

Manufacturing Knowledge Work: The European Perspective

Fons Wijnhoven

University of Twente, Enschede, The Netherlands
a.b.j.m.wijnhoven@utwente.nl

Abstract The handling of knowledge in specific contexts is often labeled knowledge management. A more precise analysis of the literature in the knowledge management field, though, distinguishes four different domains with regard to the handling of knowledge in context, i. e., knowledge management, knowledge processes, knowledge media, and knowledge exploitation. These domains we name knowledge work. We also introduce four approaches to the study of knowledge work, and operationalize the domains of knowledge work, knowledge contexts and the knowledge concept itself, to help researchers and practitioners in the manufacturing field to be more precise with regard to their analyses of knowledge work.

Keywords: knowledge work; knowledge management; knowledge processes; knowledge media.

1 Introduction

Manufacturing in Europe currently has two essential aspects:

1. It has to be knowledge intensive given the European demands for high-tech products (e. g. electronics, medicines).
2. Given the relatively high labor costs compared to developing countries, manufacturing processes in Europe require high levels of expertise to realize very high productivity.

Consequently in Europe, knowledge management (KM) has become a major issue in academia and industry in the last 30 years [21], and it is recognized that the knowledge issue is important for a firm's managers as well for operational work. This article will describe the main areas and concepts related to knowledge work.

Knowledge work has at least four roots.

1. Products and services for western economies have become increasingly complex, incorporating larger amounts of public and proprietary knowledge and technologies ([6; 11; 13]. Consequently, companies who want to stay in business have to develop management practices that incorporate a view on knowledge and technologies that are needed in the future [20; 39]. The field of strategic management has recognized this and developed the idea that the optimal use of intellectual capabilities may be the best source for sustaining competitiveness [3, 17, 39].
2. Organization and human relations professionals and academics have recognized the need for more academically challenging jobs and for using the opportunities of an increasingly highly educated work force in modern societies [3, 42, 43, 47]. This also resulted in insights concerning new work practices and processes for the creation, maintenance, and reuse of knowledge [32, 34, 35], and the development of ideas concerning organizational and inter-organizational knowledge processes.
3. Suppliers of information technology and academics in this field have developed opportunities of supporting knowledge reuse and knowledge creation by, among others, artificial intelligence, knowledge-based systems, and Internet applications [15, 28].
4. All these management, organizational, and information technological efforts have to result in better (i. e. more suitable to the new market realities) products, services, and manufacturing processes. In all cases knowledge work is not “l’art pour l’art” but intended to contribute to business processes. Research in the area of knowledge flows [24]) emphasizes this fact and also recognizes that this flow from insight into application is not always easy [26, 35, 57].

Consequently innovations in information technology, organization, and organizational strategies jointly realize the development of knowledge work. The aimed-at knowledge leverage [51] requires a supportive context which is mostly not limited to a task unit, or one organization, but often requires inter-organizational collaboration. This is particularly so for high-tech SMEs, which need much advanced knowledge that, because of SMEs limited organization size, must to a far extent be identified and acquired from other organizations, and be finally internally used [24]. These processes of external knowledge identification, acquisition, and internal utilization of external knowledge are named knowledge integration (KI).

While discussing knowledge work, we have to be aware of the huge diversity of the knowledge construct. Knowledge may for instance include person-dependent skills, explicitly described insights (like explanations, formulas, designs, predictions, and patents), effective work procedures, rules and methodologies, and databases [24; 54]. These different types of knowledge may need different ways of treatment in the four areas of knowledge work, an issue we will come back to further on.

We now can summarize knowledge work as four interrelated activities regarding knowledge in different knowledge contexts. This is presented in Fig. 1.

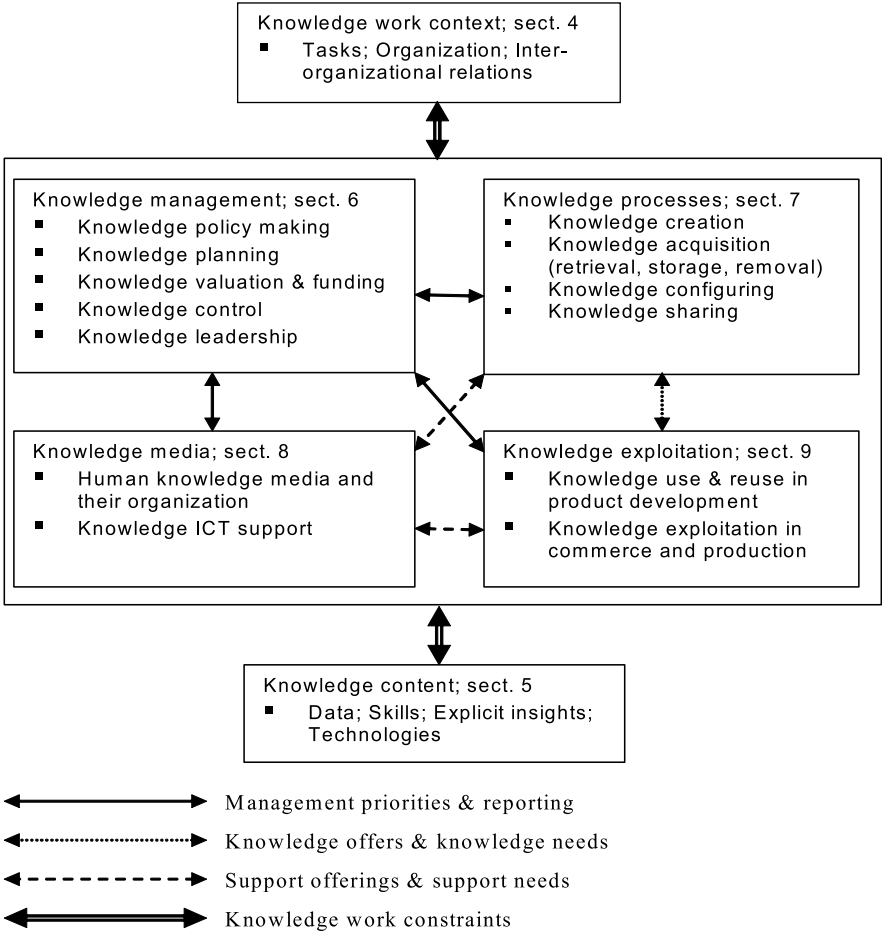


Fig. 1 A model of knowledge work based on [55]

This article discusses each of the six aspects of knowledge work, related key concepts and issues of knowledge work for research and practice in manufacturing. Before doing so, we will give some more evidence of the relevance for knowledge work for manufacturing in Sect. 2 and we will described four different ways of approaching knowledge work in Sect. 3.

2 The Relevance of Knowledge Work for Manufacturing

Knowledge work is particularly important to high-tech firms, because high-tech firms create most of their value-added by knowledge-intensive activities, like

engineering, management of high-tech facilities, research, and new product development. Unfortunately, however, it is difficult to implement knowledge work in manufacturing, because manufacturing-specific knowledge work theories, methods and techniques are rare. Most of the current knowledge work concepts have been developed in the context of large firms, particularly from the service industry (e. g. consulting). This is illustrated by Table 1, which presents a few of the major knowledge work concepts and their organization of origin.

Knowledge is regarded as the key production factor in the post-industrial society [6, 20, 39]. If knowledge is a unique competitive force, it is a core competence and provides an organization with sustainable competitive advantage. Core competencies, however, in addition to knowledge, may also include tangibles, e. g., land, money, installations, and buildings, and non-knowledge intangibles, like social networks, legal and infrastructural arrangements, power and influence. Figure 2 shows the conceptual relations between core competencies and knowledge.

Table 1 KM concepts and their organizational roots

Knowledge work concept	Authors	Organizational case studied
Knowledge strategy	[21]	Boston Consulting Group, McKinsey, Dell computers
Knowledge valuation	[41]	Skandia
Knowledge creation	[5; 35]	Matsushita; NASA
Knowledge acquisition	[20]	Philips Electronics and Sony
Knowledge sharing	[13]	CapGemini
Knowledge information systems	[22]	Ericsson
Knowledge use & exploitation	[39]	NIKE
Competence management	[20; 39; 48]	Vickers; Nokia

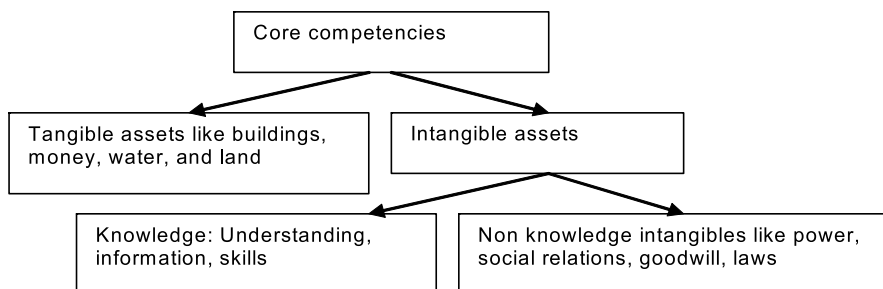


Fig. 2 Relations between core competencies and knowledge. Adapted from [54]

If knowledge work is so important for manufacturing SMEs, two major questions arise:

1. Can they move up into the knowledge work swing and be successful by working smart, or will they become the non-knowledge-based firm that has to succeed by working hard?
2. If they want to pick up knowledge work, how can they – particularly as an SME – do this, given their limited resources?

Most SMEs in western countries found out that, with respect to question 1, there is no alternative. An increasing level of production overcapacity and (Internet and telecom-based) globalization resulted in competition that was not sustainable in high-wage countries. Consequently, becoming smart has become the imperative for SMEs as well, and resulted in the occurrence of large numbers of high-tech SMEs in western countries. These high-tech SMEs have high capital investments, the profitability of which can only be achieved by highly educated professionals resulting in high salary costs per employee and the need to invest heavily in personal learning and development.

With respect to question 2, becoming smart has been achieved through business process reengineering, resulting in lean production [14; 57], as well as through superb new product development (NPD) and knowledge creation, possibly for niche markets [11]. In for example new product development, SMEs always have to identify, acquire, and incorporate external knowledge. Consequently, for understanding knowledge work by high-tech SMEs, a focus on inter-organizational knowledge processes is most relevant. This is identified by the European Committee by its sponsorship of manufacturing knowledge exchanges between firms and between firms and research institutes, like the establishment of the Virtual Research lab-KCIP (see www.VRL-KCIP.org).

3 Approaches for Knowledge Work

Knowledge work has been studied in many ways, related to very different paradigms of social reality and knowledge. Each of these paradigms has its strengths and limitations, and consequently we have to identify this to realize a full picture of how knowledge work can be studied and approached.

The two major paradigms of knowledge are subjectivism and objectivism [8; 35]. Subjectivism assumes that knowledge is connected to an individual's mind and has no objective law-like nature. In addition to people's explicit views of the world, it is often even more important to grasp their tacit knowledge while trying to understand their behavior [42]. Alternatively, objectivism is interested in the (scientific) validity of knowledge and the ability of explicating and formalizing it, possibly in manuals and information systems [15; 40]. Thus, the emphasis is on person-independent knowledge, created by making the tacit knowledge explicit and documented.

Table 2 Approaches for the study of knowledge work. Adapted from [54]

		Ontology	
		<i>Order</i>	<i>Conflict</i>
Epistemology	Objectivism	Cybernetic perspective.	Scientific Management.
		Knowledge work is discovering objective reality. Requires: data and models. Individualistic developing and testing of knowledge. Knowledge is about the production process (organizational technology). This approach is most useful when there are no conflicting perceptions of reality and information systems can handle all the knowledge needed unambiguously.	Knowledge work is used to change power relations. Requires detecting sources of conflict, and latent dysfunctions. Knowledge work is mainly done by the power elite. Knowledge is the technology of domination. This approach explains knowledge as power, which is relevant when knowledge owners (and firms) are in mutually competitive relations with each other.
	Subjectivism	Soft Systems.	Organization Development.
		Knowledge work is about perceptions that motivate behaviour and about organizational change. Requires feeling with 'reality', by soft modeling. Individuals interacting in a specific social context (culture). Knowledge is, e. g., work attitudes, collaboration, leadership, and understanding cause-effect relationships. This approach is most useful when people have to develop collaborative knowledge work settings and in which information systems may be used to facilitate work.	Knowledge work is about understanding dysfunctions caused by routine processes and problems of change. Requires: open communications, mutual feelings of trust and willingness to change. People interacting in a specific social setting (power relations). Knowledge is about social and political issues influencing organizational processes and thought. This approach is most useful when substantial efforts are needed to develop collaboration between teams and organizations.

With respect to the nature of social reality, again, two paradigms may be distinguished, one based on order and regulation, and a second one based on conflict and radical change. Knowledge has an obvious role in both of them. In regulation, it can provide or help to define the solution to shared problems and increase organizational integration and efficiency [1, 5, 7]. In radical change, knowledge may be used as an instrument for outperforming competitors in the market place, as well as a source for internal power [12, 13].

Table 2 describes the four knowledge management perspectives that result from combining the approaches on knowledge (epistemology) and social reality (ontology). The perspectives differ on:

- *definition* of knowledge work (process and purpose),
- *requirements* for knowledge work (data, views, etc.),

- definition of *knowledge actors* (a group or an individual, a specific elite, all organization members or the organization), and
- definition of *knowledge* (that changes under the influence of learning).
- *value of an approach* to knowledge work.

Our approach to knowledge work is rooted in pragmatics [10; 33], i.e. we regard all different paradigms and approaches as valuable in delivering insights that fit into each specific paradigm, but each paradigm is pragmatically valuable only in a specific situation. This implies that we need all paradigms and apply them when appropriate. In the rest of this article, we will go in more depth into each aspect of knowledge work (i.e. context, content, management, processes, media and exploitation) as presented shortly in Fig. 1 before.

4 Knowledge Context

We identify at least two contexts for knowledge work: 1) the intra organizational context, which may be more or less under control of a hierarchical regime, and 2) the inter-organizational context, which is governed by network and or market principles.

4.1 The Intra Organizational Context of Knowledge Work

Task and firm/industry setting are important contexts for knowledge work within an organization. Following this division, Nordhaug [36] distinguishes background knowledge, industry-based knowledge, intra-organizational knowledge, standard technical knowledge, technical trade knowledge, and unique knowledge, as shown in Table 3.

Background knowledge is general knowledge with often a significant tacit component like individual literacy, knowledge of foreign languages and mathematics. Industry-based knowledge is relevant for role-related organizational activities and

Table 3 Knowledge and contexts. Adapted from [36]

		Firm/industry specificity		
		Low	Medium	High
Task specificity	Low	Background knowledge	Industry knowledge	Intra organizational knowledge
	High	Standard technical knowledge	Technical trade knowledge	Unique knowledge

comprises, for instance, knowledge of the industry structure, its current state of development, the key individuals, networks and alliances. Intra-organizational knowledge is highly firm- and industry-specific, but not specific to organizational tasks or activities. This is firm-specific background knowledge and comprises, e. g., knowledge about organizational culture, communication channels, informal networks, organizational strategy and goals. Standard technical knowledge is task-specific and involves a wide range of operationally-oriented knowledge that is generally available to all actors, like financial and accounting practices, knowledge of computer programming and software packages, knowledge of craft and engineering principles. Technical trade knowledge is task- and industry-specific, i. e., generally available among firms in an industry, like knowledge of automobile construction methods and knowledge of techniques for computer hardware construction. Unique knowledge is specific across all dimensions. It consists, at the individual level, of self-knowledge and skills, and, at the organizational level, of unique organizational routines, production processes, and IT infrastructures.

4.2 *The Inter-organizational Context of Knowledge Work*

The knowledge work models developed so far by other authors (see e. g. Table 1) do not explicitly consider the need for activities to go outside the firm and detect knowledge from other organizations. Additionally, much is known in the knowledge work literature on internal (hierarchical context) knowledge work, but not so much is known about identifying, acquiring and using **external** knowledge. Section one explained that at least three stages of KI can be distinguished 1) identification, 2) acquisition, and 3) utilization.

The economic literature has extensively discussed two types of inter-organizational exchange mechanisms which have high implications for how knowledge work happens: markets and networks [27, 56]. For market exchanges to work properly, the goods to be exchanged must be very precisely defined (that is, codified), prices act as communication mechanisms, and coordination is realized via the price mechanism. The actors involved must be fully independent and, if the existing exchange mechanism does not work properly (e. g., a buyer cannot find an existing supplier or the costs of negotiating prices are too high), brokers can be useful intermediaries. In the context of KI, this involves the exchange of explicit knowledge, such as knowledge documented in patents and software, or specified commercial services (e. g., accounting and legal and financial consultation).

In the context of network exchanges, economic actors collaborate and, thus, are mutually beneficial to each other. The collaboration is mainly based on mutual trust and respect and, in such a situation, pricing is not needed (and, in addition, is a too expensive coordination mechanism, because it requires a lot of negotiations that obstruct effective collaborations). The network exchange context also enables the exchange of ambiguously and non-codified knowledge and, thus, enables the

Table 4 Comparison of knowledge exchange models

<div> <div>Exchange governance</div> <div>Market</div> <div>Network</div> <div>Hierarchy</div> </div> <div>Inter-organizational knowledge context</div>			
<i>Knowledge type</i>	Explicit	Tacit, latent and explicit	Tacit, latent and explicit
<i>Coordination</i>	Price mechanism	Collaboration	Supervision
<i>Formalization of exchange process</i>	High	Low	Bureaucratic or based on authority
<i>Means of communication</i>	Prices	Relational	Routines
<i>Network participant dependency</i>	Independent	Interdependent	Dependent
<i>Tone or climate</i>	Suspicion	Mutual benefits	Power
<i>Intermediation</i>	Broker	Network facilitation	Administration and communication offices

exchange of latent knowledge and the joint development of explicit and tacit knowledge in collaboration efforts.

Both the market and the network exchange mechanisms are radically different from the hierarchical context. Hierarchies for knowledge work may work sometimes in large firms but are mostly insufficient for SMEs, given the latter's limited knowledge resources. Table 4 summarizes the KI context variables and how these behave compared with hierarchical contexts.

5 Knowledge Content

5.1 Knowledge and Information

Knowledge is frequently defined in relation to information and data. Table 5 gives an impression of the diversity of interpretations of these three terms in the current literature. It shows that there is no unanimity on either of them, but the distinction between data, information and knowledge seems to be a very popular way of thinking about what it is what we want to identify and acquire in KI contexts. Because this chapter is on knowledge work and not on information or computer science, the distinction between data and information is not as interesting as the distinction between types of knowledge is.

Table 5 Definitions of data, information, and knowledge (based on [45])

Data	Information	Knowledge	Author
Not yet interpreted symbols	Data with meaning	The ability to assign meaning	[50]
Simple observations	Data with relevance and purpose	Valuable information from the human mind	[12]
A set of discrete facts	A message meant to change the receiver's perception	Experience, values, insights, and contextual information	[13]
Text that does not answer questions to a particular problem	Text that answers the questions who, what, or where	Text that answers the questions why or how	[38]
Facts and messages	Data vested with meaning	Justified, true beliefs	[9]
Signs/carriers	Representations with linguistic meaning	Norms & values, explicit understanding, skills	[54]
Carriers of information and knowledge	Description carried by data	Correlational and causal associations	[26]
–	Facts organized to describe a situation or condition	Truths, beliefs, perspectives, judgments, know-how and methodologies	[53]
–	A flow of meaningful messages	Commitments and beliefs created from these messages	[35]

5.2 *Different Types of Knowledge*

The Table 5 does not only show that knowledge, information and data can be differently distinguished, but also that many definitions of knowledge exist. It is difficult to be complete with classifications, but a rather interesting classification largely based on [2] is given in Fig. 3.

This classification gives some bit of the large diversity of possible knowledge classifications. The knowledge management literature has currently emphasized the semiotic distinction between tacit and explicit knowledge, which implies a focus on the problem of how tacit knowledge can be codified (if at all) and how codified knowledge can be internalized as part of personal believes. Although the other classification dimensions are as interesting, we will shortly only review some of the insights along the semiotic dimension.

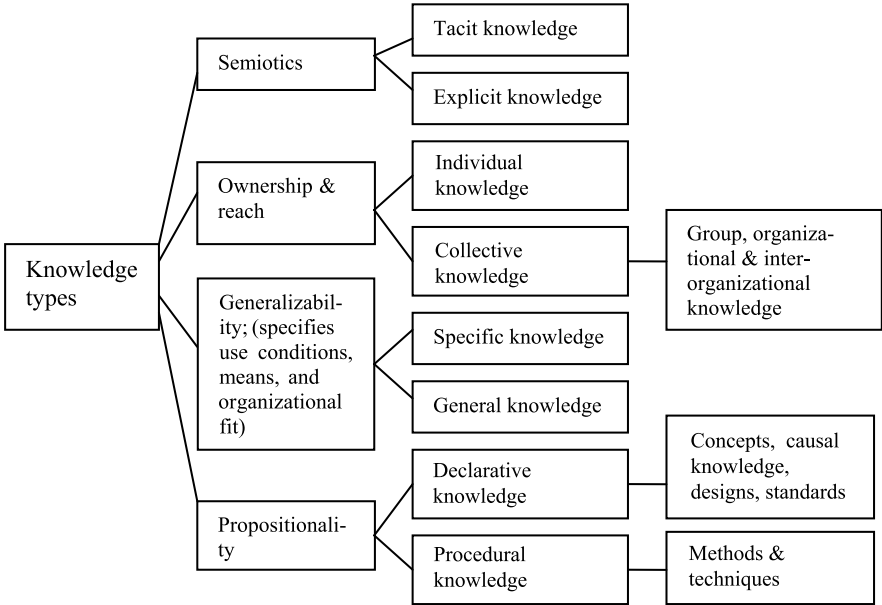


Fig. 3 A classification of knowledge types based on [2]

5.3 A Semiotic Classification of Knowledge

The semiotic dimension distinguishes besides of tacit and explicit knowledge also latent knowledge. These distinctions are useful because these three types of knowledge require very different processes, involve different problems, and demand different solutions. The distinction between tacit and explicit knowledge has been well described by the philosopher Polanyi who said that “we can know more than we can tell” [37: 4]. In short, the part that we can tell is the explicit part and the part that we cannot tell is the tacit part of knowledge. Polanyi has stressed that knowledge always has both a tacit and an explicit dimension. For example, the knowledge represented in this book is explicit because it can be explained in detail in text, figures, and tables. However, the extent to which you as a reader are able to understand this book is what Polanyi would have called the tacit part of knowledge. It is tacit since you cannot explain exactly why you understand it (or not). Just like Nonaka and Takeuchi did in the early 90s [34; 35], however, we treat these two dimensions as a distinct typology: there is tacit and explicit knowledge.

While Polanyi, Nonaka, and Takeuchi have made the distinction between knowledge that *can* and knowledge that *cannot* be expressed, their distinction is often confused with the distinction between knowledge that *is* and knowledge that *is not* expressed (for example in documents). In this book, we distinguish three levels of explicitness of understanding or prehension in order to reflect this difference. The first type is *tacit* knowledge, which is not and cannot be expressed. The

Table 6 Content: knowledge prehension and representation

		Representation	
		<i>Not represented</i>	<i>Represented</i>
Comprehension	<i>Tacit</i>	Person-dependent skills; personal knowledge;	Production volumes and characteristics, without a full explanation of how it was realized. Also much tooling, recipes and work methods.
	<i>Latent</i>	Shared informal norms and values; i. e., ‘the way we do things around here’.	Information about people with their personal knowledge (of course the personal knowledge stays personal, but the representations of the people are feasible so that they can be found). Explicit insights that can be gained after simulations, tests, and business process analyses.
	<i>Explicit</i>	Person-independent, non-documented shared knowledge embracing explanations, predictions and methodologies.	Documented knowledge and information, i. e., representations of knowledge, designs, production plans or of objects and events in reality that may be used for knowledge creation (potential knowledge).

second type is *explicit* knowledge, which is expressed, or could be expressed without attenuation. The third type is *latent* knowledge, which could be expressed, but is not because of inherent difficulties to express it without attenuation. The difficulties to express this knowledge without attenuation usually stem from the fact that this knowledge resides in the subconsciousness.

Often, the distinction between tacit and explicit knowledge is equaled with the distinction between written up and not documented knowledge, or between representation and no representation. This is basically incorrect, because often documentation/representation of explicit knowledge is forgone, due to a lack of motivation or cost effectiveness. People may not convey what they know to others because that would result in a personal value reduction or the costs of knowledge documentation will not outweigh its value. This results in the combinations of understanding/comprehension and representation (or information [44]), with related knowledge types. These are given in Table 6.

6 Knowledge Management

Following the previous arguments, we have to carefully distinguish the intra organizational and inter organizational context of knowledge work. This has high implications for the role of management in these contexts.

6.1 Knowledge Management in the Intra Organizational Context

Gulick [19] defined management as the functional elements of the task of the executive. These elements are planning, control, financing, budgeting and reporting,

organizing and staffing, coordinating and directing. Additionally, the executive tasks involve responsibility for operational management and information systems [32]. A major question is whether it is feasible to manage knowledge. Because it involves much person-dependent tacit knowledge and information, KM has obvious limitations. If we group the general management concepts under the headings of strategic, tactical and operational management [4], we find the following workable list of KM activities:

1. Knowledge management at the strategic level consists of the definition of the organization's knowledge architecture [20]. The organization's knowledge architecture is a view on which "functionalities" will be offered to customers over the next decade or so, on what new core competencies will be needed to create those benefits, and on how the customers' interface will have to change to allow customers to access those benefits most effectively [20: 107–108]. More concretely, knowledge architecture is about the knowledge and information needed in the longer term, how this knowledge and information will be acquired and handled, and how effective use can be made of it. This means that knowledge and information policies and plans must be well in line with the organization's ambitions and environments. Furthermore, within strategic knowledge management, knowledge is evaluated on its strategic relevance, by stating which competencies should be given superior attention and what control policy is needed so that knowledge is defended against fraud and theft. This activity is called knowledge control.
2. Knowledge management at the tactical level is concerned with the acquisition of resources, determination of plant locations, new product initiation, establishing and monitoring of budgets. At the tactical knowledge management level, general rules should be set for the handling of knowledge in terms of responsibilities, procedures, and means (motivational and financial). This involves organizing, financing and budgeting of knowledge management activities.
3. Knowledge management at the operational level is concerned with the effective and efficient use of existing facilities and resources within given budget constraints. For knowledge management, this implies that concrete ways of developing, storing, disseminating, using (reusing) and adjusting of knowledge and information must be established, in line of course with the strategic and tactical outlines [1, 46].

6.2 Knowledge Management in the Inter Organizational Context

In the organizational context we have to add a few important tasks to the management job. At the strategic level, we have to consider how we want to collaborate with others (if we want to do this at all), and how we want to profitably exploit knowledge in relation with the environment. Consequently, we have to develop knowledge acquisition and collaboration strategies, and we have to develop property rights and exploitation policies.

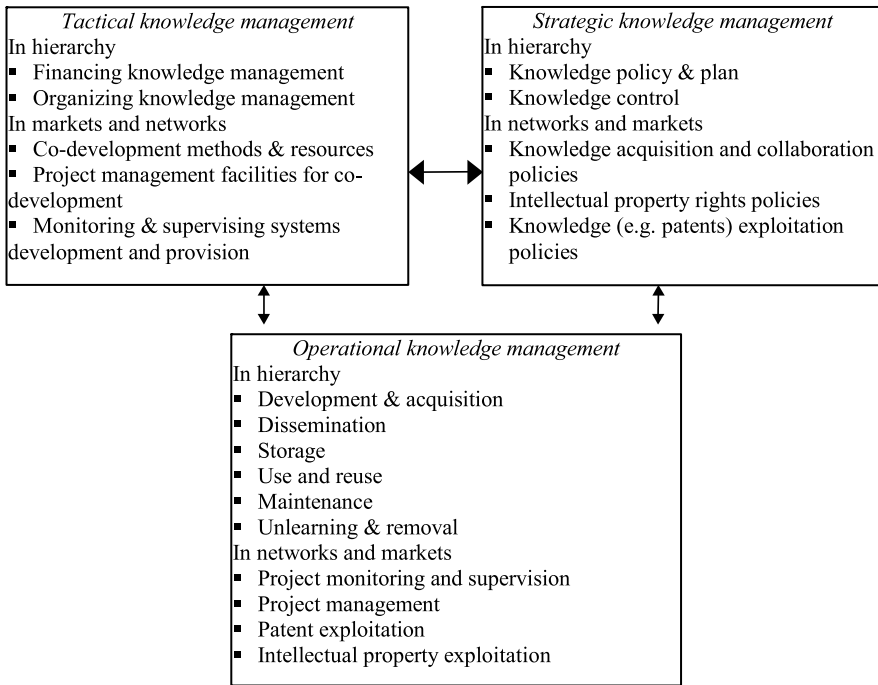


Fig. 4 A model of knowledge management. Adapted from [54]

At the tactical level, we have to consider how we can successfully inter-organizationally collaborate, how we manage and lead cross organizational teams, what co-development methods, techniques and resources we need, and how inter-organizational project management can be facilitated.

At the operational level, we have to monitor inter-organizational projects, monitor and supervise consultants, and exploit knowledge products (like patents and advice).

Figure 4 summarizes the knowledge management activities at the different management levels.

7 Knowledge Processes

Many different knowledge processes can be recognized in organizations. Much of the knowledge work literature, e. g., [13 and 26], focuses on knowledge process as the development, maintenance, storage, dissemination and removal of knowledge. These are basically knowledge evolutions. From a knowledge work perspective, this is too limited because the actual utilization of the knowledge gives the ultimate reason for knowledge work activities. Knowledge utilization and exploita-

tion, though, are treated in our framework as a separate knowledge area to be discussed in Sect. 9. Also knowledge management activities and knowledge media activities are needed to complete the list of knowledge processes. Therefore, Fig. 1 distinguished knowledge work processes.

7.1 Knowledge Evolution Processes

The KM literature contains several possible groupings or schemas of knowledge evolution processes, as shown in Table 7.

Alavi and Leidner’s [2] framework of knowledge processes – creating, storing and retrieving, transferring and applying – provides a representative schema, which we adopt, although, according to our model of knowledge work “applying” belongs to the knowledge exploitation aspect.

Table 7 Knowledge evolution schema from the KM literature

Author	Knowledge evolution schema
Alavi & Leidner [2]	creating, storing & retrieving, transferring, applying
Allee [3]	creating, sustaining, applying, sharing, renewing
McAdam & McCreedy [30]	Constructing, embodying, disseminating, using
McCampbell et al. [31]	identifying, capturing, leveraging
Holsapple & Joshi [23]	acquiring, selecting, internalizing, using (generating, externalization)

Knowledge Creation

Following Nonaka [34], knowledge creation consists of four interaction processes between explicit and tacit knowledge:

- Externalization: This is the creating of new explicit knowledge through research, problem solving and testing.
- Socialization: This is the acquisition of tacit knowledge from others, which mostly goes hand in hand with the mutual sharing of insights.
- Synthesizing: This is the creation of new knowledge from integrating different pieces of explicit knowledge and information. Nonaka uses the term ‘combination’ for this process, but we believe that this term is not so precise, and may be confused with organizational structuring of the knowledge (or what Galunic & Rodan [16] refer to as ‘configuration’).
- Internalization: This is the integration of explicit knowledge with existing implicit knowledge as, for instance, when a new technology becomes part of an everyday work practice (including existing norms, values, and tacit understandings).

Storage and Retrieval

Storage and retrieval involves two elementary processes of an organization's memory [2]:

- Acquisition of tacit or explicit knowledge by the organization and the possibility for organizational members to re-use memory resources;
- Organizing and structuring memory for individuals in an effort to add value beyond that of individual memories. This property of organizational memories is also named 'configuration' [16].

Knowledge Transfer

Knowledge transfer [18] is not a pure technical process of transferring messages from a sender to a receiver. Rather, it implies the detection of knowledge needs and values as well as motivational dispositions of the parties to transfer, receive and internalize. It also requires sufficient media richness, insight into what the receivers actually need, and sufficient absorptive capacity of the receiver [49]. Thus, due to the richness of knowledge transfer we prefer the concept of *knowledge sharing*, which implies that knowledge transfer always involves the active engagement of sender and receiver.

To summarize, thus far we have established four key knowledge processes: 1) creating, 2) acquiring, 3) configuring, and 4) sharing.

7.2 Knowledge Work Processes

Figure 1 gave some knowledge work processes related to knowledge management, knowledge media, knowledge processes, and knowledge exploitation. Here we further describe what knowledge work processes occur between these knowledge management areas.

1. Management reporting and priorities setting. This flow aims at communicating managerial priorities and means for the knowledge processes, the knowledge exploitation and knowledge media. Additionally it gives information back to knowledge management so that decisions can be made, also on basis of contextual and content understanding of the knowledge work.
2. Knowledge offering and knowledge need statement. This information flow states needs for knowledge processes from the business processes (where the knowledge exploitation happens) and supplies results of knowledge processes for knowledge exploitation.

- 3. Support offering and support needs specification. This flow aims at detecting supporting human and ICT means for knowledge processes and knowledge exploitation and supplies the actual support on basis of this and the managerial means supplied.
- 4. Contextual and knowledge constraints handling. Contextual constraints for knowledge work are given from an understanding of the contextual rules for the work. For instance pricing of knowledge may not be feasible in speedy R&D processes, whereas it may be very useful in academic publishing. Constraints handling are related to characteristics of the knowledge that has to be applied and management in the knowledge work. For instance if the knowledge is mainly tacit, knowledge elicitation and codification may be useful, though for some knowledge this may be logically and economically infeasible.

8 Knowledge Media

We distinguish two knowledge media: human and information technological. Human media have been extensively discussed in the past and are summarized in Table 8 with typical examples of their content.

Information technological media have been classified in many ways. One type of classification describes what kind of applications and technologies are supportive of what knowledge processes; another type describes architectures of knowledge information systems. An example for the first is given in [7]. [29] gives an example for the second type. Because [29]’s architecture is more informative, we present it here in Fig. 5. The elements of the knowledge management software systems of Fig. 5 will not be discussed here in detail, but several of them are discussed further in this book.

Table 8 A list of human knowledge media and related content. Adapted from [52]

Human media	Knowledge content
Individual	Professional skills; knowledge about evaluation criteria and results; explanations of procedures and decision rules; personal ethics and beliefs, performance criteria; individual routines
Culture	Schemes; stories; external communications; cultural routines; norms base
Business processes	Task experiences; rules, procedures and technology; patents and prescriptions
Structure	Task divisions; hierarchy; social structure; formal structure; communication structure
Internal ecology	Layout of shop floor; building architecture
External ecology	Client and market characteristics; competition profiles; list of knowledgeable people and organizations; technology of competitors

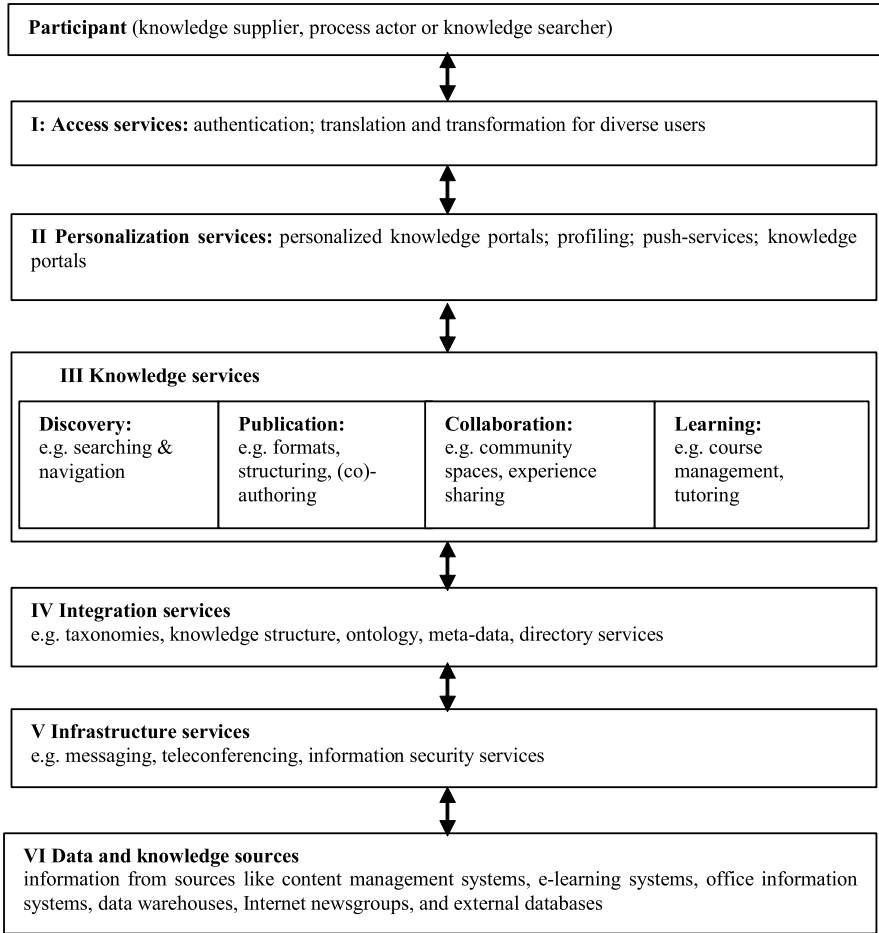


Fig. 5 Classes of IT related knowledge media [29]

9 Knowledge Exploitation

Business processes are any activity by which a company can generate incomes. We identify three knowledge-related business processes, depending on the goal of the knowledge exploitation process.

The first knowledge related process is the actual sales of *knowledge in a direct way*. This can be done in three ways:

1. Full codification of the knowledge and selling or licensing these codifications. This happens when patents are developed and sold, or when text books and research reports are sold.
2. Sales of knowledge through a transfer and education process. Here the delivery is not only codified knowledge, but skills and tacit/latent knowledge may be

transferred as well through an educational process (i. e. that the knowledge will probably become part of the adopting organization) or by hiring people with certain skills for some time (i. e. that the knowledge may be gone after completion of the hiring period).

3. Sales of knowledge institutes and departments. This implies that a knowledge owning institute may become the property of the acquirer. This implies that the institutes will maintain its people, procedures, processes and systems, and that the institute will serve the interest of another formal owner of the institute.

The second knowledge related process is the use of knowledge as a production factor in a production system. Here the goal of the knowledge is not to be sold, but to become part of a better production system, so that it improves the output volumes, quality and efficiency of the production system. As stated in Fig. 2, knowledge is often one of the production factors to generate incomes for a company. This is even the case when a company sells knowledge in a direct way, because for example marketing and legal systems will be required as well. In most manufacturing firms, knowledge is a production factor besides of land, machinery/equipment, people, money, marketing mechanisms etc. The importance of the other production factors has been clearly evident in the past e. g. by Philips Electronics, which developed a technologically superior consumer video system which run out of business because of Matsushita's better capabilities in marketing of its own VHS technology [20]. We identify two ways of exploiting knowledge as a production factor:

1. Utilizing the knowledge in the manufacturing process so that manufacturing can be done better and more efficiently.
2. Realizing the means and infrastructures to generate the commercial opportunities of the knowledge.

The third knowledge related process is the *embedding of knowledge in products and solutions* as part of solutions (new consulting concept). We identify three ways of embedding knowledge in products and solutions:

1. Realizing knowledge-intensive products, also named smart products, like washing machines with high tech facilities and automobiles with advanced motor management systems.
2. Knowledge in services, i. e. the delivery of very knowledge-intensive quality services by using advanced knowledge without actually delivering the knowledge itself. This is often the case in the consulting industry which focuses on client problem solving and not on delivering the knowledge so that the client can solve the problems itself.
3. Knowledge application in research & development and product innovation. The actual product in that case is not necessarily high-tech, but the ways of realizing it may require high levels insights. Example may be the development of new packaging material for soft drinks (e. g. keep the liquid cool without energy consumption). The core problem is the detection of proper material and making the material manufactured and usable for low prices per bin.

10 Summary and Implications

This chapter was intended to introduce the readers in some key concepts related to knowledge work. We detected six areas of knowledge work, and for each of these areas some key terms can be identified that have different related academic and managerial challenges (see Table 9). We will not go into the details of these challenges, but it is clear that knowledge work can be hardly treated easily as a homogeneous phenomenon by practitioners and academics. This requires for practice and academic to apply more nuances in focus and tasks and challenges.

Table 9 Knowledge work areas, key concepts and implications

Knowledge area	Key concepts
Knowledge context	Task related knowledge; Organizational knowledge context; Inter-organizational context
Knowledge content	Semiotic aspects; Ownership and reach; Generalizability; Propositionality
Knowledge management	Strategic KM; Tactical KM; Operational KM
Knowledge process	Knowledge evolution; Knowledge work processes
Knowledge media	ICT for knowledge work; Human knowledge media
Knowledge exploitation	Knowledge sales; Knowledge as production factor; Embedded knowledge

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