KNOWLEDGE MANAGEMENT IN THE LEARNING ECONOMY

Lundvall, Bengt-Åke and Nielsen, Peter
Aalborg University, Denmark
bal@business.aau.dk

Abstract:
This paper starts out with distinctions between different types of knowledge and with an interpretation of the wider economic context. The current era is characterized as 'a learning economy'. At the same time the use of scientific knowledge becomes more important for almost all industries. It is argued that there is a tension between knowledge management strategies that give main emphasis either to *promoting knowledge sharing by creating access to explicit codified knowledge* and strategies *creating organisational frameworks and relationships between employees that promote interactive learning*.

Key-words: Knowledge management, learning economy, interactive learning, organisational change

Introduction

This paper is about general principles regarding the economics of knowledge rather than about specific techniques of knowledge management. The most important message is still in crude and preliminary form. It refers to tensions within knowledge management both at the theoretical and the practical level. It is argued that these tensions are becoming more acute reflecting contradictory societal tendencies relating to knowledge and learning.

I see a tension between strategies that give main emphasis either to *promoting knowledge sharing by creating access to explicit codified knowledge* and strategies *creating organisational frameworks* and relationships between employees *that promote interactive learning*. The first of these may be seen as responding to a tendency of wider use of scientific knowledge in firms while the second may be seen as responding to the requirements of 'the learning economy'. My argument is that

today balancing the two strategies and finding ways to make sure that they support each other is the most important and difficult task of knowledge management.

At the level of the whole economy it corresponds to the need to reconcile and combine two co-existing and interacting modes of learning. The STI-mode (Science, Technology, Innovation) has its roots in scientific knowledge and its primary aim is to produce explicit and codified knowledge while the DUI-mode (Learning by Doing, Using and Interacting) refers to learning resulting in competence building often with tacit elements. Both play a role in most sectors but the role is different depending on context as well as strategy.

The paper starts out with some distinctions between different types of knowledge and learning and an interpretation of the wider context in which knowledge management has to operate today. The current era may be characterized as 'a learning economy' where the speed of competence building and creation of new forms of tacit knowledge is crucial for economic success. At the same time science-based industries are growing rapidly and the use of scientific knowledge becomes more of a potential for almost all industries. These contradictory trends make the management of knowledge a great challenge.

What is knowledge?

The two different strategies of knowledge management tend to have different views on what constitutes economically useful knowledge. The first tends to see knowledge as information about the world while the second gives more emphasis to knowledge about how to change the world not easily transformed into information. Therefore, before considering how to manage knowledge it might be useful to consider what it is and more specifically to reflect upon what kinds of knowledge that affect economic performance and what kinds need to be managed in order to enhance economic performance.

From know-what to know-who

In order to understand the role of knowledge management it is useful to make a distinction between four different kinds of knowledge (Lundvall and Johnson 1994):

- Know-what
- Know-why

- Know-how
- Know-who

Know-what refers to knowledge about ‘facts’. How many people live in New York, what are the ingredients in pancakes and when was the battle of Waterloo are examples of this kind of knowledge. Here, knowledge is close to what is normally called information - it can be broken down into bits and put into data bases.

Know-why refers to scientific knowledge of principles and laws of motion in nature, in the human mind and in society. This kind of knowledge has been extremely important for technological development in certain areas, such as for example chemical and electric/electronic industries. But it may also refer to interpretative frameworks based upon experience and intuition.

Know-how refers to skills - i.e. the capability to do something. It might relate to elementary production tasks but also to many other activities in the economic sphere. It is important to realise that it is not only 'practical people' who need skills. One of the most interesting and profound analyses of the role and formation of know-how is about the need for skills among scientists (Polanyi, 1958/1978).

Know-who becomes increasingly important as the knowledge base and the division of labour becomes more complex . It refers to a mix of different kinds of skills including social skills. Know-who involves information about who knows what and who knows to do what. But it also involves the formation of special social relationships to experts that make it possible to get access to and use their knowledge efficiently.

These four types of knowledge are complimentary. For instance experts with a specific know-how in medicine and law need to know a lot of factual case studies in order to practise. Scientists operating at the frontier of their fields need to combine their know-why insights with know-how when making experiments and interpreting results. For professionals of all kinds ‘know-who’ is a key resource when it comes to problem-solving.

Explicit versus implicit knowledge

Another important distinction has to do with how far knowledge can be, and actually gets, expressed explicitly and how far it is in codified form (Polanyi 1966; Winter 1982; Cohen and Foray and David 2001; Johnson, Lorenz and Lundvall 2002). This affects the way knowledge is learnt and how knowledge may be passed on in the economy. Most economically useful knowledge will be a mix of implicit and explicit elements. Normally, Know-what and science based Know-why will be more easy to codify than Know-how and Know-who.

One way to make knowledge explicit is to write it down. Knowledge that can be written down may be passed on to others and be absorbed by those who can read and understand the language. But absorbing such knowledge is seldom automatic – the idea of effortless 'knowledge transfer' is normally misleading and a 'prepared mind' helps a lot when it comes to absorb codified knowledge. In order to understand messages *about* the world (know what and know why) you need to have some prior knowledge about it. In order to implement 'recipes' about *how to change* the world (know-how and know-who) you will often need to have prior skills and competences. Scientific texts give meaning only to other scientists and manuals may prove useful only to highly skilled workers.

Local versus global knowledge

Codification and efforts to make explicit what is implicit may be seen as one important way to enhance the capacity to share knowledge in society. But to codify knowledge does not necessarily make it more accessible to others. Using a 'secret code' is a way to establish the opposite effect. In the seminal article from 1971 Kenneth Arrow uses the concept 'codes of information' with reference to more efficient means of communication inside an organization to the exclusion of outsiders (Arrow 1974). Inspired by Arrow I used the idea of establishing common codes for the establishment of efficient local communication between user and producers in the context of product innovation (Lundvall 1985).

Neither is codification the only way to generalize knowledge. Education and training systems generalize knowledge and 'embody' knowledge in people. Machinery producers may embody general knowledge in technical systems and knowledge intensive business service firms may deliver disembodied general knowledge to customers through using their skills in actual problem solving.

From the point of view of the whole economy the transformation of local knowledge into global knowledge is of great interest. Again we are operating on a scale from strictly local (personal codes and personal skills) to strictly global (mathematics as language and general human capabilities) where much of what matters for the economy is knowledge between the two extreme poles.

Is knowledge always individual or can it be collective?

It is also important to localize the levels at which knowledge may exist. Is knowledge something that only a particular individual may possess? Or can organizations be carriers of knowledge? I do find it useful to assume that knowledge may be embedded in an organisation. It is interesting to note that Kenneth Arrow when criticizing 'methodological individualism' as general dictum in economic analysis points to knowledge and learning as the fields where this dictum is most inappropriate (Arrow 1994).

We will argue that besides individual competence we find competence inherent in the organization's routines and problem-solving methods. This type of competence may be tacit in the sense that it cannot be completely transformed into information. For instance, explicit organization schemes and information systems are only pale shadows of what actually takes place within an organization. This becomes abundantly clear for instance when one organization tries to take over or merge with another. Despite an abundance of documentation and information there will always be many surprises (This was the case when Renault was negotiating with Volvo in the nineties on a merger and it was one important reason that the merger never took place).

In terms of the four types of knowledge mentioned above *know what* may be made collective and formalised in the organisation in the form of databases and registers to which members of the organization have access. *Know-why* differs across individuals reflecting that their background training as well as their position in the organisation's departments will affect their interpretative frameworks. Job circulation, common training programs and interdivisional team building are ways to reduce or at least overcome such differences. A more informal way to overcome it may be story-telling to establish common understanding and interpretation of why things happen.

Routines and shared problem-solving techniques may be seen as expressions of organisational *know-how*. Collective *know-who* is reflected both in the external network relationships that the firm has established and the internal connections among employees.

Who learns what – and how?

Learning to master the four kinds of knowledge takes place through different channels. While important aspects of know-what and know-why can be obtained through reading books, attending lectures and accessing data bases for the two other categories it is obvious that they are rooted in practical experience. Written manuals may be a great help but in order to use them some prior basic skills in the field of application may be needed.

Know-how will typically be learnt in apprenticeship-relations where the apprentice follows his master studies his 'body language' as well as his spoken language and relies upon him as his trustworthy authority (Polanyi, 1958/1978, p.53 et passim). Know-how and the capability to act skilfully is what make a good skilled worker and artisan. But, it is also what distinguishes the excellent from the average manager and scientist. Most natural sciences involve fieldwork or work in laboratories to make it possible for students to learn some of the necessary skills. In management-science, the emphasis on case-oriented training reflects an attempt to simulate learning based on practical experience.

This kind of knowledge is not easily transferred through electronic media and this is why e-learning without support from human interaction will be less effective than assumed by some of its propagators. Know-how will typically develop into a mature form only through years of experience in everyday practice - through learning-by-doing. This is true for lawyers, doctors and businessmen as well as for connoisseurs and artists. 'Wunderkinder' who seem to be born with a fully developed skill in a specific area do exist but they are exceptional. It is also important to note that the more skilful the master gets the more intuitive the exercise of the skill. While the new-beginner will tend to perform each step in an explicit sequence the outstanding expert will pursue the action in one implicit stroke.

Know-who is learnt in social practise and some of it is learnt in specialised education environments. Communities of engineers and experts are kept together by re-unions of alumnae and by

professional societies giving the participant access to information bartering with professional colleagues (Carter 1989). It also develops in day-to-day dealings with customers, sub-contractors and independent institutes. One important reason why big firms engage in basic research is that it gives them access to networks of academic experts crucial for their innovative capability (Pavitt 1992). Again, know-who is socially embedded knowledge that cannot easily be transferred through formal channels of information.

This implies that learning processes always will have local elements in them. The physical and social interaction between people is crucial for developing and sharing knowledge and communication through global formal codes will never completely substitute for interactive learning in apprenticeship-like relationships. It is interesting to note that Noble Prize winners in Science, when asked about crucial experiences of learning refer to personal face-to-face interaction with other scientists. And, the acceleration in the production of new scientific knowledge may actually increase the relative importance of processes of learning based on social interaction.

Organisational learning

Organisational learning may be seen as taking place in two different dimensions. First it brings together elements of knowledge and components of competence in new combinations – we may call that *'combinatorial learning'*. This will for instance be part of innovation processes resulting in new products and new processes. Second, it develops the communicative capacity of the organisation for instance through developing common codes and channels of communication as well as social relationships of hierarchy and trust – we may call this *'relational learning'*.

The individual that enters the organisation is expected to gradually learn how to draw upon and contribute to the collective knowledge resources. The firm may be seen as a 'community of practise' where the new entrant has to earn full membership through learning to access organisational knowledge and through learning to contribute to organisational learning. To become a full member of a community of practise is to learn know-who as well as to learn know-how (Wenger). The peripheral participant gradually becomes full member by learning who knows to do what and as well by learning how to communicate with those experts.

In this context relational learning involving individuals in interaction is especially important. Relational learning refers to learning language as well as learning to understand and co-operate with other members in the organisation (or in the external network). Relational learning reduces the costs of interaction and enhances the efficiency of communication.

The DUI-mode of learning

Learning by doing is an activity that takes place in connection with daily operations (Arrow 1962). Especially when the process is changing the operator will be confronted with new problems. Finding solutions to these problems enhances the skills of the operator and extends his repertoire. Some of the problems are specific while others are generic. Therefore learning may result in both specific and general competencies for the operator. When the process is complex – a good example is the learning-by-using of new models of airplanes - it will involve interaction within and between teams and it may result in new shared routines for the organization. As the whole organization gets more insight in the actual working of the system it might find more efficient ways to organize work and solve problems as they pop up. This is the kind of case that Rosenberg (1982) uses to illustrate learning-by-using.

But both learning by doing and learning by using may be defined as local learning processes resulting in local knowledge. This is why we should not expect any radical impact on the growth of the whole economy from learning by doing and learning by using. To lift knowledge out of its local context to generalize it and to make it global there are different mechanism. The one we will consider as part of the DUI-mode of learning is learning by interacting connecting producers to users of innovation (Lundvall 1985). For the economy as a whole a specific sector may become the one that generalizes local knowledge and diffuses it widely in the economy.

Historically machinery production constituted the most strategic sector. Machinery producers addressed many different users, gathered knowledge about their needs and about the performance of different technical solutions. On this basis they developed more global and efficient solutions on the basis of local knowledge and learning. Today the *knowledge intensive business services* tend to play a similar role. For the single manufacturing firms it is attractive to outsource certain service functions to specialized KIBS-firms. The KIBS-firm will address several customers and help them to solve their problems in a well-defined field. This gives access to local learning taking place under

diverse conditions. The KIBS-firm will be able to transform these diversity of experiences into more global and more efficient solutions.

This interpretation gives new content to the old idea pursued by Adam Smith that there is a strong connection between a more developed division of labor and economic growth. It may also be seen as supporting Karl Marx argument 'that it is only when we have reached the stage when we produce machinery by means of machinery' that we can expect a dramatic growth in productive forces. Finally it helps to explain the results from recent analytical work showing how strongly manufacturing productivity is linked to KIBS-input to manufacturing. These recent KIBS-studies indicate that a new strategic sector has substituted for machinery. Perhaps a new effort to understand the raise and fall of the so-called new economy would show that the speed up of productivity growth that was at the core of this phenomenon had more to do with the extension of the division of labor than with the extended use of ICT (Lundvall 2003).

The STI-mode of learning

The R&D-departments in big firms play a key role in STI-processes. Specific R&D-project will often be triggered by practice (problems with a product, new user needs, problems with producing) but almost immediately attempts will be made to restate the problem in an explicit and codified form. The R&D-department will start going through its earlier work as well as looking for insights that can be drawn from outside sources. In order to communicate with scientists and scientific institutions outside it will be necessary to translate the problem into a formal scientific code. While the process of searching is going on there will be a need for interaction with and feed-back from the potential users of the outcome of the process and here intermediate results will need to be presented in a language that the potential users can understand.

But all through the process documenting results in a codified form is extremely important. It is not sufficient that the single scientist keeps results in his own memory as tacit knowledge. Often the project involves teamwork where single results are needed as building blocks for other members in the team. At the end of the process – if it is successful - a transfer of the results within the organization or across organizational borders will call for documentation as well. In the case that an application is made for a patent the documentation needs to be made in a techno-scientific language that allows the patenting authority to judge the originality of the innovation.

This means that, on balance, the STI-mode of learning even if it starts from a local problem will make use of global knowledge all the way through and, ideally, it will end up with 'potentially global knowledge' – i.e. knowledge that could be used widely if it were not protected by intellectual property rights. In terms of knowledge management it corresponds well to a strategy of knowledge sharing through wide access to codified knowledge inside the firm. The generalization of the knowledge in the form of a patent and the use of licenses will make it disembodied as compared to what comes out of the DUI-mode of learning.[1]

Knowledge management as related to the two modes of learning

Both in the DUI- and the STI-mode the question of keeping key employees attached to the firma and avoiding that they get employed by competitors may be a serious concern of management. Individuals will always possess abilities and skills that are potentially useful outside the organization in which they are employed. If the employee's competencies are central to the organization, in demand by other organizations, the worker in question will be seen as a 'key employee'. In this case knowledge management will take great pains not to lose that employee to a competitor.

The situation may be different if the employee is operating inside a laboratory where much of the process is well documented (STI) or if the employee is delivering knowledge intensive services to customers (DUI). The first case may be one where it is less difficult to protect intellectual property while the second involves a potential loss of both know-how and know-who. The recent growth in the use of share options and competition clauses has as objective to preserve this category of workers in the firm. A problem with the extended use of such instruments is that they may undermine the learning capability of the wider set of firms.

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[1] There are several caveats to this ideal type of STI-mode of learning. R&D may be oriented to solve very local problems and the results may be kept secret by other means than patents. The most talented scientists will in spite of documentation be carriers of 'personal knowledge' that cannot be easily substituted. There are stories about ASEA – now part of ABB – that the major reason that major breakthroughs were made in strong current technology was a lack of documentation and controle that made it possible to have private projects in the desk drawer. And finally the patenting may be seen as the top of the ice-berg and as a signal that a lot of tacit knowledge is hidden under the surface (Hicks).

One way to tackle this problem may be to introduce a better documentation of the knowledge created in the DUI-mode. Attempts to document both individual and organizational knowledge can be more or less intense in different organizations and sometimes this documentation and is seen as being at the very core of 'knowledge management'. Some international consulting firms tend to promote 'knowledge sharing' through formal registering of experiences and joint access to data banks. Attempts are made to document every single activity and experience and then make that information available to the entire organization. Such exercises may be useful in enhancing the consciousness about the creation, diffusion and use of knowledge in the organisation. But to transform such activities into regular routines may be less fruitful than propagators propose.

There are several problems with such a strategy. The most fundamental is that not all organisational competencies may be made explicit. While there might be resistance among the experts to give away their expert knowledge the organisational competences are even more difficult to specify and codify. Some of them may work just because they remain implicit rather than explicit. Codifying flirting, joking and the respect shown for the great internal experts may be counter-productive. Making the informal hierarchy visible may undermine it and impose a formal hierarchy that is much less effective in coping with the complex reality surrounding the firm. The most important down-side of such a codification strategy is, however, that while it uses a lot of scarce intellectual resources what is documented tends to be rendered obsolete as the organization's environment changes and new types of problems enter the agenda of the organisation.

Why the STI-mode needs to be complemented by the DUI-mode

The fact that big firms are engaged in R&D-activities does not imply that they can neglect the DUI-mode. These organisations are typically exposed to a stronger transformation pressure than firms operating in sectors with a weaker connection to science. They have to cope with rapid change both in technological opportunities and in terms of market conditions. There will be frequent change in user needs and in the set of competitors operating in their markets.

The speed up of science-based innovation tends to run into bottle necks whenever the capability to absorb and efficiently use new technologies is limited. And, besides, many incremental innovations with a major economic impact will have their roots in learning by doing, using and interacting. Any

strategy to promote innovation needs to take both of these sources of innovation into account. The importance of DUI-learning in science-based sectors comes out clearly in the following statement by the president of EIRMA at the gathering of European R&D-managers 1993 meeting in Helsinki:

> *In a time of intensive global competition, speeding up the innovation process is one of the most important ingredients which enable the company to bring to the market the right product for right prices at the right time.....*
> *We know that it is not only the R&D process which is important we have to put emphasis on integration of technology in the complete business environment, production, marketing, regulations and many other activities essential to commercial success. These are the areas where the innovation process is being retarded.*
> *This subject is a very deep seated one which sometimes leads to important, fundamental rethinking and radical redesign of the whole business process. In this respect, especially during the difficult period in which we live today, where pressure is much higher, our organisations may in fact, need to be changed.* (Introductory remarks to the EIRMA -conference by the President, Dr. E. Spitz: Eirma 1993, p. 7, my emboldenings).

Actually, there might be a tendency in sectors with strong elements of STI-learning to underestimate the importance of DUI-learning, including building 'learning organisations'. The culture in the firm may be in favour of documentation and codification and too little emphasis and too low a status may be attached to human interaction and the use of tacit know-how and know-who skills.

Why the DUI-mode needs to be complemented by the STI-mode

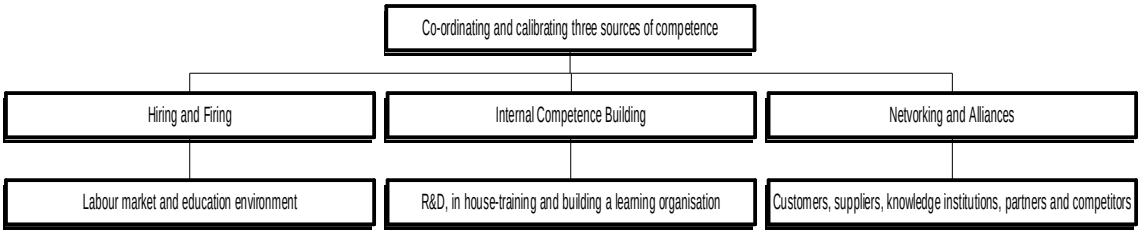
One interesting results in recent research in Aalborg is that small and medium-sized firms not belonging to High Tech-sectors that acquired competence in the form of academic personnel and strengthened their collaboration with knowledge institutions were the ones that experienced the most dramatic positive impact on their innovative performance (Lund Vinding 2002). Our interpretation of this result is that as competition becomes intensified in traditional sectors, reflecting the entrance of new competitors from all over the globe, it is no longer sufficient to base competitiveness on know-how and DUI-learning. Firms that succeed in connecting to sources of codified knowledge may be able to find new solutions and develop new products that make them less sensitive to price competition.

This is one reason why a strategy that gives more attention to codification and documentation of knowledge inside SMEs in traditional sectors may result in major rates of return. Another is the increasing division of labour at the global level where global value chains often are dominated by big firms strong in STI-mode learning. Increasingly the survival and growth of SMEs in manufacturing as in services that are sub-contractors to big international firms will depend on their capacity to document what they can do and how they do it. This becomes especially important because of the speed up of innovation in such chains. To follow and contribute to the change process becomes increasingly demanding in terms of mastering codified knowledge.

Competence building through three sources

When it comes to develop a coherent knowledge management strategy it is important to think in a co-ordinated way about the three different major sources of competence building: Internal competence building, hiring and firing and network positioning (see the diagram above).

Diagram: Knowledge Management in the Learning Organisation



Firms differ in how strongly they emphasise each of these elements both between and within national innovation systems. Japanese firms have emphasised internal competence building while most hi-tech firms in Silicon Valley depend on learning through high inter-firm mobility of employees within the industrial district. In Denmark the institutional set-up of the training system and the labour market supports networking firms and high mobility in the labour market, making it attractive for firms to locate in 'industrial districts'.

For firms already strong in the STI-mode the focus of knowledge management should be on internal competence-building and networking and more specifically on building learning organisations. For firms weak in the STI-mode the focus should be on hiring academically trained employees and on building new network connections to knowledge institutions.

The learning economy as context

We have introduced our interpretation of what takes place in the economy by using the term 'the learning economy' (Lundvall and Johnson 1994; Lundvall and Nielsen 1999). The intention is to mark a distinction from the more generally used term 'the knowledge-based economy'. The learning economy-concept signals that the most important change is - not the more intensive use of knowledge in the economy - but rather that knowledge becomes obsolete more rapidly than before; therefore it is imperative that firms engage in organizational learning and that workers constantly attain new competencies. This can be illustrated by the reference in a recent report from the Danish Ministry for Education that claims that on average half the skills a computer engineer has obtained during his training will be obsolete one year after the exam has been passed, while the 'halving period' for all educated wage earners is estimated to be eight years (Ministry of Education 1997, p. 56).

A learning economy is one in which the ability to attain new competencies is crucial for the economic success of individuals and, as well, for the performance of firms, regions and countries. The crucial importance of learning reflects that the combination of globalisation, information technology and deregulation of formerly protected markets leads to more intense competition and to *more rapid transformation and change*. Both individuals and companies are increasingly confronted with problems that can be solved only through new competencies. Intensified competition leads to a selection of organizations and individuals that are capable of rapid learning, thus further accelerating the rate of change.

The transition to a learning economy confronts individuals and companies with new demands. We see the growing emphasis on new organization forms promoting functional flexibility and networking as responses to the challenge of the learning economy. In a rapidly changing environment it is not efficient to operate in a hierarchical organization with many vertical layers. It takes too long to respond if the information obtained at the lower levels should be transmitted to the top and back down to the bottom of the pyramid. Also it becomes even more difficult to establish all competences inside the organisation. In house-learning needs to be combined with hiring highly skilled experts in the labour markets and networking with external parties. In many instances relational contracting and networking is used to enhance functional flexibility.

From the point of view of top management it is important to economize with resources including the time it takes to gather information and learn new things. To promote specialisation among employees appears like-wise to be efficient since repetition gives the employee the skills necessary to solve problems as they appear with a minimum of effort. In a world where demand and technologies develop gradually and slowly such a 'Fordist' approach to knowledge management combining strict specialisation, scale economies and 'scientific management' may be the most effective way to use knowledge. In such a context learning may be needed mainly to introduce the new apprentices once and for all.

But the speed of change is crucial for the success of such a knowledge management strategy. When markets and technologies change rapidly and the competition tends to become based upon speed and agility rather than low cost standardized products it will prove problematic to be dependent on moving information up and down in highly specialized hierarchies. The concept the learning economy signals that the context has changed in this direction and that a crucial challenge for knowledge management has become to build organisational forms that promote learning and innovation.

Innovation and knowledge creation in the learning economy

Learning and problem solving takes place in connection with all activities in the firm. But the one activity where knowledge creation and learning is most central and critical is *innovation*. The traditional view of innovation has been strongly linked to what I have called the STI-mode of learning and to R&D-efforts in the firm. Here we will demonstrate some empirical results that demonstrate that innovation is strongly coupled to the DUI-mode and more specifically to the establishment of learning organisations. Our results also illustrate that there is no clear distinction between 'innovation management' and 'knowledge management'. The organisational characteristics that promote adaptive learning also promote innovation.

There is a bias among scholars and policy makers to consider knowledge production/innovation processes largely as aspects connected to science based industries. Often this is combined with a linear view that assumes that new scientific results are the first step in the process, technological invention the second, and the introduction of innovations as new processes or products the third. There is now a rich body of empirical and historical work that shows this to be the exception rather

than the rule (Rothwell 1977; von Hippel 1988; Lundvall 1988). The recent models of innovation emphasize that knowledge production/innovation is an interactive process in which firms interact with customers, suppliers and knowledge institutions. Empirical analysis shows that firms seldom innovate alone (Lund Vinding 2002).[2]

In connection with spelling out the characteristics of the DUI-mode we have already referred to some of the most central contributions in economic theory to understanding learning (Arrow 1962; Rosenberg 1982; Lundvall 1985). A more recent analysis of learning by doing focuses on how confronting new problems in the production process triggers searching and learning, which imply interaction between several parties as they seek solutions (von Hippel and Tyre 1995). In most of these contributions learning is regarded as the unintended outcome of processes with a different aim than learning and increasing competence. Learning is seen as a side-effect of processes of production, use, marketing, or innovation.

An interesting new development, which tends to see learning as a more instrumental process, is the growing attention given to 'learning organizations' (Senge 1990). The change from a linear to an interactive view of innovation and knowledge production has also been a way to connect to each other innovation and the further development of competence. As now understood, the innovation process may be described as a process of *interactive learnin*g in which those involved increase their competence while engaging in the innovation process. There is thus a certain convergence between the organisation and the innovation literature that the institutional framework and the way organizations are structured has a major effect on the rate of learning and innovation (Andreasen 1995).

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[2] This is also the background for developing a systemic approach to knowledge production. Innovations systems are constituted by organisations contributing to innovation and their interrelationships. The organisations are firms, technological institutes, universities, training systems and venture capital. Together they constitute the context for knowledge production and innovation. The specific constellation differs across sectors, regions and nations. They are typically specialized in terms of their knowledge base, and the specific mode of innovation will reflect institutional differences (Freeman 1987; Lundvall 1992; Nelson 1993; Edquist 1997). Innovation systems may be defined as regional or national, as well as sector- or technology-specific. The common idea is that the specificities of knowledge production reflect unique combinations of technological specialization and institutional structure.

Illustrating empirically how learning organizations promote incremental innovation

The move towards learning organizations may be reflected in changes both in the firm's internal organization and in inter-firm relationships. Within firms, the accelerating rate of change makes multi-level hierarchies and strict borders between functions inefficient. It makes decentralization of responsibility to lower-level employees and formation of multi-functional teams a necessity. It is also reflected in relationships with suppliers, customers and competitors becoming more selective and more intense. In what follows we will show that the probability of successful product innovation increases when the firm has organized itself in such a way that it promotes learning. Second we will demonstrate that organizational forms promoting learning have to be seen as multi-dimensional - they typically combine several of a number of internal relationships and activities and external relationships.

The empirical analysis is based on a survey addressed to all Danish firms in the private sector – not including agriculture - with 25 or more employees, supplemented with a stratified proportional sample of firms with 20-25 employees. 6991 questionnaires were sent to the firms selected. This survey collected information from management. In total, 2007 usable responses from management have been collected and integrated in a cross section data set. This makes the overall response rate of the survey 29%, which is not very satisfying. However, a closer response analysis broken down on industries and size show acceptable variations on response rates here, and non-respondent information on some of the potential dependant variables together with comparison to other surveys, do not indicate unacceptable bias.

Obtaining a meaningful quantitative measure of innovation and innovative behaviour on the basis of information collected in firms belonging to industries with very different conditions, is not unproblematic. The phenomenon that firms refer to may vary in relation to conditions and configurations. Our data indicate that we are confronted with incremental qualitative change rather than radical change when we ask the firms whether they, in the period of 1998 - 2000, have introduced new products or services on the market. Three fourths of the innovations introduced within the period 1998-2000, were already known at the national as well as well as on the international markets. 13% of the firms have introduced at least one innovation innovations new on the national market, although already existing in world markets. A small group of firms (6%) have introduced at least one innovation new both on the national and the world market.

Bundles of organisational traits and innovative performance

In the survey, we measured the incidence of an array of organizational dimensions, which all directly or indirectly refer to contemporary theories dealing with innovation and functional flexibility in organizations: Cross occupational work groups, integration of functions, softening demarcations, delegation of responsibility and self directed teams are empirical indicators, referring to Moss Kanter's theory of integrative organization and Burn's & Stalker's organic organizations. Quality circles and proposal collection systems are indicators of Quality management (TQM) and Knowledge Management (Nonaka & Takeuchi 1995). Tailored educational system and Educational planning indicate Human Resources Development and cooperation with eksternal actors refer to innovation as an interactive process (Lundvall 1992). In the figure below the dimensions are classified in relation to the theoretical aspects they are indicators of.

Figure 1: Theoretical perspectives and organizational characteristics and practices

Theoretical perspective	Organizational characteristics and practises
The organic and integrative organization – focus on internal functional flexibility	Cross occupational working groups Integration of functions Softened demarcations Delegation of responsibility Self directed teams
Quality management – focus on engaging employees	Quality circles/groups Systems for collection of employee proposals
Human development – focus on competence building	Education activities tailored to the firm Long term educational planning
Compensation system – focus on incentives	Wages based on qualifications and functions Wages based on results
External communication – focus on external functional flexibility	Closer cooperation with customers Closer cooperation with subcontractors Closer cooperation with universities & technological institutes

Here we will analyse to what degree the organizational characteristics and practises complement each other and thus increase the chances of P/S innovation cumulatively. This might reflect that there are 'bundles' of organizational techniques that support each other and that it is only when the

firm has got several of the elements working together that it will harvest the full benefits in terms of innovative behaviour. Building on such arguments, an additive index has been constructed applying all the fourteen organizational characteristics. The empirical distribution of observations (firms) in the additive index of organization, quality control, human development, compensation and external communication is shown in the table below:

Table 2: Distribution of firms in terms of the number of organizational practices in terms of integratio, quality, human development, compensation and external communication (N = 2007).

Index	Frequency	Percent	Cumulative perc.
0	32	1,59	1,59
1	64	3,19	4,78
2	105	5,23	10,01
3	135	6,73	16,74
4	210	10,46	27,20
5	202	10,06	37,27
6	224	11,16	48,43
7	250	12,46	60,89
8	213	10,61	71,50
9	210	10,46	81,96
10	165	8,22	90,18
11	90	4,48	94,67
12	63	3,14	97,81
13	30	1,49	99,30
14	14	0,70	100,00

We have classified the firms in three groups, according to how many dimensions they have adapted in their organizations - in other words - how many organization, quality, human development and external cooperation facets are built into the firm's organization. We have thus divided the firms into three groups:

- Low level learning organization – firms that have introduced zero to four of the dimensions
- Medium level learning organizations - firms that have introduced five to eight dimensions
- High level learning organizations - firms that have introduced nine to fourteen dimensions.

This quantitative bundling aspect may be assumed to reflect the degree of organizational sophistication. Applying many dimensions signals consciousness in terms of knowledge management. In other words it signals a culture of change and learning in the firms. In table 3 results of this construction is shown. Table 3 shows how frequent high level learning organizations are in different categories of size, industry, ownership and production.

Table 3: Learning organization development by firm size, industry, group ownership and production (percent horizontal)

Variables:	High (9-14)	Medium (5-8)	Low (0-4)	(N)
All firms	28,5	44,3	27,2	2007
Less than 50 employees	18,1	45,9	36,0	1048
50 - 99 employees	35,0	42,3	22,7	437
100 and more employees	45,1	43,3	11,6	490
Manufacturing	36,3	42,9	20,8	725
Construction	14,5	42,8	42,8	318
Trade	24,5	48,3	27,2	563
Other services	19,6	45,1	35,3	184
Business service	41,2	40,3	18,5	213
Danish group	30,1	44,7	25,3	701
Foreign group	40,7	43,8	15,5	388
Single firm	22,3	44,5	33,2	903
Standard product	29,2	45,1	25,7	725
Customized product	29,8	44,9	25,3	1192

By grouping all the firms according to the index of learning organization development we get 27% in the low category, 44% in the medium and 28% in the high category. Table 3 shows that this distribution is size dependent. Among firms with less than 50 employees, only one out of five fims have developed a learning organization at the high level while the same is true for every second of the bigger firms. With growing firm size, the share of highly developed firms increases.

Table 3 shows that the frequency of high level learning organisations varies across industries. More than 40% of the firms in Business service are in the category of highly developed learning organizations, while the same is true for 36% of the firms in Manufacturing. The rest of the industries lie below the average. Another interesting result is that firms owned by foreign groups have high share in the category of most developed. Firms owned by Danish groups are closer to the general average and single - stand alone – often family firms - are below the average. The presence of foreign owned firms seems to constitute 'a progressive element' in the Danish economy while the often cherished family owned stand alone firms seem to be lagging behind both in terms of technological and organizational sophistication.

How does the frequency of use of organizational dimensions affect knowledge production and learning in the firms, as indicated by product and service (P/S) innovations? In table 4 the different categories, representing increasing levels of learning organizations are tested in a logistic model with P/S innovation as dependant variable, and with control for firm size, industry etc.

Table 4: Logistic regression of learning organization level categories, size, industry, ownership and production on P/S innovation (odd ratios, 95% confidence interval, estimates and P-values)

Variables:	Effect	Lower	Higher	Estimate	Chi-sq	P-value
High level	5,18	3,90	6,90	0,82	127,30	<.0001
Medium level	2,20	1,71	2,83	0,39	37,11	<.0001
Manufacturing	2,35	1,62	3,40	0,54	38,69	<.0001
Construction	0,69	0,45	1,08	-0,68	28,35	<.0001
Business services	2,27	1,46	3,54	0,51	15,40	<.0001
100 and more	1,61	1,26	2,07	0,30	14,23	0.0002
Danish group	0,76	0,58	1,00	-0,14	3,93	0.0475
Single firm	0,58	0,44	0,76	-0,28	15,85	<.0001

We find a five times higher chance of P/S innovation in the high level category, and even in the medium category the chance is twice as high as in the low category. Among the other factors included in the model, Manufacturing and Business services remain significant with 2.3 higher

chance of P/S innovation and Construction is negatively significant with a chance of 0,7. The effects of large size (100+) is positive but moderate. Danish group ownership and single firms have a chance below the average. In sum, the model has shown important and significant effects of the development of what we call learning organization on P/S innovation.

This illustrates that 'learning organization' that combine functional flexibility with investment in human resources, incentive systems and networking are much more prone to innovate irrespective of sector and size. It also illustrates that there is no clear distinction between 'innovation management' and 'knowledge management'. The organisational characteristics that promote adaptive learning also promote innovation. To instal them might be important an important task both for 'knowledge managers' and 'innovation managers'. Our results also indicate that it is not sufficient to invest in STI-mode of learning for instance by pursuing R&D. To be innovative you need to stimulate DUI-learning by installing traits of the learning organisation.

Conclusions

It is important to point out that I am intervening in the knowledge management debate as somebody coming from the outside. I have approached this as somebody trained in economics that wants to understand the role of knowledge and learning in the economy as a whole. What has been said and what follows are some preliminary personal reflections that need to be substantiated by more systematic research.

Knowledge management is both to manage knowledge as assets and promote learning as a process

In his seminal paper Sidney Winter (1987) makes an attempt to specify in what sense and to what degree knowledge is an 'asset' and I believe that the reason he tries to do that is that most management scholars would prefer knowledge to be something that can be thought of as one among other kinds assets. The efforts to bring annual reports on company knowledge on line with the accountancy and reporting systems of other assets may also be seen in this light. One problem with the asset perspective is the definition of ownership. Knowledge is necessarily a mix of a public and a private good. Neither is it easy to transact knowledge in the market.

Another problem is that a focus on 'a set of assets' may be too static in the rapidly changing world we have indicated by the concept of the learning economy. Here the key to long-term

competitiveness is the learning (and forgetting) capability of the firm rather than what it already knows. This is why I have chosen to define knowledge management as including initiatives enhancing the learning capacity of the firm – not least building a learning organisation. This aspect is more related to designing organisational procedures and routines than it is to managing assets.

Knowledge management – a set of techniques AND an art based on personal experience and intuition?

Soft-ware programs helping firms to manage information and specific techniques such as the use of balanced score-cards may be useful ways to organize an increasingly complex knowledge base in firms. Personally I do not see these (or other systematic attempts to codify and register what is known by the organization and its employees) as efficient substitutes for managers with experience-based skills in handling human relationships. To leave it to young inexperienced managers to implement and use such tools may not only be inefficient, it might actually be damaging for the learning capability of the firm. For instance, one way to use the balanced score card-technique might be to characterize people once and for all according to what they can do at a specific moment of time. This might lead to a 'freezing' of the competence profile of individuals that is not at all useful for the learning organization.

As illustrated by the data presented above and by many other empirical studies of 'learning organizations' or 'high-performance workplaces' there are certainly lessons to be learnt from successful firms operating in turbulent environments that introduce specific organizational characteristics such as job rotation, inter-divisional teams, delegation of responsibility and reducing the number of levels in the organizational hierarchy. The idea behind such changes is to enhance the DUI-learning in the firm and to make the firm more responsive to changes in its environment. As far as they work well they may also reduce the need for daily management, including knowledge management.

But, again, the use of such techniques, while helpful, may not substitute for skilful knowledge management where the focus is on people and on relationships between people. Even in a science-based economy with wide use of information technology the social dimension remains crucial for learning. To make sure that people get recognition both for what they do and learn and for what they are is crucial. Employees also need to know who to contact and collaborate with in specific

situations and have the confidence and incentive to do so when necessary. To master social processes that create these preconditions of learning is a management *art* that needs to be based on personal experience.

Some final words about the STI-mode and the DUI-mode of learning

It is important to note that the two modes of learning do not exclude each other. Actually elements of both are present in all business activities. While the STI-mode may be of marginal importance in some informally organised businesses the firms that use the STI-mode most intensely will be highly dependent on the successful organisation of the DUI-mode. They will operate in sectors where there is supply-driven and sometimes radical change in products and processes. To cope with these changes the need for learning by doing, using and interacting will be important.

The two modes of learning do co-exist but they do not necessarily co-exist in harmony with each other. The STI-mode calls for codification and for codes that are general while the DUI-mode tends to thrive on the basis of implicit and local codes. To promote the STI-mode documentation and the use of formal management information systems is crucial for success while the DUI-mode needs a strong focus on interpersonal relationships. Different departments and professions may be more or less in favour of one of the two modes. Accountants and scientists will call for documentation in general codes while skilled workers; engineers and sales personnel may be morereluctant to engage in detailed documentation.

An interesting hypothesis that seems to fit with empirical results is that the rate of return from strengthening one of the modes is higher the less intensively it is used in the organisation. Firms that have not been using the STI-mode intensely may benefit the most from giving more attention to that mode. While firms that use the STI-mode intensely may benefit the most from focusing on developing the DUI-mode.

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