



The structuration of organizational learning

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ABSTRACT

Although it is currently common to speak of organizational learning, this notion is still surrounded by conceptual confusion. It is unclear how notions like learning, knowledge and cognitive activities can be applied to organizations. Some authors have tried to unravel the conceptual and ontological problems by giving an account of the role of individuals in organizational learning. However, this has not yet led to an agreed upon analysis. In this article we use structuration theory to overcome the dualism of individual and organization in organizational learning. We support, illustrate and elaborate our structurationist perspective by an ethnographic and historical study of an industrial research laboratory. We show how organizational learning evolves from distributed social practices, creatively realized by knowledgeable individuals, and illustrate how these practices are enabled and constrained by existing structures.

KEYWORDS

individual learning ■ industrial research ■ organizational learning
■ structuration theory

Introduction

The concept of organizational learning has been introduced in the field of organization studies in the early work of March and Simon (1958) and Cyert and March (1963). Interest in organizational learning has especially grown since managers were told that our economy has turned into a knowledge

economy (Drucker, 1993) and that knowledge and learning are of prime importance for creating and sustaining competitive advantage (Nonaka, 1994). Organizational learning is the vehicle for utilizing past experiences, adapting to environmental changes and enabling future options. Since the early discussions of organizational learning, numerous authors have tried to illuminate the concept (for example Cangelosi & Dill, 1965; Argyris & Schön, 1978; Duncan & Weiss, 1979; Hedberg, 1981; Levitt & March, 1988; Brown & Duguid, 1991; Dodgson, 1993; Fiol, 1994; Weick & Westley, 1996; Crossan et al., 1999; Gherardi & Nicolini, 2001; Vince, 2001). These and other authors have drawn inspiration from a variety of perspectives, including psychology, management science, production management, organization theory, evolutionary economics and innovation management. Each of these perspectives has resulted in valuable insights in the conditions, dynamics or outcomes of organizational learning (Easterby-Smith, 1997). Despite the presumed omnipresence of organizational learning, this notion is still surrounded by conceptual confusion.

One central point of debate is how the concept of learning, often associated with knowledge, cognition and mental activities, can be applied to organizations. According to some authors this necessarily implies committing the ontological fallacies of reification and anthropomorphization, i.e. considering organizations as independent entities and ascribing human-like qualities to them (Berger & Luckmann, 1966). Therefore it has been argued that organizational learning should be interpreted as a metaphor in order to avoid these fallacies (Argyris & Schön, 1978; Dodgson, 1993; Gherardi & Nicolini, 2001). Cook and Yanow (1993) and Weick and Westley (1996) propose another interpretation. According to them a cognitivist perspective on organizational learning either takes the organization as an independent cognitive entity, which can only be interpreted as a metaphor, or reduces organizational learning to individual learning in an organizational context. They propose that organizational learning should be interpreted in terms more appropriate to organizations such as changing an organizational culture. Both options – calling organizational learning a metaphor and abandoning the concepts of knowledge and cognition in favor of organizational culture – try to save the concept of organizational learning by abandoning some of its traditional connotations. A third option is to stick to a focus on knowledge and cognition, but try to avoid the ontological fallacies by offering an adequate account of the role of individuals in organizational learning. It is this strategy that we will pursue in this article. However, our tactics will differ from other attempts in this direction.

To most authors it seems obvious that individuals play an important role in organizational learning. Individuals are seen as the agents or instruments of

learning (Cyert & March, 1963; Argyris & Schön, 1978; Hedberg, 1981; Shrivastava, 1983). For this reason, the relationship between individual learning and organizational learning has been discussed from early works on organization learning, such as those of Cangelosi and Dill (1965) and Argyris and Schön (1978) onwards to recent publications like Crossan et al. (1999) and Vince (2001). Several answers to the question of how organizational learning relates to individual learning have been given.

A first answer is to equate organizational learning with learning by individuals in organizations (Huber, 1991). This seems to be implied by Simon's statement that 'all learning takes place inside individual human heads' (1991: 125). An alternative version of this answer is to restrict organizational learning to learning by key individuals or learning by the dominant coalition (Dodgson, 1993). But many other authors argue that organizational learning is more than a simple aggregation of individual learning (Duncan & Weiss, 1979; Fiol & Lyles, 1985; Crossan et al., 1999; Vince, 2001). Argyris and Schön (1978) consider individual learning as a necessary but insufficient condition for organizational learning. A corresponding solution is to conceptualize organizational learning as individual learning plus the fulfillment of some extra condition. A common idea is that organizational learning involves the creation of knowledge by individuals and the subsequent transfer of gained knowledge to others (Shrivastava, 1983; Kim, 1993; Nonaka, 1994). Some authors add that what has been learned should be made independent of any individual by embedding it in organizational memory or institutionalizing it into systems, structures, strategy, routines and prescribed practices (Argyris & Schön, 1978; Hedberg, 1981; Crossan et al., 1999). Finally, Lyles and Schwenk (1992) and Boje (1994) argue that the typical feature of organizational learning lies in the working out of controversies. Some of these ideas are complementary, others contradict each other. We believe that each of the mentioned authors has made valuable remarks on the differences and connections between organizational and individual learning, but none of them has sketched a coherent and adequate picture of it. Likewise, Crossan et al. (1999) conclude in a recent summary of some major accounts of organizational learning that none of them has satisfactorily dealt with the different levels that play a role in organizational learning. And Nicolini and Mezner (1995: 730) stated that the relationship between individual learning and organizational learning is far from clear and that more work, both empirically and theoretically, is necessary.

One major problem is that analyses often start by opposing individual learning and organizational learning and afterwards try to reconcile them. In this article we will argue that that is an inadequate starting point. Existing

literature suggests that organizational learning is an inherently social process (e.g. Brown & Duguid, 1991; Gherardi, 2000; Gherardi & Nicolini, 2001). This is also indicated by the attention given to the role of social phenomena like consensus formation and power (e.g. Boje, 1994; Vince, 2001) and will further be argued for in this article. In our opinion, one of the reasons for the lack of a coherent and adequate account of the role of individuals in organizational learning, is the lack of grounding in genuine social theory. Although Gherardi and Nicolini (2001) were able to trace sociological roots in publications on organizational learning, social theories are seldom taken as the starting point of studies of organizational learning (exceptions are Nicolini & Meznar, 1995; Araujo, 1998; Gherardi & Nicolini, 2000). Most inspiration in the theory of organizational learning seems to be derived from theories of individual learning. Several authors, for example Dodgson (1993), would like to connect organization theory and psychology, in order to apply concepts developed for individuals to organizations as well as to discuss the learning of individuals in an organizational context. Above we noted that the direct application of individual learning concepts to organizations is often intended as a metaphor. Morgan (1997) showed that such a use of metaphors plays a generative role in the development of knowledge about organizations. Metaphors may inspire to see similarities between objects, phenomena or processes. Saying metaphorically that a particular man is a lion, points at his lion-like characteristics. However, as Morgan (1997: 5) notes, the use of metaphors may make us blind to differences. There is no reason to assume that organizational learning processes are to a large extent like individual learning processes. Building theories of organizational learning based on theories of individual learning alone, makes it hard to capture the social nature of organizational learning.

Our contribution is intended to be as follows. In this article a coherent account of the role of individuals in organizational learning is developed. This account neither neglects the individual or the organizational level nor reduces organizational learning to one of those levels. Moreover, it is able to integrate previous insights. Further, we want to defend the claim that organizations can learn, without having to take recourse to calling it a metaphor or committing the fallacies of reification and anthropomorphization. Our analysis of organizational learning will draw upon structuration theory as developed by Giddens (1976, 1979, 1984). There are four reasons why structuration theory is a particularly useful starting point when discussing the relationship between individual and organizational learning. In the first place, the relationship between individual and collective phenomena is at the heart of structuration theory. Second, Giddens puts the knowledgeability of actors on the front-stage of his theory. This makes his theory

useful for the analysis of knowledge and learning in organizations. Third, Giddens' analysis of structure enables addressing the interplay of cognition, power, economic resources and norms. The fourth reason is that the structuration theory sketches a dynamic picture of social reality that is well suited to the dynamic nature of the phenomenon under study. In the second part of this article, we illustrate, support and elaborate the use of a structurationist model of organizational learning by examples drawn from an ethnographic and a historical study of an industrial research laboratory.

Structuration theory

Structuration theory (Giddens, 1976, 1979, 1984) is an ontology of social reality that attempts to overcome dualisms that have become deeply entrenched within social theory: subjectivism versus objectivism, individual versus society and social atomism versus holism. Giddens developed structuration theory while critically reflecting upon social theories focusing predominantly on structures, such as Marxism and structural functionalism (e.g. Merton and Parsons), and interpretive sociologies such as ethnomethodology (e.g. Garfinkel), symbolical interactionism (e.g. Mead) and phenomenology (e.g. Schutz). Giddens claims to have incorporated important insights from these theoretical streams, while abandoning their drawbacks (Giddens, 1984: xxii). Structuration theory is not without its critics (e.g. Held & Thompson, 1989; Mestrovic, 1998). For example, the more post-modernist inspired Mestrovic (1998) blames Giddens for overemphasizing knowledge and skills, and neglecting emotions. However, that is not a serious problem for our current undertaking, since we are predominantly interested in knowledge and cognition in our re-interpretation of organizational learning. Over the last years structuration theory has received increasing attention within the field of organization studies (see, for example, Orlikowski, 1992; Barley & Tolbert, 1997).

Structuration theory reconceptualizes the dualism of individual versus society as the duality of agency and structure. Agency and structure, the subjective and objective sides of social reality, are considered to be inseparable. They meet each other in recurring social practices. To develop this thesis, Giddens had to rework both the concept of social structure and that of the acting individual.

Social systems have structural properties. A social system exists of the reproduced relations between actors or collectivities, organized as regular social practices. This makes practices the primary domain of the social sciences (Giddens, 1984: 2). Practices are recurring and regularized actions of

individuals situated within a social system and meanwhile creating and recreating that system (Giddens, 1976: 75). Structure exists as a property of social practices. Social structure has often been seen as a stable, constraining phenomenon, like the skeleton within a body or the walls of a building. Giddens sketches a dynamic picture of structure, as both outcome and resource for action, both constraining and enabling. According to structuration theory, structure consists of rules and resources. Giddens distinguishes two types of rules: interpretative and normative. Interpretative rules govern the way actors interpret the world in which they live. They constitute the cognitive aspect of social structure. Normative rules regulate the legitimization of actions. Resources fall apart into authoritative resources (power relationships) and economic resources. This interpretation of structure is different from and broader than the way structure is commonly used in organization theory. For example, it encompasses what is generally taken to be organizational culture. One of the main concepts of structuration theory is the 'duality of structure'. This means that social structures are both the outcome and the very medium of social interaction (Giddens, 1976: 121). Structures are outcomes in the sense that they are produced and reproduced in interaction. Structure is a resource for interaction in the sense that actors do not construct social reality from scratch, but draw upon pre-existing structural elements in their actions. The existing rules and resources make human actions possible. On the other hand, however, human action is constrained by existing structures. Structure is both enabling and constraining.

In order to draw upon pre-existing rules and resources, and therewith reproduce them, actors have to be 'knowledgeable' of them. 'Knowledgeability' refers to the knowledge individuals have of the circumstances of their actions and the rules they follow. Some of this knowledge is propositional in character, but most of it is carried in what Giddens calls practical consciousness. Practical consciousness refers to what actors believe about their context and the conditions of their actions, but are unable to express discursively (Giddens, 1984: 375).

In addition to a redefinition of social structure, structuration theory implies that the notion of agency, of the individual acting person, has to be reworked too. The individual is not a rock bottom given (Giddens, 1984: 215). Individuals necessarily draw upon pre-existing rules and resources. Their practices are possible because of a pre-existing structure. This entails a 'decentering of the subject'. It does not imply that actors are slaves of existing structures. They have the power to 'act otherwise', the possibility to say 'no' (Giddens, 1984: 12). This implies that the means whereby systems are reproduced, the interactions of knowledgeable actors, contain within them the seeds of change. However, ascribing knowledgeability to actors

does not imply that they are omniscient about their motives, conditions and consequences of their actions. Giddens speaks of 'unacknowledged preconditions' and 'unintended consequences of action', which form the bounds of knowledgeability (1984: 294). Both play an important role in the production and reproduction of structure. This construction and reconstruction of structure by the interaction of knowledgeable actors is called 'structuration'.

Giddens also addresses the question how we should interpret our talking about an organization's actions. We speak of an organization firing one of its employees, selling products and taking over another organization. Does this mean that organizations have agency, i.e. the possibility to causally intervene in the world? When we zoom in, we will find people filling out forms, packaging products, signing contracts, etc. According to structuration theory, organizations are nothing more than the regularized practices of individuals. Organizations differ from other social systems in the degree in which there is an emphasis on the reflexive regulation of system reproduction. The individual actors are the agents of these practices; they are the ones who are able to make a difference. Organizations therefore do not have agency (Giddens, 1984: 220). The apparent ability of organizations to act consists of the agency of its constituent members. Therefore, for example, the statement 'the government has decided . . .' is shorthand for a statement about actions of individuals. Sometimes the shorthand statement can be useful. But when we want to look inside an organization, we will have to find out how individual practices contribute to what can be described as organizational action.

Toward a structurationist model of organizational learning

In this article we follow Argyris and Schön (1978), Duncan and Weiss (1979), Shrivastava (1983) and Nicolini and Meznar (1995) and consider organizational learning to be the increase or development of organizational knowledge. We take organizational knowledge to be knowledge that is held by one or more organization members, accepted as knowledge and applicable in organizational activities (Duncan & Weiss, 1979). The identification of organizational learning as the development of organizational knowledge, implies that we distance ourselves from a strict behaviorist interpretation of learning, in which learning consists of changes in (potential) behavior. But our interpretation is compatible with an intermediate interpretation of learning that is frequently advocated in the literature on organizational learning, stating that learning consists of a change in the range of (potential) behaviors, but only so far as this change is brought about by a change in knowledge

(Shrivastava, 1983; Huber, 1991; Dodgson, 1993; Crossan et al., 1999), since the requirement that organizational knowledge is applicable in organizational activities, implies that the development of organizational knowledge leads to a (potential) change in organizational activities. This interpretation of organizational knowledge implies that not all knowledge that organization members have, or assume to have, is organizational knowledge, because much of that knowledge cannot be used in organizational activities. Furthermore, we do not reserve the term organizational knowledge for knowledge shared by all members of an organization. Members of an organization execute different tasks and will develop their knowledge in relation to their tasks (Tsoukas, 1996). In most organizations, especially the larger ones, only a part of the available knowledge will be shared by all members. Organizational knowledge is distributed in character (Hutchins, 1995; Tsoukas, 1996). Concluding, based on these earlier works, we define organizational learning as the development of knowledge held by organizational members, that is being accepted as knowledge and is applicable in organizational activities, therewith implying a (potential) change in those activities.

We extend this interpretation of organizational learning by building upon structuration theory. According to structuration theory, social systems consist in recurring practices. Therefore, we assume that changes in organizational activities consist of changes in the recurring practices executed by members of an organization. Moreover, according to structuration theory, changes in practices are brought about from within practices. Thus, based on structuration theory, we hypothesize that the process of organizational learning is realized in organizational practices, as a specific form of structuration. By focusing on practices, a structurationist perspective on organizational learning fits with the growing attention for practice-based learning and knowing (e.g. Lave & Wenger, 1991; Engeström & Middleton, 1996; Gherardi, 2000). Gherardi conceives learning 'as an inseparable and integral part of social practices' (2000: 1060). Lave and Wenger (1991) explain how learning processes of apprentices do not consist in the transfer and absorption of explicit knowledge, but in the legitimate peripheral participation in the practices of a community. Furthermore, structuration theory suggests that we should take into account the dual nature of practices. One side of this dual nature is that these practices are always part of a social system. They are undertaken within a structured social context, which is both enabling and constraining. Practices are not random activities, but socially situated and more or less routinized activities. By emphasizing the structuredness of practices, structuration theory moves beyond an earlier theory on institutionalization like the social constructivism of Berger and Luckmann (1966). The other side of the dual nature is that practices are carried out by

knowledgeable individuals. This makes practices the phenomenon of interest when trying to come to grips with the role of individuals in organizational learning. A structurationist account of organizational learning should focus on recurring practices in which knowledge is developed that can be applied in organizational practices. Figure 1 represents this rudimentary structurationist account of organizational learning.

In the second half of this article we will support and elaborate this structurationist perspective and illustrate how it can illuminate processes of organizational learning. For that purpose we will use an ethnographic study of an industrial research laboratory, supported by a historical analysis of the same laboratory. This empirical research will be introduced first.

Empirical research

An industrial research laboratory can be seen as an institution specialized in the creation of organizational knowledge. Our studies have focused on the Philips Natuurkundig Laboratorium (Philips Physics Laboratory). Royal Philips Electronics is one of the world's biggest electronics companies, with sales of EUR 37.9 billion in 2000. Its headquarters are currently located in Amsterdam (the Netherlands), but its 192,000 employees are distributed over 60 countries. Philips' product divisions are active in the areas of lighting, consumer electronics, domestic appliances, components, semiconductors and medical systems. The Philips Natuurkundig Laboratorium, commonly abbreviated as NatLab, was founded in 1914. At that moment Philips was predominantly active in the production of light bulbs. The first activities of the NatLab consisted of trouble shooting and testing incandescent lamps. In the 1920s Philips employed a diversification strategy, in which the NatLab played an

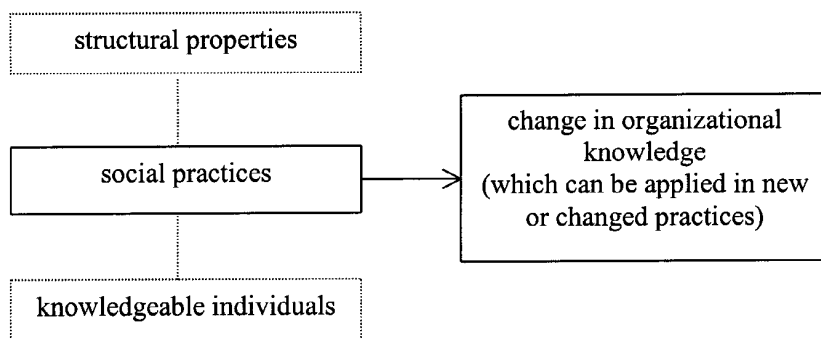


Figure 1 Outline of a structurationist model of organizational learning

important supporting role. Nowadays the NatLab is one of the largest industrial research laboratories in the world, having a staff of about 1700 people. From its inception it has been located in Eindhoven (the Netherlands).

One of the authors conducted an in-depth ethnographic field study within a research group at the NatLab. This group was called 'Materials Mechanics and Heat Transfer' (MMHT) and consisted of 25 members at the time of study. All but three of these group members were men, including the group leader. Most of the group members were Dutch. Four were from other countries. The field study took place between April and December 1999. Data were collected by observing, tape-recording and discussing interactions between researchers, interviewing organization members and studying documents. These data were analyzed using the grounded theory approach, a systematic approach for the development of theory out of qualitative data (Glaser & Strauss, 1967; Strauss & Corbin, 1990). However, existing theory, in this case structuration theory, played a more important role in analysis than is advocated by grounded theory guidelines. Analytical efforts are focused predominantly on one particular episode of organizational learning in this article. However, the episode does not stand out as dissimilar from other episodes. This analytical strategy is employed because it reveals the fine texture of practices (see, for example, Engeström & Middleton, 1996). The particular episode that is described and analyzed occurred when one of the participants was shadowed for about two weeks, implying that many of the relevant actions and interactions were observed directly.

In addition to the ethnographic study, another author studied the history of the NatLab from 1914 to 1946, based on an elaborated investigation of archival data and oral histories. These included annual reports, correspondence, minutes of meetings, publications in the *Philips Technical Review*, historical interviews with NatLab members and earlier publications on the history of Philips. The complete results of this historical study are presented elsewhere. The historical and ethnographic studies differ in method and time frame, but addressed comparable questions. Processes of organizational learning are not a recent phenomenon, as Easterby-Smith (1997) emphasized. This justifies the use of historical data and makes the combination with an ethnographic study of the same organization fruitful for the theoretical analysis presented in this article.

Organizational learning practices

In the morning of Friday 25 June 1999, Jason and Rick walk from their rooms to a clean room in another building where Warren and Bruce are

waiting to execute a series of experiments with them.¹ In order to understand this particular meeting, it is necessary to provide some background on these persons and the practices they are engaged in.

Warren and Bruce are operators of a small pilot line for the production a particular type of PolyLED displays. Since the discovery of the electro-luminescent characteristics of the polymer PPV at Cambridge University in 1989, many industrial research laboratories and universities started working on the development of polymer-based displays. These are often called PolyLEDs (polymer light emitting diodes). Within Philips Research, 'PolyLED' is a large project as well (see Visser, 1998). An early attempt to commercialize a PolyLED-based technology is the production of polymer backlights. These are small, monochromic displays, for example to be used in mobile phones. Warren and Bruce operate the equipment for the spin-coating of the polymer layers for these backlights. Spin-coating consists in dropping a coating liquid (such as a polymer in a solvent) on a flat surface, spinning this surface at a high frequency and evaporating the solvent. This coating technique is able to yield homogeneous layers. However, Warren and Bruce are unable to control the thickness of the coating layer. Moreover, two types of irregularities keep appearing: the so-called 'beach-effect' and the 'corner-effect'.²

At the beginning of June, Warren and Bruce had informed Jason and Rick about these problems. Jason and Rick are both members of the 'coating-cluster' (comprising six researchers and several projects), which is part of the MMHT-group. Rick is a young research engineer, previously assisting David, now assisting Jason. Jason is a research scientist, who holds a PhD in physics. Among other tasks, he is the leader of a small project providing research support for the spin-coating of polymer displays. In a recent meeting of the coating-cluster, Jason had taken over the position of David in this particular project. In reaction to the problems of the operators, the researchers sent some of their research-reports, containing theoretical insights on spin-coating. However, David, Rick and Jason were surprised to hear that the operators did not use the theories to tackle their problems. Rick says to Jason:

I think it is very strange . . . I have sent a number of reports to Warren, but they still have the peculiar habit of saying 'we want to decrease the thickness of the layer, so we use [strategy x]'. But – that's what David said as well – we have been nagging for three weeks 'there are limits to that strategy'.

Therefore, Jason and Rick have thought up two series of experiments,

intended to show the applicability of their theory, refine their insights and convince the engineers.

In the meeting on 25 June, Jason and Rick want to show that the required thickness can be reached by two alternative strategies, based upon other values of spin-coating parameters such as acceleration, speed and duration. They expect that both strategies will decrease the beach-effects as well, but they do not expect to solve the corner-effects today. In the clean room, Warren and Bruce program their machines with the parameters given by Jason and Rick, based upon the first alternative strategy, and spin a first series of discs. To investigate for irregularities, the coated discs are inspected by the naked eye. The operators and the researchers tell each other what they see. The operators measure the thickness of the coated layers by making scratches and observing the resulting scratches under a very strong microscope – a piece of equipment Jason and Rick are unfamiliar with. Unfortunately, the first series of experiments does not yield the expected and desired results.

Since the first alternative strategy proved to be unsuccessful, the researchers want to pursue the second alternative strategy in a second series of experiments in the afternoon. After lunch, Rick goes to Alice, a research engineer of a group specialized in polymers, to get a new bottle of polymer. In the afternoon, an experiment executed according to the second alternative strategy is followed with much curiosity. The disc appears to have the right thickness and to be free of both the beach-effect and the corner-effect (which they had not expected to solve today). The operators and the researchers react enthusiastically. They spin a second disc in the same way – with the same successful result – to show others. Together they drink a cup of coffee. A leader of the PolyLED project joins them, and they tell him about the results. Warren and Bruce ask the researchers for a report on the experiments and their implications, ‘written in Dutch, on the level of secondary vocational education’. The researchers return satisfied to their own building and have a conversation afterwards with their colleagues, including David. We will return to this conversation later.

A number of conclusions can be drawn about this episode. A first thing to note is that organizational learning has occurred. New knowledge about the spin-coating of polymer displays is developed that can be applied by Warren, Bruce and others in the further product development practices of the PolyLED project. This was not reached by just transferring a research report. Though the researchers initially thought that their reports contained the necessary answers, actual practice turned out to be more complicated. To be applicable in organizational practices, knowledge has to become tailored to and situated in the practices in which it will be applied. This

supports the view of those authors emphasizing the situated and practice-based nature of knowing and learning (e.g. Lave & Wenger, 1991; Gherardi, 2000). Moreover, it can be noted that a range of different practices contributed to this learning process. These included constructing hypotheses, preparing materials, executing experiments, observing, measuring, arguing, calculating, drawing conclusions and writing up results.

These practices were part of the work of several persons and stretched out over time and physical and social space. Though it is hard to pinpoint a starting point of a learning process, we may say that this particular process took off with the recognition of problems by the operators of the pilot production line. Given the existing involvement of the research group in the PolyLED project, these operators could call upon the researchers for assistance. At that moment this learning process became stretched over members of two different communities-of-practice (Lave & Wenger, 1991). Both communities are involved in spin-coating, but their knowledges, languages, artifacts and objectives differ. The researchers hoped that their research reports could have functioned as boundary objects (Star & Griesemer, 1989), spanning the boundary between the community of researchers and the community of the operators, but that did not succeed. Therefore the researchers became further involved. Crossing boundaries between communities poses serious difficulties, but enabled the learning processes of the researchers and the operators as well.

Not only were different practices interwoven in this learning process, learning practices were part of several interwoven learning processes as well. In the above description we focused on the solving of the spin-coating problems. However, for the researchers this was a part of another learning process, which was not finished at all. Following their experiments in the clean room, Jason and Rick returned to their rooms in the afternoon. Together they visited David and told him proudly that they had solved the engineers' problems and that they had even solved the corner-effect. However, both of the irregularities did not behave in correspondence to Jason's theory. David responds: 'If I understand it correctly, you have solved the problem but do not know how you did it.' David goes on to propose an explanation for the anomalous findings, but retracts it as incorrect immediately. The theoretical learning journey has to proceed further. The researchers' goal is to develop more general technical capabilities, which can be applied in a wide diversity of situations. This requires the development of theory explaining why a particular solution worked for a particular problem, like David asked for. Further involvement in other problem-solving practices with regard to the spin-coating of PolyLEDs, or the spin-coating of television screens, in which the researchers are involved as well, may enable the

elaboration of theoretical understanding. Researchers at the NatLab often think of particular projects in which their assistance is required as 'carriers'. Specific projects provide temporarily financial support and legitimation to work on a subject – they carry their research efforts for a while. The work on the spin-coating problems faced by the PolyLED operators was valuable in its own right, but it was also just a step in the researchers' learning process of articulating more fundamental theories.

A third learning process can be recognized in this particular episode. The researchers and the engineers are learning to cooperate. As David noted after expressing the frustration that the engineers did not follow their reports: 'He is an operator, not a research engineer or scientist. We have to learn how to deal with these people.' This particular episode emphasized for Jason and Rick that the transfer of theoretical reports does not suffice. Recognizing the value of practice-based knowing, Jason remarked to Rick: 'You have to listen carefully to operators like Bruce and Warren. They are often right.'

Structure and agency in organizational learning

In the introduction of our structurationist model of organizational learning, we hypothesized that activities making up an organizational learning process would be enabled and constrained by existing structures. The practices described in the previous section do not have a random nature, but have recurring and structural characteristics. The enabling effect of existing structures was clearly noticeable when Jason took over the position of David in the spin-coating project. Jason did not have to start all over again. He could draw upon existing structures.

According to structuration theory, structure consists of rules and resources. A resource that influenced this action is the possession of the spin-coating equipment, a necessary condition for these experiments. The researchers also own spin-coating equipment themselves, but those machines do not have the right specifications for these experiments. Interpretative and normative rules enabled and constrained practices as well. Interpretative rules are the means by which individuals make sense of the world surrounding them. They comprise the knowledge held by members of an organization. In the story of the spin-coating experiments, both the researchers and the technicians draw upon their knowledge. The experiments and measurements of the technicians are enabled by their knowledge of the machines and the microscope. When they were given the spin-coating parameters required for the experiments, they could routinely execute them. The researchers used their theories to construct hypotheses on the required speed, duration and

acceleration. However, the researchers' focus on the construction of abstract theory constrained them in providing usable instructions. 'Our analytical work has a certain elegance, but it is sometimes a little too far away from reality', said Jason. On the other hand, the practical outlook of the operators constrained them in using the abstract theory. The difference between the interpretative rules employed by the researchers and the operators shows that structures should not be considered as monolithic wholes. Organization members that are part of different communities have different rules and resources to draw upon. Nevertheless, some rules may span boundaries. This holds for the normative rules enabling and constraining the support that the coating researchers provide to the PolyLED project. Given that a small research project on the coating of PolyLEDs was agreed upon for 1999 – partly paid for by internal clients, partly from a company research budget – the operators could expect support from the researchers. However, the form this support takes is not clear-cut – the rules leave room for interpretation and negotiation. The leaders of development projects often require quick solutions, with a high degree of certainty and often for short-term problems. Jason remarked:

We as researchers have to tie ourselves to a planning. It is crazy how quick they expect results. You saw on Friday how badly we understand the phenomena, but still we have to deliver. (. . .) We offer a 50 percent chance on a good solution, but that does not always satisfy the internal clients.

Researchers try to prevent becoming too deeply involved in the day-to-day problems of development projects, since they are oriented toward the longer-term goal of developing basic capabilities. Normative rules do not need to be formalized. They encompass much of what is often described as organizational culture in the field of organization studies. For example, the researchers were very satisfied with their informal interactions. Members of the coating-cluster keep each other informed about the progress of their research and try to contribute to each other's projects as well. This was visible when Jason visited David right after their experiments to share the results with him and to gain feedback. Such an informal norm is also enforced informally. At lunch one researcher told the story of another researcher at the NatLab who was unwilling to share his knowledge with others. This was sanctioned by ridiculing this behavior.

In the preceding paragraph we explained that organizational learning practices exhibit structural properties, but we also hinted at the fact that they are not determined by structures. The realization of practices is not a

mindless automaticity, but a skillful realization. Even quite routinized practices, such as the execution of measurements, are not fully predetermined. Deborah, a research engineer of the MMHT-group, pointed at a stepwise instruction hanging on the wall near an experimental set-up that she had to operate, and referred to herself as 'a monkey who has learned a trick'. Being one of the lowest educated employees of the group, she identified herself with the structural characteristics of laboratory work. However, others disputed this self-image. Chris, an older research engineer, said that even when executing a large series of identical experiments, one has to be knowledgeable about what one is doing. Repeating experiments provides the opportunity to improve the measurements: 'Someone with experience can make a machine ten times more precise.' Taken together, the remarks of Deborah and Chris point at the co-presence of structure and agency. The role of individual researchers is most decisive when creativity is required. This was the case when the researchers faced the unexpected experimental outcomes and started searching for an explanation for those anomalous results. Existing theory and interpretative schemes did not suffice at that moment and needed to be rejected or extended in new directions.

When analyzing organizational learning as a structuration process, we should not only focus on the ways in which structures enable and constrain learning practices, but also on the way in which the same practices recreate and change structural characteristics. For example, for the operators it was important to tell about the successful experimental results to one of their project leaders. They even spin-coated a second disc to show him. His approval of the results provided legitimization for changing their spin-coating practices. The practices making up learning processes are reinforced and restructured over time. The episode we focused on reinforced several structural characteristics by following existing rules, but it also contained the seeds for change. For example, the reflections of Jason and Rick on their interactions with the operators, described above, could be the onset of a restructuring of organizational learning processes.

It is especially by historical investigations that we are able to show the dynamic features of social structures for organizational learning (e.g. Varma, 2000). The history of the NatLab shows various developments in the way organizational learning is organized. Founding the NatLab was itself a move structuring learning processes. It meant that problem solving around the production of incandescent lamps started involving a separate research organization. Gilles Holst became director of the NatLab at its inception in 1914. Holst's idea about what an industrial laboratory's task had to be, becomes clear in a proposal in which he stated that 'an industrial laboratory is a facility where problems relevant to the industry are investigated with the

aid of scientific methods and instruments'. Holst proved the business value of industrial research by carefully embedding it in the Philips company as a whole. In the 1930s, Holst attempted to formalize his organization in order to cope with its expansion. For example, research activities became structured into groups, formal protocols were developed prescribing the stages that the development of a new radio set should pass and a protocol was introduced for submitting patent applications. Nevertheless, he wanted to organize the contacts within the NatLab as informally as possible. Holst also stimulated his researchers to publish scientific articles in external journals and to participate in the international colloquia held at the NatLab.

Holst's successor was Casimir, who directed the NatLab from 1946 to 1972. Casimir continued to encourage researchers to keep in touch with scientists all over the world. In doing so, he stimulated his researchers in their creativity, without the burden of too much bureaucracy. In this period the Philips Research Department became rather separated from the rest of the company. In this period there was no project-wise budgeting at the NatLab. Casimir was against this as he feared that this would be an obstacle for the research freedom that was necessary for doing 'fundamental' research.

In 1972 Pannenberg succeeded Casimir as the research representative in the company's Board of Management. In the same year he gave a presentation for the NatLab management in which he explained his view on the developments of research within Philips. In the first place his impression was that there was now, more than in the time of Holst, a lot of scientific knowledge outside industries that should be 'translated' by industrial research organizations for use within their companies. He also had the opinion that the knowledge that was to be developed in these research organizations was of a less 'basic' character than before. At the same time he insisted on a decreasing attention to 'technology push'. Instead, he pleaded for an increasing attention to 'market pull'. In the beginning of the 1990s, it was decided that the majority of research projects have to be financed by product divisions, in order to ensure the alignment of research work and business objectives.

Of course, not only leaders are able to bring about changes in the structuration of organizational learning. For example, according to the existing research-structure in the 1920s and 1930s, Holst was mainly responsible for the research program at the NatLab. In that period, an important research program concerned X-ray equipment. This research was a technological but not a commercial success. For that reason, Bouwers, the formal head of the sub-department doing X-ray research, was perpetually called upon to justify his research and position. Behind the back of Holst, Bouwers sought to gain support of Anton Philips, the company's top man. This was a successful move

because Anton turned out to be fully prepared to offer the support Bouwers needed. As a result of this, Bouwers' X-ray department got a quasi-autonomous status. This quasi-autonomous status lasted for several years.

This excursion into the history of the NatLab shows how the formalization of research work changed over time as well as the scope of learning processes. In the first years of the NatLab learning processes were typically oriented at business problems, and learning processes spanned the boundaries between the research laboratory and product divisions. Under the leadership of Casimir learning processes occurred predominantly within research or spanned the boundaries between the NatLab and the wider scientific community. During the last decades, business problems became more important again as drivers of organizational learning processes.

Conclusions and discussion

Our main objective in this article has been to deliver a contribution to unresolved questions regarding the relationship between individuals and organizational learning. We have used Giddens' structuration theory to overcome the dualism of organization and individual in the study of organizational learning. Based upon structuration theory we stated that organizational learning consists of changing organizational practices via the development of knowledge, realized in social practices. Indeed, the analysis of an episode of organizational learning showed the development of knowledge to be practice-based in two senses. First, in line with the views of Brown and Duguid (1991), Lave and Wenger (1991) and Gherardi (2000), the increase of knowledge that is applicable in practices, could not be realized outside the context of those practices. Second, we showed how the development of this knowledge was realized via a diverse range of practices, executed by a range of persons and stretched over time and space. This is one argument for the claim that organizational learning is a social process. Another argument is that these practices are not random, but structured. They are realized by employing social rules and resources, which gives them a recurring nature. Nevertheless, these structural properties do not determine activities. Individual actors extend rules in new directions, negotiate the meaning of rules and change structural characteristics. Therefore, organizational learning can be interpreted as a process of structuration, by which practices get changed and which is itself changed in practices.

These findings imply that organizational learning cannot be reduced to individual learning, individual learning within an organizational context, or individual learning plus something extra such as the sharing of knowledge.

An analysis of organizational learning should not start with focusing on individual learning and try to link this with organizational learning. Nor is organizational learning a process completely distinct from individual cognition. Knowledgeable actors are necessary to creatively realize practices. We believe that our structurationist conceptualization of organizational learning integrates both the individual contributions and its organizational character in a well-balanced manner. This view yields important implications for the facilitation of organizational learning. If managers and consultants want to open the black box of organizational learning, they should not use models of individual learning as guiding mental models. Practitioners should focus on the social practices yielding organizational learning, the way these practices are structured and the way they are accomplished by knowledgeable organizational actors.

Finally, we claim on the basis of our analysis that organizations do learn. In our approach we do not interpret organizational learning as a metaphor. That does not mean however, that we step into the pitfall of reification and anthropomorphization. Reification can be thought of as the apprehension of human phenomena as if they were things in non-human or superhuman terms (Berger & Luckmann, 1966: 89). In our account of organizational learning, however, the constituting roles of human agents are essential. Saying that an organization learns is not more mystical than saying that an organization grows or that an organization acts. We have avoided anthropomorphization by limiting the analogies with human learning. To assume that organizations go through the same processes of learning as human beings do seems unnecessarily naïve (Cyert & March, 1963: 123). The apparent likeness in the learning activities of human beings and organizations does not imply that the underlying processes are necessarily alike, as we hope to have shown.

This study has several limitations. We have analyzed processes of organizational learning using qualitative studies of an industrial research laboratory and focused on one particular learning episode. In order to extend a structurationist perspective it is necessary to investigate how learning processes in other types of organizations differ and correspond with respect to characteristics we identified: the structure, realization and structuration of learning practices, the differentiation of practices, the interwovenness of learning processes and their extension over time, space, persons and communities. Moreover, we have started with the adoption of structuration theory and focused only on a number of core concepts of that theory. It would be worthwhile to investigate the ways in which other social theories may provide additional or even conflicting interpretations.

Notes

- 1 Names have been changed in order to protect anonymity.
- 2 A beach-effect and a corner-effect both damage the homogeneity of a spin-coated layer. A beach-effect consists of ripples, like sand on a beach sometimes has. A corner-effect consists of a thicker layer in the corners of a spin-coated surface.

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