

SPOKEN-ABOUT KNOWLEDGE: WHY IT TAKES MUCH MORE THAN 'KNOWLEDGE MANAGEMENT' TO MANAGE KNOWLEDGE?

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1. Knowledge – the reality challenge

Unimerco a/s is a company depending on knowledge for its success. For CEO Kenneth Iversen - and for all of his colleagues in Unimerco - leading, managing, and developing knowledge processes internally and with suppliers and customers is a dominant aspect of every single workday.

This is hardly surprising. After all Unimerco is a company operating at the forefront of industrial development, and 'knowledge' seems to be the central concept in almost any discussion about what is new at this forefront. Not least in the European discussion, it has become established convention to talk about the knowledge-based economy. This again is reflected in an abundance of academic writing, consulting service offerings, and IT-products aimed to understand knowledge and knowledge processes and to assist companies in handling knowledge.

The surprise is that all of these contributions play little or no role in Unimerco's efforts to master the knowledge challenges. The conceptualization of knowledge in dominant academic theory and consulting service offerings seem to be disconnected from the challenge of mastering knowledge in the competitive reality of a pioneering company.

The aspiration of this article is to at least sketch an understanding of knowledge that has the potential of real usefulness for companies. To achieve this we take the long road back to the theoretical foundations of the concept of knowledge in order to set the definition straight. This will lead us to identify and correct some of the predominant misconceptions. More importantly, it allows us to outline a new framework for understanding knowledge. Based on that, we suggest some directions for dealing with the present reality challenges of companies like Unimerco. We perform a preliminary test of the framework against our observations in Unimerco, and we outline some of the next steps which we believe can re-align theory with practice and lead to useful results for companies.

In the process we confront two of the dominant trends in the theory of knowledge as it pertains to companies. Mainly, we deal with 'knowledge management' as it has become known since the early 1990s in the academic debate, but especially as it has gained

¹ The article has been produced as part of the EU funded FP5 project *Tracking the New Economy Transformation* (IST-2001-37325). The theoretical insights are the result of joint discussions based on the draft manuscript of N.C.Nielsen's forthcoming book on the political economy of the knowledge society. The empirical work on Unimerco was carried out by M.C.Nielsen as part of a CBS team project. It should be disclosed that N.C.Nielsen is a non-executive member of the Unimerco Board.

momentum as a new fad in the consulting industry, and as a buzz word for the sale of quite a number of software products.² It is important to get to grips with the misconceptions underlying the ‘knowledge management’ trend, because almost all of the available service offerings to help companies deal with their knowledge challenges represent this kind of thinking, but even more because we are unaware of any company that has achieved significant improvements in competitive performance by adhering to knowledge management recommendations.

The fundamental problem of knowledge management is that it mistakes codified knowledge for knowledge. As a consequence the emphasis is on identification, capturing, documentation, and dissemination of codified knowledge, not least by the use of IT-systems. We show in the article that codified knowledge is only one aspect of knowledge, and that it can never replace – nor indeed be successfully applied without – types of knowledge which are outside the codified domain. This is why so many ambitious, well-intentioned, and well-funded attempts to create knowledge management systems in companies have resulted in databases and communication systems with huge collections of documented, codified knowledge entries, which have been compiled against significant organizational resistance, and which are hard to find when needed and rarely used. When used, the documented knowledge often turns out to be incomplete and unusable or outdated. Ultimately our criticism of knowledge management is that its concept of knowledge is too narrow. Hence, knowledge management ends up instituting compilations of disconnected, incomplete, and useless fragments of knowledge.

The other dominant trend we address has not come nearly as much to the attention of companies as knowledge management and has certainly not been commercialized in consulting services and IT-products to the same extent. This is a school which focuses on tacit knowledge and on how organizations optimize and share tacit knowledge in what has been labeled ‘communities of practice’. The valid contribution of the school is that tacit knowledge has been recognized as important and indeed as the irreducible foundation of all knowledge. On top of that the tradition offers companies very real guidelines on how to optimize tacit knowledge processes. The short-coming is that typically communities of practice are closed around their contextual setting and around tacit dimensions of knowledge, which also means that they tend to be relatively static and incapable of dealing with dynamic dimensions of change in knowledge. One consequence of this is that most of the applications of insights from this tradition have been heavily biased towards shop-floor learning. Our criticism is that the basic mistake is equivalent to that of the knowledge management tradition: An aspect of knowledge – its tacit dimension – is seen as all of knowledge.

Our argument is that knowledge is the dynamic unity of the different dimensions: Codified knowledge in itself is incomplete and not knowledge at all. Tacit knowledge in

² Several examples of this can be found in Tom Stewart: *Intellectual Capital*, Doubleday 1997; in Leif Edvinsson and Michael Malone, *Intellectual Capital*, HarperCollins 1997, and in Rudy L. Ruggles III, *Knowledge Management Tools*, Boston 1996. A major part of the articles on the subject coming out of the consulting world falls within the same mode of thinking.

itself is constrained and hardly capable of developing. The knowledge without which no company can perform is the dynamic unity of the two dimensions where iterations from form to form are mediated through other forms such as spoken and spoken-about knowledge as well as imbedded knowledge. Spoken-about knowledge turns out to play a pivotal role in the dynamic unity.

This insight has far-reaching and very significant practical implications. As a preliminary step it explains why neither ‘knowledge management’ nor the ‘communities of practice’ schools seem entirely relevant for Unimerco. At the next level it points towards an understanding of knowledge which will have relevant applications.

To get to the fuller understanding of knowledge we have to take the argument through several steps, some of which might seem distant from the practical implications.

First we look at the technological and economic drivers of change. We see how they are driving companies to redefine all the relationships which constitute our very concept of a company. Knowledge appears to be the key factor in the transformed relationships. This is why the transformations are being discussed under the headline of the ‘knowledge-based economy’. Unfortunately, much of the current literature about knowledge and its role in the transformation – the trend which we summarize under the label ‘knowledge management’ – is characterized by some basic misconceptions which see the development as the triumph of codified knowledge over other forms of knowledge. To move beyond these misconceptions we show that the classical theory of knowledge can be seen as a persistent, but failed attempt to establish the validity of pure, codified knowledge. Thereby, all the unanswerable questions of the classical theory of knowledge line up to invalidate the foundations of ‘knowledge management’. We see how the newer theory of science has given up all claims on the rational completeness of codified knowledge, and therefore has moved beyond the assumptions of knowledge management long before that tradition was introduced. Finally, we see how cognitive science aligns with these conclusions, and lead to an understanding of knowledge as contextual, selective, and concept dependent, which all in all take us far beyond the misconceptions of knowledge management and towards a new framework for understanding knowledge.

Based on this we are able to outline a system of knowledge, within which tacit and explicit knowledge interact and depend on each other, and where their interaction is mediated through the category of spoken-about knowledge. Tacit knowledge is concrete and confined. Any move towards more explicit forms, ultimately towards codified knowledge will require reduction and abstraction, and lead to detachment, but will enable reflection. Any attempt to apply the results of reflection will require interpretation and the reintegration of aspects of knowledge from which the codification abstracted.

Additionally, we see how the dynamics between focal and subsidiary knowledge add to the overall dynamics of the knowledge system; how no account of the knowledge system will be complete without the category of imbedded knowledge, and how all of the forms of knowledge have organizational or social as well as individual aspects.

As we move into the company to apply this understanding of the knowledge system to the actual knowledge processes, we take a brief look at the work done on ‘communities of practice’; since this is the other prominent attempt in the literature to understand what is at stake. We see how this attempt has given us a deeper understanding of the way companies manage to make tacit knowledge organizational, but also how that is not enough to understand what is really at stake for companies. We then test our systematic framework on a first mapping of the knowledge processes in Unimerco, and exemplify how the framework helps us expose important and critical features of the actual knowledge processes.

In the last three sections of the article we first try to elaborate a bit more on how companies can optimize their knowledge processes by working in three dimensions which we label knowledge enablers, knowledge receptors, and knowledge processors. We try to exemplify what each means in Unimerco. After that we take a broader look at the strategic implications for companies as they are going through the ever more knowledge intensive transformations, again with lessons from Unimerco as a guideline. And finally, we point towards next steps in a research agenda that will lead to a substantial and practical understanding of knowledge in companies and in the economy.

Unimerco – the case

Unimerco A/S was founded in 1963 as a tool distributor and supplier of tool oriented services to the furniture industry. The culture of the company was craft and service oriented.

Over the last 15 years the company has transformed itself to a high end specialized tool supplier and production optimization service provider for the auto, aerospace and off-shore industries. Starting out as a local Danish company, Unimerco has become a small global company with subsidiaries in Norway, Sweden, Germany, the UK, and the US. The next two subsidiaries will be located in Eastern Europe and China. The transformation was undertaken while expanding, growing and maintaining profitability every single year, leading to a present year revenue of m\$ 80 and after tax profits of m\$ 7.5

Throughout, Unimerco has been awarded a number of prizes, most recently the Danish Quality Award, Danish Environmental Management Award, The Danish Energy Prize, No. 1 Best Place to Work Competition, Denmark and EU, and the Ford Motor Co – The 2003 Manufacture Engineering Excellence Award.

2. The drivers of transition

To understand why knowledge has gained increased urgency in company strategies as well as in academic debate, we need first to understand what is changing in the economy.³ What are the technological and economic drivers of change? There seems to be some level of consensus about these questions:

Technological developments and globalization of supply have led to a situation of supply overcapacity and hyper-competition. We see hyper-accelerated technology development not only in IT, but also in telecom and materials technologies. While parts of this development follows paths of continuity, there is a growing number of unpredictable discontinuities, some of which are based on a crossing pattern of convergence and divergence.⁴ The challenge of more imbedded knowledge in each product and process generation is exacerbated by ever shorter product generation life-cycles. Companies are faced with the imperative of keeping up with rates of technology change while also dealing with the relative slowness of changes in demand, consumer behavior, and social and organizational practices.

As if these conditions were not challenging, companies are also faced with political issues of global reach and urgency: Globalization is on-going, but increasingly conflict ridden. There is a real growth in global wealth, but also increasing – real and perceived – inequality and polarization. Environmental imbalances lead to growing costs, constraints, and regulations, as well as the risk of disruptive catastrophes.

The directions of change that companies have taken in response to these pressures are well described and documented, though it is important to stress that we are not seeing any simple, unified picture. Not all companies have gone equally far in each direction; not all sectors are equally influenced, and there is of course a wide variety of particular adaptations of a common direction. Within this complex picture, however, some important common denominators, or trends, seem to be:

- the time allowed by competition from the need for change is recognized to successful implementation of change is so short that no time is left for cumbersome processes of reporting up and intervention down through several layers of hierarchy
- the amount of knowledge imbedded in each function is large, complex, and predominantly tacit, and can only be mastered by persons who are fully involved, so the likelihood of timely and adequate intervention from higher up in the hierarchy is very low

³ For an excellent overview of these processes see John Zysman: Production in the Digital Era: Commodity or Strategic Weapon? BRIE working paper 147, Berkeley 2002.

⁴ To exemplify: While computers and TV-sets are converging just as printers, fax- and copy-machines are, there is an equally strong tendency of divergence, for example when what used to be one PC is replaced by a desk-top, a lap-top, and a PDA.

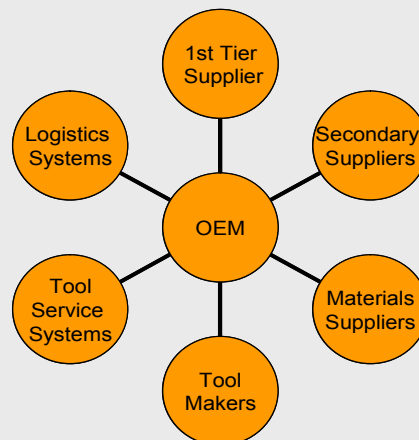
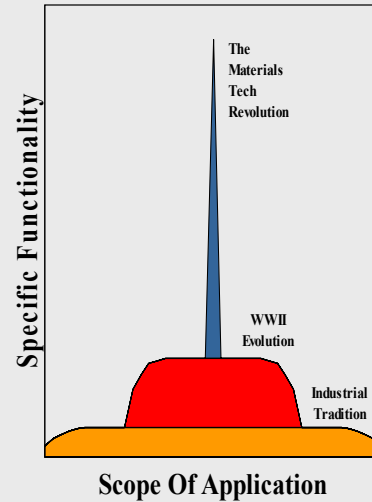
Unimerco – The drivers of transition

The materials technology revolution

The materials technology revolution has led to a drastic increase in the number of industrial materials. A few universally applied materials have been replaced by thousands of functionally specific materials. As each material requires specific designs, processes, tools etc., the ubiquity of thousands of functionally designed materials have revolutionized tools and made highly specialized tooling technologies such as those Unimerco masters necessary.

The global division of labor

As no single company can maintain in-house expertise sufficient to handle all aspects of all the new materials deployed in products, the materials technology revolution leads to changes in the global division of labor and strategic outsourcing. Thus, it is significant that the Unimerco niche derives from outsourcing rather than displacement of competitors. The actual global division of labor required to create space for a company at Unimerco's level of specialization is truly mind boggling, not least considering the fact that it entails direct sharing of knowledge from the first to the last link.



- Solutions to concrete challenges in processes or products require the complex combination of knowledge vested in different functions. This cannot be mitigated by hierarchical intervention, but requires a direct sharing of knowledge among those actively involved
- For all of these reasons knowledge must also be shared among companies – between supplier and OEM; between customer and purveyor. This requires relations of knowledge sharing with a continuity, bandwidth, and symmetry way beyond what is possible within a conventional market transaction

All in all this leads to fundamental changes in the nature of the relations that are constitutive for our conventional concept of a company. The company arose during the very early stages of the industrial revolution as a subset of the societal organization of the division of labor. Internally, the company was a non-market organization with a functional division of labor coordinated and directed through a managerial hierarchy. Externally, the company as a subset was positioned and regulated as part of the wider division of labor through its external relations, which were all mediated by the market and processed in the form of market transactions.

What we see as the effect of the described drivers of transition and the resulting changes, is that *internally* the traditional form of hierarchy is collapsing, and the separation of different functions is overlaid by processes of direct coordination and sharing of knowledge. The dependant and dispensable employee who acts under the direction of the managerial hierarchy and whose efforts are coordinated with the work of other employees through and by that hierarchy, now becomes the de facto owner of some of the knowledge without which the company could no longer develop and compete. This knowledge can only be activated by the employee; problems must be identified and their solution initiated by those directly involved in the primary work process, because only they have a chance of mastering the complexity of knowledge involved in that specific process. When the solution for a problem involves several functions, this again cannot be achieved in time by and through the hierarchy, but only through direct interaction and direct knowledge sharing between those involved in the functions

Externally relations are no longer fully definable in terms of the market transaction: Procurement and the relationship with suppliers change from one situation, where the company tries to dominate dependent subcontractors and put pressure on price, to a new situation where companies select suppliers based on their unique knowledge and skills in domains, which the buyer can no longer attempt to master in-house. This new relation cannot be based on unilateral dependency, and must have continuity far beyond a transaction between procurement of one company and the sales function in the other company, because the essence of the relation includes the sharing of crucial knowledge over time. In much the same way, customers are no longer accessed solely through a sales process or with the means of mass marketing. The customer is the source of unique knowledge and hence indispensable for future competitiveness. Marketing and sales are transformed from mass marketing and transactions to relationship marketing and the building of loyalty around a company brand.

Along the same lines we can map changes in the relations with knowledge partners, with shareholders and with stakeholders. The sum is that all the relations of the company are transformed, and that they are transformed interdependently, For example customer brand-loyalty is inconceivable without a concurrent alignment of employees around that same brand and its inherent values. The employees are after all involved in all crucial touch points between the company and the customer.

The total set of relationship transformations is summarized in this table:

Knowledge Processes – the relationship transformation

	Employees	Customers	Suppliers	Competitors	Knowledge partners	Shareholders	Stakeholders
Traditional relation	One to many control through hierarchy	One off market transaction by salespeople	Price driven control game by procurement people	Minimum direct contact – War game	Minimize use of external sources of knowledge	Anonymous mass to be handled through mass market communication	Not relevant
Trend	All relations change from asymmetric, control oriented, one-off to symmetric, continuous, rich on substance, partnership oriented relation. No single relation can be optimized without the other relations being optimized as well						
New relation	Employees as owners and partners	Close sharing of knowledge; long term partnership	Supplier as source of knowledge; long term partnership	Competitors as partners in networks of scope	Enhanced reliance on external knowledge partners	Intense investor relations	Responsible relations with all stakeholders

Unimerco – The new relation							
	Employees	Customers	Suppliers	Competitors	Knowledge	Shareholders	Stakeholders

In principle, these transformations are redefining our concepts of a company and of the market. Therefore, the consequences of the transformations are likely to have a long term revolutionary impact on the economy.

3. The nature of knowledge processes: Clarifying some misconceptions

It is clear from the logic of these transformations of the constitutive relations of the company that knowledge is a key factor. Indeed, this is the primary reason for labeling the changes in the economy as a change towards the knowledge-based economy. The internal hierarchy is bypassed and control diluted by knowledge relations. The division of labor and separation of functions are being mediated towards reintegration through knowledge sharing. Market transactions are being overlaid by knowledge interaction.

To reach the depth of understanding of the transformations which will help companies cope, we must understand the role of knowledge. Unfortunately, within the current literature about the knowledge revolution, the dominant knowledge management school is based on some fairly basic misunderstandings. Codified knowledge is seen to be the primary and most valid manifestation of knowledge. The predominance of information technology and the triumph of scientific knowledge are perceived by the school as leading to increasing codification of knowledge. The balance is seen to be tipping: Since knowledge can only be worked on and communicated with IT if it is codified, we are forced and motivated to codify more and more.⁵ And since scientific knowledge grows in importance and gets more and more direct financial weight, the assumption is that its inherently codified nature contributes even more towards tipping the balance so that more knowledge will tend to be codified, and the importance of other forms of knowledge will diminish. At the basis of these assertions is an underlying assumption that systems of codified knowledge are rationally complete. This assumption seems to come right out of the most conventionalist apologetic schools of the theory of science from the late 1800s (trying to save the traditional form of the legitimacy of science in the face of the collapse of Newtonian physics as undisputed paradigm), and though these schools stand repudiated by any theory of science since, the assumption keeps popping up in the knowledge management literature.

During the 1990s insights into the interdependence of science and innovation gained through empirical studies served as eye-openers and in relation to these common assumptions. Several studies showed that less than 3% of the value of innovation derived from relatively new codified knowledge.⁶ The time lag from scientific codification to application was shown to be not only long – around 20 years – but also constant over the latest 100 years.⁷ The impression that the time lag might be shortening was demonstrated to be only partially true, and within the classical ‘discovery science’ domains not true at all. Any trend towards shortening the gap was limited to ‘design science’ domains such as IT, materials technology, and in some instances biotech, and even in these cases the gap remains quite long.⁸ These eye-openers show us that the story of enhanced, accelerated innovation and the knowledge-based economy involves much more than science and codified knowledge: We need to dig deeper.

Even without resorting to recent research we can identify why the concept of knowledge propagated by the ‘knowledge management’ school is flawed. The concept falls short of both the classical theory of knowledge and the past hundred years of theory of science. The basic assumptions are the same, but the consistency and honesty about the problems inherent in these assumptions, which signify the greatness of the tradition, are ignored in

⁵ An example of this same fallacy, formulated outside the knowledge management school, can be found in Jean-Francois Lyotard’s often heralded critique of the development in *The Postmodern Condition: A report on knowledge*, University of Minnesota, 1984

⁶ Many of these studies summed up in Terence Keley, *The Economic Laws of Scientific Research*, London 1996

⁷ Best demonstrated in a study from the US Department of Defense, 1993

⁸ For the distinction between ‘discovery science’ and ‘design science’, see Rikard Stankiewicz: *Digitalization-induced evolution of innovation systems: The case of biotechnology*, 2003. This study was also part of the FP5 EU-project on Tracking the New Economy Transformation.

the knowledge management literature. From Plato onwards the tradition is characterized by the attempt to justify knowledge achieved by an autonomous subject about an independent object. Plato ends in the problem that no concrete object can be identified and individuated from any number of universals, and no universal can be induced from the specific. His solution is to relegate any specific object to a status of secondary reality.⁹ Descartes finds certain ground for knowledge in the disembodied mind, but again at the cost of what can be known about any reality that is not cognitive.¹⁰ In the empiricist tradition from Locke to Hume only the particular independent objects have primary reality. This means that only their primary, non-qualitative properties are real; that nothing universal can be known, and in the end that the existence of the world cannot be stated with certainty.¹¹ Kant's synthesis is enabled through the claim of synthetic a priori knowledge, but still does not solve Plato's problem of the impossibility of bridging from universal to particular.¹²

In this sense the tradition of theory of knowledge can be seen as a long line of courageous and very consistent attempts to justify the possibility of knowledge by a subject of a reality that is independent and separated from it. All attempts turned out to be in vain. So in effect the tradition becomes as a giant effort to demonstrate that if subject and object are separated and disjoint, then objective knowledge – i.e. knowledge about the object that is true of the object and independent of the subject – is not possible. Obviously, this conclusion pertains to the very possibility of rationally complete systems of codified knowledge, and hence to the foundations of knowledge management.

Much of the current literature about the knowledge-based economy ignores this conclusion by arguing as if the problem did not exist.

We could also turn to the theory of science. After the breakdown of the Newtonian paradigm and shortly after of the conventionalist and the logical empiricist attempts to save the idea of objective, independent, and self contained rationality and truth, all of the 20th century theory of science has been in a process of more or less orderly retreat from that concept. It is clear that verification is not possible. Ultimately, falsification is equally impossible. Absolute commensurability of scientific theories has had to be given up.¹³ Finally it has become clear that one level of segmentation of reality (for example a molecular level), might be a necessary, but never a sufficient condition for phenomena at a higher level (i.e. biological or social phenomena). This means that any attempt to

⁹ See Plato's dialogue *Theaitetos*, not least in the wonderfully commented edition by F.M. Cornford, London 1960, but also Alexandre Koyre: *Discovering Plato*, New York 1945.

¹⁰ Other than going to Descartes' own works, these points come out well in two very different commentaries, Jonathan Ree: *Descartes*, London 1974, and George Lakoff and Mark Johnson, *Philosophy in the Flesh*, New York 1999, the chapter on Descartes pp 391-415.

¹¹ An analysis of the main early empiricist philosophers that brings out this aspect very clearly is Jonathan Bennett: *Locke, Berkeley, and Hume*, Oxford University Press 1971.

¹² Other than going to Kant's *Kritik der reinen Vernunft* and his *aesthetics* the two classics which analyze his position in this respect are George Lukacs: *Geschichte und Klassenbewusstsein*, Luchterhand Verlag 1968, and J. Habermas: *Strukturwandel der Öffentlichkeit*, Frankfurt 1961.

¹³ A tour de force through several of the main positions in this development can be found in Imre Lakatos and Alan Musgrave (ed): *Criticism and the growth of Knowledge*, Cambridge University Press 1970.

reduce the explanation of all of reality to one unified science is futile and false.¹⁴ All of this is ignored in the knowledge management literature.

So what is knowledge, and what do we know about it?

There are several sources of knowledge about knowledge, including new thinking within the theory of knowledge¹⁵; a number of different attempts to rethink the theory of science¹⁶; significant new insights arising from so-called ‘second generation’ cognitive science¹⁷, and some outstanding attempts to understand knowledge processes in companies, particularly those tightly linked to practical experience from knowledge intensive companies¹⁸. The sum of these insights is that knowledge is contextual, selective, and concept dependent. Let us briefly discuss each of these key characteristics.

Knowledge is contextual: No knowledge can be true and no knowledge can be linked to reality independent of context. A statement that appears universal is necessarily an abstraction and can only be true if interpreted into a context. The links between a statement and its context – both in terms of what defined its origin and in terms of its potential application – are multiple and complex but definitely include the fact that knowledge is embodied, that it is personal, social, and historical.¹⁹

Knowledge is selective: Reality is infinitely rich and any context can be perceived in multiple ways. Any perception and any form of knowledge represent a selection of what is relevant and pertinent, and of what is not. Because of this fundamental relation all knowledge will be abstractive and reductive and in need of interpretation. Selection determines what is in focus, and what is subsidiary, and what is just passive background. Selection determines the level of segmentation – are we looking at a physical system of mass and energy, at atomic configurations, at a set of biochemical processes, at biological creatures, or at a social situation? What constitutes the relation between part and whole, not to mention the relation between selected subset and all other possible selections; between that which has been selected and whoever made the selection?²⁰

Knowledge is concept dependent: Whenever knowledge is expressed it is dependent on the language in which it is expressed. Content and meaning of a statement varies with language. At one level this fact is a matter of a degree of incommensurability between natural languages. At another and more fundamental level this dependency follows from the metaphorical nature of a very large proportion of the concepts we use to talk about our reality. The metaphorical concepts are not only not literal in meaning, they also have several non-identical meanings and uses, most of which cannot be eliminated even in

¹⁴ This is argued most strongly by Polanyi in *Personal Knowledge*, and by Mario Bunge in *Scientific Realism*, New York 2001, for example pp 167 ff

¹⁵ From Merleau-Ponty and Foucault over Todes to modern pragmatism; Wenger.

¹⁶ Kuhn, Feyerabend, Bunge, Polanyi.

¹⁷ Damasio; Lakoff and Johnson.

¹⁸ Nonaka; Suchman; Seeley-Brown.

¹⁹ Polanyi; Wenger; Lakoff.

²⁰ Foucault, Bunge, Polanyi.

formal use.²¹ This is true also of many of the basic concepts which we utilize to formulate and express scientific knowledge such as space, time, cause and effect.

These three characteristics of knowledge imply a number of radical consequences for our theory of knowledge: Knowledge is not the insight of an autonomous, neutral subject into an independent objective reality. Knowledge is a function of the inalienable unity of embodied subject and the world in which it is objectively imbedded and takes part. Any codified form of knowledge is thus incomplete and can only become full knowledge through the interpretation and the addition of knowledge, which cannot be codified or even expressed within its present framework of codification. The plural meanings of its conceptual metaphors cannot be accounted for within its framework of codification. Furthermore, neither the specific selections on which knowledge is based nor the context on which it is dependent can be expressed as part of the codified statement itself. Any codification of knowledge is constituted in conditions which must remain tacit within the given framework of codification. Therefore, knowledge is not and cannot be primarily codified, just as there cannot be a process of increasing codification of knowledge. Growth in codified knowledge is part of the growth in the full body of knowledge, so new codified knowledge will always be just the top of the iceberg. Any codified knowledge is only knowledge on conditions which cannot be included in its codification, and which must remain tacit within this system of codified knowledge. There is no rationally complete system of codified knowledge.

4. *The system of knowledge – dynamics and main categories*

On the basis of these characteristics of knowledge, we can define the internal dynamics and the main categories of our knowledge system. While obviously it makes sense to differentiate the concepts of tacit and explicit knowledge, we have seen that the two are not independent of each other, but dynamically linked. Whenever we seek to reflect or work on a dimension of tacit knowledge, the very nature of this operation includes bringing aspects of the tacit into focus and thus exposing it to some kinds of the selection and abstraction process, which in itself is a step towards codification. And whenever we codify or even express knowledge, the codification or the expression is dependent on conditions, the nature of which is tacit.

These dynamics within the system of knowledge prove to be the constitutive feature of the growth, creation, and application of knowledge. Before we investigate these dynamics in more depth, we need to discuss some of the main categories of the system of knowledge, and thereby some of the forms and aspects in which knowledge appear.

A main distinction is between tacit and explicit knowledge. Tacit knowledge is concerned with all those areas of *know how* where we know what is needed to accomplish intended changes without being able to express the knowledge involved. It is

²¹ Whorf, Nida, Quine, Lakoff

clear that by far most of what we do in every day life out is based on the activation of tacit knowledge. It is also clear that much of what in one situation is tacit can be expressed in other situations. For example the fact that I am right now focusing on what I write, and therefore pay no attention to and cannot express the physical process of writing, does not mean that it is impossible for me in another situation to focus on the writing process and actually make much of the knowledge involved in that process explicit.²² There are, however, many indications and quite a bit of evidence suggesting that some of our tacit knowledge is not only *unspoken*, but also *unspeakable*. This evidence includes observations in brain physiology of the disjoint location of centers of implicit and explicit memory; the fact that whereas the human brain processes a minimum of 11 mb/s, we consciously handle a maximum of only 40 b/s²³, as well as the logical and empirical observation that the basic knowledge involved in our language capability cannot in itself be expressed.

Another key observation about tacit knowledge is that in its pure tacit form it is not only contextual in a concrete sense; it is also absolutely confined to its context. This implies an absence of reflection and a very weak and limited potential for growth and improvement in knowledge. A basketball player can improve her lay-up skills by training and multiple repetitions, but without comparison of success from day one to day ten, and without some comparison with other players, and some reflection on what made the first attempt successful and the second not, improvement is likely to be random and limited. But comparison involves selection and abstraction, and if not an outright explicit expression of the involved knowledge or aspects thereof, at least the ability to think and talk about some part of the knowledge. Though there is yet no explicit knowledge, there is a dimension of ‘spoken-about knowledge’, where comparison and reflection are enhanced by anecdotes; by incomplete linguistic impressions, or by metaphors and metonyms. Anyone can get an illustration of the richness and pervasiveness of this ‘spoken-about’ category by observing a group of kids on a basketball court or a group of adults in the process of jointly cooking a meal.

Just as tacit knowledge bifurcates into unspeakable and unspoken, *explicit* knowledge can be either *spoken* or *codified*. Spoken knowledge is verbally expressed knowledge that has not been formalized within a formal, strict code.²⁴ Spoken knowledge plays a significant role both in the process of making knowledge explicit and communicable and in the process of interpreting codified knowledge towards applicability. Very large bodies of knowledge exist in spoken form without ever having been codified. Because of the overwhelming focus of attention on the codified knowledge of formal science, there has been a tendency to overlook the role of spoken knowledge in the overall system of knowledge. To get a full understanding of the richness and complexity of knowledge processes, this tendency must be avoided.

²² See the brief discussion on focal and subsidiary knowledge below, and for an in depth analysis see M. Polanyi: *Personal Knowledge*.

²³ Manfred Zimmermann, quoted from Tor Nørretranders: *Mærk Verden (Touch the World)*, pp 163-5.

²⁴ We follow the main trend within the newer theory of knowledge by distinguishing between knowledge expressed in spoken, natural language and knowledge expressed in a more formal code as mathematics.

We already discussed (see the first part of section 3 above) the tendency to focus on codified knowledge; to identify codified knowledge with ‘real’ knowledge, and to assume that over time relatively more knowledge will be codified. There is even a tendency to define the concept of the knowledge-based economy by the assumed triumph of codified knowledge. We have also seen that this is a misconception. Codified knowledge can only be generated in a process that starts in a dependence on context, which cannot be expressed within the codification. An essential part of the process is selection, abstraction, and reduction, and again the criteria and conditions for this selectivity cannot be expressed within the codification. Finally, despite the appearance of formality of the system of codification, any statement will always be language dependent and fundamentally reliant on metaphor and metonyms. This implies dependency on non-literal and multiple meaning, which is constituted outside the framework of codification and even beyond what can be made explicit. In other words all codified knowledge is incomplete in its codification and complemented only through the addition of knowledge, which within this codification is necessarily tacit.

As a consequence all codified knowledge must be interpreted and added to before it is completed as knowledge, and much of this value adding comes from tacit dimensions.

This does not detract from the fact that codified knowledge represents a huge amplification of the reach and scope of our overall system of knowledge. The amplification of tacit knowledge inherent in our basic ability to speak about it is multiplied many times over – and progressively so – as tacit knowledge is exposed to the challenge of codified knowledge. We must not forget, however, that this challenge can only become real through our ability to interpret and add value to the body of codified knowledge in order to synthesize back through the layers of abstraction and selection down to the now reflected context of application. The ability to do this is mostly tacit, and in terms of the framework of codification it is always tacit.

We are now getting to the core of what characterizes the knowledge system and its dynamics. Tacit knowledge can be enhanced, leveraged, and amplified by being spoken-about, spoken, and codified. Any step in this direction enables reflection and amplification. But any step also implies selection, reduction, and abstraction. Therefore, spoken and codified knowledge is incomplete and dependent on the addition of tacit aspects to be related back to reality and context and thereby to be applied. Growth of knowledge and the key knowledge process in the knowledge-based economy is not the growth of codification, but the intensified exposure of codified knowledge to the tacit and spoken-about interpretation and application, and the reflection of tacit knowledge through the challenge of codified knowledge. We believe that the defining characteristic of the knowledge-based economy is the possibility of a much more intense and iterative re-integration in processes back and forth between the main categories of the knowledge system.²⁵ Several points follow from this core:

²⁵ This insight can be deepened significantly by looking at the interconnections in a historical perspective. To do that is beyond the scope of the present article, but it is discussed extensively in N.C.Nielsen’s upcoming book. Prior to the industrial revolution hardly any part of the knowledge involved in production processes was codified. As a matter of fact all dimensions of knowledge involved were directly integrated

First, whereas some methodological attention has been paid to the process of codification, little work has been done on how to enhance the synthetic interpretation process. This of course also means that the method of codification needs to be revisited, so we need to develop a new methodology of the complete knowledge process. At company level this has significant implications for strategy, organization, and competitiveness. Also for regional economies it has implications for competitiveness, and for theory the implication will be a reinvention of the theory of knowledge and the theory of science.

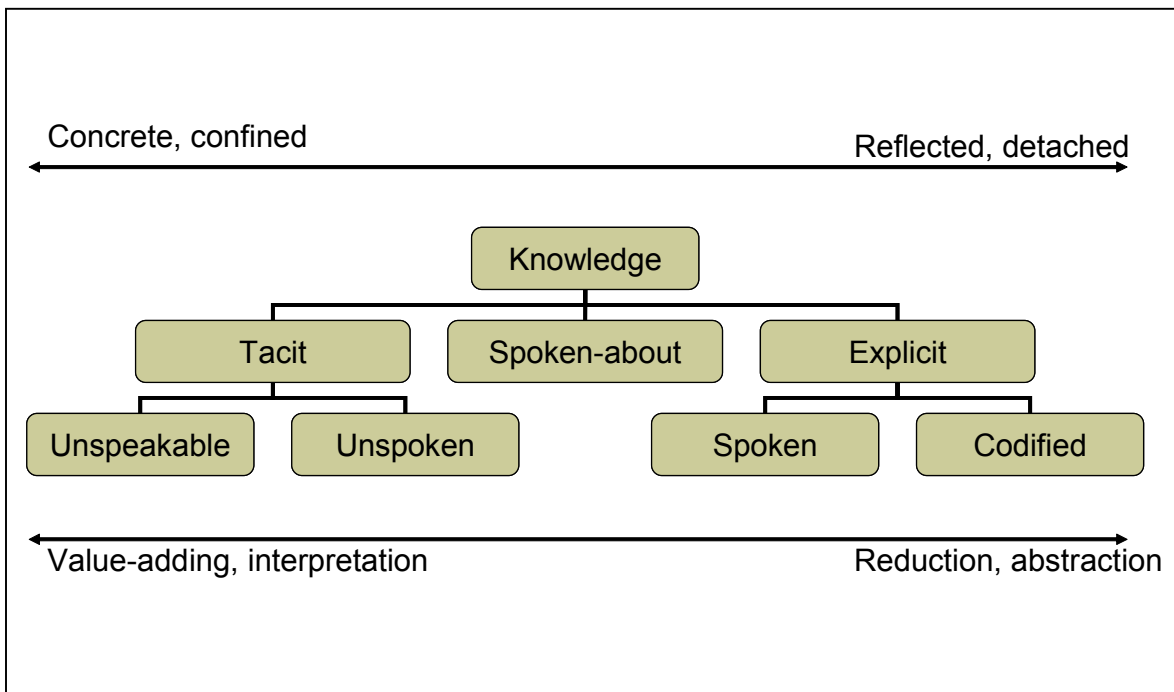
Second, it follows that no specific form of codification has a given priority over other forms. It is legitimate to re-codify a body of knowledge if a different codification promises to be more fruitful in the interaction with the present context of tacit and spoken-about knowledge and application.

And third, in a radical interpretation of the characteristics we have assigned to codified knowledge and its dependence on metaphor, all explicit knowledge is spoken-about knowledge rather than spoken or codified knowledge. Since reference and meaning are not and cannot be consistently literal and definitive, even our most codified statement of knowledge is less an explicit direct expression of knowledge and is more another way of speaking-about knowledge. Though we believe it makes sense at least for conventional and heuristic reasons to stick with the categories of explicit, spoken and codified knowledge, the category of spoken-about knowledge gains further importance. We introduced it as an intermediary step in the process of making knowledge explicit and allowing reflection of tacit knowledge. We see now that spoken-about knowledge is a legitimate step in the process of interpreting and adding value to codified knowledge. To be able to speak about knowledge can be a necessary and hybrid, which enables us to enrich and thereby apply codified knowledge much more quickly than otherwise possible. The non-literal, multi-faceted meanings of the metaphors inherent in codification not only allow for hybrid, spoken-about forms, but make them inevitable.

in the person performing the work process. Codification was linked to knowledge domains that were not activated in production, but were part of other societal functions. The upside of this was a certain form of integrity and dignity for the worker and in the work process; the downside was a very slow rate of innovation and growth of productivity. During the industrial revolution this unity vested in the person was broken. The workforce performing the immediate work processes was no longer planning, managing and controlling the overall production process, and over time the separated managerial function began to employ codified knowledge in the form of engineering and technology to develop the process. Significant parts of the knowledge employed in production became codified, but removed from those performing the physical work processes, and disintegrated from the involved tacit knowledge. The drivers of change which we discussed in the first sections of this article have an erosive impact on this disintegration. The knowledge vested in production processes is too large and intense to be mastered by anyone not fully involved in the process. Hence the planning and control has to be reintegrated with performance of the process. And the codified knowledge can no longer be applied without a deep involvement in the context of application that drives the process towards dynamic reintegration of the different forms of knowledge from tacit and imbedded to codified, as we are discussing it in this article. The specific forms of the division of labor, and the institutions developed to organize those forms, which came out of the industrial revolution are being changed in quite fundamental ways. This is one of the reasons that the knowledge revolution we are discussing might be fundamental in the same sense as the industrial revolution.

The system of knowledge unfolds as the dynamic interplay among the categories of tacit, spoken-about, and explicit knowledge. Within this dynamic, tacit knowledge can be unspeakable as well as unspoken and explicit knowledge can be spoken as well as codified. The dynamic is defined by the interplay of a process of selection, abstraction, reduction, and reflection going one direction with a process of interpretation, value-adding, and application going the opposite direction. Spoken-about knowledge emerges as the crucial, enabling form in the interplay, which allows the process to intensify and accelerate. The system is illustrated in the figure below:

System of knowledge – main categories



Three additions to this overview of the system of knowledge, its main categories and processes will be helpful when we use the system to understand the processes within our case company, Unimerco.

The first addition relates to the distinction we already discussed between focal and subsidiary knowledge. This distinction fits into the system with focal knowledge located at the border between tacit and explicit, since focal knowledge can be and often is spoken or spoken-about, but can be tacit, and with subsidiary knowledge clearly located as tacit, though not necessarily as unspeakable, since what is subsidiary in one phase might easily be focal in the next.

The second addition is once again often overlooked, but has enormous, growing scope and impact. It is the category of imbedded knowledge. One of the ways codified

knowledge can be handled is by imbedding it into procedures, tools, or technologies. A simple example is the way the rules and procedures of calculation are imbedded in a pocket calculator. Prior to being imbedded they represented codified knowledge. Once imbedded this knowledge is at the disposal of a large number of users, who can do more complex calculations more quickly than people who do not have access to the tool with its imbedded knowledge. A subset of the knowledge compiled in society is available to everyone at the very limited cost of learning to use the tool. In this sense we are dealing with knowledge in a form that is neither explicit nor tacit in any trivial sense. The knowledge imbedded has always been explicit and codified before it is imbedded. However, for the user it is very rarely explicit in its full scope and complexity, and the tacit knowledge required of the user is tool and use related knowledge rather than the knowledge that was imbedded in the tool. This is the reason why anyone with mastery of a pocket calculator can out-perform someone using a pen and a notebook for calculations, but will most likely under-perform if expected to do the same calculations without the tool.

All societies have developed pools of imbedded knowledge, some of it imbedded in social structures and practices, and other parts available in the form of tools and technologies. But the relative dominance and impact of imbedded knowledge in industrial and post-industrial societies are mind-boggling no matter how we look at it, in the perspective of every day life; in terms of the knowledge activated in any company, or in terms of the functioning of the society. We are far from fully understanding how much of socialization is concerned with building the kind of 'technology literacy' that enables most members of a modern society to activate and leverage a significant scope of imbedded knowledge. There is also quite a way to go before we understand the difference between the companies in which imbedded knowledge makes employees less competent and more dependent, and those companies where imbedded knowledge is a real lever for the active knowledge of employees as well as for the company.

The third addition is the distinction between social or organizational and individual knowledge. There is no simple way of mapping this distinction onto the knowledge system. For example, it is often asserted that tacit knowledge by its very nature is vested in individuals and is hard to share. But there are clearly forms of tacit knowledge which belong to an organization as well as to individuals. Just think of the numerous every day tasks we are competent to perform as part of a team or in a specific social context, but which we could not even start to deal with outside that team or context. Capabilities of that nature seem to represent organizational tacit knowledge. At the other end of the knowledge system, codified knowledge in the form of scientific knowledge appears to be essentially defined by its public and hence inherently social status. But as we have seen, codified knowledge including scientific knowledge is only completed as knowledge by the addition of dimensions which are tacit and therefore not obviously social.

Once again we come to the realization of greater complexities in knowledge than expected at first glance. We shall not attempt to map the distinction between social and individual knowledge onto our illustration of the system of knowledge (how can this type

of complexity be mapped in two dimensions?), but this does not mean that the distinction can be ignored in further work.

With these three additions – of the categories of focal/subsidiary knowledge; of imbedded knowledge, and of the distinction between social and individual knowledge – we should be ready to take our picture of the knowledge system and its dynamics and use it to describe and understand the actual challenges of knowledge processes in companies.

5. Knowledge processes in companies

Our analysis up to this point explains why knowledge management has had such limited success in companies. The overemphasis on codified knowledge makes it logical to give priority to database and communication systems that encourage codification, documentation and storage of organizational knowledge. The lack of insights within the knowledge management tradition into the dependence of codified knowledge on the other dimensions of knowledge makes the difficulties of this approach inevitable. Codification has meant reduction of context and meaning. What was documented has tended to be of no use to anyone, as evidenced by the actual under-utilization. For the same reason very few have been motivated to make the extra effort and actually codify and document their knowledge. Why produce what no one is going to use? The proliferation of incentive schemes to encourage employees to document knowledge and re-use it is in itself a symptom of the depth of the problems. Without a clear understanding of the specific interconnection of the different forms of knowledge, there is neither a sensible way to select the right knowledge for the right form of codification, nor obvious ways for the organization to apply its codified knowledge. The efforts are bound to be in vain.

From the other end of the system of knowledge there is a significant school of thought, which is positioned in opposition to the knowledge management tradition, and focuses on the issue that organizations will only know – and own what they know – if they are able to share tacit knowledge and thereby raise it from an individual to an organizational status. The roots of this school can be found in studies of apprenticeship learning, and in anthropological studies of learning in traditional communities.²⁶ Within the school it is documented how communities gradually include new members by involving them first in legitimate peripheral positions, from which they can observe the social practice, and then step by step involve them in more active roles, from supervised simple operations to more independent responsibility for complex and complete practices. This is a process through which not only new members are allowed to learn, but which also facilitates the sharing of improvements among established members of the community, and the ability of the community to speak-about the knowledge involved. Finally, it is a way of

²⁶ Prominent examples are Jean Lave and Etienne Wenger: *Situated Learning. Legitimate Peripheral Participation*, Cambridge University Press 1991; S. Chaikin and J. Lave: *Understanding Practice*, Cambridge University Press 1993; Etienne Wenger: *Communities of Practice: Learning, Meaning, and Identity*, Cambridge University Press 1998; Lucy Suchman: *Plans and Situated Actions*, Cambridge University Press 1987. The school has strong roots in the pragmatist tradition.

ensuring that tacit knowledge of one member becomes the tacit and spoken-about knowledge of the whole community.

The analysis of communities of practice along these lines have helped understand the practices of sharing tacit knowledge and of spoken-about knowledge in companies, and it has certainly enabled companies to remove constraints from the sharing of tacit knowledge. There is no doubt that Unimerco – like many other companies with a strong knowledge culture and a tradition for apprenticeship learning – is a well-functioning community of practice.

The weakness of the school is that the communities of practice it describes tend to be relatively static in knowledge just as tacit knowledge in itself is confined to its context. To get to grips with knowledge in a dynamic sense, which is what we must do in relation to companies on the verge of the knowledge-based economy, we will have to move beyond viewpoints configured around either tacit or codified knowledge.

In his book on *The Knowledge Creating Company*²⁷, Ikujiro Nonaka shows that the crucial knowledge creating processes in a company are dependent on the sharing of tacit knowledge with tacit knowledge; of tacit knowledge with codified knowledge; of codified knowledge with tacit, and of codified with codified. He describes this process matrix:

	Tacit knowledge	Explicit knowledge
Tacit knowledge	Socialization	Externalization
Explicit knowledge	Internalization	Combination

We agree that this picture captures some first valuable insights, but we are also convinced that all the dimensions of the knowledge system as we defined them above need to be included in and add value to a full mapping of the knowledge processes. Indeed, when looking at the actual examples in Nonaka’s book and even more in his recent *Enabling Knowledge Creation*²⁸, he seems to be moving in that direction, as illustrated by quotes such as this:

*“Making a case for knowledge re-creation is crucial, because explicit knowledge packaged and dispatched is lifeless; on its own, it has no passion, vigor, or vision. Only when this explicit knowledge is internalized, when it is transformed into shared tacit knowledge, does it contribute to a local business operation’s capacity to act.”*²⁹

We have seen that the knowledge system consists of intense and iterative processes between the different categories of knowledge, and that each category can transfer directly into each of the other categories. Therefore, our hypothesis is that a full mapping

²⁷ Ikujiro Nonaka: *The Knowledge Creating Company*, Oxford 1995

²⁸ Ikujiro Nonaka, Georg von Krogh, Kazuo Ichijo: *Enabling Knowledge Creation*, Oxford 2000.

²⁹ *Ibid* p 236.

of the knowledge processes in a company would need to include all of the categories of the knowledge system in a process matrix.

In our preliminary study of Unimerco, we have chosen to eliminate one of the distinctions, between unspeakable and unspoken knowledge, and include both as tacit knowledge, since we have found no short-term practical way to distinguish between the two categories in empirical analysis. Because of this step we lose some refinement of analysis, but that must be dealt with in future research.

We have chosen to include imbedded knowledge and its interaction with the other categories, partly because this category captures forms of knowledge that are not in any simple way included in the other categories, and partly because of the importance of the role of imbedded knowledge in any modern company.

This means that the task of analyzing the knowledge processes of a company can be initiated by mapping specific processes within a five by five matrix of codified, spoken, spoken-about, tacit, and imbedded knowledge. Our hypothesis is that there are identifiable, meaningful processes in each of the quadrants of this matrix – in most cases a large and complex number of processes in each quadrant – and that the mapping of them will give important insights into the company as part of the knowledge-based economy.

If the hypothesis is true there will be a meaningful issue of how to optimize each of the processes, and of identifying constraints and weaknesses in the knowledge system of a given company. This includes very specific design issues such as how to segment and define the principles of codification in order to optimize all the processes to and from the codified dimension. We shall see how this is an area where Unimerco has taken action with remarkable success.

In the theoretical analysis of the categories and dynamics of the knowledge system, we found that spoken-about knowledge plays a crucial role in enabling the tighter and more accelerated integration from codified to tacit knowledge. Based on this we would expect processes evolving around the spoken-about category to emerge with relatively high importance in any successful knowledge intensive company.

These hypotheses were exposed to empirical testing through a preliminary mapping of significant knowledge processes in the day-to-day operations of Unimerco against our process matrix. A comprehensive view of the processes was taken, including not just internal work, but cooperation with customers, suppliers, and knowledge partners. Actual processes were identified for each window in the matrix with the exception of two borderline cases related to imbedded knowledge. Results of our first mappings can be seen in the matrix below:

Unimerco – Knowledge processes

From:	To:	Codified	Spoken (Explicit)	Spoken-About (Metaphors, Anecdotes)	Tacit (Unspeakable, Unspoken)	Imbedded
Codified		UM Cooperation with universities and industrial research centres	Theory (ion implantation) is concretized into a UM context	System revolution becomes agenda for everyone as “keep it simple” (example)	DB data to human process Designs converted into practical solutions in test centre	DB data direct to machine Designs converted into programmed solutions in test centre
Spoken (Explicit)		In client interaction the ready spoken to codified gets crucial System building and DB	UM–University Value chain dialogue High level customer dialogue	Internal communication about customer specifications	Training programs and instruction	?
Spoken-About (Metaphors, Anecdotes)		Metaphors function as ‘black box’ pointers within otherwise codified systems	Metaphors enrich explicit statements	Cross fertilization of metaphors and anecdotes	Spoken about as catalyst of tacit learning	?
Tacit (Unspeakable, Unspoken)		Specific operation parameters identified, documented and entered into DB	Point learners extract tacit knowledge from key persons and translate into training	Anecdotal evidence on specific in-the-field experience (case/war stories)	Apprenticeship Communities of practice	Experience based optimization of lay-out etc.
Imbedded		New technology specification add to body of codified knowledge	Training programs and manuals add to explicit pool of knowledge	Technology forms frame of reference for non-explicit dialogue	Knowledge acquired in machines enable and update work processes	Direct machine to machine interfaces

It was relatively straight-forward to identify processes that fit the windows in the matrix. The difficulty was to select just one for each, even using fairly broad categories in most cases. None of the identified categories and processes was in any simple sense reducible to any of the others. On that basis it seems clear that a full mapping of the knowledge processes of any company will require at least this framework of categories. In that sense the framework is confirmed.

Just as the empirical mapping by no means pretends to be exhaustive, this brief article is not the right context to go into detail on each of the identified processes. However, some highlights will help expose important features of the actual processes as well as our understanding of the knowledge system.

Example 1: Knowledge acquisition. Unimerco acquired the company Dandia to get access to Dandia's unique mastery of diamond coating technologies and processes in order to strengthen the service offering to auto industry tool makers. Initially, the acquisition was a disappointment since it turned out that most of the crucial knowledge in Dandia was vested in a very tacit way in just one person. To deal with this situation Unimerco selected four point learners to work nearly full time with that person, and to learn from him in a classical apprentice type of osmosis (tacit to tacit). Among these four bright and highly skilled persons the learning process evolved day by day into more reflected forms (tacit to spoken-about) and eventually reached the point where they were capable of expressing most of the knowledge in spoken form. One significant driver in this process was the fact that Unimerco additionally allocated ten key people to come to Dandia every other Monday to work with and be trained by the old master but in particular the four point learners. This cohort of ten is by now the core team of Unimerco's growing diamond coating business, and their knowledge is spread to the teams working with them (tacit to tacit). This certainly relies on the language developed to speak-about the knowledge (spoken-about to tacit), and on the explicitly spoken form it has taken in the training programs (spoken to tacit). Much of the practical learning takes place in work processes utilizing the advanced diamond coating equipment (imbedded to tacit). The knowledge has been progressively codified in Unimerco's norm database (tacit to spoken-about to spoken to codified knowledge), which again is utilized in the performance of any contract (codified to tacit knowledge). During the internal process of codification, the Unimerco teams have reached a point where their own codes enable them to interact directly with and learn from engineering teams from equipment suppliers and from universities (codified to codified, often mediated in spoken to spoken and through imbedded knowledge).

Example 2: Re-codification of production database. Though Unimerco has always understood that the knowledge utilized in the execution of its very sophisticated services is embodied in its people, the company has also understood and emphasized the need for standardization, documentation, and codification of solutions. Serious investment was made into the Unimerco tools database, which had a complete collection of all Unimerco tool blue prints and hence was considered the primary vehicle for documentation, sharing, and re-use of knowledge. In recent years the database and its use began to be questioned. In spite of very high discipline it began to occur that new tools were not documented in the database, or that the updates were made late and only after active managerial intervention. In reviews with customers there were complaints that Unimerco would try to push one of its existing solutions rather than listening to the real needs of the customer. Internally the blueprints were sometimes seen as obstacles to continuous improvement of existing solutions. The massive body of codified knowledge was seen to take primacy over the living knowledge of the Unimerco teams. All of these factors contributed to the monumental decision of re-codifying Unimerco's knowledge database through a fundamental change in segmentation principle. Instead of a database of complete blueprints, the Unimerco database now consists of a much more granular collection of Unimerco norms, each of these specifying the standards of one tool detail. The codification has so to speak gone from a collection of previously made 'statements' to the complete 'alphabet' and 'grammar' utilized by Unimerco in constructing

‘statements’. The effects of this change have been very significant: The individual employee or the team has reclaimed mastery of the processes, while the database is the codification of existing organizational knowledge which leverages and can be leveraged in the execution processes. Continuous improvements as well as interaction with customers about solutions have been enhanced, and documentation of new knowledge in the form of elements of new solutions is no longer a problem, since it has become an integrated part of the process. Many of the granular components of the norms database have even come to life in the daily language of spoken-about knowledge within the company.

Example 3: Change of organizational systems. Unimerco was one of the pioneers in documenting and even certifying its management systems and procedures with certification of quality, environmental impact as well as energy systems. Historically, this had enabled the company to win positions with high-end customers and led to better documentation and transparency in processes. But over time the systems began to be seen as counter-productive. They inhibited flexibility, and tended to vest control and responsibility in systems rather than in teams. Therefore all the classical management systems were changed during 2002 from explicit procedural prescriptions into systems of delegation of responsibility and accountability. This resulted in a major re-alignment of knowledge and responsibility within the organization, which empowered the individual employee and operating group, and enhanced the ability to change and innovate. All in all, it became a major cultural revolution in the company, involving all employees, and enabled through a very intense dialogue in which the change process and all its aspects were identified and spoken-about under the evocative heading ‘keep it simple’.

Example 4: The nexus of spoken-about knowledge. As seen in the example of ‘keep it simple’, many of the very intense and complex knowledge processes in Unimerco seem to be anchored in spoken-about elements. Codified knowledge is domesticated into the Unimerco context by substitution of formalized statements with well known context-pointers, metaphors or anecdotal references. Explicit statements are enriched the same way. In processes of learning or adaptation of new knowledge there is a very intense and for outsiders almost unintelligible process of cross-fertilization of pointers and metaphors. Learning of tacit knowledge in daily practice or during apprentice arrangement is clearly leveraged by an existing and ever growing language to talk about key elements, including non-literal reference to norms from the shared database. Complex changes in systems and codification become a common agenda when included in storylines. Very explicit new customer specifications are interpreted into the Unimerco community of practice in a ‘spoken-about’ short hand. New practical or in-the-field experience is shared in the form of war stories and anecdotes. Large chunks of imbedded knowledge are handled through a sophisticated system of contextual reference to practically mastered technology. All in all, there is hardly any core iteration between tacit and explicit knowledge that does not rely on the very rich fabric of Unimerco’s system and language to speak-about knowledge. This is definitely true of all internal knowledge processes. But it is equally true of processes involving external partners or sources of knowledge. Either they are in such close and long-term interaction with Unimerco that a shared language to speak-about knowledge has had time to evolve. Or it

turns out to be a key role in the internal Unimerco process to link the codified form in which the external knowledge can be accessed to the internal universe of spoken-about knowledge in Unimerco.

While the empirical study of the knowledge processes in Unimerco is preliminary, it still points to some early conclusions. The evidence suggests that it would not be possible to conceptualize the complexities of the overall processes without at least the conceptual framework we have utilized. We are convinced that much of Unimerco's competitive success is based on comparative superiority in enhancing the iterative knowledge processes in the complex web between tacit and codified knowledge forms. This superiority is not least due to conscious as well as intuitive organizational design aimed at optimizing these processes. We believe that spoken-about knowledge is the crucial nexus in the optimization of the iterative processes, and that many of the key organizational features of Unimerco have combined to create an unusually rich environment for generating an appropriate language and culture for this.

Other than these provisional conclusions, the study primarily points towards a further research agenda, as well as suggesting some promising practice areas for experimental and exploratory initiatives in companies.

6. Optimizing the knowledge processes

It is clear that any company needs to optimize its ability to handle knowledge processes to sustain success. It is also clear that this is not achieved only by implementing the solutions that are presently being offered by consultants and IT-providers under the broad heading of 'knowledge management'.

As we have seen these solutions are disabled by the misconceptions of knowledge, which we discussed in the early parts of section 3, and they do not contribute much beyond different technological solutions and organizational incentive schemes to promote the capture and dissemination of codified knowledge. In most cases they do not come close to the level of sophistication that was involved in Unimerco's need to re-codify knowledge in order to achieve better processes between tacit and codified knowledge.

Neither does adherence to the recommendations by the 'communities of practice' school enable companies to optimize knowledge processes. As we have seen, Unimerco is a master in this dimension, yet that alone would never be enough to succeed as a knowledge intensive company in a fierce and ever-changing competitive environment.

Our recommendation to companies is to take the best from the two schools – 'knowledge management' and 'communities of practice' – but to rethink them by forcing them to intersect and by exposing both to the challenges of developing the real internal and

external iterative unity of knowledge. This universe of challenges is obviously way beyond the present scope of the two schools.

We have learned from Unimerco that meeting these challenges involve the design and optimization of *knowledge enablers*; a system of *knowledge receptors*, which as we will see include *imbedded bridges*, and finally, based on this the careful optimization of *knowledge processors*.

Knowledge enablers and the need to rethink ‘knowledge management’ as ‘enabling knowledge creation’ is one of the key findings of Nonaka and his colleagues.³⁰ It addresses the fact that whereas knowledge cannot be commandeered and is very hard to control, people gain knowledge and will share and create new knowledge as part of any work process if allowed and enabled to do so. Most companies, even those which emphasize the importance of knowledge in their strategies, tend to inhibit rather than enable knowledge, because they believe knowledge can be managed within the control and command structures and incentives of traditional hierarchical organizations, or because they have been unable to move beyond such an organization. Unimerco’s answer to this can be seen in the case illustration on knowledge enablers:

³⁰ Their previously quoted book on Enabling Knowledge Creation provides a convincingly thorough mapping of all the many dimension of knowledge enabling, as well as a clear argument why knowledge management does not do the job. Since this article does not leave us room for even a brief overview, we encourage readers and most especially practitioners to seek inspiration and understanding directly in this book.

Unimerco –
*Knowledge process
enablers*

- **Architecture:**
Unimerco's
facilities have
open space
lay-out,
integrating

A knowledge enabling environment can take many forms. When it is nurtured well, it becomes a source of self-reinforcing knowledge processes. Without a good and vital knowledge enabling environment, the company will not succeed in competing based on its knowledge processes even if all other conditions for creating a successful knowledge intensive company are fulfilled.

Knowledge receptors are the sum of all those factors in and about a company that make it more capable to assimilate new knowledge without a full, new knowledge acquisition, adaptation and interpretation process. The factors include established procedures, practices and relations, and not least the installed base of already mastered technology with its imbedded knowledge. They also include the developed language to speak about certain types of knowledge as well as the existing internal codifications and their ability to be expanded to hold new bodies of knowledge.

A simple example, of very high real life impact, is the arrival of a next generation software driver for one of Unimerco's tooling centers from the supplier. The driver might represent 10 or more man-years of new knowledge, but at Unimerco it is downloaded on a number of existing machines; it works within both the existing user interfaces and the existing links to the Unimerco norms database (or this integration is taken care of by one or two persons at Unimerco who developed the original links). The effect is that significant new knowledge is added to Unimerco's capabilities and very quickly converted into functional improvements of customer solutions at low marginal cost to Unimerco. Much of the work of mastering this knowledge was done in the past and now is imbedded in competencies, procedures, databases, and technology, where it serves as a highly effective receptor of new knowledge. This entire installed base serves as bridges and infrastructure for Unimerco and saves the company from having to navigate uncharted territory. Thereby it becomes a powerful barrier of entry to new competitors.

There are two prominent risks for companies with well developed knowledge receptor systems. The first one is a day-to-day risk and is concerned with the lower visibility of the introduction of a new body of knowledge. When an organization is capable of adapting significant new knowledge almost in its stride, the new knowledge becomes a non-event and is paid less attention. It is well known from office organizations that very significant new functionalities in software updates are underutilized, when the updates take place over-night and basically without changes in the user-interface. Even users who have been actively wishing for a certain new facility in their mail program end up not using it if the implementation of the update is too seamless. There are obvious ways to deal with this risk. It is necessary, however, to be aware of it.

The second risk occurs more rarely, but has momentous consequences. The stronger the passive receptor of a company is developed and the better it is imbedded, the more effectively the company deals with continuous growth in knowledge within its domains. At the same time the company becomes so much more vulnerable to discontinuities. The more the company has relied on the strength of its passive receptors, the less it can deal with new knowledge that falls outside the scope of these receptors. This risk spells a very important management trade-off: Short-term optimization will always be at the cost of longer-term flexibility and innovation. This is one of several reasons for the re-codifications undertaken by Unimerco described in section 5, example 2 above. The change in segmentation of the knowledge database of the company was very clearly a weakening of the ability to absorb new solutions completely within the passive receptor

system. At the same time it removed the non-event character of new knowledge, and it enhanced the ability to adapt to discontinuities.

Knowledge processors are fully organizational in nature and are built around all the organizational groupings and practices which are active in each of the many knowledge processes. In Unimerco they include the way the company works with a key supplier setting up a team of key employees from both organizations and building their ability to interact and share knowledge over time. They also include the significant investment by Unimerco in qualifying each of the sales engineers working with key clients in order to move up from selling discreet tools and services and in stead partner with the clients to achieve optimization of the client's production process. This has involved upgrading each sales engineer with a very deep understanding of all the knowledge developed in Unimerco about production processes. It has also required building a relationship with the client where the Unimerco engineer is accepted as a member of the client-team because he is able to add value to the team's total knowledge. A further example would be the systematic and real time communication of client specifications among persons working in sales, design and production, as well as the knowledge distillation and dissemination process we already described with point learners around diamond coating.

There are numerous examples, and many of them represent genuine organizational innovation. Many are the result of direct management intervention or long iterative processes of trial and error where suboptimal results (misunderstandings by production teams of customer specifications; unrealistic promises of delivery times by sales engineers) have driven change of practice, organization or roles until more optimal outcomes have been achieved. To the external observer most of the ways the Unimerco organization configures itself around the different knowledge processes can appear like a living organism, which understands what must be achieved, and continuously seeks to optimize itself.

Knowledge enablers, knowledge receptors, and knowledge processors are all clearly aspects of the Unimerco knowledge organization. They all interact and they cannot be fully defined independently of each other. To optimize the knowledge processes all three have to be in play. Our hypothesis is that these three concepts will make sense in the description of every single knowledge intensive company, and that each will be better understood as more research is done. For the context of this article it is sufficient to highlight these aspects as yet another very complex, but also very intuitive side of the beautifully honed knowledge machine that Unimerco is.

7. *The company's way towards the knowledge-based economy*

We have gone fairly deep into the workings of one company which is unique in many ways and must be seen as one of the pioneering companies of a new, much more knowledge intensive breed. Our research has most likely just scratched the surface of

how the real knowledge processes of Unimerco function. But even this initial picture is quite daunting in its radical departure from our conventional concept of a manufacturing services company.

When we look at the strategic challenges facing Unimerco, the departure seems even more radical. Unimerco has had to learn that the kind of partnerships with customers that are necessary to unfold the full knowledge potential of the relationship, can take years to build. Yet this slow ramp-up on the customer side is not the biggest constraint for growth, partly because it also represents a significant barrier to entry of competitors. More importantly, the necessary time investment to develop customer partnerships is still shorter than the time it takes to ramp-up internal resources. Historically it takes around 5 years to bring a Unimerco subsidiary up to full speed so that it masters its processes as well as the original Unimerco organization and can match both quality and profitability. And it is not unusual for a new, well qualified employee to take two years or more before he or she is fully performing (depending of course on the individual as well as the function).

In this way Unimerco represents a puzzling paradox. On the one hand Unimerco is unique in the way it has mastered the acceleration of knowledge processes in their iterations between tacit and codified forms of knowledge. On the other hand the cost of this achievement is an organization, a culture, and a set of competences that cannot be easily reproduced, which means that Unimerco's most significant growth constraint are the internal barriers: How quickly can the company bring on board new people? How quickly can new subsidiaries be developed up to full Unimerco performance?

Unimerco started its transformation to this level of knowledge intensity some 15 to 20 years ago. There is never a day and certainly never a month or year where the company does not ask what it has learned and where it needs to change and improve. The willingness to experiment; the readiness to learn from others; the focus on continuous improvement as well as on-going reflection on what can be learned and where habits should be changed more radically are all pervasive in the company. This has made Unimerco a pioneer among knowledge intensive companies.

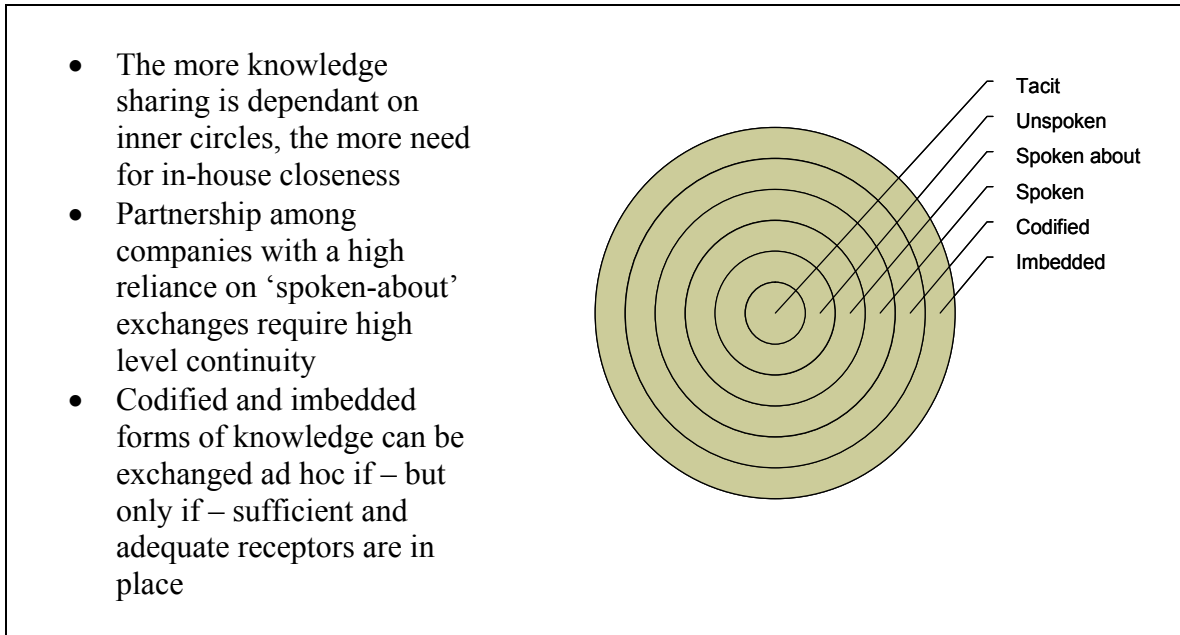
Still the people in Unimerco see themselves as having only just started the process. We believe it is useful to keep this in mind when we seek to identify how far we have progressed on the learning curve on knowledge processes in companies.

What can Unimerco and any other company learn from our analysis of knowledge processes that will help direct their transformations as they adapt towards success in a more knowledge-based economy?

First of all, we believe that the nature of the different knowledge processes have a very high impact on company segmentation. Some processes by nature must take place in the same physical location. Other processes can thrive between several companies, but only if they have relatively long-term relations with a high level of commitment and a high bandwidth of communication. And other knowledge processes can take the form of ad

hoc transfers if and only if the knowledge receptors in the companies are adequate and sufficient for the task. We have tried to illustrate the company segmentation criteria in the figure below:

Knowledge criteria for company segmentation and network density



A first lesson is that companies over time must segment, focus and build their network relations according to these segmentation principles.

The substance of this lesson is implied in the nature of the knowledge process challenges which the company must learn to master. It has to integrate knowledge processes across all the aspects of the process diagram, and in particular to get better at accelerating the iterations of these processes. This means that it has to access codified knowledge and codified substrates of its own knowledge and interpret it into its concrete tacit substance. Seen from the opposite end of the process this amounts to an on-going exposure of the confined tacit knowledge of the company to the challenge of codified knowledge. There is no way to achieve this without developing a rich ‘spoken-about’ knowledge culture which can mediate the iterations. While this culture by its very nature is primarily internal, it has to be extended into shared cultures and languages with longer-term close partner companies. And from this basis the company must aggressively tap into the much wider universe of codified and imbedded knowledge contributions which is open to any company that has learned the art of knowledge iteration.

As we have seen in the Unimerco example these changes amount to very fundamental changes in leadership. Regardless of the legal and financial ownership, leadership has to

recognize every employee as a de facto owner of the company. The internal relations have to be reinvented and turned into knowledge process enablers. The metaphorical core of all knowledge processes and eventually of the new alignment of the relations of the company has to be identified and branded. The design of the company as a knowledge receptor has to be optimized as an on-going process. Eventually, the company needs to shorten the time lag of knowledge and accelerate innovation by enabling knowledge processes and adding capabilities for receiving and processing knowledge.

As we saw in our discussion of the transformation of all the constitutive relations of the company, the knowledge intensive company will eventually be quite different from what we used to call a company. In that sense we might be in the early stages of a revolution.

8. *Next steps in the research agenda*

We see this article less as a set of final results than as a research agenda. The conceptual framework needs to be unfolded and argued in much more detail and scope than what has been possible here, but we consider it a relatively solid foundation. Thereby, we have declared our position in many of the present debates. We are skeptical of those positions which argue the possibility of an IT-based knowledge fix; the primacy and growth of codification, and believe knowledge accounting to be possible and meaningful. The next steps on the theoretical conceptual front will be a continued integration of new insights from cognitive science into our understanding of knowledge in organizations, and a development within the theory of science of a much more elaborate understanding of the logic of application (complementing the new understanding of the logic of discovery).

On the empirical front we have merely begun. The observations from Unimerco serve mostly to illustrate the conceptual points so far, though we believe they give an initial substantiation of the conceptual framework. A comprehensive empirical mapping of the knowledge processes in Unimerco is still outstanding. After that follows the need for research in other companies and types of companies. Unimerco is hardly typical. In view of the volume of research concentrated on knowledge intensive service firms, we consider it necessary to expand empirical research into companies with material processes such as Unimerco. In that respect we see our observations as a first step forward. On one hand these observations need to be realigned with the findings from knowledge intensive service firms. On the other hand several colleagues have pointed out to us that companies in the tool industry have always represented a particularly knowledge based segment of manufacturing. This of course means that conclusions from Unimerco cannot automatically be generalized to cover all of manufacturing. We do believe, however, that as the process of knowledge based flexible specialization gains momentum, the situation known from the tool industry will spread to more segments of

the manufacturing sector. In that respect findings from companies like Unimerco might turn out to be more broadly applicable than presently seems to be the case.

Three perspectives for future research appear to have special significance:

The first is the historical status of the changes we are tracking. Companies and the market as we have known them for some centuries were part of the outcome of the transition from agricultural feudalism to industrial capitalism. We have seen how the intensity of knowledge processes implies a transformation of all the constitutive relations of the company. This transforms the very nature of the company, and hence the market. The scope of these transformations is one of the big questions in need of answers. The most radical answers will see the present transformations as revolutionary in the same way the industrial revolution was revolutionary.

The second perspective is concerned with the transformation of relations at a much more concrete level. Unimerco's delivery of tools and tool services is turning into systematic on-going optimization of the client company's production processes. The resulting knowledge interaction between the two companies is very like the one known between professional service firms and their clients. This indicates that Unimerco – and similar companies – have much to learn from best practices in professional services. Companies like Unimerco begin to look like professional service firms, but still with physical processes. Some professional service firms seek to commoditize and industrialize their service offerings. Product companies like IBM acquire service firms like PWC. All of these changes seek to address and develop more knowledge intensive relations and deliveries. But they also lead to new types of companies. The question is what defines the emerging types of companies and their value-chains?

The third perspective is simple to identify, but the most difficult to deliver. Research into knowledge processes in companies must lead to results of practical application towards the optimization of the processes. We are very aware that this article is far from delivering in this sense, but we believe it can be done by pursuing the agenda we have suggested. In the meantime we are certain that Unimerco will continue to raise the bar.