2	Generic Model 3	Work Process Model 4	Connective Model 5
Purpose of work experience	Bridge to work	Codevelop-ment between education and work	Key skill/ competence assessment	Attunement to work environment	Reflexivity
Assumption about learning and development	Adaption	Adaption and self-awareness	Self-management	Adjust and transfer	Vertical and horizontal development
Practice of work experience	Managing tasks and instructions	Managing contributions PLUS recording experiences	Managing action plan and learning outcomes PLUS managing situations	Managing work processes, relationships and customers PLUS adding value for employer and supporting employability	Developing the connective practices PLUS entrepreneur-ial ability
Role of education and training provider	*Provide:* formal preparation programme	*Facilitate:* briefing for and debriefing of work experience	*Build:* portfolio of achievements	*Support:* reflection in and on action	*Develop:* partnerships with workplaces to create environments for learning
Outcome of work experience	Skill acquisition and know-ledge of work readiness	Economic and industrial awareness	Assessment of learning outcomes	Systems thinking	Polycontext-ual and connective skills

14.4.1. The work process model

One response to the classic problem of division between formal and informal learning that many models have failed to address satisfactorily has emerged from within the German VET tradition. The concept of 'work process knowledge' – understanding the labour process in terms of product-related, labour organisational, social ecological and systems-related dimensions – has been introduced to assist apprentices and teachers to overcome the dilemma of 'inert knowledge', that is, knowledge which has been taught but has not proved useful in practice (Kruse, 1996). When in 1985 Wilfried Kruse first introduced the term *Arbeitsprozesswissen* (later redefined in the English language from 'labour process knowledge to 'work process knowledge'), he was pointing to the kind of knowledge that belongs to experienced workers. On the one hand it was an insight into changing working practices in different industries; computerisation and new occupational profiles had been introduced. On the other hand, Kruse's attempt has to be understood against a background of a specific approach in the area of qualification research which was guided by the aim of adapting people to rather narrow occupational profiles created in a Taylorist tradition. In contradiction to this approach, Kruse postulated that a kind of knowledge is required – and will be even more so in the future – that does not only refer to isolated atoms of work behaviour but to the work process as a whole and combines theoretical as well as practical knowledge.

In terms of the typology, the main distinguishing feature of the concept of work process knowledge is that it draws attention to the combination of theoretical and practical learning, prepares apprentices to engage more rapidly with new organisational forms of production and enables them to move into alternative work environments more easily (Fischer and Stuber, 1998).

The primary purpose of work experience, from this perspective, is to help students attune themselves more successfully to the changing context of work through participating in different communities of practice. The idea of 'attunement' recognises that the development of any individual is affected by the task or activities which he or she is asked to undertake in a specific context and that the context, in turn, is also affected by their development (Kindermann and Skinner, 1992).

It has been noted, however, that work experience will not by itself promote work process knowledge and that it needs to be mediated – perhaps by the introduction of concepts or by subject knowledge – and that the process of mediation may take place within the workplace and company training centres (Attwell and Jennes, 1996). Thus, Attwell and Jennes conclude that

German VET programmes will have to evolve further to help students connect formal and informal learning. A major project involving the University of Bremen and the Volkswagen company – the GAB project, described elsewhere in this book – explores how vocational tasks can be transformed into 'tasks of learning and working' (Bremer, 2000), thus helping apprentices to connect different types of knowledge.

14.4.2. The connective model

This model of work experience is based upon the idea of a 'reflexive' theory of learning (Guile, 2001) which involves taking greater account of the influence of the context and the organisation of work upon student learning and development, the situated nature of that learning and the scope for developing 'boundary crossing' skills. It also entails developing new curriculum frameworks which enable students to relate formal and informal, horizontal and vertical learning. Points of connection with the GAB project, referred to above, are thus possible.

The term connectivity defines the purpose of the pedagogic approach which is required to take explicit account of the vertical and horizontal development of learning. Supporting students to understand the significance of these two dimensions of development constitutes a pedagogic challenge for teachers in educational institutions as well as those with responsibility for development in the workplace. In this, the idea of mediation is crucial. As should by now be clear, this idea is not conceived as a form of compromise, nor as a way of 'juxtaposing' two types of knowledge but, rather, as the resituation of different types of knowledge in different contexts. This is one of the key 'tension points' for development within the work process model and an approach which has great potential. It could lead to encouragement of students to understand workplaces as a series of 'interconnected activity systems' (Engeström, 2001) which consist of a range of 'communities of practice' (Lave and Wenger, 1991; Wenger, 1998) and 'distributed resources' (Hutchins, 1997). In addition, it involves teachers and workplaces in appreciating that work experience provides a range of very different ways of learning, compared with the way that students normally learn in school (Guile and Young, forthcoming).

Understanding the development of connectivity requires attention to the complexity of language (Griffiths and Guile, 2004). Wells (2000) suggests that the relationship between language and the forms of knowledge associated with different 'communities of practice' is much more complex than has generally been assumed. Language serves a dual role: on the one hand, it is the principal medium in which the understandings gained in the

past are made available for acquisition and use in the present. On the other hand, the process whereby these understandings are 'shared' is very far from being one of simple transmission and repetition. Wells employs the term 'metaknowing' to convey the idea that knowledge is built through reflecting on social practices and using the 'resources' available in 'communities of practice'.

In summary, connectivity means that teachers and workplaces ensure that work experience provides an opportunity for learners to 'learn to negotiate how they learn' in workplaces, since this is critical to effective workplace performance (Beach and Vyas, 1998), and to learn new capabilities that are gradually being required in 'high-performance' workplaces (Guile and Fonda, 1999). Also, they need to support learners to appropriate concepts acquired through vertical development, and which are external to the context, and to mediate the relationship between their formal programmes of study and trends in labour and work organisation. Thus, learners not only have to develop the capacity to participate within workplace activities and cultures; they must also learn how to draw on their formal learning and use it to interrogate workplace practices. Eraut (1999) suggests that this could involve the use of prior knowledge, seeing the relevance of concepts, resituating the concepts and integrating new knowledge. These ideas about learning through work experience imply a reappraisal of human resource development strategies (as well as management and developmental practices) by 'host' organisations and of the pedagogic practice of teachers, since students and workers have to learn how to enter unfamiliar territory and work collaboratively in different communities of practice.

14.5. Exploring models of work experience: some reflections on methodology

In order to develop a methodology which allowed explorations to take account of the different contexts in which young people found themselves on work experience and the influence of those contexts on the process of learning, the TSER project took up socio-cultural learning theory. This theoretical tradition raised important questions about how to explore learning in context. Thus, for example, an approach was developed to be used flexibly in the different member states to explore the learning which occurred through work experience. In turn this could provide data for analysis in the construction of a typology of work experience.

Questions and issues about methodology arising from socio-cultural learning theory raised important questions. For example, the idea of mediation proved particularly productive in a study which was to take account of the way in which learners used cultural objects and 'experienced others' to support and develop their understanding of the context of work and the relationship between the formal component of their education and the practical or informal experience gained in the workplace. The idea of the community of practice also raised two important questions: how easily did learners:

(a) make the transition from one context to another;
(b) gain access to and operate in work contexts?

The recurring assumption in most studies of work experience in both general education and VET has been that transition and access are accomplished *ipso facto*. This assumption neglects to take into account the extent to which participating in a 'community of practice' results in changes in identity as well as knowledge and skill.

Our explorations of learning theory emphasised the importance of systematic inquiry into how far educational institutions recognised that when learners move between contexts (or make 'consequential transitions'), they have to develop the capacity to act as boundary crossers. This involves developing the polycontextual skills (Engeström et al., 1995), which allow people to relate different types of knowledge and to resolve problems which arise in different contexts. The other object of inquiry illuminated by explorating learning theory was how far educational institutions recognised that host organisations needed to provide opportunities for learners to observe, discuss and try out different practices with members of the community which they had joined temporarily.

Finally, an important mode of inquiry was needed to address the idea of dialogue within and between activity systems. This opened up many issues about the extent to which educational institutions and workplaces encouraged learners to conceptualise their experiences in different ways and allowed these conceptualisations to serve different purposes, such as enabling learners to develop a holistic understanding of work, to contribute to work practices and to work collaboratively to transform practice. In relation to educational institutions, inquiry was needed to establish the extent to which learners were supported to relate formal and informal, horizontal and vertical learning.

These theoretical and methodological reflections were important in informing our exploration of the dimensions of the typology and its modelling. They inevitably raise further questions for research and for

development (Griffiths and Guile, 2004) suggesting that new conceptual tools be developed to assist learners undertaking programmes of work experience so that they may understand both the evolving forms of work practice and the types of dialogue encountered in workplaces and education.

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CHAPTER 15

Decentralised learning: integration of working and learning

Peter Dehnbostel, Gaby Molzberger

15.1. Background and framework of the decentralised learning programme

The German vocational and educational system, with its orientation towards the concept of *Beruf* (profession), is highly formalised and regulated. Different agencies, such as the different states (*Länder*), the Federal State (*Bundesländer*), chambers (*Kammern*), professional associations (*Berufsverbände*) and private enterprises, all share responsibility for organising vocational education and training. The dual system of German vocational education uses two basic learning places: vocational schools and private companies. Besides vocational school and company workplaces associated with it for apprenticeship, there are several other learning places located away from production, for instance training centres and other external training places. All learning places and institutions have clearly defined characteristic educational assignments; vocational school is traditionally responsible for theoretical knowledge oriented towards scientific curricula and general educational content, while workplaces have to do with work experience and practical expertise.

Since the late 1970s, technological innovations, specifically the rise of information and communication technology, have changed the character of work processes in a dramatic way: formerly monotonous work processes have been replaced by more holistic and demanding work processes. By the end of the 1980s, the parameters of production had been redefined in the industrial sector and the number of employees has fallen, yet at the same time new opportunities for encouraging professional and personal development had opened up. However, with changing methods of production and increasing service orientation, a strict distinction between theoretical learning on the one hand and practical learning on the other hand becomes increasingly questionable. Additionally, in modern working

environments, qualification needs and demands become next to unpredictable. This compounds the definition of obligatory and sustainable curricula for a respective profession. As in other European countries, in Germany the gap between theory and practical application needed to be addressed in a new way.

Within this situation in Germany, some enterprises together with the Federal Institute of Vocational Training and Education (BIBB) ([54]) discussed questions and challenges concerning new methods and learning content on the shop floor, acquiring key qualifications through work-based learning and finding new ways towards a more open and flexible learning system. The starting point of the initiative was the recognition that new forms of combining learning and working and new concepts of industrial learning had become necessary and possible. In the beginning of the 1990s, these reflections resulted in the decentralised learning programme.

Four crucial themes were outlined by a number of enterprises with the BIBB:

(a) new learning venues and new combinations of learning venues;
(b) new methods and didactical concepts for workplace learning;
(c) further education of training staff;
(d) analysis and development of the workplace to improve learning.

These fields fixed a general framework for developing decentralised learning and working concepts. The themes were modified in the process of developing and evaluating the concept. In total, twelve pilot projects joined the programme (Dehnbostel et al., 1996). In the beginning, the model projects concentrated on initial training in the dual system. Afterwards, they were extended to further education. In developing decentralised concepts, one can see how initial and further education are coming together.

The principal leading idea of decentralisation is to be seen in the extension and relative autonomy of the newly developed work-learning venues. Competence, relative self-organisation and responsibility are delegated to these venues. Generally, decentralisation of enterprises, institutions and structures means the process of shifting and delegating tasks and competences to the base. This is done to increase decision-making and responsibilities in the places where the direct work is carried out. With decentralisation, self-organisation and autonomy increase and regulation and instruction decrease. This does not mean a general reduction in regulations and social norms, but rather their continuous renewal by democratic participation and legitimacy.

([54]) See http://www.bibb.de/en/welcome.htm

The concept of decentralised learning comprised two central aspects: organisational and didactical. This shaping of the learning situation is aimed at the application of work process knowledge according to the profession profiles. On the organisational side, new learning venues were established in or with regard to the shop floor. These learning venues – such as learning bays, learning stations or technical centres – were placed within a network of different learning venues, including training centres and – mostly for initial training – vocational schools in order to maximise the advantages of centralised and decentralised learning venues. On the didactical side, decentralised learning seeks to integrate learning and working. The didactical concept combines formal and informal learning processes.

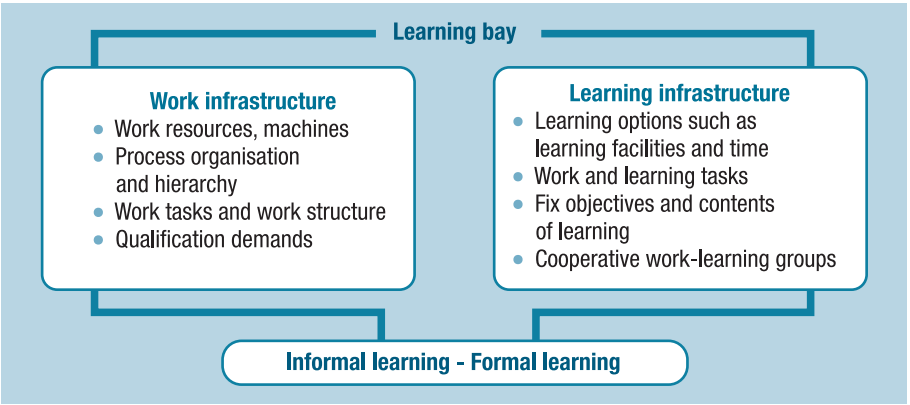
This chapter presents two examples of this new organisational and didactical approach developed in the programme entitled: *Decentralised learning: learning bays and work and learning tasks* (Dehnbostel and Molzberger, 2001).

15.2. Learning bays

Currently, learning bays can be seen in operation in more than 50 industrial medium-sized and large companies in Germany. They were first developed in the programme Decentralised learning, especially in the model project Decentralised learning in teamwork in two Daimler plants located in Baden-Württemberg (Dehnbostel, 2001; Dybowski et al., 1999). One of these plants is a truck assembly plant and the other a car assembly plant. Shortly after the beginning of the model project, the learning bay model was transferred to several mainly medium-sized enterprises.

There are two central project innovations attained: placing learning bays in the middle of the work process and developing group work and group learning. Learning bays are supplied with a double infrastructure: that of a normal workplace and that of a learning place. Thus, learning bays include work resources, machines and typical work tasks as well as learning facilities such as notice boards, multimedia and time for using it. Work-bound learning in learning bays integrates informal and formal learning. The learning infrastructure is the basis for formal learning, whereas the work infrastructure is the basis for informal learning. The following figure illustrates the double infrastructure in learning bays:

Figure 1: **Double infrastructure of learning bays**



During initial training, learning bays were set up to produce gearshifts, for axle assembly, maintenance and customer/after-sales service. Usually a group of four to six apprentices spends about six weeks at a time in one learning bay. The complete apprenticeship lasts three-and-a-half years and the apprentices spend only the last one and-a-half years of their apprenticeship in learning bays. Before doing real work with high demands and responsibilities, apprentices have the opportunity to acquire knowledge and skills by first-hand experience, doing the same work as skilled workers in surrounding workplaces. They are accompanied by a skilled worker who has the ability to train and who is designated the learning bay trainer. Each apprentice performs all the different tasks in a kind of job rotation, including the role of the group speaker and leader.

The combination of formal and informal learning mostly takes place in the form of group learning. Planning, carrying out and checking assignments is done by the group collectively. The work and learning content are continuously discussed by the group, as are the personal attitudes of each group member and the group leader. Technical, social and methodical skills are learned by experience and theoretical instruction. The apprentices coordinate their tasks by themselves. They have to learn how to conduct consultations and write protocols. They also learn how to use presentation and visualisation techniques. The learning bay trainer designs the necessary methods for this purpose. The trainers' central role is to support and monitor learning. The real challenge lies in imparting knowledge and proficiency using methods other than the traditional, trainer-centred approach. Instead they need to create learning situations and environments for independent learning and encourage trainees to acquire expert, methodical and social

competence. Support, monitoring and coaching processes replace the conventional concepts of teaching and instruction. Learning bay trainers spring into action when they are asked. They also get involved when they see that the group is not able to solve the tasks or resolve conflicts within the group independently. Here it is important to sense when the time is ripe to intervene, so that they neither interrupt independent group processes, nor cause damage by being too slow to step in.

The trainers also develop and design the workplace as a learning location or a learning bay. In this, tension and contradictions are often unavoidable, for the activities in the workplace are subject to business criteria and calculations, whereas educational goals are set in the context of training. In addition, trainers are often unfamiliar with and unpractised in investigating their own workplace in the search for potential learning situations. In practice, a model covering five phases has been devised for developing and designing learning bays, as illustrated in Figure 2.

Figure 2: **Model of phases for developing and designing learning bays**

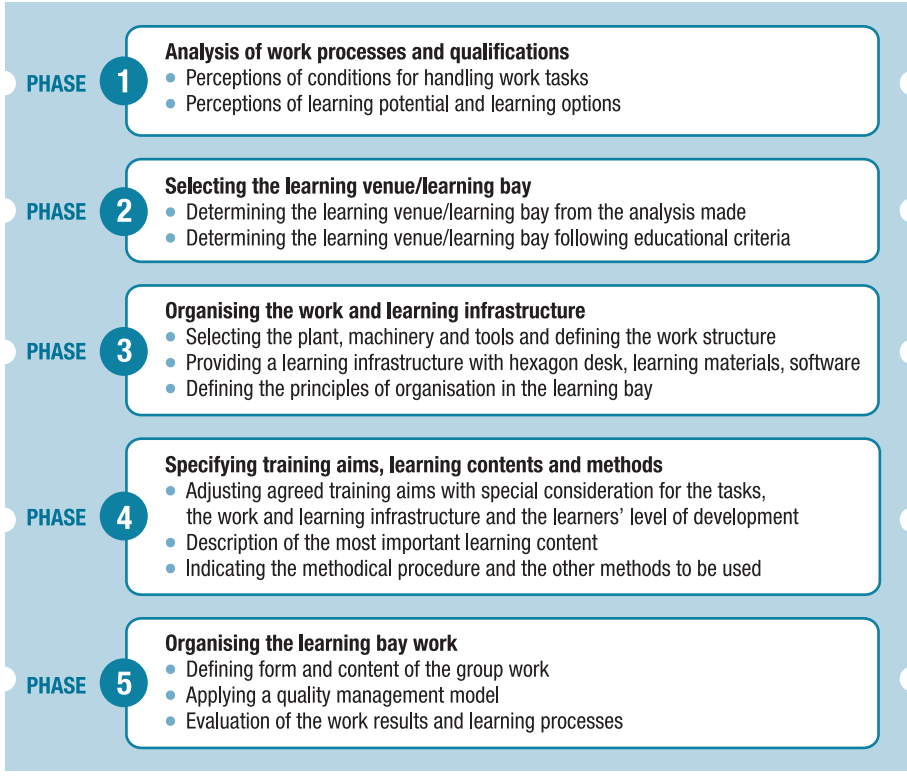
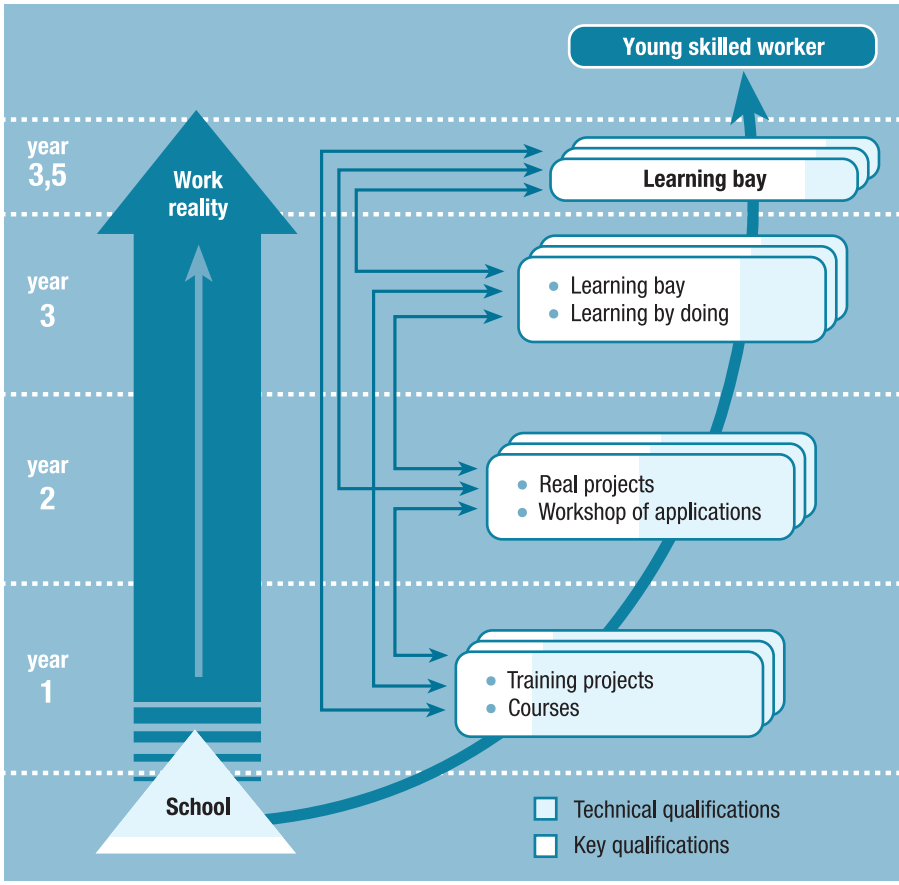


Figure 3: **Learning bays and venue combinations**



The first phase analyses which tasks are to be completed and which qualification requirements and working conditions are involved. The resulting findings, taking work-related and educational criteria into account, lead into a second phase for the decision as to whether the workplace under examination should be selected as a learning bay. The structure, equipment and organisational principles of the learning bay are laid down in a third phase. In phase four, the learning goals, contents and methods are decided on the basis of the working-learning situation, the training level of the trainees and the skills intended to be conveyed. The final fifth phase involves the actual planning of work and procedures in the learning bay and the preparation of a model to assess the quality of work in the learning bay. This last phase can be subdivided into a planning and an assessment phase.

In the apprenticeship of Daimler Chrysler in Baden-Württemberg four different types of venues are combined: vocational school, the training centre, the traditional shop floor for learning by doing and the new learning bays. These venue combinations – called learning networks – are supposed to maximise the advantages of the different learning places. In learning bays especially, key qualifications like team ability and self-directed learning are acquired. The following figure shows the growing importance of key qualifications in the development of the learning track. Additionally, it shows the different venues of the apprenticeship including the differentiation in the first two years of apprenticeship in the training centre of Daimler Chrysler.

It is important that the department where the learning bay is situated is responsible for the costs. In this way learning bays become more integrated in the work process. The department has an interest in the learning processes and it is linked to other learning places and modern training concepts. The learning bay receives its assignments either directly from the computer-controlled order and planning system or from the master or from other departments. For further vocational training, the learning bays have, in principle, the same structure. However, one important difference is the duration: further training in learning bays usually lasts only from two to five days as opposed to about six weeks during initial training. Another difference is the actual content. At present, learning bays for further training are mostly used for adjustment purposes. Thus, technical skills dominate.

In summary, learning bays can be characterised in the following way:

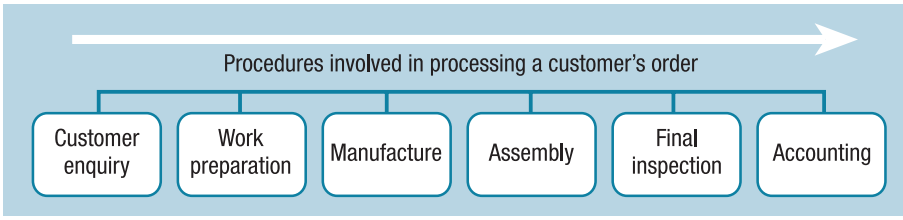
(a) learning bays are workplaces on the shop floor which are expanded with learning facilities and where trainees – young people and adults – accomplish work tasks mostly on their own;
(b) the trainees work in a team. The teamwork is arranged in a manner similar to the model of semi-autonomous group work;
(c) learning bay trainers primarily fulfil the role of an attendant or advisor. She or he is always a skilled worker of the respective department. Also their task is to analyse, select and design workplaces as learning venues;
(d) the work tasks are holistic and contain potentials of learning and shaping;
(e) sometimes learning bays are sites for innovation in work processes, especially in the field of new work organisation and new work arrangement.

15.3. Work and learning tasks in small and medium enterprises

Another way of combining learning and working was founded in the decentralised learning programme (Dehnbostel et al., 1996). A work and learning task system for vocational training was developed and tested specifically for small enterprises. In the model project Decentralised earning for small and medium enterprises, training was decentralised insofar as it was split up and distributed to several companies which specialised in that respective part of the training. This resulted in a broader training basis and more autonomy for the individual company training venues. A network of all participating small and medium-sized companies came into being. Some of the training competences and tasks which had previously been concentrated in a single company were delegated elsewhere. The concept was developed and tested for various training sequences, mainly for the second year of apprenticeship. The work and learning task system was flexibly applied in the companies concerned.

In the pilot project, workplaces were transformed into learning venues by a selective approach to the work carried out there, and its potential to yield suitable work and learning tasks. The small and medium-sized enterprises participating in the model project all had holistic tasks, transparent organisational structures and recognisable interrelational links. Demarcations between different functional areas, e.g. management, administration, work preparation, manufacturing, final inspection and accounting, were usually either non-existent or less pronounced than in larger companies. The task profiles and the associated skill requirements were accordingly coherent and holistic. These quality characteristics, which in turn were found to result in strong social ties, and the presence of skills and expertise integrated in the process, were targeted for their particular merits to produce the work and learning tasks. In principle, they extend over the entire work process illustrated in the following figure.

Figure 4: **Complete work process**



In order to understand the work situation in the participating companies, a multi-step procedure was carried out involving each company using skill analysis as well as analysis of typical work tasks. In the case of the work task, the aim was to identify 'typical' tasks on the basis of two criteria. On the one hand, the tasks were those regularly handled within the company and towards which the work structures and work media were geared, while on the other, they were to be significant for the apprentices' occupation and also highly transferable.

The findings of these investigations were fed into the process of selecting vocational training workplaces. The work and learning tasks were real-life job orders enriched with training elements. In the analysis of work tasks typical of a given company, the manufacture of a shaft or a swivel part, for example, was identified as having relevance for the learning process. In order to have a didactical impact, the task was analysed and broken down into individual work steps, from order placement and work preparation via manufacture and quality control to completion of the order. The analysis focused on the skills needed for individual action and the entire complex of actions and additionally on the enrichments to be added for educational reasons. Manuals drawn up for the training staff and the trainees set out the work and learning tasks in curricular form. The shaft task was adopted in a way that, as an element of the swivel part, it could be applied to numerous production variants and used in many different companies. The following work and learning tasks were developed and tested on numerous occasions: turning parts, assembling parts as teamwork, familiarisation with cutting tools and shaping technology, and crafting wooden parts.

Except for this last task, intended as training for qualification as a wood mechanic or joiner, the tasks are intended for use in training regulations in the metalworking technology field. The work and learning assignments are structured and deployed according to the following characteristics:

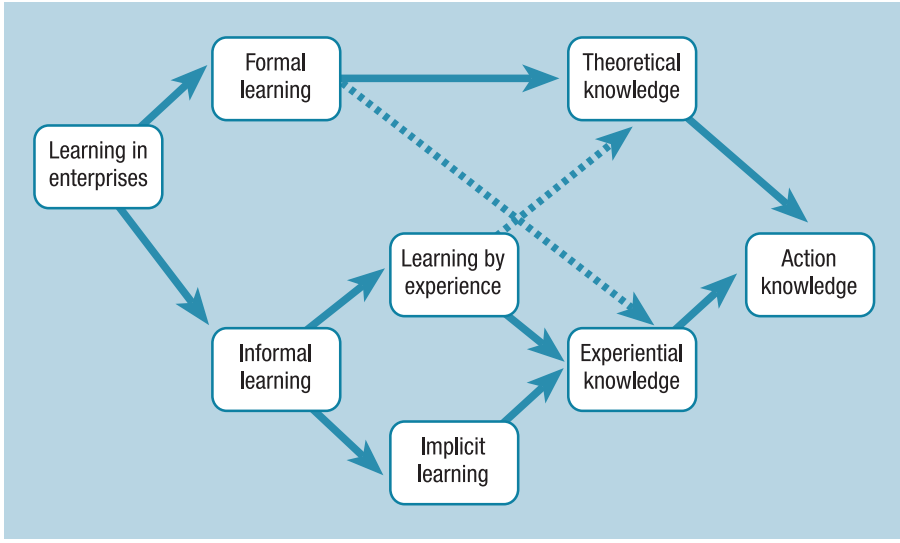
(a) work and learning tasks involve holistic work and learning processes during which technical, social and interdisciplinary skills are acquired;
(b) they are tackled to an increasing extent in self-organised teamwork with each team member bearing a high degree of responsibility;
(c) learning processes are driven by action and experience, learners thereby acquiring experiential knowledge;
(d) issues relating to the design and organisation of the work are considered in depth and associated with a continuous process of improvement;
(e) the selection and enrichment of the tasks are geared to the profile of the training regulations and directives.

15.4. Conclusions and proposals for research and development

Within the context of initial and further vocational training, the notion of learning about work and the combination of learning and working has become increasingly important. The model projects and further research in the field of combining learning and working has shown that, in principle, a distinction has to be made between informal and formal learning. Formal learning is based on fixed content and objectives, while informal learning is uncertain and it produces learning results without planning them. This does not mean that in the process of informal learning intention is lacking, just that this intention is related to the tasks and enterprise developments and not to learning subjects.

Furthermore, with informal learning it is possible to make an analytical distinction between learning by experience and implicit learning. Whereas the latter usually occurs without reflection and subconsciously, learning by experience is mainly due to the reflective assimilation of experience. Obviously both kinds of learning overlap in work and in life. The following figure shows how learning in enterprises can be differentiated and networked with the main kinds of knowledge.

Figure 5: **Kinds of learning and knowledge in enterprises**



The figure shows that experiential knowledge results mainly from informal learning or, in other words, from learning by experience and implicit learning. There is also a weak link from formal learning to experiential knowledge because experience is gained in every formal learning situation. Conversely, formal learning leads mainly to theoretical knowledge with informal learning also contributing to a small extent. Both the theoretical knowledge and the experiential knowledge lead to action knowledge, which is the central objective of today's initial and further vocational training. Action knowledge includes work process knowledge, but in addition focuses on the learners' mental processes of integrating formal and informal learning processes. The concept of decentralised learning concentrates on the pedagogical shaping and organisation of the learning process rather than on the product of work process knowledge (see Fischer, Boreham and Röben, Chapter 5 in this volume).

However, unlike formal learning, informal learning and the combination with formal learning in vocational training has been insufficiently documented, analysed and certified in Germany (Bjørnåvold, 1999). Neither in vocational training concepts nor in examination and appraisal procedures is it regarded as a learning dimension in its own right. If this situation is to change, there is a need to identify and evaluate the competences which are developed through informal learning and the new combination of formal and informal learning (Scholten, 2001). Also in need of documentation and analysis are the vast differences which exist in terms of registering and processing the experience gained by individuals or teams when planning, executing and monitoring a work task. The experience acquired depends on various factors such as pre-existing knowledge, instruction value and routine. At a higher level, reflection on such experience is similarly dependent on various factors. More generally, there is a need to ascertain the extent to which informal learning contributes towards improving experiential knowledge, work process knowledge and action competence.

In practice, learning has increasingly been incorporated into the workplace in various forms for years. For the future, the widening of the concept of decentralised learning to networks of different learning venues will be a challenging task. There is a need to gather and analyse these networks and forms of learning in research projects. The following research proposals have been formulated with regard to issues and problems raised by the decentralised learning programme and further research on the topic of work-related learning. They particularly refer to gaps in vocational training research.

15.4.1. Analysis of the combination of intentional learning and learning by doing in decentralised learning forms

Decentralised learning forms such as quality circles and learning bays have become more relevant in enterprises. They stand out by the way they link intentional learning with learning by doing. A significant reason for the more widespread application of integrated learning lies in the specific learning requirements of enterprises which have undergone restructuring measures. Continual improvement and optimisation, customer and business process orientation and a high level of innovation demand the integration of work and learning. The concept of the 'learning enterprise' can be regarded as a synonym for this need for integration.

Investigations into learning forms combining decentralised, intentional and experience-based learning should basically concentrate on two different dimensions: organisation structure and didactical approaches. As far as organisational structure is concerned, research must analyse how decentralised learning forms are incorporated into the structuring of operations and company organisation in the respective enterprises and to what extent they form a part of vocational training courses and qualification programmes. It is vital to draw up a typology of decentralised learning forms to provide both a sound basis and instructions for their application and implementation. As far as didactical concepts are concerned, research must ascertain whether the combination of intentional learning and learning by doing as an independent learning concept is practicable in the long term. We can assume that learning in highly developed work processes is conceived as an experience-based and largely self-organised process, enhanced by intentional learning goals. We must analyse and implement this by devising criteria to be used for designing work environments conducive to learning.

15.4.2. Constitution, recording, recognition and certification of informal learning

In Germany, didactical concepts do not recognise informal learning as an independent form, but often classify it as occupational socialisation. It generally plays no part in examination and assessment procedures, even though it is taken into account as a whole for admission to external examinations, entry to study courses for students without formal university entrance qualification, and in practical examinations in the dual system. Procedures must be introduced to record, analyse and evaluate the results and skills demonstrated through experience-based learning processes. This will make it easier to develop a form of certification that covers informal learning directly. When recording and recognising informal learning, we must

assume that the content of experience at work depends to a large extent on work situations and learning potential. We must analyse the extent to which informal learning results in experience-based knowledge and leads to a higher level of competence and to work process knowledge.

The vastly different ways in which people register and process the experience they gather by carrying out tasks in the workplace must be recorded. Simple, repetitive activities, for example, offer only low learning potential and learning opportunities. There is hardly any scope for learning by doing in this context. In contrast, varied, complex work situations with considerable learning opportunities normally offer plenty of scope for learning from experience, as has been shown by the above example of learning bays. How people register experience depends on various factors such as personal knowledge, retention capacity and individual routine. In the same way, reflection on experience also depends on various factors, although we must differentiate between subjective and external, or objective, aspects. This has not yet been researched or analysed. Neither have the possibilities and limitations of experience-based learning in relation to personality and competence development been the subject of much research up to now.

15.4.3. Concepts and instruments for analysing modern work-related learning processes

Vocational training research is still in its infancy with respect to developing sound methods or instruments for recording and analysing modern work-related and work-bound learning processes. The traditional investigative procedures, which involve methods such as document analysis, interviews and workplace observation, are unsatisfactory and do not meet the requirements of qualitative research on modern work processes. Above all, it is necessary to record the central relationships between economic, corporate and vocational education and training content in the analysis of work-bound and work-related learning processes. In open work processes characterised by a relatively high level of autonomy, these relationships cannot be surveyed quantitatively. Even the traditional qualitative methods based on interview and observation are inadequate for recording working procedures geared towards improvement, optimisation and learning processes.

As regards qualitative research methods, we can assume that research issues and hypotheses are not constituted on the basis of a theory, but are themselves considered and treated as a part of theory development in the relevant field of enquiry. This inductive methodological research approach

makes it possible, in principle, to incorporate the relevant analysis, results and findings into subsequent stages of the study. With this, in methodological terms, a concept emerges which is open to the object of the research and which is suitable for recording process-like and networked work-bound and work-related learning processes.

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CHAPTER 16

Learning and working tasks as elements of work-related vocational education and training

Falk Howe

16.1. Introduction

In the Federal Republic of Germany, initial vocational education is principally carried out in two venues. For one part, the young person is an apprentice in a company; for the other part, he or she is a student in a vocational training school. Both institutions have posed questions about the function each should serve in the dual system. With relation to subject matter, vocational pedagogy developed concepts for both learning sites at the beginning of the 20th century, and these are still widely used today. The syllabus of courses at school is mainly based on the theoretical knowledge of science and engineering. In contrast, industry determines the basic skills required for professional practice and these are taught in workshops and courses. Thus, theoretical knowledge and basic skills are divided between the two parts of the apprenticeship system. The dual system therefore represents an ordered 'side-by-side' structure rather than an actual 'being-together' (see Rauner, 1998).

However, with the emergence of the concepts of total work process and action-oriented learning in the 1980s (see Hacker, 1986) there was every indication of a change with immediate consequences for the duality of vocational education and training. It was now expected that vocational schools would impart theory which originated in analyses of the overall work processes or complex work systems. Hence vocational schools had to reconsider their traditional concept of theory-based learning and reorient themselves toward the reality of the company's business process. Companies also explored the learning potential of work and shifted their training from courses to the working environment. With the common content

of the company's work reality, it became a central goal of reform to replace 'abstract duality' with 'concrete cooperation'. At the beginning of the 1990s, the National Institute for Vocational Education and Training (BIBB) started pilot projects for 'cooperation between different learning venues' (Holz et al., 1998; Pätzold and Walden, 1999) as well as for 'decentralised learning' (Dehnbostel, 1992). This initiated the identification and use of learning-intensive workplaces. In this context, the idea of learning and working tasks gained increasing importance.

This chapter is based on evidence gathered by the Institute of Technology and Education (ITB) ([55]) of the University of Bremen in numerous pilot projects and experiments on this subject. The concept was further developed and improved, jointly with trainers and teachers who set up the learning and working tasks for the vocational training programme as well as with the apprentices who carried out the tasks. In the meantime, a manual has been developed as an instrument for workplace practice (Howe et al., 2001). This has provided assistance to interested trainers and teachers to plan out and to work on the development, performance and evaluation of learning and working tasks.

16.2. Characteristics and importance of 'shaping-oriented' learning and working tasks

The model of dual cooperative vocational education and training requires, among other things, new teaching and learning strategies. Trainers and teachers are challenged to make training more work- and work process-oriented. The inclusion of vocational training in the enterprises' work and business processes makes it possible to conduct the hands-on part of the training in the workplace, using state-of-the-art technology. By taking part in the actual work processes, trainees gain first-hand experience of job techniques and work organisation and of how their goals and administrative requirements become a part of the deliverable and the work process. Furthermore, this on-site work experience also gives trainees the opportunity to learn how to affect these development processes. In this context, shaping-oriented learning and working tasks, carried out as projects, assume a key role. The expression 'learning and working tasks' indicates that learning and working, as well as the vocational training elements from both vocational training schools and companies, are

([55]) See http://www.itb.uni-bremen.de/index2.php?newlang=deu

combined. The term ‘shaping-oriented’ indicates that the trainees learn how to tackle job tasks critically (with respect to the applicable techniques, work organisation and working conditions), seek alternative solutions and are able to put them into practice.

Teaching and learning strategies in vocational training and education range from a decidedly shaping-oriented approach, i.e. the training is almost exclusively carried out through projects, to a general course-oriented approach, i.e. the training is based on a set of theoretical classroom courses. The goal of the learning and working tasks is to contribute to increasing the amount of shaping-oriented training.

The fundamental characteristics of shaping-oriented learning and working tasks are that the trainees are encouraged to discover and use freedom of action to accomplish the tasks, to seek alternative solutions, often through a teamwork approach, to evaluate alternative courses of action and therefore to become capable of making grounded decisions. Trainees agree to procedures among themselves and with their trainers and teachers. In this framework, the role of the trainers and teachers is basically that of facilitators and they assume the functions of moderators and advisors. Their role is supported by formulating assignments, which allow the trainees to structure the task development process mostly on an independent basis; the recommendations made by the trainers and teachers, in fact, may help them to accomplish this, but they are an exception to the rule.

The learning and working tasks are developed, performed and finally completed. This division, however, misleadingly suggests a narrow separation of the various parts of the project, which does not exist, at least not in these terms. The various phases and the relative subdivisions, in fact, are permeable; they influence and intermingle with each other. Their characteristics, however, change from task to task: learning and working tasks never follow a pre-determined model.

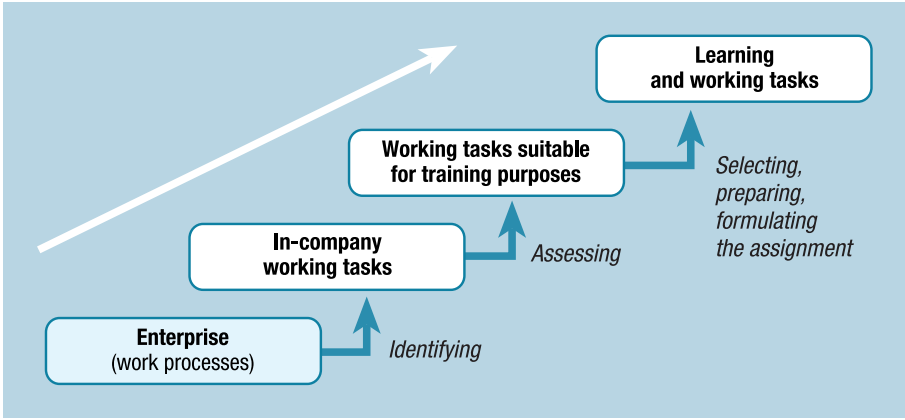
By shifting learning into work processes, learning and working tasks constitute a link between training and the world of work. Trainees understand clearly what they are learning for. In ideal cases, they even demand new skills or knowledge because these are needed to cope with the task. Thus, training units such as courses acquire logical importance and their success will directly affect the progress of the project.

16.3. Development of 'shaping-oriented' learning and working tasks

To develop shaping-oriented learning and working tasks means:
(a) to identify in-company job tasks;
(b) to check whether or not they fulfil the criteria of shaping-oriented training;
(c) to assess learning opportunities;
(d) to select the right in-company tasks for training;
(e) to prepare the tasks;
(f) to formulate the assignment.

Development is not solely the responsibility of trainers and teachers. Trainees may also be involved in this phase, in a number of ways.

Figure 1: **Development of learning and working tasks (flow diagram)**



16.3.1. Identifying in-company job tasks

Shaping-oriented learning and working tasks are based on the enterprises' work activities. Consequently, the starting point for their development necessarily is assessment of the work and business processes of the enterprises where the training is to be carried out. In this field, there are many tasks suitable for vocational training and education, but appropriate starting points have to be found. All those involved in vocational training may take part in this identification procedure, including trainees.

To develop ideas and proposals for learning and working tasks or to examine assignments to be accomplished as a learning and working task, the following key questions must be taken into account:

'What are the enterprise's products?'
or
'What services does the enterprise provide?',
and
'What kind of business process forms the context for the production or the service (from order to delivery)?'
and finally
'What tasks or jobs which are part of these business processes are the responsibility of skilled workers of the specific occupation?'

These questions can usually be answered without too much effort. Trainees can explore these aspects in their enterprises and present the results in their examination in the vocational training school.

For a better understanding of the in-company working tasks, it might be useful to conduct a company survey together with the trainees. To achieve this, it is desirable to develop, as carefully as possible, a detailed questionnaire or research grid. Only with arrangements of this kind can a general visit be transformed into a targeted survey. But even if the preparatory work is done with the utmost accuracy, it will never be sufficient to give an exhaustive idea of the processes taking place inside an enterprise. Therefore, besides taking into account the macro-context of the enterprise, it is equally important to search for details directly on the ground and to acquire further information by interviewing the employees at the workplace. Obviously, the most interesting aspects concern the activities, tasks and actual difficulties that skilled workers tackle on a daily basis, the same ones the trainees will find themselves faced with in the future.

16.3.2. **Assessing the in-company working tasks**

Once in-company working tasks have been identified, the next step is to establish which of the tasks are suitable for training purposes and may be used as learning and working tasks. The training suitability of the in-company job tasks is assessed by trainers and teachers jointly.

The key question
'Does the in-company working task fulfil the criteria of shaping-oriented training purposes?'
may be transformed into a question list. Such a list should contain the following aspects among other things:

(a) ability and skills of trainees;
(b) ability and skills of trainers and teachers;
(c) requirements and conditions of the enterprise;
(d) requirements and conditions of the vocational training schools;

(e) required resources;
(f) potential for shaping-oriented training;
(g) exemplification of the occupation;
(h) financing.

This checklist is particularly useful for assessing the first learning and working tasks, because trainers and teachers must still get used to the new procedure.

After having selected suitable working tasks, it is necessary to check the learning opportunities they offer to trainees and which training needs they satisfy. Consideration has to be given to the fact that the trainee activities are not limited to acquisition, application and consolidation of skills and knowledge for solving the practical problems associated with learning and working tasks. They have a much broader scope. Consequently, assessing the training potential of a task does not only concern the possibility of gaining specialist skills, but also extends to social and methodological abilities. A learning and working task, therefore, enables the application of manifold learning opportunities.

16.3.3. Selecting the learning and working tasks

Once the training suitability of the in-company working tasks has been determined, it is necessary to select those which can be used for training purposes. The trainers and teachers must work out how they may contribute to the training process. Each shaping-oriented learning and working task has multiple learning potential, with regard to gaining both the skills for immediate performance of the task and the general knowledge that may be applied to any purpose. It is worthwhile, in the selection phase, to decide what may be learnt from the learning and working task, in respect to its content, but also more broadly.

The following questions may help at this point:

'What content and knowledge can be transmitted by the learning and working task? What training objectives achieved? What learning opportunities are being exploited?'

'Which of the in-company working tasks, when adequately developed, may become a learning and working task capable of transmitting the content and achieving the goals in an exemplary and general fashion?'

Based on the above premises, a single in-company working task may lead to different assignments, according to the arrangements, and therefore to different learning and working tasks.

16.3.4. Preparing learning and working tasks

After a suitable learning and working task has been selected, it has to be prepared. The aim is to determine and put in place the prerequisites enabling the trainees to accomplish the learning and working task. Trainers and teachers have to provide the following, inter alia:

(a) agreements must be concluded with interested enterprises and with the vocational training school;
(b) the prescribed authorisations must be obtained;
(c) the necessary resources must be ensured.

The considerations made in this preliminary phase obviously correspond to the criteria followed for assessing training value. However, while the selection of suitable learning and working tasks addressed only the basic aspects of each task, it is now necessary to define the first details. These include:

(a) required information;
(b) preparation of the content;
(c) assignment of responsibilities;
(d) preparation of resources;
(e) timetable;
(f) preparation of the teaching methodology;
(g) evaluation criteria.

While preparing a learning and working task it is recommended that as much room as possible should be left for trainee activities. Often they can be involved in the preliminary phase and carry out certain jobs.

16.3.5. Formulating the assignment

When preparation of the learning and working task is complete, the next step is to put the assignment in writing to the trainees. Sometimes, in training practice, this step is left out, but in the case of learning and working tasks it is absolutely necessary because in the case of oral formulations:

(a) more information than necessary for the learning process is usually given;
(b) the trainees may take imprecise notes on the task;
(c) after a short while it is no longer possible to reconstruct the exact nature of the task.

Especially with learning and working tasks of a certain complexity, whose performance requires rather a long time, the written formulation of the assignment is an important guide, not only for the trainees, but also for the trainers and teachers. In order to comply with the written requirements, they must first of all have a clear grasp of the scope and goals of the task.

In formulating a task the following aspects of the assignment must be taken into account:

(a) it relates to an actual job task or an actual work activity in an enterprise;
(b) it must be described briefly, but clearly;
(c) it includes the customers' needs (e.g., appearance, colour, material, strength, handiness, price) and also specifies any regulatory and environmental requirements;
(d) it invites trainees to develop alternative solutions or pathways and to choose the most suitable ones, on good grounds;
(e) it may include general specifications, according to the trainees' level of independence;
(f) it contains indications relating to the timetable (date of delivery, any deadlines to be complied with, in the production phase, for example) and relating to the available time for the performance of the task;
(g) it contains information on the type of collaboration (teamwork, partnership);
(h) it requires that, at the completion of the project, it is necessary to evaluate the learning and working task as a whole;
(i) it contains information on reporting (also beyond the customer's requests, if necessary);
(j) it contains indications on the presentation.

16.4. Performance of shaping-oriented learning and working tasks

To perform a learning and working task means:

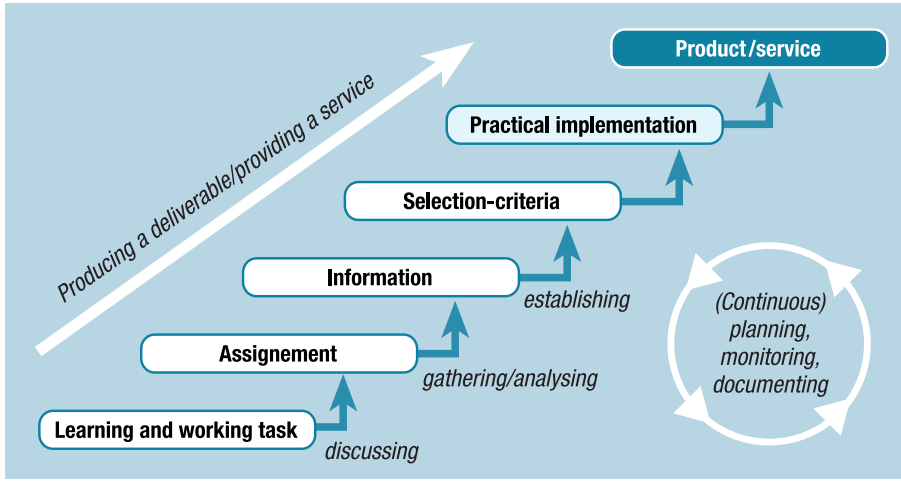
(a) to discuss the assignment;
(b) to collect and analyse the necessary information;
(c) to cope with the task;
(d) to plan and monitor its progress and to report the findings in a coherent way.

The performance of a learning and working task is basically the responsibility of the trainees; it is their project.

Trainers and teachers are not supervisors who show the trainees what to do, or do their job for them. Rather, they take on the role of experts, moderators and consultants to the trainees. It is extremely important that they do not provide predetermined solutions and concepts, even when relatively strict guidance might still be necessary (for example, in case of the first learning and working task). This does not mean, however, that the

trainees are left totally on their own. It is essential that the trainers and teachers illustrate the organisation and planning methods to be applied in the performance of the learning and working task and make them available to the trainees. Otherwise, trainees left without proper assistance, especially in the first learning and working task, may feel overtaxed with the work. For trainers and teachers this new commitment does not mean following and appraising the trainees' learning and working process alone. They must also continuously reflect on their own role and change their attitude, for example if they realise they are giving too many and too detailed instructions. They should put their trust in the trainees' abilities.

Figure 2: **Performance of learning and working tasks (flow diagram)**



Performing the learning and working task, trainees must be left sufficient freedom of action, so that they can learn from their own experience. The meaning of the word experience, as it is used here, includes the possibility of making mistakes, of making wrong or inadequate decisions, of creating misunderstandings, of inappropriate undertakings or plans, of noticing shortcomings or deficits too late, etc.

The change of perspective does not only concern trainers and teachers but also trainees, who are often not used to studying and working independently, a legacy of traditional schooling. Initially it is not uncommon for them to assume their role as that of consumers and to expect complete and detailed instructions from the trainers and teachers. Instead, trainees must clearly understand that most of the responsibility for the success of the learning and working task lies on their own shoulders.

16.4.1. Planning, monitoring and documenting of learning and working tasks

The performance of a learning and working task requires continuous planning, monitoring and documentation of the agreements, decisions, procedures and partial results, as well as continuous reflection on these. Conclusions from regular evaluation meetings affect the subsequent progress of the work and must therefore become the subject of continuing feedback and receive adequate attention. In other words, this process is one of permanent development and improvement, which is passed through a number of iterations.

Continuous planning and monitoring includes the following, inter alia:

(a) making agreements;
(b) taking decisions;
(c) agreeing to the general procedures and the single work steps;
(d) presenting and monitoring the partial results;
(e) changing or adapting the work plans and timetables;
(f) ensuring adequate feedback of experience and findings for improvements.

Coordination of this work, agreements between the partial teams and monitoring of the work progress requires discussion meetings at regular intervals. At these meetings, the trainees may disclose any problems, mistakes and solutions, exchange experiences and make the necessary agreements relating to the content and organisation of their work.

Of particular importance is the requirement that, right from the beginning, the trainees document their work in progress. These need not necessarily be perfect reports; in many cases short notes or observations are quite enough. Later on, this material will become the basis for the final evaluation and general documentation as well as for the presentation held at the end of the learning and working task.

16.4.2. Discussing the assignment

After they have received the assignment, the trainees need sufficient time to fully understand the subject and scope of the learning and working task and to become familiar with it. Following this initial period the trainees may assemble the first development, processing and solution proposals. In this phase, trainers and teachers must encourage the trainees to take their proposals forward, while remaining backstage. The trainees' ideas must not be commented on immediately, nor openly rejected; they must not be obliged to follow a predetermined path right from the beginning.

Part of the discussion is the joint creation of an inventory by trainers,

teachers and trainees. The aim is to establish the abilities and skills, as well as the resources and information, which will be necessary to cope with the task. The results of the inventory constitute the basis for reflections on which shortcomings exist and how they can be remedied during the performance of the learning and working task.

Experience suggests that during discussions on the subject and scope of the assignment, the trainees realise that they cannot solve all the problems individually. They see that it is necessary and meaningful to break the learning and working task into partial assignments and to set up sub-groups to deal with them. In this phase, it is important that the trainees understand that teamwork is an appropriate solution and makes sense, as well as that it is to their advantage to pursue this path to accomplish the learning and working task. This way, the work done with a partner, or as a member of a team, is seen as the necessary consequence of the assignment, and is not experienced as a compulsory invitation, such as 'Team work today!'

16.4.3. Gathering and analysing information

The inventory made at the assignment discussion establishes the skills the trainees should gain to perform the learning and working task. In this manner, the trainees are encouraged to gather and analyse information concerning:

(a) the deliverable;
(b) the manufacturing process;
(c) the technology to be used;
(d) the tools to be employed;
(e) the necessary materials and aids;
(f) the requirements relating to environmental issues and safety;
(g) the applicable prescriptions in general.

The information should be of a general nature,

'What am I required to know, basically, about the manufacturing process, technology, tools, materials and aids?'

but must also refer to the requirements and conditions in the enterprises involved in the training, as well as in the vocational training schools,

'Which resources are available at the learning and working places?'

How and where they gather the information, the trainees must decide at the beginning on their own. Then, if they get stuck and are unable to proceed, they can always ask their trainers and teachers to help them out.

The information gathered is necessary, first of all, to allow the trainees to start working at the job. But it is also useful as a source from which to draw the criteria for decision-making and evaluation, in the course of task.

16.4.4. Selection, decision-making and evaluation criteria

In order to make a grounded choice between the alternative options, and ultimately decide on the implementation of one or another, it is necessary to establish precise selection, decision-making and evaluation criteria. These criteria may be drawn from the requirements that the various parties concerned (e.g., customer/client, standardisation rules, requirements associated with environmental and social aspects) relate to the deliverable or service.

They are also affected by the conditions at the working and learning sites (machinery, tools, materials, etc.). The criteria thus established are used to evaluate, classify and ultimately select one of the proposed development and solution alternatives.

Furthermore, the trainees may establish the basic criteria according to which their own work will be assessed, such as:

(a) compliance with the requirements prescribed for the deliverable or service;
(b) the quality of the technical performance (use of skills);
(c) the quality of the planning and collaboration;
(d) the individual's contribution to the overall performance;
(e) consideration and implementation of alternative solutions and development procedures;
(f) the implementation of improvement proposals.

If, in this phase, the assessment criteria for individual performance are already established, the trainees know, throughout the complete process of the learning and working task, in which way their work will be measured and marks will be given.

16.4.5. Implementation of learning and working tasks

The practical implementation of a learning and working task basically refers to producing a deliverable or providing a service. The trainees must decide together, based on the criteria they have established, to adopt a certain procedure and a certain (technical) solution. It is also possible that various teams implement different alternatives, which may then be compared and assessed in the final evaluation phase.

In this case, the alternatives may all represent a 'correct' solution and meet all the prescribed requirements (for example, those referred to in the assignment). This procedure is excellent for explaining, from the point of view of shaping-oriented vocational education and training, that the best solution as such does not exist. The trainees may understand that there are only appropriate solutions, with reference to certain aspects and requirements.

As well as the actual production of the deliverable or provision of the service, other activities that are necessary to perform the task correctly must be taken into account:

(a) changing the learning and working places according to the work organisation, production process;
(b) regular contacts and agreements with the customer or client, suppliers;
(c) testing alternative solutions, i.e. comparing the different manufacturing processes, materials, job plans;
(d) calculating costs;
(e) assigning partial tasks to third parties (e.g., tests carried out by experts, jobs that require special skills);
(f) protecting against accidents at work.

In the course of the project, trainees develop the knowledge required for practical implementation of the learning and working task largely on their own. Furthermore, missing skills may be learnt and exercised by attending appropriate courses. Learning and working tasks cannot totally replace traditional training methods. In fact, traditional class teaching and lectures, demonstration and imitation have a role to play. The context, however, is fundamentally different, because the trainees need the content to cope with the task. They are concerned with accomplishing their assignment and, therefore, they assume a totally different attitude, compared to the classroom lesson method, which they often consider too boring. Even small exercises, aimed to develop and improve their skills, are tackled by the trainees with more motivation (and, therefore, with better results), if they are necessary to proceed more speedily and with greater self-confidence in performing a complex task. At this point the pay off is that the trainees clearly understand the application context of these training measures. They know that with the completion of the courses, the next step is the immediate practical application of the things learnt. Thus, courses make sense and their success will directly affect the progress of the project.

16.5. Completion of shaping-oriented learning and working tasks

The completion of learning and working tasks is an important part of the teaching process. It is not only a simple appendix of the performance.

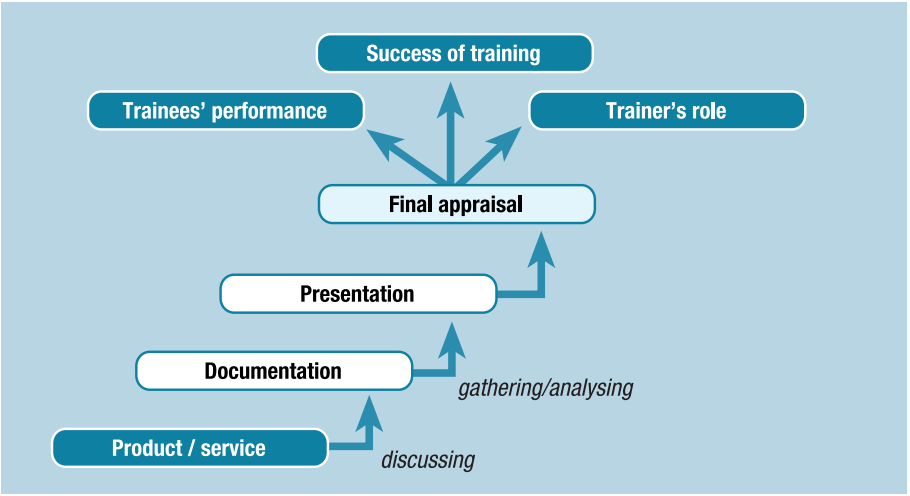
To complete a shaping-oriented learning and working task means:

- to prepare the project report;
- to present the project and its results;

• to perform the final appraisal of the project's progress and output.

In this context, the presentation represents, in many cases, the final crowning achievement of the project.

Figure 3: **Completion of learning and working tasks (flow diagram)**



16.5.1. Documenting learning and working tasks

Since the preparation of orderly and accurate documentation is part of the work of skilled workers and craftsmen, for example, in connection with support services or customer relations, it is advisable to provide for documenting also in connection with the learning and working task. The partial reports and observations noted down by the trainees during the task should be summarised to a general documentation developed in the final phase. In many cases the delivery of task-related documentation is requested by the customer, and such a request is an explicit aspect of the assignment. Besides the basic documentation, other supporting documents may be prepared, such as instructions for use, calculations, technical specifications, etc.

In this phase too, as in the performance phase, it is necessary for the trainees to conclude planning and arrangements. Partial tasks have to be broken down and be concerted in respect of the whole learning and working task; responsibilities have also to be determined. To prevent this from becoming an indefinite affair, the trainees establish the type of documentation to be developed on the basis of the assignment received. It is also necessary that the working groups agree to the documentation

format and layout, to produce a final picture that is pleasing. The documentation does not necessarily need to be produced on paper; new media provide an excellent alternative. For example, the possibility of reporting a learning and working task on the Internet or on CD might be considered.

The documentation is also an important learning and working aid for future projects. Therefore, producing weak documentation has to be avoided. Besides describing the deliverables at the final stage, and the adopted procedures, processing techniques and troubleshooting strategies, it is also important to report any mistakes, deadlocks and misunderstandings. Then, if the effectiveness of certain programming and evaluation methods and instruments have been tested and proved, these too should be illustrated, accompanied by any practical details related to their use. From their experience, regardless of whether it is good or bad, the trainees may benefit in the future, employing and applying them to new and different circumstances.

16.5.2. Presenting the learning and working tasks

In the context of shaping-oriented learning and working tasks, presentation plays an important role. In many cases it represents the climax of the entire project. At the deadline, for example, established for the delivery of a deliverable, the trainees present the performed learning and working task, the procedures adopted to accomplish it and its output to the customer himself and to the guests (namely, the trainers and teachers not involved in the on-the-job training task, the pupils of other vocational training courses, enterprise managers, perhaps also representatives of the political world and the press). Obviously, they must be prepared, on this occasion, to answer any questions, to give reasons for their procedures and decisions, to illustrate any problems encountered and their troubleshooting solutions. Trainers and teachers must take into account the fact that the presentation is the trainees' business and that, therefore, they must play the leading role.

For the trainees, organising and making the presentation are a further and demanding element of the task assigned to them, as well as an opportunity to reflect on the accomplished work. In a certain sense, it is as if they were preparing for a sales or delivery meeting with the customer. Presentations give the trainees many opportunities to express their creativity, with regard to their course and the use of the media. Consequently the responsibility should be left to the trainees themselves, as far as possible.

16.5.3. Final appraisal of the learning and working task

16.5.3.1. *Joint appraisal by teachers, trainers and trainees*

The success of the training activity has to be appraised. This operation is designed to find out which learning opportunities could be realised by performing the learning and working task and should be carried out jointly by teachers, trainers and trainees.

It should be made clear, that the success of the training project is not limited to the specialist content or technical skills, but is multilayered. A learning and working task also enables the application of methodical and social abilities. However, experience tells us that the judgement on the validity of the training method expressed by the trainees at the final appraisal is based, at least initially, on the technical skills and the knowledge gained. Usually, in fact, trainees have a very limited understanding of the concepts of learning and knowing. Only the assessment of the multilayered learning opportunities exploited through the learning and working task allows them to understand clearly that, successfully developing and performing a job task, demands possessing methodical (e.g., process planning or the capacity to analyse information) and social (e.g., the capacity to work efficiently with a partner or as the member of a team) abilities.

16.5.3.2. *Appraisal by the trainees*

Besides continuous assessment of learning and working in the course of the project, the complete progress and the outcome of the task must also be the subject of a final appraisal by the trainees.

An important starting point and aid may be the collection of notes, comments and observations and the partial reports. Without these supporting documents it might easily be forgotten what may have emerged, at that time, as a key situation or crucial point. It might also occur that some prerequisites or conditions may be seen differently, compared to the beginning, in the light of the experience gained during the performance of the project.

The final appraisal gives the opportunity of discussing and assessing, once again, the opportunities provided by the learning and working task, in respect of both the procedures and the solutions. One may understand why, during the performance of the task, priority was given to a certain (technical) solution or procedure, and the key function of the compromise becomes clear: the adopted decisions and solutions represent a mediation between the different interests and needs in respect of the deliverable or service.

In performing their appraisal trainees may employ the following criteria:

(a) success of the training activity;
(b) accomplishment of the deliverable or service requirements;

(c) alternative processing methods and solutions;
(d) collaboration;
(e) individual contribution and performance;
(f) problems and troubleshooting;
(g) errors and deductions from errors;
(h) requests for change, improvement proposals made to trainers and teachers.

16.5.3.3. *Appraisal by the trainers and teachers*

The final appraisal of the training and teaching task by the trainers and teachers pursues different objectives.

First, appraisal and ranking of the trainees' performance are based on the criteria established by the trainees themselves in the course of the discussion on the assignment. This gives the appraisal the necessary transparency. Obviously, the results of any tests carried out in connection with the performance of the learning and working task may also be taken into account. Because the trainees do most of their work as a team, it is often difficult to establish accurately the individual performance of each team member. There is no easy answer in this respect, but the involvement of the trainees makes this problem easier to deal with.

The fact that trainers and teachers, within the framework of the learning and working tasks, do not have a supervisory role but act as moderators and consultants, obliges them to assume a self-critical attitude with respect to their role. They must consider whether the trainees have been given sufficient freedom of action or have been given too explicit instructions; they must also consider whether the trainees were overtaxed because of confusing learning and working situations. Furthermore, trainers and teachers have to think over whether, at certain points, it proved difficult to keep a sufficient degree of restraint, and whether the expert's personality intruded too much.

Feedback from the trainees is valuable. Experience has shown that they are very insightful in judging if they have been given sufficient trust and opportunities and if they have received adequate support. Also the observations made by colleagues only indirectly involved in the learning and working task, as well as any criticisms and comments made by customers, should be taken into account. They can give indications for the external effects of the task and for the impression on outsiders made by the trainees performing the task.

16.6. Experience gained from the concept of shaping-oriented learning and working tasks project

The arrangement of vocational education and training with the help of shaping-oriented learning and working tasks and their inclusion in enterprises' work and business processes has proved itself in different pilot projects (for example in the pilot project 'GoLo', see Heermeyer et al., 1999; Howe et al., 1998). It has been confirmed that the interaction of learning and working improves the quality of vocational education and training. Trainees who performed learning and working tasks usually achieved better results in examinations, and this has occurred even though examinations do not currently take into account much of what trainees have learned in connection with learning and working tasks (e.g. with a view to social and methodical competence). In addition, owners of companies were very satisfied with the young skilled workers because they found their way in the companies without any major problems. More training was unnecessary. The presentations of the trainees made learning success obvious. In many cases it was surprising how self-assuredly and competently they replied to questions referring to the deliverables, the manufacturing process, the technology used, alternative solutions etc.

Vocational training based on learning and working tasks also produced other benefits, besides the integration of learning and working and the consequent improvement in the quality of training. Inasmuch as the learning and working tasks were identified, selected, performed and evaluated jointly by the trainers and teachers, their work became a unifying experience. This resulted in considerable intensification of the collaboration between the parties and in the elimination of reservations or fears in their relationship. It appeared that collaboration cannot be prescribed but needs mutuality. All protagonists could bring their specific competences and appreciated that collaboration benefited their own tasks. In many cases, after a short time arrangements were made and decisions were taken quickly, directly and unbureaucratically. Mostly, a telephone call was enough. Learning and working tasks allowed professional trainers and teachers to investigate state-of-the-art work and business processes adopted by the enterprises, as well as their operating contexts. This important training knowledge was then transferred to the apprentice workshops and vocational training schools, i.e. to institutions traditionally far removed from the actual workplace. Furthermore, as the required project materials were usually made

available by the customer, it allowed the reduction of training costs. If the projects also envisaged the development and performance of job tasks, they contributed to the value-creating process within the enterprise. Therefore, the additional cost of training was reduced. If, in addition to that, it were possible to integrate the enterprise's key processing activities into the training, it would have relieved non-professional trainers of part of their job. On the one hand they were supported by the trainees, on the other hand professional trainers and teachers took over most of the organisational and methodical work. And finally, trainers and teachers emphasised the strong motivation this type of training produced in trainees. They received from the trainees, who collaborated in their training with creativity and a great deal of commitment, positive feedback about their work.

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CHAPTER 17

Developing a modern curriculum for the automobile industry

Rainer Bremer

17.1. Introduction

The authorities in every country with an established system of vocational education and training (VET) are preoccupied with keeping it in step with external conditions. This arises from the need to make continuous adjustments to technological change and labour market conditions. New 'vocational profiles' (*Berufe*) ([56]) have to be created and former ones revised. However, despite the efforts invested, as soon as the latest curriculum addresses the current state of technological change, the process of revision has to start again, resulting in further delays.

This way of viewing the problem indicates a wrong understanding of modern vocational curricula. Vocational education and training should not be concerned with teaching students or apprentices science or technology *per se*, or indeed academic disciplines. In comparison with the typical structure of the general education curriculum – for example, mathematics for pupils aged between 12 and 16 – vocational curricula should not be derived directly from science.

For example, carpenters deal with right angles when constructing artefacts. Every apprentice has to make a rope of 12 m length with two knots (or markers), the first at 3 m and the second at 7 m. If the rope is put against a roof construction that should be a right angle, it has to be folded at each knot and then the two ends should meet. If this happens, the angle tested is a right angle. However, to use a rope as a carpenter's tool you do not have to know Pythagoras' theorem ([57]). A carpenter who knows how to

([56]) See the discussion on the meaning of vocational profiles (*Berufe*) in a footnote on the first page of Chapter 12 of this book written by Felix Rauner.

([57]) This states that if one side of a triangle is equal to the root of the sum of the square of the other two sides ($c=\sqrt{a^2+b^2}$), then it must be a right angle). The interesting thing about this is first, that $3^2 + 4^2$ (9 + 16) comes to 25 as an integer of which the root is 5 – an integer too – second, that all numbers (3, 4, 5, 7, 9, 16 and 25) in the dimension of the rope fit the relevant dimensions of roofs, at least in the metric system.

use the rope has the right tool to find a right angle 99 % of the time, without having any knowledge of Pythagoras' theorem.

For some time, the vocational use of scientific knowledge as outlined above nurtured prejudices about the low-level intellectual demands of work-related training compared to that of general education. The carpenter's rope is a good symbol of the structural difference between vocational education and training and general education; some people can follow scientific methods without actually understanding them. The conservative reaction – more particularly in the German context – was to lead those people to scientific understanding by raising the level of curricula in vocational education and training, e.g. Pythagoras for carpenters. Similarly, as it appeared necessary for a young apprentice metal worker to learn as much as possible about what he will have to deal with later on, he should have knowledge about what an engineer has determined the job of a metalworker to be. Thus, the revision of vocational curricula reached the following level of scientific knowledge:

(a) the first step was marked by the addition of more general knowledge to the vocation as exemplified in the earlier discussion about the carpenter's rope;
(b) the second step was marked by a specialisation of scientific knowledge within the hierarchy of an industrial engineer's knowledge on the one hand, and an industrial worker's knowledge on the other; thus, the worker should become a 'mini-engineer'.

With this solution a trap was sprung. The revision of vocational curricula along these lines ended badly. The more scientific content inserted into the curricula, the less vocational it became. This was particularly evident in the modernisation of the curricula for industrial vocations. From now on changes in technology and technology-oriented processes would determine what was needed in the vocational education and training curriculum of young industrial workers. Thus, the new and revised curricula marginalised the work processes that future workers would have to master.

Although the movement to add more general educational content to vocational curricula or specialised knowledge within the framework of engineering knowledge was based on good intentions, it failed in its aims. The direction should have been to concentrate on the demands of industrial work that include (anticipate) rapid changes, i.e. to highlight how workers can deal with future changes.

This chapter examines an attempt to relate modern vocational curricula to work process knowledge instead of specialised scientific knowledge. The next section outlines a project undertaken to introduce a work process

knowledge based curriculum in the Volkswagen company. Following a brief summary of human development theories relevant to the project, the remainder of the chapter deals with the project evaluation.

17.2. Vocational curricula based on work process knowledge

Based on a consulting assignment with the government of the Northrhine–Westfalen (State) in Germany, the Institute Technology and Education (ITB, University of Bremen) offered a solution to vocational education problems by means of conferences, publications and training (see Rauner, 2000). The solution put forward was based on the ITB's concept of 'core-vocations' ([58]). This concept was further developed and tested in a real industrial context in the Volkswagen company. The Volkswagen (VW) Coaching Gesellschaft ([59]) realised that the concept of reducing the number of vocational profiles to a few core-vocations would provide an opportunity to modernise their vocational training programme in line with real vocational tasks and conditions.

These vocational tasks were identified by 23 workshops involving about 250 workers. The concept of 'core-vocations' implied that most tasks could be concentrated in five vocational profiles. This number gives an idea of what core-vocations mean: reducing 27 vocational profiles to five. In the workshops 'qualified workers' described their current vocational tasks. The workers were selected for excellent skills in carrying out their vocational tasks ([60]).

The eight hour long workshops had the following structure:

(a) introduction (what do we want to do?);
(b) identification of the participants' vocational/occupational backgrounds;
(c) description of the vocational tasks (minimum 12; maximum 18);
(d) discussion of the results;
(e) discussion about what participants think about current practices in vocational education and training.

All of the participants had undertaken vocational training, mostly before they became workers at VW, in line with the dual system tradition in Germany. All of them had chosen a vocational career with the intention of

([58]) In German: '*Kernberufe*'. (The word profession gives a better understanding of the German word '*Beruf*'. See discussion on 'Beruf' at the beginning of Chapter 12 in this book.)
([59]) This autonomous company, established as a separate company from the mother company Volkswagen, offers training mainly to Volkswagen but also to other companies.
([60]) See chapters by Rauner and Röben in this book which deal with this issue.

reaching the status of qualified workers (average age 35 years). They confirmed the core-vocations thesis with regard to advanced industrial production. The following five core vocations were identified:

(a) industrial mechanic;
(b) industrial electrician;
(c) industrial toolmaker;
(d) automotive mechanic; and
(e) industrial office worker.

Though all of the workers had received different specialised vocational training, there was a degree of consensus about the five vocational profiles. It was agreed that most vocational tasks can be described under the umbrella of these five profiles. Accordingly, new blueprints for an innovative vocational training and education curriculum, handling the demands of modern industrial automotive work, could be formulated.

The GAB project, as it was called in the German language ([61]), therefore was a pilot project for producing blueprints for new vocational profiles. The stages of the GAB project were as follows:

(a) in the first stage, lasting one year in six plants (involving 450 apprentices) five new curricula were prepared, one at each plant (or in a cooperation between two of them);
(b) in the second stage, all the plants that had apprentices for the selected vocations introduced the new curricula for most of the apprentices (1050 from each plant).

In this way a normal three and a half years period of vocational training was introduced. After three years the number of apprentices involved was to reach 4.150.

The implementation of vocational tasks into a new structure of vocational education and training entails a conversion process. The results of the workshops on vocational tasks only gave an idea of the professional standards of industrial work. These tasks had to be used as the basis for a vocational training programme. The concept of GAB contained a further hypothesis about how one learns that can be called the 'logic of development'; an expert has to begin as a novice. The process of teaching requires a concept of training that focuses on the limited knowledge of a novice as the starting point leading up the professional ladder.

Training normally begins with a set of systematic instructions about what determines the knowledge and competence of a vocation. This knowledge

([61]) GAB (*Geschäfts-und arbeitsprozess bezogene Berufsausbildung*) means business and work process oriented vocational education and training.

is usually derived from science and is taught to students who will never be scientists. This will not work. The logic of development principle, in contrast, is to be seen as a principle to enable apprentices to develop from novice to expert. To do this there must be a focus on real work tasks.

However, the content of traditional vocational training is organised in courses (hydraulics, pneumatics, bookkeeping, PCs and so on) and is separated from production and assembly lines. In some traditional vocations time is reserved for real work. For example, automotive workers spend about 40 weeks in the second and third year of training in the plant. But this is working and not learning, meaning that they undertake tasks that demand a very low level of competence. Although this is real work experience, it is not integrated with the learning concepts of vocational training.

To fulfil the aims of the GAB project it was required:

(a) to have preparation training workshops;
(b) to link production orders with the training workshops;
(c) to create 'islands' of production and service accompanied by learning within the specialised departments of the plants.

It is difficult to realise these concepts because they require the support of managers who ordinarily have nothing to do with vocational training and education. However, within a timeframe of four years there is an opportunity for slow but possibly lasting changes.

17.3. Theories of human development

A theory of development or *Bildung* as it is called in the German language (see Bremer, 1999a and 1999b), based on a logic of development underpinned the GAB project. A brief summary of the theories of Piaget (1983), Kohlberg (1996) and Havinghurst (1972) which followed a developmental logic and were considered to have relevance for the GAB project are presented and discussed below.

17.3.1. Piaget's theory

Piaget analysed childhood and adolescence, with the aim of developing a theory that is valid for all human beings. Variations in individual development, according to his theory of cognitive development arise from different levels of intelligence. This seems to be compelling because his measurements were based on mathematical tasks, so the solutions can only be right or wrong. However, when he tried to apply the methods of measuring cognitive development to the development of moral consciousness, he faced a serious

problem in identifying the three different stages: the pre-conventional, conventional and post-conventional moral consciousness. The problem with this theory is that, in the first stage, there is no moral dimension at all (children accept others through sympathy or because of the fact that they have power). In the second stage morality is fixed by rules to be followed (children follow rules, not principles). It is only in the third stage that moral consciousness, guided by principles, exists. Unlike the second stage, the third one can be called a level of moral consciousness. Piaget's theory is characterised by a scientific, more exactly by a positivistic understanding of development. He placed the stages of development in a strictly consecutive order and logic. However, he found something like logic in only the third of the three stages. For this reason it must be concluded that Piaget's theory – although being a well-known theory of development – cannot be applied to the development of vocational skills.

17.3.2. **Kohlberg's theory**

While Piaget was interested in the development of children's cognitive and moral thinking, Kohlberg focused principally on the further development of moral thinking and reflection. He tested the stages and levels of moral development. He did not believe that the levels and stages of moral thinking are based on age but rather on the quality of reflection. His favourite method was to design moral dilemmas for which there are no solutions like right/wrong but involved putting forward different arguments. The kind of tasks (e.g. to break into a chemist's shop to save one's life) Kohlberg designed, dealt with severe problems. Kohlberg tried to fix the logic of moral understanding in accordance with universal moral principles. However, the social context of moral reflection is missing. The more universal moral principles are given special emphasis, the more people face discrepancies with social values. Depending on the case, compromises are required (a good example: soldiers are not allowed to refuse killing people). But what does this mean for the logic of moral development in adult people? In short, a truly logical model of development is sometimes not valid in a scientific context. Kohlberg discovered something he was not looking for. It may be called a 'third' factor between alter and ego (see Oevermann, 1983), something like a social artefact, which is very relevant to the development of individuals but very different from the mathematical logic on which Piaget's instruments were based and the different levels of moral understanding Kohlberg was looking for. In conclusion, a critical reflection on Kohlberg's work leads one to take into account the importance of the context in which (young) people develop their competences.

17.3.3. Havighurst's theory

This leads us to Havighurst's theory of developmental tasks, a pedagogical theory in its origin. According to this theory, everyone has to solve distinctive tasks on the way to becoming an adult, e.g. to move from one's parent's house or to attain economic autonomy. Accordingly, the development of young people must be related to the contextual social background and therefore the logic of development is a social one, influenced by the stage or level of social development to be addressed. That is the most important aspect of Havighurst's theory to be applied to development within a vocational context. He laid the ground for seeing development as an independent variable and used development tasks to produce hypotheses about the course of development. Thus, the theory of Havighurst can be used as a basis for a theory of vocational development.

A good curriculum based on the different stages of vocational development from novice to expert will enable young people to become professionals. Through observing their development, information about the quality of the curricula and the related didactics is provided.

17.4. Evaluation of the GAB project

Evaluation started one year after the beginning of the project. Two evaluation approaches were used:

(a) self-evaluation by the trainers: through relating the learning and working tasks to be developed and executed by the trainers, a standardised self-evaluation process was implemented;
(b) evaluating the professional development of apprentices in line with the logic of development. The development of the apprentices was evaluated under several aspects, for example, their competences in three dimensional tasks: handling instruments, working within professionalised contexts and working in social contexts. The levels of development and the steps that lead from one level to the next were identified. To obtain the required information we used a standardised questionnaire and, in the case of indistinct findings, interviews were undertaken.

A third task was undertaken as part of the evaluation. This related to the development of a new structure of blueprints for the learning based on:

(a) structuring and organising the vocational and scientific contents related to vocational profile in close connection with the vocational tasks;
(b) giving them a sequence based on the logic of development;

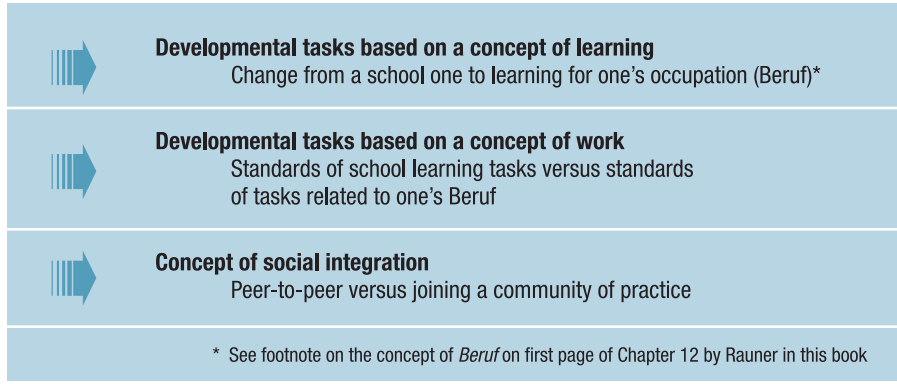
(c) describing the contents and method in a way that the schools as well as the training centres in the company can work with a common platform.

These blueprints, called *Integrierte Berufsbildungspläne* ([62]) were developed with the collaboration of the vocational teachers.

17.4.1. Project research on the development of competences and vocational identity

Havighurst's theory, discussed earlier, was applied to education by Gruschka (1985). Students were given tasks with the character of a dilemma (e.g. little Peter is misbehaving in the sandpit and the teacher has to react to this). Applying the methodology of Gruschka, an instrument for measuring vocational development was developed in the GAB project. In analysing the trainees' solutions, the researchers found out something about the level and elaboration of professional solutions. Thus, in adopting Havighurst's theory and Gruschka's method, the challenge in the GAB project was to find vocational tasks which embody or indicate the development of professional competences and vocational identity (see Figure 1).

Figure 1: **Development from novice to expert through the three concepts of learning, working and social integration**



To specify vocational development tasks one has to consider the competences of expert-workers. These have to adapt continuously, because they are confronted with new technologies, new tasks and new forms of social organisation in their workplace. Their state of expertise depends on their having concepts to deal with those changes.

([62]) Integrated blueprints for a vocational profile.

The following three key concepts are crucial:
(a) learning;
(b) working;
(c) social integration

These represent the whole of expert knowledge, disposition and professionalism. (See Figure 1.)

The last aspect is characterised not only by a huge reserve of knowledge but a special form of vocational identity typical of communities of practice. Thus we can say that one of the most important aims of vocational development is to become a member of such a community and to be recognised and acknowledged by the experts within that community. Central to this is the concept of vocational identity. To have an identity implies not only showing some common attributes of thinking, doing and feeling, but integrating these within the entity of 'the person'. During the last 30 years in philosophy and social sciences this concept of identity has been criticised as being part of a moral programme (see Adorno, 1979 and Habermas, 1973, 1983). It was seen as a social concept typical of the bourgeois society.

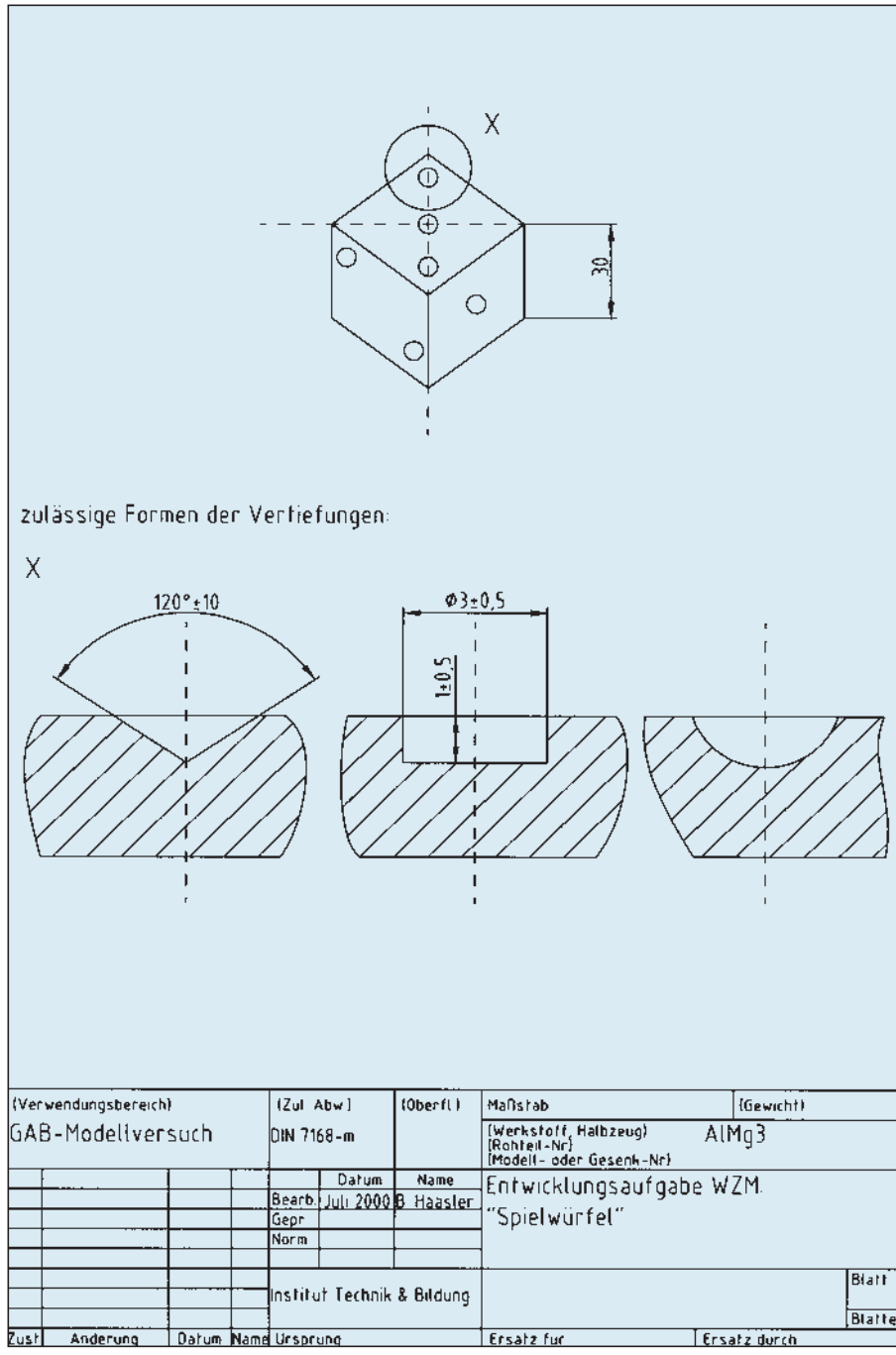
Although critiques of the concept of identity have been put forward in modern sociology (for example the counter notion of 'patch-work-biography') the evidence of the traditional meaning of identity remains. What has changed, however, is that now a single individual does not seem to have his/her unique identity but shares characteristics of his/her mind or behaviour with a distinctive group. Identity now marks the frontier between the group and the individuals belonging to it. Vocational identity is now a category of distinction but also integration. This relates to the social function of identity.

We can draw a parallel with the notion of 'vocational communities of practice'. That means, individuals who join a group by becoming professionals go through a socialisation process which ends in membership. Just like the formation of cultural identity, the process of learning and growing includes assimilation. To belong to a community of practice in relation to 'earning one's living' means that someone appears to outsiders to be a special kind of person, but to the members of the community appears as normal individual.

17.4.2. **Evaluation research**

The purpose of the evaluation research was to find out if the changed vocational training and education brought the apprentices into deeper contact with the vocational tasks of a tool mechanic.

Figure 2: **Task for apprentices**



The progress of 30 apprentices was tested. They belonged to four groups who were trained by the same department and had exactly the same training over a period of 16 months.

17.4.3. The task selected for evaluating competence development

A typical task for a tool mechanic was selected. To understand the task it was important to emphasise two points:

(a) tool mechanics never produce parts but the tools needed for producing parts. After 16 months of vocational education and training it is expected that the apprentices know this to be the function and role of their vocation;

(b) this meant that, in the first evaluation task, it was not so important for apprentices to demonstrate an elaborate solution that could be devised by a highly-skilled tool mechanic (professional competences), but to portray how tool mechanics approach their work (professional identity).

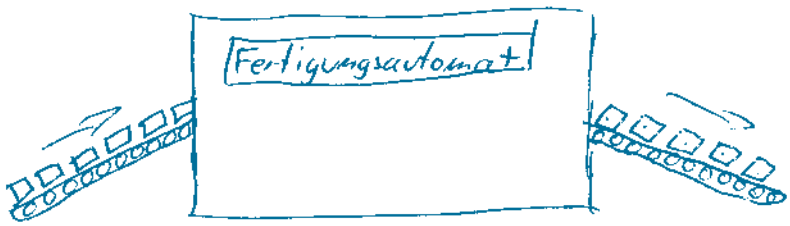
The task selected involved asking the apprentices to work out a plan from which ready-made cubes of aluminium could be made into dices similar to ones used in board games. They were asked to find a solution for specific volumes of cubes, 5,000 and 50,000 (see Figure 2).

Everybody is familiar with a dice, which would seem to be a rather simple thing in industrial production. But to produce large volumes at low cost and high efficiency is different. There is no single possible solution, but many and we were interested in the variety of solutions. Of the 30 apprentices, 10 had to solve the task for themselves; the other 20 had to work together in groups of two. In the end there were 20 solutions of 30 apprentices.

17.4.4. Proposed solutions of the apprentices

The range of solutions was surprising. They started from those meeting none of the demands and ended with solutions that could only have been expected from experienced workers. A sample of the solutions is presented below ([63]).

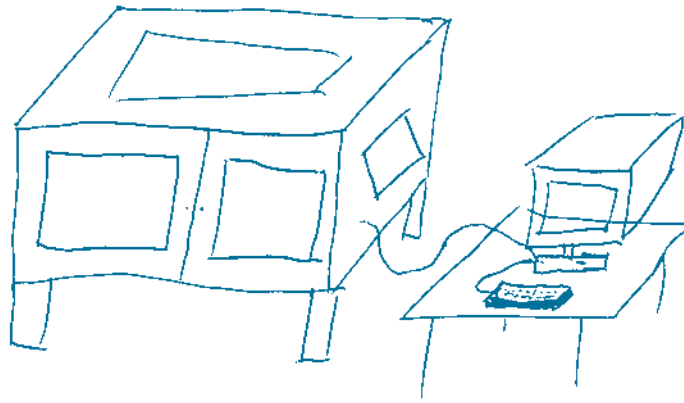
Figure 3: **Automatic production machine**



([63]) The actual drawings of the apprentices illustrating their solutions are reproduced here.

The first of these (Figure 3) is not a solution at all. The apprentice drew one of the automatic machines (*Fertigungsautomat*) he had seen, almost as if he was a visitor to the plant. His solution is that of a child; he seems to have asked: 'Why do we need tool mechanics when everything is made by machines!' There was no indication of what was expected in undertaking a task using the level of competence corresponding to one's professional identity.

Figure 4: **CNC–production**



The second solution (Figure 4) is another 'black-box' variation, something like a chest of drawers becoming high-tech because of being linked to a computer via a cable. What both of the first two solutions have in common is that no realistic, workable technological solution is put forward.

The next solution (Figure 5) shows production as a large scale process able to deal with a high number of items. The apprentice attempted to portray an assembly line process (*Bandarbeit*) but not having sufficient width on the page, the second part of the drawing was placed underneath the first part. Again, this solution is without real consequences, because each of the six sides of the cube has to be treated separately. This tells something about the experiences of the apprentice, in that while he is impressed by industrial production processes, his solution only illustrates what he has learned in the training workshop, where he has learned to drill pips separately. It shows that he is still not able to transfer his knowledge about industrial production to real tasks but rather lapses back to the methods he was used to in the training workshop, which are not the methods of professional industrial work.

Figure 5: **Assembly line production**

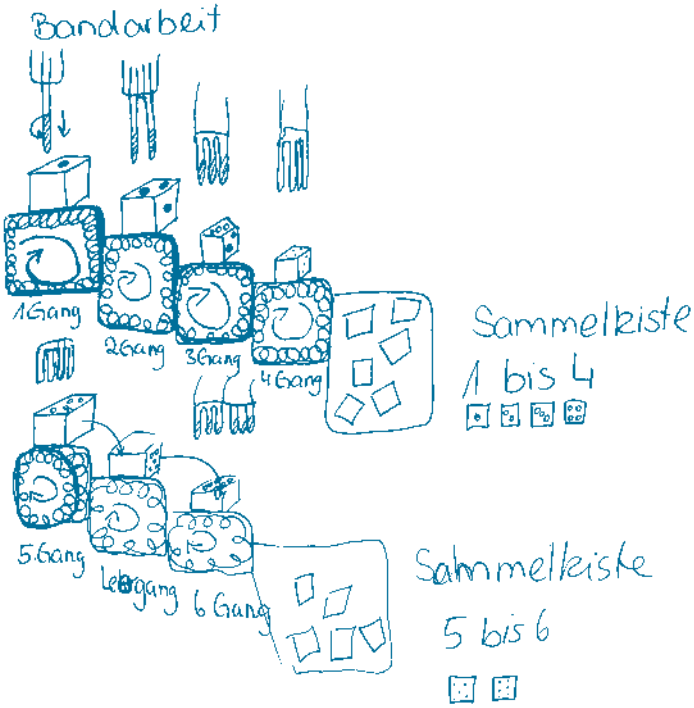


Figure 6: **Single parts production (1)**

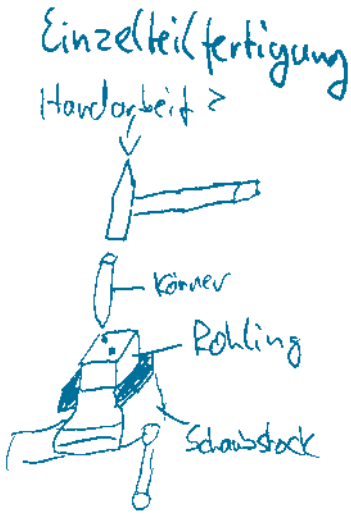
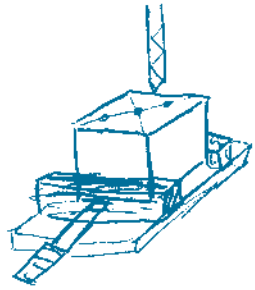
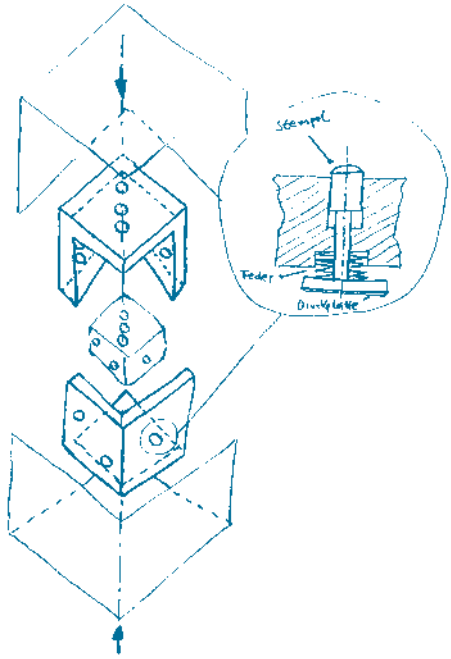


Figure 7: **Single parts production (2)**



The solutions shown in Figure 6 and Figure 7 are not appropriate for industrial production processes. Because the apprentices interpreted the problem wrongly, they started to produce the dices themselves one by one. What they should have done was to construct a production tool. These solutions show that they do not yet know the meaning of vocational tasks. They are only reproducing their experience in the training workshop. It would not be possible to put the pips on 50,000 cubes in this manner, because they would have to be made by hand.

Figure 8: **The solution of a tool mechanic**



The solution presented in Figure 8 is an excellent one which shows all of the features and characteristics of an intelligent solution by a tool mechanic. The guiding idea is to get all the 21 pips on the cube at once with a single mechanical movement. This is a state of the art solution.

17.5. Concluding comment

The first results of the evaluation allows one to make a judgement on the effectiveness of the new curriculum. The variety and quality of the solutions offered by the apprentices may be surprising but this relates to the problem of initiating change. The apprentices who have not grasped the nature and demands of the development task had not even begun to appreciate the nature of the vocational learning in which they are participating, whereas the apprentice who produced a solution worthy of a tool mechanic had a firm concept of professional working and would be accepted in its community of practice.

The poor (wrong) solutions put forward by the majority of apprentices are a result of what can be called 'training that is typical of a training workshop'. The apprentices reproduce what they have learned about methods and tools that are typical for the training workshop but not for real industrial work. There is still a big gap between the concepts underlying the pilot project and the reality to be found in the company's vocational education and training practices.

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SECTION VII

Policy issues

CHAPTER 18

Learning through work experience: prospects for European knowledge development

Pekka Kämäräinen

18.1. Introduction

This chapter reflects on the prospects for European knowledge development related to learning through work experience. It is based on two European cooperation projects that were funded by the Targeted Socio-Economic Research (TSER) action in the context of the 4th Framework Research Programme. One of these projects studied the educational significance of work experience placements in different European educational contexts. (It is presented in a more detailed manner elsewhere in this book; see the contribution of Griffiths and Guile.) The other project – a 'work process knowledge' network – analysed work process knowledge in different sectoral and organisational contexts. This project has provided the working context for some of the central chapters in this book. (See in particular the introductory chapter of this book by Fischer and Boreham.) The aim of this chapter is not to present basic information on these projects but to explore the contribution of the two projects and their follow-up activities to joint knowledge development at the level of European cooperation. The opportunity for such reflection arises from the fact that the two projects have developed follow-up measures in the context of the Cedefop research arena (Cedra) ([64]). These capitalisation measures have contributed to knowledge resources – this publication and another one by Griffiths and Guile ([65]).

The starting point for the chapter is an analysis of the main project-specific conclusions as contributions to further knowledge development.

([64]) See http://www.trainingvillage.gr/etv/Projects_Networks/Cedra/

([65]) See Griffiths, Tony and Guile, David. *Learning through work experience for the knowledge economy: issues for educational research and policy*. Luxembourg: Office for Official Publications of the European Communities, 2004.

Consequently, the chapter recapitulates on some of the main issues raised by the two projects and relates them to each other. Then, it will discuss the changing policy contexts that, on the one hand, have characterised the initial phase of the said research activities and, on the other hand, overshadow their capitalisation actions. It is possible to draw attention to different evolutionary phases in the role of research. The chapter first gives a picture of earlier European policy discourse on competitiveness and the knowledge society. This discourse is analysed as a linear approach to the use of research in supporting European policy. This earlier discourse will be confronted with more recent features of European policy development. These are highlighted as giving indications of a more interactive relationship between research and policy development.

Based on these analyses, the chapter discusses the prospects for strategic knowledge development that links research-based knowledge development to policy-oriented working agendas. The aim of the working agendas is to provide reflective support and feedback for policy development and to mobilise different research-based knowledge processing. In this respect, the chapter makes an attempt to draft a joint working agenda for capitalising current research on work-related learning as a support for reflective policy development. In the final conclusions, the facilitating role of the Cedra will be reflected from this perspective.

18.2. Research context: two European cooperation projects

18.2.1. **Background**

The common research context for the two projects to be analysed has been the EU-programme for Targeted Socio-Economic Research (TSER). This special programme was launched within the 4th Framework Programme for Research and Development during the time when European policy debates focused on the issues of competitiveness and the knowledge society. In this context there was a concern that there was a lack of socio-economic research and a gap in utilising the outcomes of such research.

The programme provided funding for transnational research projects (for primary research activities) and networks (for compiling and analysing existing or emerging research results). The project Work experience as educational strategy for 21st century (acronym WEX21c) ([66]) was launched

([66]) See http://www.trainingvillage.gr/etv/projects_networks/ero/prj_view.asp?theID=181

as a transnational research project. The other project – Work process knowledge network (acronym WHOLE') ([67]) – was launched as a transnational research network.

The Cedefop research arena (Cedra) has been developed to promote research-based knowledge development and active knowledge utilisation in the context of European research on vocational education and training. For the two projects, collaboration with Cedra has provided the opportunity to take further steps in knowledge development on the basis of mutual enrichment and joint planning of follow-up measures.

A brief summary of issues that arise in the two projects is given below. Afterwards, some working perspectives are developed for further knowledge development and mutual exchanges. These explorations are then related to further questions concerning the role of research-based knowledge in the context of European policy development.

18.2.2. Issues arising from the project 'work experience as an educational strategy' ([68])

The main thrust of 'work experience as an educational strategy for 21st century', was to provide a common framework for analysing different policy approaches and educational concepts that integrate work experience into vocational curricula. Until recently, most models of work experience have either ignored the influence of context upon learning or have approached this issue mechanistically. However, the concepts of context and practice are now increasingly recognised as crucial to the emerging debates (Guile and Griffiths, 2001) about how students learn and develop through all forms of work-based activities. These and other explorations have provided the main result of the project: a typology of work experience models, which includes the innovative connective model. These models are analytical rather than descriptive; no specific work experience programme fits neatly into any of the models and some programmes may contain elements of more than one model.

([67]) See http://www.trainingvillage.gr/etv/projects_networks/ero/prj_view.asp?theID=182

([68]) This summary of the main results draws extensively from texts by Toni Griffiths and David Guile. See in particular Griffiths et al. (2001) and Guile and Griffiths (2001). See also the contribution of Griffiths and Marhuenda in Kämäräinen et al. (2002).

18.2.2.1. *Model 1 - Traditional model: launching students into the world of work*

This model reflects:

(a) the tendency in apprenticeship-based work experience programmes to mould and adapt students' skills in workplaces (Vickers, 1995; Stern and Wagner, 1999a, 1999b);

(b) the tendency in school-based work experience schemes, which were introduced in the UK in the 1970s, to assume that students unconsciously or automatically assimilate relevant workplace knowledge, skills and attitudes and internalise the implications of occupational changes occurring in the workplace (Watts, 1983).

This emphasis upon both adaptation and assimilation in the traditional model of work experience is a distinctive feature of a technical-rational perspective on education and training and assumes that knowledge and skills can be taught quite separately from the context of their use. Conceptualising work experience simply as 'launch' leaves little incentive to develop a theory of how students learn and develop through work experience (McNamara, 1991; Granville, 1999).

18.2.2.2. *Model 2 - Experiential model: work experience as codevelopment*

This model reflects the view expressed in many American and European approaches that all stages of education should be made relevant to students and that there should be a more problem-based approach to education and greater use of enquiry-based models of teaching and learning (Prawat, 1993). In the case of work experience programmes, it has resulted in the development of models of work experience, which were based on experiential learning. Despite these pioneering developments, the mainstream curriculum in most EU countries was left broadly unaffected, with work experience effectively kept separate from it. Equally, the whole question of the relationship between theoretical study and work experience, even in countries with strong apprenticeship systems, was also left unresolved (Griffiths and Guile, 1999).

18.2.2.3. *Model 3 - Generic model: work experience as an opportunity for key skill assessment*

One of the main education debates in Europe in the late 1980s and early 1990s concerned the attempt to promote a greater sense of learner autonomy and self-discipline, particularly among low-attainment level students, within general and vocational education programmes (Green et al., 1999). These developments have led, in the UK in particular and, to a lesser

extent, in other parts of Europe, to the emergence of what may be referred to as a generic perspective on learning. In the case of work experience, the emphasis on student-centredness and learner-autonomy has been interpreted as planning, managing and evaluating the learning on a work experience placement through the use of statements about learning outcomes, which are a part of a personal action plan (Miller, 1996; Oates and Fettes, 1997). This plan serves as a type of contract between the individual, the workplace and the education institution, thus facilitating student self-assessment and external verification of key skill development within a workplace. However, by playing down the need for those in education or workplaces to explore with learners the extent to which experience is influenced by the constraints of its context, the generic model of learning has not taken note of the fact that learners have to be immersed in ideas as well as in the world of experience.

18.2.2.4. *Model 4 - Work process model*

One response to the classic problem of division between formal and informal learning that the other models have failed to address satisfactorily has emerged from within the German VET tradition. The concept of work process knowledge – understanding the labour process in terms of product-related, labour organisational, social ecological and systems-related dimensions – has been introduced to assist apprentices and teachers in overcoming the dilemma of inert knowledge, that is, knowledge which has been taught but has not proved useful in practice (Kruse, 1996). The main distinguishing feature of the concept of work process knowledge is that it draws attention to the combination of theoretical and practical learning, prepares apprentices to engage more rapidly with new organisational forms of production and enables them to move into alternative work environments more easily (Fischer and Stuber, 1998). It has been noted, however, that work experience will not by itself promote work process knowledge and that it needs to be mediated, perhaps by the introduction of concepts or by means of subject knowledge. This process of mediation may take place at the workplace and in company training centres (Attwell and Jennes, 1996).

18.2.2.5. *Model 5 - Connective model*

This model of work experience is based upon the idea of a reflexive theory of learning (Guile, 2001) which involves taking greater account of the influence of the context and the organisation of work on student learning and development. Emphasis is placed on the situated nature of learning and the development of boundary-crossing skills. It also entails developing new

curriculum frameworks which enable students to relate formal and informal, horizontal and vertical learning. The term connectivity defines the purpose of the pedagogic approach, which is required to take explicit account of the vertical and horizontal development of learning. So, on one level, learning through work experience calls for the formation of new mediating concepts which assist learners to develop the forms of social interaction that support dialogic problem solving (Guile and Griffiths, 2001). On a different level, it involves learners as connective specialists (Young, 1998), using specialist knowledge and skill acquired in formal education to understand why certain types of performance are required in different work contexts and how to work with others to produce new knowledge. Thus, teaching and learning become more a product and process of interaction within and between contexts; the successful mediation of these relationships is based on recognition that learning involves the negotiation of learning as part of workplace experiences.

18.2.3. **Issues arising from the work process knowledge project** ([69])

As a contrast to the previous project, the main thrust of the work process knowledge network cannot be summarised by one leading theme or by one central framework. Instead, the research cooperation activities of the network have focused on developing a common working environment that is based on the central concept of work process knowledge and on several linked research issues.

In brief, the concept of work process knowledge can be introduced as a way of describing the kind of knowledge which employees need for working in organisations which have developed more flexible structures, and which have introduced new technology in search of greater competitiveness. The concept of work process knowledge is increasingly used in discussions exploring the relationships between work, learning on-the-job, organisational development, individual knowledge, collective knowledge and occupational competence. The concept signals more than practical know-how or procedural knowledge, for this way of knowing also encompasses theoretical understanding. However, the development of work process knowledge over the last few years has also been stimulated by a more theoretically inspired enquiry into industrial epistemology, concerning the nature of knowledge that is needed for work.

([69]) The summary of the issues arising from the 'work process knowledge network' is taken from the introduction by Nick Boreham to publication Boreham, Samurçay and Fischer (2002a). See also the contribution of Boreham in Kämäräinen et al. (2002b).

The crucial distinction which cognitive ergonomics suggests is that between declarative and procedural knowledge; the former is knowledge that, and the latter knowledge how. Procedural knowledge is said to be useful for guiding action, while declarative knowledge is not. The basic assumption is that the real world is represented inside the mind of an individual operator in the form of a procedural knowledge consisting of frames, schemata, production systems, operative images or other types of mental picture.

However, field studies of how employees actually use knowledge in real working environments tend to contradict this account. To take the first point, it must be accepted that consciously held symbolic knowledge is communicable to others, and capable of being elicited by interviewing. However, the studies carried out into work process knowledge by the WHOLE network emphasises that much of the knowledge in organisations is tacit, for example embedded in social relations in the workplace, and difficult to put into words. Against this, the studies carried out by members of the network emphasise that much knowledge in the workplace is held collectively; indeed, such knowledge can best be viewed as part of the culture of the workplace.

Considering the kinds of interventions needed to develop work process knowledge in the workplace, a critical factor is the way in which the workplace is organised, especially how roles are allocated, and how the work is managed. Attention should also be paid to the boundaries arising from spatio-temporal arrangements in the work place. The development of work process knowledge requires effective use of participative work redesign and knowledge management tools that facilitate the sharing of know-how across occupational demarcations.

18.3. Questions for joint knowledge development

In this section some questions for joint knowledge development within the Cedra context are outlined. In the first phase the follow-up has been characterised by two parallel but mutually coordinated activities. At this point it is not possible to analyse to what extent the two follow-up projects have produced answers and made progress in joint knowledge development. This would require closer examination of this volume and the parallel publication by Griffiths and Guile (2004). However, the questions indicate essential challenges for further knowledge development and for focused dialogue between mutually complementing approaches and views.

18.3.1. Questions concerning the work experience project

(a) The project covered a broad range of work experience schemes in different educational contexts. Is it possible to develop a map of particular target areas and related critical issues considering the existing material and emerging policy debates?

(b) The main conceptual result was the typology of different educational models for work experience schemes. Although it has been discussed as a classification instrument, there is considerable interest in its application as a means of enquiring into the nature of the learning associated with different approaches to work-related activities. Is it possible to develop the typology as a dynamic framework that takes into account pattern evolution through contradictions and cross-fertilisation?

(c) The project worked with theory, case studies and country studies. How can these elements be capitalised in the context of further knowledge development?

18.3.2. Questions concerning the work process knowledge project

(a) The project focused primarily on the analysis of work process knowledge within organisational contexts. How can this analysis be linked to educational strategies for promoting work-related learning?

(b) The project produced somewhat contradictory results concerning the development of work process knowledge and learning opportunities within organisational contexts. How can such contrasting evidence be interpreted in the context of educational policies and schemes that aim to promote the quality of work-related learning?

(c) The project had several sub-themes that deepened the analysis of diverse sectoral and organisational contexts. How can the results of these sub-themes be integrated into a further reflection on the educational implications of work process knowledge?

18.3.3. Questions concerning cross-fertilisation and joint follow-up measures

(a) Is it possible to develop specific links between the analysis of work process knowledge and the further development of the framework of educational models for work experience?

(b) Is it possible to integrate elements from both approaches in the context of joint empirical analysis of new cases that have relevance for both approaches?

(c) Is it possible to utilise the outcomes of cross-project cooperation within further follow-up activities?

As has already been indicated, it is not possible to discuss at this point to what extent the two projects have made further steps in the context of their joint activities. Instead, it is appropriate to discuss what kind of role such measures may have in the context of developing a European research culture.

18.4. Use of research within European policy development

18.4.1. **Earlier European policy discourse** ([70])

European policy discourse on competitiveness and the knowledge society had strong normative orientations. These overshadowed the contribution of socio-economic research, such as the European green paper *Partnership for a new organisation of work* (European Commission, 1997), which presented arguments in favour of the widespread adoption of 'new forms of organisation of work ... based on high skill, high trust and high quality' (p.1). The Green paper underlined the obsolescence of the bureaucratic work systems which achieved great success over the last hundred years. Another example was the conclusion of the Essen meeting of the European Council in 1994, which identified the need for 'a more flexible organisation of work in a way which fulfils both the wishes of employees and the requirements of competition' (green paper *Partnership for a new organisation of work,* p.3).

In this context it appeared that the role of research would be to demonstrate how the policy goal of more flexible organisation of work could be achieved on the basis of new forms of work-related learning and a better awareness of the role of work process knowledge in the context of organisational change and learning.

18.4.2. **Recent European policy developments**

The general landscape of European current policy development was shaped by the Lisbon Summit (March 2000) and its conclusions concerning the need to promote a series of ICT- related initiatives in different fields of policy development. This gave rise to diverse policy initiatives (such as eEurope, GoDigital, eLearning) that were prepared by the respective European Commission services. The general progress of these initiatives is being

([70]) This sub-section is essentially based on the work of Nick Boreham (2002a) in which he analysed the European policy context that characterised the launch of the TSER-programme and the expectations of the role of research as a support for European policies.

monitored in the context of the Lisbon follow-up process that is linked to the agendas set by the rotating EU Presidencies. Alongside the above mentioned eLearning initiative and the subsequent action plan, the European Commission has prepared a Communication on lifelong learning (2001). Basis on the Communication, the Commission organised a public debate and consultation among the Member States of the European Union.

These measures do not necessarily shift the emphasis to more interactive dialogue between policy makers, practitioners and researchers. However, they give a picture of growing complexity and the need to develop new instruments to promote innovation. In this respect, there is a challenge for research to reflect upon its possible role and contribution in the emerging policy context.

18.4.3. Role of research-based knowledge development

The brief description of the two successive periods gives some indications of the changing relationships between policy processes (as contexts for knowledge utilisation) and research (as a provider of knowledge). In the earlier period, policy-related demand was formulated in terms of generalised normative orientations (e.g. knowledge society). Thus, research could meet such needs with generalised interpretative frameworks and empirical results that can be related to specific priorities related to the development of knowledge society. Such research approaches can be characterised as responsive practice in European VET research.

Social demand for research-based knowledge is no longer characterised by highly generalised research needs and policy orientations. Instead, the landscape of European and national programmes is becoming a more faceted mosaic that calls for more specific contributions. The research approaches that try to meet these needs can, on the one hand, take a very specific focus and contribute to isolated initiatives. On the other hand they may provide complex interpretative frameworks that reflect processes of renewal and change from the perspective of change agents. The first approach can be characterised piecemeal engineering whereas the second can be termed transformative practice.

18.5. From knowledge elements to strategic knowledge development

18.5.1. Working concepts for strategic knowledge development

So far the areas of research have remained somewhat disconnected from each other and from emerging new policy contexts. The concept of strategic knowledge development is used here to promote connectivity. The concept of working agenda refers to the basic tool for analysing and shaping such connectivity within selected content areas. The working agendas are structured as different zones for strategic knowledge development and so can relate to different knowledge elements and different scopes and functionalities related to knowledge utilisation. Whereas the concept of working agenda is related to limited content areas with natural boundaries, the concept of strategic knowledge development requires a broader view. Thus, it is possible to develop a general idea of the kinds of diverse zones in which the diverse working agendas can be based. It is possible to indicate the following kinds of zones for knowledge creation and knowledge utilisation:

(a) the zone of mapping basic models and 'everyday life innovations';
(b) the zone of developing frameworks for conceptual systematisation and for promoting system-wide innovations;
(c) the zone of analysing curricular concepts and initiatives that respond to emerging challenges;
(d) the zone of building strategic capacity to contribute to renewal and change in vocational learning culture.

18.5.2. Shaping a common working agenda on work-related learning

The elements of work-related learning within vocational curricula provide a basis for the transformation of content-based vocational learning elements into contextual vocational learning. Systematisation of work-related learning opportunities within organisational contexts (or within sectoral and regional networks) provides a basis for transformation of prior competences via contextualised organisational learning. The basic challenge for strategic knowledge development is to analyse different links between work experience placements and education and training programmes. For such mapping the TSER-project Work experience as an educational strategy for 21st Century (WEX21c) developed a five-model typology. However, the typology focuses mainly on interpreting the educational relevance of work experience. The contrasting perspective – the role of systematic contextual

learning in promoting organisational and professional renewal – is not covered within the framework. On the other hand, the analysis of work process knowledge provides a more diversified picture.

Concerning the conceptual systematisation of dispersed initiatives, there is a difficulty in finding a general shape. This refers both to educational and organisational contexts. However, in some of the sectoral initiatives the social partners are preparing the ground for a more structured debate. This is particularly the case with initiatives that try to:

(a) develop a capacity for knowledge sharing on the basis of sectoral competence bases;
(b) develop networked learning structures for related knowledge processing.

In this context there can be joint social partner and initiative pilot projects for mapping and analysing processes of renewal and change in sectoral enterprises and for drawing conclusions concerning relevant education and training measures. The main point of interest is to explore to what extent such initiatives can develop conclusions concerning the role of education and training provisions in the context of change management and in the exploration of alternative career prospects.

18.6. Conclusion

It is essential to note that the original research context that has been analysed in this chapter –the work of the two TSER-funded projects – has provided different kinds of knowledge elements. The main results of the project on work experience have been conceptualised as a common framework that makes it possible to analyse different curricular contexts for workplace learning. The main results of the project on work process knowledge can be perceived as an interpretative web for understanding the kind of knowledge that is actually used in ordinary and critical work situations. So far these knowledge elements have been perceived as related to each other but there has been no detailed exploration of the prospects for mutual enrichment.

It has been pointed out in this chapter that the earlier phase of European policies focused on general frameworks and normative orientations. The role of research was to provide evaluative feedback or enhanced frameworks. Thus, the earlier policy contexts provided a basis for responsive approaches in European VET research. In the latter phase, European policy contexts are characterised by a mosaic of parallel and overlapping initiatives that can be

linked to each other. This change of contexts provides a basis for a gradual transformation of the role of research from general responsiveness towards a more focused strategy. On the one hand this may lead to narrower research contributions that support piecemeal engineering. On the other, this may provide a basis for transformative practice in the relations between research, policy and practice. The latter option requires joint analysis of research-based findings as contributions to strategic knowledge development.

The methodological groundwork in the context of Cedra provides some new facilitation tools and patterns of work to promote strategic knowledge development by means of transversal coordination frameworks linking parallel working agendas to each other. This can promote mutual learning and innovation transfer.

In this context it is possible to characterise the role of Cedra as a joint resource environment for capitalisation of the outcomes of European projects and as a platform for further knowledge development. This can promote the transition from responsive practices to transformative practice in research and development activities. Therefore, Cedra is not merely a framework disseminating research results as such but as a context for further knowledge development.

The strategic knowledge development framework can create bridges between research contributions and contexts for knowledge utilisation. Therefore, Cedra is not merely an arena for an internal research reflection but facilitates dialogue between research, policy and practice. Cedra, which is founded on the principle of collaboration with certain European cooperation projects and interested European researchers, thus promotes collaborative knowledge sharing.

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CHAPTER 19

Process knowledge and the development of further education professionals in Scotland

Roy Canning

19.1. Introduction

The paper provides a critical account of the development processes used for further education (FE) professionals in Scotland. It begins by describing the FE sector in some detail and then discusses the different pedagogical models used to underpin the construction of national standards for teaching FE lecturers. In particular, it put forward a critical analysis of both competence-based models and reflective practice models used for the development of intermediate and professional skills in a knowledge-based service industry. An alternative pedagogical framework is proposed which builds upon theoretical developments in the concepts of situated learning and process knowledge.

19.2. Further education sector

Increasing attention has been directed towards further education as a key provider of education and training in meeting the economic and social needs of the country. The government has not only emphasised the importance of the sector, but also with favourable public expenditure policies (within the Comprehensive Spending Review) has provided funding to allow colleges to expand their offers in the post-16 curriculum.

There were a total of 411 408 student enrolments in Scotland's 46 further education (FE) colleges in 1997-98. The majority of enrolments (86 %) were for vocational courses, of which 81 % attended part-time and 19% attended full-time. Over half of vocational enrolments were by women (53

%) and 55 % were by students aged 25 and over. Subjects relating to information technology, basic skills/access and engineering continued to be the most popular further education courses in 1997/98. Enrolments in colleges increased by 28 % in the last three years.

Interestingly, nearly 28 % of all higher education (HE) study in Scotland is provided in FE colleges and 40 % of Scots entering full-time higher education for the first time do so in an FE college. The colleges employ nearly 12 000 full-time equivalent staff, 56 % of which are teaching staff. It is this intermediate group of professionals and their development needs that are the focus of the paper.

Since 'incorporation' ([71]) a culture of 'new managerialism' has become all pervasive (Day and Hadfield, 1996) leading to new forms of governance, devolved budgetary systems, performance indicators and a growth in student numbers matched by a reduction in the unit of resource. This period of growth was undertaken within a quasi market ideology that can be typified by a strong central control of funding by the Scottish Office and a contrived competitive environment created between institutions. Colleges thus became business-like' as distinct from private businesses. They could, for example, develop their own strategic business plans (within the guidelines set by the Funding Council), negotiate terms and conditions with their staff, appoint independent boards of governors and hold capital reserves for future investments. Incorporation thus encouraged diversity within the sector and the establishment of devolved management structures. However, it can also be argued that this has led to fragmentation and overlap within the sector and, perhaps more important, the lack of a collective voice in influencing government policy in post-compulsory education.

Randle and Brady (1997) see this business-like culture as a source of tension between managerial and professional paradigms. The teaching staff within FE have traditionally constructed their identities within the precepts of occupational experts and champions of student learning. However, new managerialism demanded more of them. The teaching staff were now required to embrace team management and leadership practices and adopt more collaborative models of engaging with students, peers and colleagues from the sector. For example many colleges have restructured in order to create flatter organisations, with more authority given to academic staff to engage in a wider range of student processes, e.g. recruitment, guidance

([71]) The 1992 Further and Higher Education Act resulted in the 'incorporation' of 43 of Scotland's 45 colleges. This meant that the statutory duty for FE was transferred from the local authorities to the Secretary of State for Scotland and colleges received their funding directly from the Scottish Office.

and retention. Lecturing staff are also witnessing significant changes in their roles as they re-skill to deal with new curricula dealing with emergent industries e.g. call centres and megatronics. This reconceptualising of the role of teacher in FE also required a rethink of professional development approaches away from the 'technicist' competence methodologies to a greater emphasis on individual, team and organisational development processes.

19.3. Problems with competence

The last two decades of the 20th century marked an upsurge in competence-based approaches to professional development. The writings of Jessup (1991) and Burke (1989, 1995) provide the essential theoretical underpinning for the UK competence-based model. Competence in this sense is concerned with employer-led standards, outcome-based performance criteria and criterion-referenced assessment. The peculiarly British version of what constitutes competence has been attributed to the influence of educational technocrats associated with the interventionist youth training policies of the 1970/80s (Ainley and Corney, 1990). The aim was to establish employer-led standards of performance that are derived from a functional analysis of occupations. The standards are then assigned to one of five national levels and assessed using criterion-based methods.

The FE sector in Scotland was not immune from the new vocationalism with occupational standards being introduced for management and teaching staff. However, it immediately became clear that the UK version of competence was ill-suited to the development of professional teaching staff.

There are many different notions and definitions of competence. Is competence an attribute of the individual based on an ideal type? Are competences job requirements, independent of the attributes of the jobholder? Is competence a set of occupational skills and knowledge? The peculiarly British version of what constitutes competence is derived from a process of functional analyses of occupations. Conceptual ambiguity and complexity lies at the heart of the contentious debate about competence-based education. The FE model of competence attempts to achieve the impossible by defining competence in generic terms. At the outset the standards programme aimed to develop a list of performance criteria, range statements and specifications of knowledge and understanding that would cover all colleges and occupational settings for the intended work group. In order to do this the occupational standards had to operate at a meta level of

competence, decontextualised from the social and cultural situation of everyday practice. The list of competences, therefore, becomes so generic that it encouraged innumerable and potentially conflicting interpretations of what was competent behaviour. From an FE perspective, teaching staff repeatedly talked about the lack of clarity of the standards, the ambiguity of the language and the jargon.

It is an error to regard competence as an isolated mental capacity, divorced from the environment. Being competent has a situated component reflecting the specific environmental context and time-bounded nature of professional practice. Any attempt to decontextualise the situatedness of praxis can only lead to a sterile and post-rationalised interpretation of competent behaviour. The ultimate logic of this process will drive the potential teacher to attempt to shape work-based evidence of performance to the external occupational standard rather than use the standard to improve work-based performance. Therefore, the teacher will reinterpret his/her situated experiences to fit the narrative of generic competence, losing in the process the very essence of professional practice that made a difference within his/her environment. This is particularly the case where there is a strong ethical and moral component of professionalism. Judgements here are made on the probability of outcomes based on a socially constructed notion of right and wrong. Decisions are never risk free and reflect a gradient of judgements that are neither totally competent nor incompetent. Pretending to capture this complexity of judgement and tying it down to a set of performance criteria is seductive in its simplicity and concreteness. However, it is also misleading and presumptuous in that it fails to distinguish between the novice and the expert practitioner and between knowledge and understanding.

Literature attempts to deal with the problematic concept of competence by drawing a distinction between the words competence and competences and identifying meta-competences as a sub-set of skills. This rarely takes the reader much further as it clouds already murky waters. Perhaps the most useful conceptual advance in clarifying thinking in this area is derived from the work of Eraut (1993) who distinguished between competence and capability. The latter is defined as underpinning knowledge and understanding of concepts, facts and procedures, the personal skills and qualities required for a professional approach to the conduct of one's work and the cognitive processes which constitute professional thinking. Here, Eraut subsumes competence under the broader definition of capability, emphasising knowledge and understanding and the integration of theory and practice. There is a realignment of behaviour and thinking, of the

existence of gradients of professional practice and the role of constructed knowledge. To an extent the language of capability has been embraced by the FE sector as it grapples with the concepts of knowledge and understanding. No longer can it be assumed that behaviour subsumes knowledge and that the demonstration of practice is sufficient in itself. Understanding why action is necessary is as important as understanding what action is required. The key is in contextualising cognitive-emotive thinking in order to act competently within the confines of professional and collective practice.

A second strand of debate within the notion of competence is the part played by reflection in stimulating action. The argument for recognising the complex nature of professional practice is described by Schön (1983) in his critique of the technical rationality model of professional knowledge. Schön presents an alternative model of professional practice based on reflection-in-action. Here the professional practitioner is guided by knowledge-in-action, a tacit, spontaneous, conscious and critical response to an unfamiliar context. This process results in on-the-spot experimentation based on reflection-in-action and leads to personal and collective action that brings about a change in professional practice. This is akin to Kolb's (Kolb et al., 1974) model of learning and development. Action leads to an awareness of the situation; this is followed by reflection and conceptualisation and then by experimentation and change.

The experience of FE teachers supports the contention that the competence model only takes us part way around this cycle of learning. The teachers report that action is invariably followed by reflection but that this, in turn, rarely leads to a wider conceptualisation of the problem and to any form of experimentation and change. In essence, teachers claimed that being competent simply meant reflecting on past performance for the purpose of accreditation. There is little sense of demonstrating any coherent body of knowledge or that competence will, in turn, transform personal or professional practice. What is left at the end of the day is an accreditation process of prior experiential learning. In this sense it can be argued that it is a process of recycling inadequacies. This is a central critique of the competence model. The behaviourist and atomistic construction of standards is inherently weak as it is too occupationally specific and lacks sufficient educational and pedagogic content. The superficiality of the theoretical basis of professional and craft practice is its Achilles heel.

19.4. Situated learning and process knowledge

With the demise of competence-based approaches within the FE sector, alternative models of staff development were explored, including those coming under the umbrella titles of situated learning and process knowledge. There is a wealth of literature on the richness of learning that can occur in the workplace (De Jong, 1997). The expansion of full-time tertiary education, the growth in government-funded agency programmes and the decline in apprenticeship training have all tended to marginalise the workplace as a location for legitimate learning (Billett, 1992). In contrast, theoretical developments in the field of cognitive psychology (Lave and Wenger, 1991) emphasise the legitimacy of learning within authentic productive environments. In Scotland, a number of work-based initiatives – Scottish vocational qualifications, Investors in People, modern apprenticeships and, more recently, the new deal – have been launched in an attempt to redress the balance, firmly rooting learning and development processes in the workplace.

In work-based vocational education we are encouraged to think of learning as occurring within and between 'learning zones' (Deissinger, 1996) and involving spatial and temporal dimensions that go beyond context or background and explore the possession or ownership of learning spaces (Gray, 1999). This, in turn, involves multiple actors in a socially constructed environment where the instructor plays a key role in transforming learning (Engeström, 1994). This does not deny the need for a structured learning process but rather reasserts the importance of the productive nature of work itself as integral to skill and knowledge development and social learning (Fuller and Unwin, 1998; Ainley and Rainbird, 1999). However, much of what is learnt at work remains at the tacit level and often requires to be complemented by formal learning processes. As Engeström states:

> 'Although there are many occasions of productive learning in everyday situations, most of everyday learning consists of conditioning, imitation and trial and error. Investigative deep level learning is relatively rare without instruction or intentional self-direction. For that reason instruction is necessary.' (Engeström, 1994, p. 48.)

In Scotland there has been a long history of situated learning in the heavy engineering and construction sectors. However, the socially constructed experience of 'serving your time' as a learner was highly variable and often enacted within the culture of sectarianism and gender discrimination associated with the traditional craft trades. The various waves of inward investment by American, European and South East Asian companies in the

light engineering, oil & gas and electronic industries accelerated the anti-collectivist human resource management culture and further eroded the status of craft unions and the traditional learner models of training (Knox and McKinlay, 1999). Finally, the move away from manufacturing to a service-based economy is more pronounced in Scotland, further stimulating the development of different forms of apprenticeship embodying the new employment and learning relationships of a knowledge-based society.

Within the workplace, informal and formal learning structures combine to enrich the learning experience. This has been recognised within the literature on (work) process knowledge (Boreham, 2001). Here the emphasis is on expanding the awareness of work roles in the organisation through understanding the wider context of knowledge-intensive work. For FE staff this has meant developing an awareness of the interdependency of the activities of different departments, imbedding this awareness within a collective workplace culture and recognising the tacitness of much of the knowledge that is constructed in the workplace.

Although much of the literature on process knowledge is couched in the language of modernity and counterposed with Taylorism, its application within a post industrial setting is entirely relevant to the service industries and particularly those devoted to the production of knowledge.

19.5. The coproduction of vocational curriculum

Concurrent with this expansion of FE provision is the Government's desire the raise the level of professionalism of staff within the sector. With this in mind a national framework for a qualification leading to the teacher qualification (further education) – TQFE – has been established based upon the *National guidelines on provision leading to the teaching qualification (further education) and related professional development*. A number of higher education providers in Scotland (currently three) have been invited to develop vocational curriculum programmes for FE staff that are consistent with the guidelines.

The FE sector requires professional, self-motivated and flexible staffing in order to accommodate the demands of the future. Flexibility and professionalism are the hall-marks of the knowledge worker and any jointly produced vocational curriculum needs to be based on a rationale which explicitly aims to produce novice teachers who are predisposed towards understanding knowledge constructed within the workplace. There are some interesting differences, however, between such a process knowledge

based programme and those informed by other pedagogical models. For instance, such a model needs to go beyond a reflective practice framework that is simply a matter of 'thinking about what you are doing'. Much misunderstanding has been evidenced by the simplistic use of reflection in its everyday sense. The most prominent advocate of reflective practice has been Schön who has been extremely influential in shaping professional training in areas such as teaching and nursing. Schön (1983) regards reflective practice as an attribute of the experienced professional who has been able to build a repertoire of solutions to the complex problems of the professional context. If we accept this view, it is not sensible to regard novice teachers as reflective practitioners because they do not possess the necessary expertise. If we aspire towards fostering the development of reflective and a self-evaluative habitas that will eventually lead to the display of mature reflective practice, then a broad basic understanding of context and imbedded cultural practices in the workplace is an essential foundation. The jointly produced vocational curricula, therefore, have to be concerned with ensuring that competence is present but also that it is underpinned by a depth and breadth of knowledge which is the mark of the informed professional as well as the competent one.

Both reflective practice and competence are potentially problematic terms that have implicit (or explicit) ideologies behind them. In that these ideologies are not entirely compatible there is a tension between approaches to training based on reflective practice and competence models. An explicit goal of Schön's influential book was to defend the notion of professional knowledge from increasing demands for accountability that was becoming evident in the 1980s. The crude version of the tension would hold that reflective practice upholds professional autonomy (and professional immunity from accountability) while competence models make professional knowledge explicit (and devalue professional experience and expertise). Part of the problem arises from the way in which competences are broken down by functional analysis to give a number of behaviourally based descriptions of professional behaviour (Canning, 1998, 1999). This is a perfectly legitimate and defensible way of creating a set of assessment criteria that can be used to assess professional competence. The competences of the Guidelines present a carefully planned assessment framework within which a programme will readily function. Competence models may become problematic when assumptions are made about competences as a representation of professional knowledge. Useful as criteria though they are, it seems unlikely that professionals store their knowledge and skill as a series of discrete behaviours; becoming competent

is not a matter of accumulating competences.

It is more likely that these behaviours are the outward sign of a more holistic competence, a complex interaction between knowledge, skill and attitudes that underlies professional competence in experts. It is this underlying competence, with its underpinning process knowledge and values, which informs pedagogical developments within the TQFE. FE lecturers are thus encouraged not to accept good practice as self-evident, as given and as the same thing for everybody, with the consequence that they all simply have to learn how to do it. Instead, a more reflective, interpretative approach is favoured, in which the processes of teaching and learning are viewed as partly problematical, given the very wide range of social factors, political pressures and student characteristics with which lecturers must contend. They are, therefore, encouraged to develop their approaches to teaching and learning, by discussing, sharing and developing their ideas, by testing these out in practice, by analysing, monitoring and evaluating performance, the unsuccessful as well as the successful, and by reading significance into what their students say, write and do. The study of the wider process of constructing knowledge within their colleges and through analysis and discussion with others are essential to developing this interpretative, reflective and evaluative capacity.

An example of this emphasis on the coproduction of curriculum is the requirement to provide an understanding of the broader contextual and environmental processes involved in college governance. A module within the programme entitled National college policy does this through encouraging the students to engage critically with how their own college policies are formulated in the context of external funding pressures and the broader socio-economic environment. To facilitate this process senior mangers from the colleges give lectures at the University on strategic thinking and problem solving within a FE context.

The Institute of Education is a research active department of the University of Stirling. Research expertise has a number of advantages for the coproduction of vocational curriculum. Policy-based research within FE encourages a collective enquiry-based approach to teaching and curriculum development. Here formal education combines with the construction of workplace learning. The aim is to broaden and deepen the knowledge base of practitioners, to help them understand the wider processes involved in their organisation and the wider FE environment. Only then can they situate their own learning within a culture of collective practice.

19.6. Concluding point

The paper argues for the reconceptualisation of our thinking about the learning processes used within initial teacher education programmes in further education. It identifies the inherent weaknesses of using competence-based and reflective practitioner models to inform the pedagogical design of learning interventions and, in turn, points to alternative leaning constructs developed from the theoretical work dealing with situated learning and process knowledge.

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CHAPTER 20

Work process knowledge and lifelong learning policies [72]

Michael Osborne

20.1. European Commission policies

There is a plethora of documents describing lifelong learning policies at European level. Since the publication of the white paper *Teaching and learning* (European Commission, 1995) the policy of the European Commission (EC) has shaped many developments at national level. This publication placed particular emphasis on combating social exclusion through offering 'second chance schools'. This was put forward as one of five main guidelines for action in striving for a knowledge-based society. These guidelines sought to encourage the acquisition of new knowledge; to bring schools and the business sector closer together; to combat exclusion; to develop proficiency in three Community languages; to treat capital investment and investment in training on an equal basis.

The launch of the Socrates II programme (European Commission, 2000a) and the continuation of the Leonardo da Vinci programme (European Commission, 2000b) continued to support many of these policies. The *Memorandum on lifelong learning* (European Commission, 2001) produced as a follow up to the European Council meeting in Lisbon in March 2000, summarises the concerns of the European Commission, and illustrates a number of practices pertaining to its key messages.

This Memorandum drew together and reasserted policies in relation to lifelong learning, defining it in the following terms:

(a) all learning from cradle to grave, from the early years through adult life – including the third age – encompassing a common core of knowledge and skills which goes beyond basic numeracy and literacy;

[72] This chapter is a further development of a paper presented at the Council of Europe Workshop, *Lifelong learning for equity and social cohesion: a new challenge to higher education*, held in Kranjska Gora, 9-11 November, 2000.

(b) not only concerned with employment-related skills, but also about updating all kinds of abilities, interests, knowledge and understanding throughout life;
(c) all kinds of learning, including non-formal, such as acquiring vocational skills at the workplace or language skills through, for example, participating in a study circle organised by an non-governmental agency (NGO) and learning informal skills, such as learning how to play football or a musical instrument together with friends.

The *Memorandum on lifelong learning* furthermore emphasises six key messages as follows:

(a) new basic skills, gaining and renewing skills for sustained participation in the knowledge society, which demands a guarantee of universal and continuous access to learning. Particularly important are IT skills, foreign languages, technological culture, entrepreneurship and social skills;
(b) raising levels of investment in human resources;
(c) innovation in teaching and learning; effective teaching and learning methods and contexts for the continuum of lifelong and lifewide learning;
(d) valuing learning; the need to understand and appreciate participation and outcomes, especially in non-formal and informal learning;
(e) guidance and information; providing easy access to good quality information and advice about learning opportunities for all ages;
(f) bringing learning closer to home; providing lifelong learning opportunities as close to learners as possible.

These imperatives first show that the EC is pointing towards a common core of lifelong learning that encompasses more than basic literacy and numeracy. Some of the area of skills and knowledge the EC highlights are unsurprising (digital literacy, for instance), but the emphasis on entrepreneurship might not have been anticipated. Second, lifelong learning is firmly positioned as an activity that is very much employment-related. Third, using the expression, 'lifewide learning', implies that the boundaries of places within which learning occurs are bounded neither by time nor place.

It is quite clear that, at a European Commission level, the concept of work process knowledge links well to lifelong learning priorities. It is now generally accepted that learning is not an activity that is confined to formal institutions. Much valuable knowledge is developed in non-formal and informal sectors, and the workplace is, for many, the most significant location of this development. In a global environment, investment in human capital is vital for many industries to sustain competitiveness. Equally for individuals, investment in their own learning ensures their position in the labour market and provides opportunities for personal development.

Much of this development is facilitated by the acquisition of knowledge that is constructed in the act of working, namely learning through work (Seagraves et al., 1996a). In this context the concept of work process knowledge (*Arbeitprozesswissen*) potentially can make a valuable contribution, in as much as it focuses on understanding the whole labour process and thus encompasses a broad conception of knowledge that is potentially transferable to other contexts and locations. In a number of countries, and the UK perhaps presents a particularly clear example, recognising the value of such learning has been well established in recent years. Much practice has, therefore, sought to codify and accredit this knowledge which, as described in the work process knowledge model, is tacit, and held collectively as well as individually.

20.2. National policies

At national level also, a range of policies and practices concerned with lifelong learning and continuing education exist in a number of countries within Europe, many of which are described by Davies (1995), the Council of Europe (1996, 2000), the European Continuing Education Network (EUCEN) (1997), Taylor (2001), Schuetze and Slowey (2001) and Osborne and Thomas (2003). The policies of different European nations were explored in a Eurydice publication (2001) and in a special issue of the *European Journal of Education* (2001). On a wider international level, Healy (1996) provides a useful overview of international experience and comparisons from the perspective of the OECD. Healy describes a range of initiatives that have been introduced in a number of countries to facilitate flexibility in course provision, and to allow transition between the labour market and work. Concerns about exclusion find particular emphasis in the Mumbai Statement on Lifelong Learning, Citizenship and the Reform of Higher Education to the 1998 World Conference on Higher Education in Paris (UNESCO, 1998). A recent publication from the University of Stirling (Murphy et al., 2002) provides detailed case studies of initiatives in Australia, Canada, Finland, France and the UK.

It would be impossible to outline the range of policy directions being taken in the different European countries, but a few cases exemplify the trends. First, in many countries there is tension between lifelong learning policies serving as an economic instrument, as against being a vehicle for social inclusion and widening participation in formal learning. This tension is reflected in a number of countries where responsibilities for ensuring

individual competitiveness in the labour market are being firmly placed upon the individual. In Finland, for example, the principle of lifelong learning occupies a prominent position in ministerial guidelines (Ministry of Education, 1997/1998). However the ways in which the concept has been applied in government pronouncements has been criticised for its excessive focus on the needs of employers, and for shifting educational responsibility too much onto individuals (Tuomisto, 1997; Rinne and Salmi, 1998; Silvennoinen and Tulkki, 1998). Similarly in Sweden, according to Asking and Foss-Fridlizius (2000) the concept of lifelong learning has developed into more of an individual and institutional endeavour than one managed by the state. They suggest that in Sweden lifelong learning focuses more on non-formal and informal learning in different settings rather than on the role of formal institutions and exchange between education and work.

In a number of countries the emphasis on increasing and broadening participation in learning manifests itself in institutions developing 'outreach' programmes and creating flexibility within provision through a range of structural arrangements. Outreach may take the form of work-based learning where the formal sector collaborates with industrial partners to deliver and accredit learning in the workplace; these particular mechanisms are dealt with in some detail later on in this chapter. Flexibility takes the form of creating transformations and adjustments to the structure, administration and delivery of programmes (Murphy et al., 2002) and is exemplified by the increasing emphasis on open learning, particularly that which is mediated by information and communications technology (ICT). It is certainly the case that prominent in many government policies is the development of an information society, which is seen as a major competitive advantage. This, in turn, has seen a number countries focus on creating significant information technology capacity in an effort to increase educational services for dissemination over information networks. For instance in Finland, the Open University operation, developed in the 1990s, has pioneered this form of provision and this manifests itself the Finnish Virtual University, a common service of all universities (Taylor, 2001). Similarly in Spain in recent years, considerable focus has been placed on the role of distance education through the medium of information and communications technology as exemplified by the Universitat Oberta da Catalunya (UOC) and its virtual campus (Mora and Vidal, 2000). In the UK, the establishment by government of the University for Industry (UfI), is seen as a key mechanism for promoting lifelong learning and introduces a quite new dimension to the potential for the use of ICT within a work context. This 'public-private partnership will boost the competitiveness of business and the employability of individuals' and aims to

work with businesses and education and training providers to make learning available at locations and times suitable to learners either in their homes or through a national network of 251 learning centres, using ICTs (UfI, 2000).

The United Kingdom is often cited amongst Organisation of Economic Cooperation and Development (OECD) countries as a prime example of policy innovation in respect to lifelong learning, having introduced a range of initiatives in post-compulsory education and training in recent years. It is thus given particular attention in this account. In recent times a focus on widening participation and increasing access to education has underpinned the present UK government's lifelong learning strategies. The particular need to promote social inclusion has been the theme of a number of recent reports and policy papers published in the UK: the Fryer, Kennedy, Dearing and Garrick Reports in 1997; the various green papers on lifelong learning in 1998 (Department for Education and Employment, DfEE); Scottish Office (SO), 1998; Welsh Office (WO), 1998; Scottish Office Consultation Paper on Social Inclusion (SO, 1999). However, in more recent times the cost of expansion has been highlighted in policy. Thus, in the white paper *The Future of Higher Education*, the Secretary for Education and Skills signalled that the English HE sector faces some 'hard choices on funding, quality and management' (Department for Education and Skills, 2003, p. 4).

In the drive towards inclusion there has been considerable emphasis on employability; as a consequence, stress has been placed on learning within the workplace. In practical terms this emphasis is translated into a range of policy initiatives framed around social exclusion that seek to tackle under-participation and widening access. For example, in Scotland, in both further education and higher education the following are amongst current initiatives: funds allocated in 1998-1999 and 1999-2000 to both sectors by Scottish Higher Education Funding Council (SHEFC) and the Scottish Further Education Funding Council (SFEFC) to promote wider access initiatives (including widening access through part-time study); allocation of funds to promote growth in student numbers, particularly from under-represented groups have an added premium; encouraging new forms of partnerships between educational providers, advice agencies and employers through the aegis of the proposed Scottish University for Industry, using ICTs as an important vehicle; the establishment of a University of Highlands & Islands; the large investments in the 'new deal', modern apprenticeships and training for work; the right to time-off work for 16-17 year olds; establishing a national qualifications framework based on the 'higher still' and Scottish credit and accumulation transfer (SCOTCAT) frameworks.

In the UK it has been acknowledged in recent years that formal

institutions are not the only places where legitimate and potentially accreditable learning takes place. In particular, there has been growing attention given to work-based learning, the wide-ranging concept of linking learning to work roles. Moreover, with the increasing use of national credit transfer and accumulation schemes, and the application of accreditation of prior (experiential) learning schemes, a number of institutions have sought to award credit towards partial, and in some cases 'whole-recognised', qualifications based on workplace learning. The necessity of such approaches is evidenced in part by individual demand; the workplace is recognised by many individuals as the most common location of learning (Taylor and Spencer, 1994). Furthermore, the importance to individuals of the connection between learning and employment is illustrated by a recent study of adult learning in the UK, commissioned by the DfEE. This research, conducted with a representative sample of 5 653 adults aged between 16 and 69 years of age, found that 58 % of reported episodes of 'taught learning' were connected with a current job, and a further 17 % were done with future paid work in mind (Beinart and Smith, 1998)

At governmental level, increasing interest in work-based learning in the UK during the past 20 years is closely associated with the overarching objective of successive administrations to increase and broaden access to continuing, further and higher education. This concern with access is driven, to an extent, by considerations of social justice, but equally (and on occasions more often) has been associated with the concern of governments to increase the competence of individuals within the workplace and thereby make workers and companies more competitive economically (Department of Education and Science (DES), 1987, 1991).

Certainly, for the previous Conservative governments, work-based learning was among the fields that promoted its objectives to develop a more skilled workforce and contribute to meeting the national training targets formulated by the Confederation of British Industry (CBI). For instance, lifetime target 1 stated that 'by 1996, all employees to take part in training or development as the norm' and lifetime target 2 'that by the same time 50 % of the employed workforce to be aiming for national (Scottish) vocational qualifications (N(S)VQs) or credits towards them' (National Advisory Council for Education and Training Targets, 1993) ([73]).

([73]) The N(S)VQ structure is based on five levels within a wide range of vocational areas. These levels range from basic education through to the equivalent of postgraduate study. The government set revised targets in 1998 which state that 50 % of adults should achieve a level three qualification (broadly equivalent to the first level of post-school vocational qualifications) by 2002 (NACETT 2000).

Within higher education it was the Department of Employment (DoE) that since the mid 1980s on an UK wide scale (ED, 1990) aimed to 'promote the conditions for a competitive, efficient and flexible labour market' (Duckenfield and Stirner, 1992). Among its initiatives has been the funding of seven innovative development projects in work-based learning in higher education institutions. The effectiveness of these initiatives has been evaluated by Fulton et al. (1996) who propose a number of possibilities for further development.

During the 1990s, both the Scottish Higher Education Funding Council (SHEFC, 1994a and 1994b) and its English equivalent the Higher Education Funding Council for England (HEFCE) funded parallel developments under the aegis of Flexibility in teaching and learning. A number of these initiatives have focused on developing work-based learning programmes with the potential collaboration of employers.

20.3. Structures

The possibility of even considering many of the aforementioned models as providing learning opportunities would not exist were it not for the acceptance of a range of structural changes in vocational and higher education and the implementation (at least in some institutions) of radical pedagogical models. These include national credit frameworks, credit accumulation and transfer systems (CATS), accreditation of prior (experiential) learning (AP(E)L), the introduction of semester systems and the development of modular curricula.

In the UK, the Robertson Report (Higher Education Quality Council (HEQC), 1994) advocated the creation of a national credit framework across the UK to facilitate flexible student mobility and to increase student motivation, and this concept gained great momentum as a key proposal of the well-known Dearing Report (Her Majesty's Stationary Office (HMSO), 1997). The notion of such a framework is that there should be a common cross-institutional set of levels of post-school education within which credit can be obtained. This framework is linked to the notion of accumulating and transferring credits towards qualifications. Together the national credit framework and CATS are seen to be key structural vehicles for ensuring that learning can be 'banked', and built towards qualifications in a flexible fashion. Although such national frameworks within a European context have a longer history in the UK than elsewhere, it is evident that this structural vehicle is gaining popularity in other countries. In Denmark, the recent adult

education and continuing training reform in Denmark (Carlsen, 2001) advocates the increased use of accreditation schemes to ensure that 'knowledge and skills acquired in informal and non-formal learning contexts will be recognised at all levels' (Carlsen, 2001, p. 45).

CATS are intimately linked to the practice of accreditation of prior (education) and learning (AP(E)L) and its close 'relative', accreditation of work-based learning (AWBL). The historical development of APEL and its move from the margin to the mainstream is described by Storan (2000, p. 14). He notes that the Council for National Academic Awards (CNAA) stated that 'appropriate learning at higher education level, wherever it occurs, provided that it can be assessed, can be given credit towards an academic award' (CNAA, 1986). APEL is an approach, influenced by theoreticians such as Dewey (1938), Kolb and Fry (1975) and Chickering (1986) that involves students reflecting upon experience and then, through a guided process, gathering evidence of learning achieved in a variety of informal learning situations, including the workplace, often in the form of a portfolio. Perhaps the most innovative national model of the use of AP(E)L is found in France where models such as the assessment/appraisal of skills (*le bilan de competences*) and the accreditation of prior and work-based learning (*la validation des acquis professionnels*, VAP) are used routinely to secure entry to and credit within universities. National statutes give individuals the right 'to an analysis of their personal and professional skills and competences and of their aptitudes and motivations, with a view to defining an individual career plan (*un projet professionel*) and, if appropriate, to identify training needs and possibilities' (Davies, 1999). Furthermore, these statutes permit HE institutions to accredit prior learning for the purpose of admitting students to courses leading to national diplomas or to competitive entry examinations in the same university (Feutrie, 1997, 1999). According to Davies (1999) in 1996-7 around 10 000 applications were made under the VAP scheme and just under 8 000 of these were successful; the overwhelming majority of acceptances were for access. Although the VAP has not fulfilled its expectations in terms of numbers and remains a minority activity in the context of the totality of the system, Davies suggests, nonetheless, that it represents a fundamental challenge to the status quo, with regard to the central construct of the *diplôme* and the professional and organisational cultures, which surround it. A new piece of legislation of 17 January 2002 on social modernisation *(loi de modernisation sociale)* includes an important chapter on professional training and development *(formation professionnelle)*. It has re-energised the previous VAP legislation into a broader and more powerful VAE *(Validation de l' Experience)*, extending the

1992 and 1993 Act and decree to all diplomas and professional qualifications (Pouget and Osborne, 2004).

Other countries in Europe are also considering introducing APEL within their systems of post-compulsory education. For instance, in Norway a comprehensive *Competence Reform* has a focus on documenting and assessing non-formal and informal learning (Norwegian Ministry of Education, Research and Church Affairs, 2001). In The Netherlands, among a number of policy options for lifelong learning and described as 'no-regret' options (in as much as they are likely to be supported by any government of any composition [Dijkstra, 2001]) is the recognition of competence gained in non-educational institutions.

The further structural features of semester systems, replacing the traditional three-term structure, and modularisation offer additional elements of flexibility. Many UK institutions now offer a two-semester system traditional in the US, and some have also introduced a third period in the summer, and effectively run a trimester system. Increasingly, undergraduate and postgraduate programmes are offered in modular fashion and allow students to build qualifications from a range of elements over periods that suit them rather than the institution. Furthermore, since the mid 1990s many universities have introduced accredited continuing education programmes ([74]) therefore adding substantially in some institutions to the elements from which an award can be constructed. In part this flexibility has been dictated by the need to maintain departmental and/or institutional survival in an increasingly combative market for students. Nonetheless, the structural features of a national credit framework, CATS, 'semesterisation' and modularisation provide an important backbone for accrediting work-based learning.

An important question is the extent to which the structural arrangements previously described can accommodate the particular way of knowing implied by work process knowledge. The way in which the work process oriented curricula are being implemented in Volkswagen is antithetical to educational provision that is based on what often manifests itself as a fragmented set of procedures. Modular systems within which credit can be accumulated flexibly in the sense of order, time and place, clearly do not have the holistic character of the work process curriculum.

([74]) For further detail of accredited continuing education see Osborne (1997).

20.4. Understandings of work-based learning

Work-based learning has been the term used earlier, and needs further explication in the context of the UK. It is a term with a wider-ranging ambit than work process knowledge, but is inclusive of this concept.

Since the early 1980s, a number of authors have defined work-based learning and a useful summary is provided by Brennan and Little (1996). These authors note that 'work-based learning can be defined as linking learning to the work role, but this does not only mean preparing for a specific job'. Quoting from a project of the University of Leeds (1996), they report on ways in which 'linking learning to the work role' can be understood:

> 'performance or task related, particularly where circumstances are changing; problem-based, usually associated with tackling problems of production, design or management; autonomously managed, with learners expected to take a large measure of responsibility to ensure they learn from their work activities; team-based, in that tackling problems often requires effective cooperation with different roles and expertise; concerned with performance enhancement; innovation centred, which creates opportunities for learning and providing experience of managing change.'

In our own work at the University of Stirling we have defined three strands of work-based learning: learning for work, learning at work, and learning through work (Seagraves et al., 1996a). Learning for work is conceived as being broad and includes anything, which can be labelled vocational. It can be delivered in school, college, at home, by television or at work. Learning at work is related to training, and development delivered in company. It could be delivered by company personnel, consultants or staff from educational establishments. For both learning for and at work to be useful there may be need for reinforcement by means of learning through work. Learning through work is integrated into the doing of a job; it includes the application of job-related learning and the skills and knowledge acquired in the process of doing the job. Clearly this latter concept links well to the work process learning model and its concern with a broad-based understanding of knowledge that is constructed in the workplace at the time of use. The process of the construction of knowledge as being about the resolution of contradictions between codified knowledge and direct experience resonates well with the conception of learning through work.

Garrick and Kirkpatrick (1998) summarise how these conceptions of work-based learning are informed by a range of theories of learning in the field of adult education, including reflection-in-action (Argyris and Schön,

1987), critical reflection (Mezirow, 1990), experiential learning (Boud et al., 1993), self-directed learning (Candy, 1991) and independent learning (Brookfield, 1990).

20.5. Motivating stakeholders

The provision of learning opportunities for those in the workplace tends to be motivated by factors associated with economic development, institutional survival, demography and personal fulfilment. The relative importance of each of these factors depends on the stakeholder under consideration: government, industry, individual worker or educational institution.

Until recently, the traditional focus of the university sector has been educating school leavers: work-based learning and other continuing education initiatives were viewed as marginal activities, and indeed hardly considered to lie within the remit of these institutions at all. Although universities often incorporated periods of work experience into vocational courses, in many cases no learning objectives were set and the learning that may have resulted was not assessed. In recent years, however, a number of factors have led universities to reconsider the role of work-based learning within their institutions. The government's imperative to increase access and flexibility and to introduce enterprise skills have given an impetus for change. A number of projects have sought to systematise the incorporation of work-related and transferable skills into the undergraduate curriculum. Notable examples in the UK include: the use of learning contracts in sandwich placements at Napier University (Marshall and Mill, 1993); the Scottish applications of learning through experience (SCALE, 1992), a project which developed models for accrediting experiential learning in a number of institutions; and the Employment Department funded structured industrial practice studies (SIPS) project at Glasgow Caledonian University which developed a model for integrating academic learning and workplace activity, and which also focussed on developing personal transferable skills (Fenoughty and Kemp, 1994; Kemp and Seagraves, 1994a and 1994b; Seagraves et al., 1996b). More recently, developments have seen the creation of accredited work-based learning fully embedded into the undergraduate curriculum even in non-vocational degrees, for example at the University of East Anglia (2000) within the 'learning through earning' project. At the University of Wolverhampton (2000), credit is awarded to undergraduates undertaking structured or unstructured part-time, vacation or voluntary work.

More recently, developments have focussed not only on broadening the experiences of traditional students, but also on developing new routes into higher education for different constituencies, and on shifting the location of learning to off-campus locations. This type of initiative is perhaps best exemplified by projects that aim to create bespoke courses to meet the needs of large companies. The most well-known model, based on an original US framework, is the Ford ASSET programme developed by the Ford Motor Company together with Anglia Polytechnic University with Employment Department funding to enable engineers to gain credits towards a degree for the knowledge and abilities acquired through work. Such models may consist of simply delivering existing university programmes in the workplace, but may also incorporate significant elements of APEL. For instance, the ASSET model has also been used to credit a post experience award for social workers at the same university within the framework of nationally recognised professional body qualifications, and incorporates processes of APEL (Winter and Maisch, 1996). Projects such the Scottish higher education and employers collaboration (SHEEC) at Glasgow Caledonian University and the University of Stirling arose directly from the UK's Government's *Enterprise in Higher Education* initiative. SHEEC provides examples of models of accreditation of work-based learning (AWBL) at a range of undergraduate and postgraduate levels, in two different vocational areas – management and nursing – and in a number of public and private sector organisations (Carmichael, 1992; and Osborne et al., 1993).

Initiatives have not only aimed to provide credit at university level, but have focussed on the accreditation of prior experiential learning in the workplace as a means of demonstrating the ability to access higher education. For example, the Developing employment-based access to learning (DEAL) project, funded by Scottish Enterprise, and jointly undertaken by Glasgow Caledonian University, University of Stirling and Napier University provides a further example of the potential for work-based learning, assessment and accreditation in a range of subject areas and at a range of levels from access to post-graduate within specific companies (Reeve et al., 1995). In achieving these aims the project has developed a model for work-based learning which is built on the notion of partnership between employers and educational institutions. Within such partnerships work-based learning opportunities, leading to recognised awards, have been negotiated between the learner, the employer, the educational institution and, where appropriate, professional bodies.

Certain developments have sought to meet the requirements of particular

niche markets. For example, directly out of the DEAL project the University of Stirling and associates have sought to develop that model of work-based learning within small and medium-sized enterprises (SMEs) using Employment Department funding in the Earning in smaller companies project (LISC) (Osborne et al., 1995; and Seagraves et al., 1996a). The extent to which the possible merits of work-based programmes might be recognised at corporate and individual level within SMEs is, however, open to question. Although they play a vital role in developing the economy, stimulating competition, developing new technologies and new products and creating new jobs, such organisations frequently do not have the human resource development expertise and infrastructure which larger companies enjoy. It is less likely that their employees can take advantage of personal and professional development opportunities through in-company provision and/or access to further and higher education. These problems are often seen to be compounded by a lack of financial resources, higher labour mobility, tight schedules with no 'slack' to allow employees time away from the workplace, and insufficient numbers of employees needing training at any one time to provide it in-house. Furthermore, research evidence suggests that the economic benefit to SMEs in investing in employees is not demonstrated (Storey and Westhead, 1994). The LISC project not only reports a series of structural problems in developing education and training opportunities in SMEs, but also raises considerable doubts as to whether these firms perceive a need for any form of provision other than that which provides a short-term fix. Elements of that work have been developed further on a European scale under the aegis of Leonardo da Vinci funding (Oberski et al., 2000).

Some institutions have aimed to develop dual accreditation awards that are both competence-based within the NVQ framework, and knowledge-based within the framework of traditional university study (Sheffield Hallam University, 1996 and University of Luton, 1996), though there is little evidence of the success of such schemes.

20.6. The advantages of learning in the workplace

For industry, the advantages of offering educational opportunities of any sort to employees are economically based. They have been summarised by Chadwick (1993) as including the creation of 'a better educated and more adaptable workforce, improved morale, improved industrial relations bringing with it a better understanding of the business, enhancement of the

company's image and the creation of a company wide learning environment. In a number of companies, the desire to create work-based opportunities has led to a range of innovations including the well-known employee development programmes such as Ford's EDAP, created in 1988 to provide non-job related learning opportunities in collaboration with trades unions. The benefits of such schemes have been assessed by Parsons et al. (1998) for the DfEE. These are encouraging a learning culture, contributing to the improvement of productivity, efficiency and customer service and enhancing the confidence, morale, commitment and motivation of the workforce.

Other schemes for employee training, education and development take the form of corporate universities, perhaps the most well known of which is the Motorola University, which 'serves the extended Motorola family, meaning employees, their families, suppliers and customers' (Densford, 1999). The vastness of this enterprise is indicated by its $100m budget, 99 sites in 21 countries, 400 professional staff and 700 programme developers, writers, translators and instructors. All 150 000 employees are obliged to take at least 40 hours of training per year.

The need for British industry to reorganise production processes and introduce more flexible working practices at a time when there is a relative dearth of new skilled workers has placed considerable pressure on government and industry alike to encourage those within employment to upgrade their skills and knowledge (Employment Department, 1993, 1994a). Individuals within this framework have to balance the desire of their employer to mould their educational aspirations in line with corporate objectives with their individual requirements for self-fulfilment. Recent research, nonetheless, suggests that the workplace is seen by individual employees to be the most common location of learning and many respondents think that learning associated with work should be subsidised (Employment Department, 1994b). This work also provides further evidence of the assertion made by Cross (1981) that initial participation leads to further participation, as it was found that more than twice as many existing learners (66 %) as non-learners (28 %) indicated their intention to pursue further studies. Unsurprisingly perhaps, the majority of respondents (55 %), whether learners or non-learners, agreed that training at work can lead to promotion, a finding replicated in many previous surveys, notably that of Carp et al. (1974) in the United States. Thus, there are number of indicators at individual level that suggest a potential demand for work-based programmes.

The work process knowledge model clearly fits well within policy frameworks that have been created at European level. It provides a model

whereby frameworks can be put in place to develop the knowledge and skills of individuals and so contribute to capacity building within enterprises. Furthermore, potentially it can build upon a strong evidence base of the perceived desire by individuals for work-related learning opportunities. Policy makers at a pan-European and national level clearly have signalled the importance of work-based learning and this is manifest in a range of initiatives, which are exemplified by the UK model.

There are, however, some caveats. Much of the workplace development previously described is qualifications-led, this being a consequence of the funding for work-based developments being linked to quantifiable performance indicators. While the desire for qualifications is understandable at an individual level, it is not necessarily the priority of enterprises. Also, much of the funding for initiatives related to work-based learning has come from government or the EC. It seldom becomes an activity that is embedded in the practices of enterprises (especially SMEs) once funding is removed. The challenge is to demonstrate to organisations that there are economic benefits in investing in workplace learning. The work process knowledge model ultimately faces the same economic challenge. However, it offers a reference point that is transparent to industry in as much as it promotes collaborative endeavour based on the work process of that industry.

Furthermore, many of the developments within the field of work-based learning have been linked with narrow competency-based programmes built upon the notion that learning can be reduced to a set of discrete non-related packages. It is argued that this learning can be neatly measured against government inspired benchmarks, and procedures can be developed for accrediting prior (experiential) learning and fitted within credit accumulation and transfer systems. Such methods are presented as a means by which greater opportunities for participation within lifelong learning can be provided, since they offer the flexibility 'required' in modern society. Although, it can be argued that there are considerable merits associated with these structures, ultimately there are doubts about the richness of such fractured learning and, in certain cases, doubt about whether it is learning as distinct from qualification that is the objective of many schemes. The work process knowledge model with its emphasis on the coproduction of vocational curricula, involving collaboration between companies and technical institutions of learning, seems to offer an alternative model with less flexibility, but greater robustness.

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CHAPTER 21

Work process knowledge and labour relations in the Spanish steel industry

Karsten Krüger

21.1. Introduction

It is obvious that the organisation of work determines how workers carry out their tasks and the competences to be used in the process. Any restructuring of an organisation implies a modification of its competence structure. The debate about work process knowledge must be seen in relation to this (see Kruse, 1985). The green paper *Partnership for a new organisation of work* (1996) indicates that introducing forms of work organisation based on work process knowledge is a bargaining process that occurs on different levels.

Some of the main questions raised by the restructuring processes in industry are as follows. Which characteristics will the new labour processes take? What competences are required by the workers and in which labour conditions will they work in the future? It is evident that these are questions dealing with the collective bargaining process. However, we want to formulate these questions in a different manner, which is: what role does the structure of industrial relations play with regard to introducing new forms of work organisation based on work process knowledge and learning?

Before outlining an answer to this question, based on the experience of modernising processes in the Spanish steel industry, we want to highlight the fact that the concept of work process knowledge can be used in different ways. The different chapters in this book show that:

(a) we must distinguish between work process knowledge as a form of knowledge, which has always existed, in one form or another, in all enterprises (see Fischer, 2000) and work process knowledge as a political concept for improving the learning processes of enterprises, for defining vocational/professional curricula ([75]) and for enhancing work organisation and working conditions;

([75]) See for example the contributions of Felix Rauner and Rainer Bremer in this book.

(b) work process knowledge is strongly related to the balance of power within enterprises, economic sectors, educational and training systems and society as a whole. In all these areas work process knowledge is a basic power resource.

Current discussions on work process knowledge indicate that it has been recognised as a fundamental part of the cognitive structure of enterprises and professions. This implies that there is a need for new curricula concepts, which form part of the political discussion about the vocational professional training system. Furthermore, the experience within enterprises indicates that recognising work process knowledge as a fundamental part of an organisation's cognitive structure forms the basis of modern strategies to adapt enterprises to the changing environment ([76]). In both cases we can observe aspects of power, which are a dimension of modernisation processes.

From the perspective of power, we discuss the role of industrial relations in restructuring enterprises. We make reference to the modernising processes of enterprises in the Spanish steel industry. We will explain the problems faced in the 1990s and how these problems were addressed by a sector-wide initiative supported by two ADAPT projects. Both projects were based implicitly on the concept of work process knowledge and their objective was to elaborate instruments and tools to enable the steel enterprises to adapt themselves to new conditions within the sector.

21.2. Power games and resources

The organisational theory of 'micropolitics' (Küpper and Ortmann, 1986) interpreted organisations as a configuration of multiple linked power games, where the actors used strategies based on cooperation or confrontation. Restructuring processes unleashed new forms of power games. Theoretically these types of power games cannot be explained by classical game theory. The former is quite different in the following aspects:

(a) they do not suppose a limited number of players who are fighting for a clearly defined aim;

([76]) We maintain that most modern management concepts are implicitly based on recognising the work process knowledge of workers. The main objective is using work process knowledge for organisational restructuring processes, often without recompense for the workers. On the other side, the article of Rik Huys and Geert Van Hootegem (in this book) depicts a scepticism about the existence of the proclaimed new forms of work organisations. Their chapter argues that the so proclaimed new work forms do not contribute to an improvement in the work process knowledge of workers.

(b) there are no clearly defined game rules. The rules are formed as a result of the game itself and may be modified during the game;
(c) the strategies of the players are characterised by a 'bounded rationality'. This means that the actors are designing their strategies based on limited information;
(d) the interests of the different players are not solely antagonistic. Games based on antagonistic interests between the players can be termed as zero-sum-games, where the benefits of one player are at the expense of one or more other players. However, in organisational games the benefits or non-benefits are not clearly defined. It depends on the evaluation of different players. Normally we are talking about non-zero-sum-games. However, despite this, the different players could design their strategies based on the paradigm of zero-sum-games.

Defining and evaluating power resources also forms part of the game. Every player has 'objective' resources related either to them personally or to their position within the enterprise. Nevertheless, it depends on the interaction between the players if these resources are considered to be sources of power. Based on Bourdieu's capital theory, we distinguish four fields of power resources: a) economic capital; b) cultural capital; c) social capital, and d) symbolic capital. On the level of organisations, a fifth type of capital must be added, which can be called 'organisational capital'. This type of capital refers to the control of crucial nodes of social communication in the organisation (Bourdieu, 1992, 1987, 1979).

Economic capital can be differentiated in economic organisations in relation to:

(a) the contribution of a person or group to the added value produced by an enterprise;
(b) the economic recognition that someone receives regarding their expected or actual work performance.

There are three different forms of cultural capital:

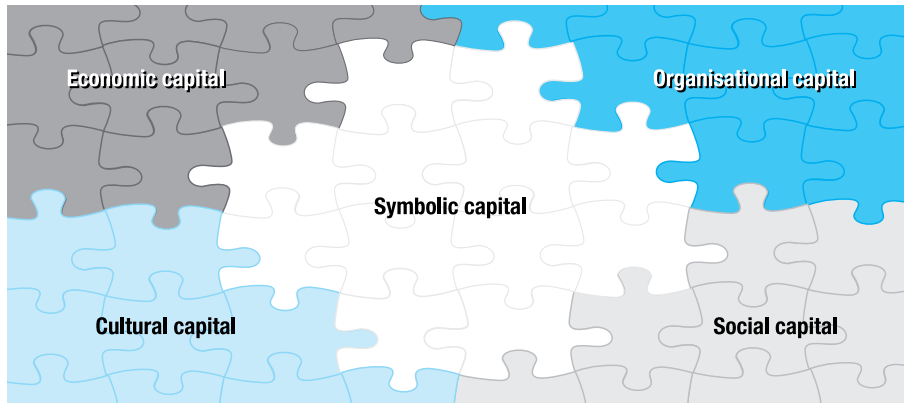
(a) objectified cultural capital, such as books, paintings, artistic objects, but also machines and other types of technological instruments. Within economic organisations, the last type of objectified cultural capital is more important than the others;
(b) cultural capacity, for instance manual and technical abilities as well as other knowledge forms. This type of cultural capital makes reference to knowledge in the broadest sense, which goes beyond academic scholastic knowledge;
(c) institutionalised forms of knowledge such as socially recognised educational and professional titles.

For Bourdieu, social capital refers to the network of social relations within and outside of the organisation, in which someone is integrated and can be used, when a person needs support or help from others. Social capital according to Bourdieu can be differentiated further. On the one hand, the notion of organisational capital refers to formal and structured social relations within and outside an organisation related to the functional position of an individual in the organisation. On the other hand, the notion of social capital (in the strict sense) is limited to the informal social relations of an individual that are considered as relevant by the organisation as a whole, or by the other players involved in the organisational game. Although formal relations per se are important for the organisation, it is necessary that the organisation or its members recognise the value of informal relations.

Through the recognition and positive evaluation of social and organisational relations by the organisation, or its members, the social and organisational capital could lead to a re-evaluation of the other types of capital (see Bourdieu, 1992, p. 64).

Symbolic capital refers to the prestige that is conferred on an individual or a group within an enterprise. This type of capital has its basis in the other capital forms, which are converted into symbolic capital through symbolic recognition. The actors or social groups have 'credits' of prestige. An example of symbolic capital is the symbolic recognition of a cultural capital by means of certificates or professional titles.

Figure 1: **The 'capital' structure of an organisation** ([77])



([77]) In the exposition we have only presented five types of capital, but the capital theory of Bourdieu is open to the inclusion of other capital types. In another project on the evaluation of training programmes, Bruna and Krüger propose six types of capital, adding corporal capital, which makes reference to the health of the person (Bruna and Krüger, 2001).

Organisational transformation based on work process knowledge changes the configuration of the capital structure in the organisation and between the players. Work process knowledge is one of the main factors involved in organisational power games; it has been, and continues to be, one of the power resources of the workers against the impositions of the enterprise and its superiors. Therefore, restructuring processes focusing on work process knowledge are of central importance, with regard to the actual power relations of the enterprise and its industrial relations system.

A critical factor for the success of such strategies is the orientation of the game. The game will develop differently if the actors are playing in accordance with a zero-sum-game or of the non-zero-sum-game.

In this context, the configuration of power games within industrial relations on different levels – national, regional, sector and enterprise – influences the process of organisational restructuring. Below, an example of good practice that supports and promotes strategies of human resource management based on work process knowledge, is provided through analysing the industrial relations system of the Spanish steel industry.

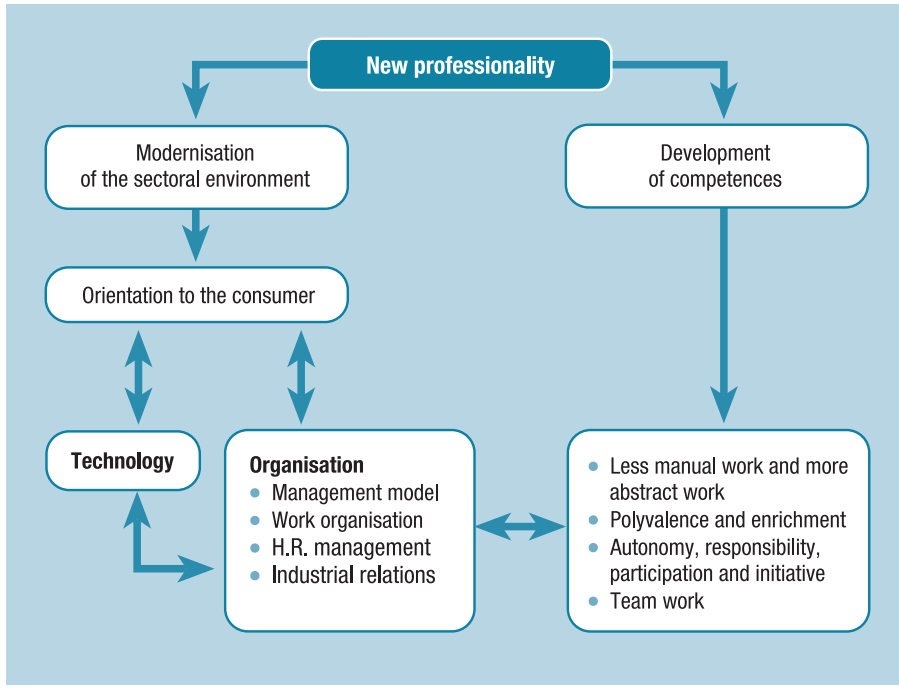
21.3. A sectoral project based on work process knowledge

A project to introduce a 'new professionalism' in restructuring the companies of the steel industry in Spain towards non-Taylorist forms of organisation began in 1996. The project was promoted by the employers' associations in response to the profound changes taking place. The transformation of markets towards trade internationalisation and greater global competitiveness, as well as the widespread introduction of computer technology in production processes, created a need to find ways to adapt to this changing environment. Without expressing this openly, the project was based implicitly on the work process knowledge (WPK) concept.

The design of the project included the following phases. First, a conceptual base was drawn up and an initial definition required of the new professionalism, put forward in terms of organisational changes in the different industrial sectors. Four basic criteria were put forward:

(a) transition from manual to more abstract work;
(b) principles of polyvalence and work enrichment;
(c) wider worker autonomy, responsibility, initiative and participation;
(d) teamwork.

Figure 2: **The change project**



The initial concept was revised following a diagnosis of 10 companies where analysis was made of the work procedures, cognitive structures and existing change projects. The diagnosis also served as a means of preparing companies for change. It was based on a series of interviews with representatives of all companies: senior management, managers of the different functional areas, foremen, members of the company committee and operators.

In the end, the results of the diagnosis – detailed description of the work processes, the strengths and weaknesses of the company and recommendations for action – were presented to both the management and the work councils of the participating companies. Based on this diagnosis, a broad programme of professional training aimed at new professional competences was drawn up. Later on, this training was provided in the different companies of the sector.

The analysis of the companies gave an initial picture of the complex power structure within the companies and made it possible to identify the strengths and weaknesses of the continuous training programme to bring about change in the companies. Interviews with people from different areas

of the company showed that some perceived that, far from favouring their position of power, the project and the expected organisational changes would have the opposite effect.

One indicator of the problems associated with applying WPK concepts is the failure of companies to introduce mechanisms, implicitly based on this concept, such as quality circles, groups for continuous improvement and operative meetings at production level. Although, nearly all of the companies visited experimented with such mechanisms, none were capable of continuing with them for long. A certain degree of continuity has been enjoyed only with regard to the application of project management principles at a management level. At this level of the organisation the traditional principle of management by functions (through the strict compartmentalisation of the management tasks) was replaced by process management. Other mechanisms introduced to improve the involvement of the workers in the organisational processes and to make better use of their knowledge of the work processes, did not bear fruit.

A certain trend may be seen among the companies visited with regard to the failure of the quality circles or groups for improvement, although the measures did bear fruit in the first phase of application. According to the managers and the workers, the latter showed interest in participating in the different measures and produced ideas for improvement. In the medium term, however, all the groups failed due to a lack of feedback from the management. In other words, the failure of the groups was due to the communicative passivity of the management. It became clear that an active communicative attitude from the management in reporting on the receipt of ideas, carrying out ideas or explaining why certain ideas are not carried out is essential to motivate groups to continue. This would have required symbolic medium term recognition in the form of incentives for ideas about improvement, signifying recognition of workers' knowledge of the work processes. Company management boards were not willing to accept this change in the capital structure of the companies, due to the implications this would have for the structure of organisational capital within the companies. Explicit recognition would have meant a change in institutionalised roles within the companies and the reconfiguration of the capital structure. Managers would have been accountable to the workers for their decisions with respect to ideas for improvement and which would have introduced a kind of management based on communicative dialogue, instead of top-down mechanised information flows.

Nevertheless, the diagnosis of the companies indicated that progress has been made in the sector towards new forms of organising work and towards

a new professionalism, not in the broad sense but in a rather limited way regarding two of the four criteria outlined above:

(a) technological change means that work in this industrial branch is less manual and more abstract than before, requiring a change in the competences of workers. However, these changes in competences, which were undertaken through continuous training programmes have, in some cases, caused functional problems in production;

(b) technological change and the need to reduce the number of have compelled companies to introduce principles of polyvalence. However, most companies did not apply this principle universally, but rather created a polyvalent scheme that is capable of working in a broad working area. This entails a new professional category, non-existent in companies until now. Other workers are offered (or in some cases have demanded) a certain polyvalence in their work, but within a far smaller working area. This kind of polyvalence has been generally encouraged by means of a supplement to salaries, regardless of whether or not the workers actually rotate jobs. Most companies have also opted for some measures to enrich work by introducing quality systems to production. Growing customer orientation makes more demands on the quality of products, which cannot be satisfied merely by quality controls carried out in one department of the company. The principle of producing quality, instead of controlling it, must be followed.

In summary the organisational situation in companies in this industrial sector may be considered as neo-Taylorist. When compared with classical Taylorist forms of work, the neo-Taylorist forms are based on workers' knowledge of the procedures, but without recognising it explicitly and without using it as a reason for profoundly reorganising decision-making procedures. Thus, business reality contradicts the business discourse. This is reflected in the views of managers as is illustrated by the following examples:

Manager 1: 'To be able to attain appropriate management levels, to be able to make these changes and to be able to have people suitably prepared, it is necessary to have a series of measures that are not exclusively modifying procedures (setting up a lot of PCs or changing the systems of applications, which is what we are doing). We need to go further into matters concerning the working culture or philosophy of individuals and of the organisation with reference to people.'

Manager 2: 'Another point to mention is the following: in terms of flexibility and mobility, people are not very willing or not very prepared for the changes implied by professionalism, which is already appearing in all the companies.

It is not only that it changes the day-to-day way I do things. It also means that I must be willing to do different things each day, to take on different projects; that is, I need the agility, resilience and mobility that is derived from organisational structures and from areas of the organisational chart, which is no longer like a pyramid. This means coordinating with people in other areas from whom you accept contributions because you are one of their customers.

These two quotes show that management is aware that it is not enough to improve standardised work processes and invest in technology. It is also necessary to change the structure of the company and its processes, resulting in recognising and improving the competences of workers that were not recognised up to now nor integrated in organisational processes.

If the business discourse points to the application of WPK concepts, it may be asked why the reality does not coincide with the discourse. However, it must be pointed out that changes made in the work process have already implied recognition of the workers' knowledge of the work procedures and that the neo-Taylorist use of the cultural capital of the workers by the companies has been a source of tension. The changes introduced in the companies in the sector are based on the application of work process knowledge. In the first instance, the application of WPK as an instrument to restructure work processes is mediated by recognising and exploiting the existing professional competence of the workers. In Spanish companies, with their rigid systems of professional classification, these are competences that have not yet been recognised by company management and are not covered by the collective agreements negotiated at sector or company level. In companies that have already introduced the principles of polyvalence and job enrichment, the subject of worker requalification has been a highly disputed matter. Former tables of worker profiles have become obsolete and company management boards have unilaterally introduced new ways of recognising competences. In one case, for example, workers who agree to work in three different posts receive a bonus on the top of their salary, regardless of whether or not they actually work in the three positions. In another company, the revised salary classification of the workers caused discontent among the staff and also among the company committees, which demanded collective negotiation on such matters. Generally, workers have perceived that the principles of polyvalence and job enrichment (for example introducing quality control in production or the integrating administrative tasks) increase the intensity of the work for which they are not sufficiently compensated financially. In some companies this has been addressed by means of supplements to salaries.

However, the reaction of the workers and their representatives indicate that, in the medium and long term, it will be necessary to review the professional classifications throughout the sector through the formal recognition of the competences related to the knowledge of working and organisational processes.

This discussion on salary categories and the tacit competences of workers is already under way, not only in this sector but also in many others. This change must be seen against the backdrop of a Spanish labour market that has been characterised by:

(a) a dual employment structure characterised by a segment of fixed term contracted elder employees, with a high percentage of lowly qualified employees, and by another segment of young temporary workers with an increasing educational level;
(b) a low level of social recognition of professional titles;
(c) the absence of social recognition of professional competence related to the work process knowledge acquired through experience.

In recent times, recognising work experience and acquired competences has become a central theme in collective negotiations ([78]) in the traditional industrial sectors such as the metal and chemical industries ([79]).

The aforementioned experiences relate to the restructuring activities in two sector-based projects –SIDEPROF y INFOSID – which took WPK as its basis. These two projects were developed successively in the last five years. Two sets of instruments were created which included the materials for several modules of continuous training oriented to reinforce the technical, social and organisational competences of workers, employers and directors. The development of these competences at the vertical and horizontal level of an organisation implies a deep restructuring of the capital structure of the organisation. The transformation of informal work process knowledge into formal competences affects the cultural and organisational capital structure of the enterprise. In media terms this entails symbolic recognition and economic recognition. This means that continuous training programmes in the enterprise will transform the internal capital structure, which will generate pressure to change the labour relations model within the enterprises.

([78]) This is, for example, one of the key elements in the discussion of the recently founded Spanish National Qualification Institute.

([79]) The competence debate has a different impact in different economic sectors. However, this chapter cannot discuss the Spanish industrial system in depth but only make reference to some frontrunners in that debate such as the metal and chemical sectors.

Figure 3: **Model of work organisation**

Tayloristic model	Current model	Future model?
• One worker – one work place • Hierarchical relations • Separation between production and staff functions	• More functional flexibility, but limited to a few persons • Hierarchical principles but much leaner • Separation between production and staff functions but with many exceptions • Integration of quality and work security in the work process	• Functional flexibility • Relations of cooperation among the different levels • Greater links between production and staff functions • Integration of a larger number of functions • Team work

Figure 4: **Model of human resource management (HRM)**

Tayloristic model	Current model	Future model?
• Logic of numerical adaptation • Dominant strategy: early-retirement • Rigid system of professional classification • Limited continuous training projects oriented exclusively to technical competences • Formal continuous training	• Logic of numerical adaptation • Dominant strategy: early-retirement combined with temporary contracts for new workers • Rigid system of professional classification • More continuous training projects oriented to technical competences and work process knowledge • Formal continuous training within centres and enterprises	• Proactive and anticipative logic of HRM • Probable strategy: early-retirement combined with fixed contracts for new workers • Probable strategy: work time reduction for those older than 45 and an increase in the recruitment of new staff • More flexible professional classification systems • Continuous training projects oriented to technical competences and work process knowledge • Continuous training based on work process learning and the transmission of knowledge and experience between older and new workers

The provisional results of the two projects had a considerable impact on the enterprises. The Spanish steel industry is leaving behind the Tayloristic work organisation principles such as:

(a) one person to one local work place;
(b) hierarchical structures;
(c) separation between production and staff functions.

At the end of the 1990s, the steel enterprises are developing other ways of organising their work processes based on the concept of work process knowledge. Nevertheless, it is too soon to classify the new model of work organisation and labour relations. The two European projects are oriented towards the development of a human resource and organisational restructuring programme that ended when the training modules were implemented in the enterprises. So, in the absence of a follow-up project, it is impossible to make a clear statement about the actual model of work organisation and labour relations in the Spanish steel industry. However, in Figures 3 and 4, we can find some tentative indicators of the main changes taking place in the two Spanish steel enterprises.

21.4. Industrial relations and work process knowledge

This brief exposition indicates some of the changes occurring in the Spanish steel industry. The concept of work process knowledge is being used as an instrument to change the enterprise in response to a changing environment, a contrast with former unsuccessful restructuring projects. A key element in the success of the two projects outlined above was the support by the two major trade unions UGT and CCOO on both a sectoral and enterprise level (see Krüger, 2000). The relationship between the employer's association and the trade unions that was implicitly based on the paradigm of non-zero-games (while acknowledging their different interests) has been crucial in promoting the initiatives. Thus, the governance structure for industrial relations in the steel sector was a basic factor for the success of the modernisation process in the enterprises and the sector as a whole.

The innovative methodology that involved players from different levels in bringing in their work process knowledge, made it possible for employees to see the possibilities of winning in this new power game. Within the enterprise, the project team not only held discussions with the management and the works council but also spoke to foremen and workers. On the sector level, representatives of the trade unions were actively involved in the project

from the start, from design to evaluation of the results. They constantly informed their representative in the enterprises about the status of the project, its products and results.

This innovative structure of the projects opened the way to change the orientation of the power games within the enterprises. The former dominant strategies of the zero-sum-games were substituted by strategies based on the non-zero-sum-game. ([80]) However, it should be pointed out that agreement between the different social actors (representatives of the entrepreneur association, trade unions, managers and representative of works' councils) that the projects had been a success, the end result cannot be known without an empirical study of the transformations made by the Spanish steel enterprises in the last five years.

Another important factor to be considered is that only a reduced number of steel enterprises survived the conversion process in Spain. In fact, the Spanish sector is dominated by one big international enterprise. There are approximately five other large enterprises with more then 1 000 employees and a number of medium and small enterprises. These enterprises are concentrated in four autonomous regions (Asturias, the Basque region, Valencia and Catalonia). That means that one is dealing with an industrial sector with a small number of enterprises and a manageable industrial relations structure. This reduced structural complexity, and the proximity of the representative of the social actors to the enterprises, have been crucial factors in opening the way for a sector-wide modernisation initiative.

These examples show that at least advanced concepts like new professionalism and work process knowledge can form part of the discourse of modern management concepts. At the same time, the strength of the resistance to change and the risks involved in using these concepts should not be underestimated. These obstacles can be overcome and the risks can be reduced by the involvement of the social actors and the use of structured dialogue to assure that the power game is played on the basis of the non-zero-sum-paradigm. The definition of rules based on the principle of the non-zero-sum-game enables each actor to evaluate the modification in his capital structure and the capital structure of the organisation. In this sense, it is possible for all actors to win in the restructuring power game. Nevertheless, this does not mean that the process occurs without conflicts. On the contrary, this type of modernisation process is full of conflicts that endanger the success of the whole process. However, the change from a sum-zero-game to a non-zero-game increases the chance of resolving such conflicts.

([80]) This does not imply that the games were played without conflicts. On the contrary, there were many conflict points.

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European perspectives on learning at work:

the acquisition of work process knowledge

Martin Fischer
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(editors)

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Work process knowledge provides a framework for understanding the complex knowledge required by employees in modern organisations. This knowledge is necessary because of the introduction of more flexible ways of working and learning including new technology.

The concept of work process knowledge enables us to resolve contradictions between theory and practice and indeed contradictions within work itself. It also provides a framework for forging partnerships between education and training institutions concerned with formal learning and enterprises focusing on work-based learning

This book brings us up to date with current debates about work process knowledge, through presenting the research findings of experts from nine European countries in the fields of learning theory, knowledge development and education and training. Ways of teaching and learning theoretical knowledge that can have a greater impact on professional practice are examined in this book.

The book is of interest to researchers, university lecturers, teachers and trainers, curriculum designers, students and policy makers and managers who wish to understand the nature of learning in modern enterprises.

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