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Title of chapter “Knowledge Networking for Collaborative Commerce”

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KNOWLEDGE NETWORKING FOR COLLABORATIVE COMMERCE

ABSTRACT

This chapter aims to describe inter-organizational “knowledge networks” and demonstrate how they have ushered in a new paradigm of collaborative business by forging links between internal and external knowledge and information resources. The overall aim is to classify and review various approaches in inter-organizational knowledge networking whose objectives may span a multitude of needs: from “loose” information sharing that may be not connected to financial transactions between the networking organizations, to “tight” knowledge exchanges that are related to commercial transactions and enable the creation of value from leveraging the interchange of knowledge assets.

INTRODUCTION

In today’s hyper-competitive global marketplace, it is pivotal for enterprises to manage not only tangible resources but also to exploit their intangible knowledge assets. A consequent outcome of this realization has been the surge of interest in knowledge management. Knowledge management has been an item of strong interest in recent times in the research community [see e.g. Alavi and Leidner (1999), Davenport et al (1998), Nonaka (1991 and 1994), Nonaka and Takeuchi (1995), and Zack (1999)]. However, research addressing the management of knowledge across organizational borders can best

be described as sparse [see e.g. Holtshouse (1998)]. To date, there is yet to be a significant undertaking that looks at issues in managing knowledge across borders. This is unfortunate when looking at the increasing evidence that organizations are aware that they are part of a complex network of connections with their partners and customers. This network is not merely a supply chain or a financial connection— it is based on an increasingly intimate sharing of information and knowledge. The search for innovation and competitive advantage is increasingly focused on the cultivation and exploitation of these knowledge chains.

On the other hand, information and knowledge exchange across the organizational boundaries becomes crucial within the area of collaborative commerce. The concept of collaborative commerce, and more generally, collaborative business has been recently introduced to encompass: all stages of collaboration between organizations from cradle-to-grave (initiation, management, operational life and dissolution); all phases of extended products' life cycle (conception, design, manufacturing, usage, maintenance, end-of-life); all forms of collaboration (ad-hoc, mediated and planned); and all enterprise assets in any type of business network (people, ICT-systems, processes and knowledge assets).

The task of developing and managing knowledge assets in the collaborative business environment poses new challenges both to knowledge management theorists and practitioners. Companies at the forefront of these initiatives are extending the notion of the virtual community to include stakeholders outside the company (OVUM, 1999). This means sharing a collaborative engineering environment with suppliers and business partners, or forging new relationships with customers through regular e-mail contact or user-discussion forums.

This chapter aims to describe inter-organizational “knowledge networks” and demonstrate how they have ushered in a new paradigm of collaborative business by forging links between internal and external knowledge and information resources. The overall aim is to classify and review various approaches in inter-organizational knowledge networking whose objectives may span a multitude of needs: from “loose” information sharing that may be not connected to financial transactions between the networking organizations, to “tight” knowledge exchanges that are related to commercial transactions and enable the creation of value from leveraging the interchange of knowledge assets.

The present chapter is organized as follows. After two sections on the importance on knowledge and knowledge management and on the issues inherent in managing knowledge within collaborative commerce efforts, it presents a typology of knowledge sharing networks and analyses the technologies for enabling the operation of knowledge networks. It then presents and analyses (using a validated knowledge management framework) two ~~toolsets~~[toolkits](#) for inter-organizational knowledge networking. It discusses the benefits and challenges associated with inter-organizational knowledge sharing and concludes with future trends and emerging models for knowledge networks.

KNOWLEDGE MANAGEMENT AND KNOWLEDGE NETWORKING

Knowledge and Knowledge Management

The task of developing and applying “Knowledge Management” (KM) as a new discipline is a challenging endeavor. This new discipline must successfully respond to the diverse needs of companies in a timely fashion. However, despite a wealth of books, reports and studies, neither researchers nor practitioners have an agreed definition of “Knowledge Management”. The term is used loosely to refer to a broad collection of organizational practices and approaches related to generating, capturing and sharing knowledge that is relevant to the organization’s business. There are many different interpretations as to what it exactly means and how to best address the emerging questions about how to effectively use its potential power; see e.g. Nonaka & Takeuchi (1995), Davenport & Prusak (1998), Edvinsson & Malone (1997) and Wiig (1995). Some would even argue that “Knowledge Management” is a contradiction in terms, being a hangover from an industrial era when control modes of thinking were dominant.

Whatever the term and the definition employed to describe it, knowledge management is increasingly seen as signaling the development of a more organic and holistic way of understanding and exploiting the role of organizational knowledge in the processes of managing and doing work.

But [which is the role of a unique concept of](#)~~what would~~ “knowledge” ~~be~~ in an organizational setting? Debates and discussions about the definition of knowledge abound. In everyday language, it has long been the practice to distinguish between

information — data arranged in meaningful patterns — and knowledge — something that is believed, that is true (for pragmatic knowledge, that works) and that is reliable. The interchangeable use of information and knowledge can be confusing if it is not made clear that knowledge is being used in a new and unusual sense, and can seem unscrupulous insofar as the intent is to attach the prestige of knowledge to mere information. It also tends to obscure the fact that while it can be extremely easy and quick to transfer information from one place to another, it is often very difficult and slow to transfer knowledge from person to another.

A definition that is suitable for our purposes is the one given by Davenport and Prusak (1998), who define knowledge as "a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of "knowers". In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms". This definition highlights two important types of knowledge - explicit knowledge and tacit knowledge; see also Nonaka and Takeuchi (1995).

Tacit knowledge refers to that knowledge which is embedded in individual experience such as perspective and inferential knowledge. Tacit knowledge includes insights, hunches, intuitions, and skills that are highly personal and hard to formalize, making them difficult to communicate or share with others. Tacit knowledge is also deeply rooted in an individual's commitment to a specific context as a craft or profession, a particular technology or product market, or the activities of a work-group or team. With other words tacit knowledge is deeply ingrained into the context, i.e. the owner's view and

imagination of the world and into his/her experience, which is previously acquired knowledge.

Explicit knowledge is knowledge that has been articulated in formal language and which can be easily transmitted among individuals. It can be expressed in scientific formulae, codified procedures or a variety of other forms. It consists of three components: a language, information and a carrier. The language is used to express and code knowledge. Information is coded externalized knowledge. It is potential knowledge, which is realized when information is combined with context and experience of humans to form new tacit knowledge. The carrier is capable to incorporate coded knowledge and to store, preserve and transport knowledge through space and time independent of its human creators.

Both explicit knowledge and tacit knowledge are important for the organization. Both must be recognized as providing value to the organization. It is through the conversion of tacit to explicit knowledge and explicit to tacit knowledge in the organization that creativity and innovation are released and the potential for value creation arises. The goal, then, is to leverage both explicit knowledge and tacit knowledge and to reduce the size of the organizational knowledge gaps.

Knowledge Networking

A common thread running through many knowledge management initiatives is the challenge of developing and supporting new network-based communities, through which companies can improve internal collaboration and work more closely with partners and customers. Networks of people and networked organizations are emerging because the classic hierarchy of the bureaucratic model is slow to respond to the recent changes in the business environment. In the network, activities still need to be coordinated and

integrated, but this integration relies on knowledge and relationships and a clear common sense of purpose. This has led to ideas about “work as a network of conversations” and the “hypertext organization”; see Nonaka and Takeuchi (1995). Networks may take various organizational forms, ranging from communities of practice between individuals with similar experiences and or purposes to supply chains of companies that exchange knowledge within their industry.

Knowledge networking levels correspond to what Nonaka calls the “ontological dimension” in his model of organizations as knowledge creating mechanisms; see Nonaka (1994). This ontological dimension refers to the social interactions, which begin at the individual level and then by communication between organizational boundaries let knowledge expand and grow-up.

According to Nonaka and Ray (1993) if new knowledge is relevant to the needs of the organization, it is likely to permeate through groups and divisions and thereby extend the community of interaction dealing with that knowledge. New knowledge that has a potential to support more advantageous ways of doing things is likely to be retained as a subject for further debate within the network and may also lead to an extension of the network. For example, what eventually proves to be a successful product might emanate from a R&D department and gradually acquire a greater circle of interested parties within the organization as the dimensions of its potential impact become more clear. As news of the emerging product travels beyond the organization, the circle will grow still wider embracing competitors, customers, firms dealing with complementary technologies and so on. Thus the network will go beyond the original "hard core" of knowledge creators to include those that are in some way affected by the exploitation of that knowledge.

However, there is no reason to suppose that there will be linear sequence of expansion – starting from the individual, progressing to the group and subsequently to the organization and beyond. The knowledge network could span departmental and organizational boundaries from the outset. Possible members of this community such as suppliers, customers and competitors might all enter the knowledge networks at any time. Knowledge networks are relationships among entities (individuals, teams, organizations) working on a common concern and they embed dynamism for collective and systematic knowledge asset creation and sharing. The structure of a knowledge network implies principles of coordination that not only enhance the individual capabilities of member entities, but themselves lead to capabilities that are not isolated to the network's members. Cooperation can also engender capabilities in the relationship itself, such that the members develop principles of coordination that improve their joint performance. Or they might involve more complex rules governing the process by which innovations are collectively produced and shared. In this sense, the network is itself knowledge, not in the sense of providing access to distributed information and capabilities, but in representing a form of coordination guided by enduring principles of organization.

Knowledge networks have five critical characteristics that differentiate them from other similar organizational structures and mainly from communities of practice; see e.g. Wenger (1998) and Wenger and Snyder (2000). These characteristics are following: knowledge networks are responsible for creating, sharing, protecting and cultivating common knowledge assets; knowledge networks are working networks and they are purpose-driven; knowledge networks require organizational commitment beyond the commitment of their participating members; knowledge networks are built on expertise,

not just interest – or common practice – alone; and knowledge networks aim at the development and strengthening of the learning capacity of all members

Mentzas et al. (2002) distinguish between four levels of knowledge networking: individual; team; organization; and inter-organization. The individual level refers to the capabilities, experience, competencies and personal development issues treated at the individual level of the knowledge worker. The team and organizational levels include the internal company networks, i.e. the informal, self-organizing or the formal networks of people involved in related activities (e.g. project teams) that are built within an organization. The level of inter-organizational networks refers to inter-enterprise relationships, value networks where each focuses on core competencies, as well as on the accessibility to external, developed capabilities. Hence networks with customers, competitors, subcontractors, partners etc. are included in this level. It is this fourth level of inter-organizational knowledge networks and their impact to and implications for collaborative commerce that is the focus of our analysis in the following sections.

KNOWLEDGE AND KNOWLEDGE NETWORKS IN COLLABORATIVE COMMERCE

Collaborative commerce is the use of on-line business-to-business exchange to facilitate the flow of business processes in addition to transactions (Raisch, 2001), (Gartner Group, 1999). Business partners can exchange information such as inventory data by using a Web server as an intermediary. Furthermore, companies are seeking to exchange proprietary data, jointly manage projects, and cooperate on the design of new products. Collaborative commerce may also speed up cycle time for interaction between trading

partners. Collaborative commerce requires that data, such as product pricing, inventory and financial information be shared among business partners.

When business collaboration moves beyond basic interaction to mission-critical collaboration, the question of public versus private exchange becomes an issue. Many of the capabilities and services required to drive significant value have been difficult to implement in a public environment. Public exchanges have struggled with a number of issues including (Ferreira, 2002):

- ⇒ The massive scope of true transformation of an entire industry's value chain
- ⇒ Integration of multiple technologies
- ⇒ Addressing member concerns around security and privacy
- ⇒ Enrolling, and integrating member company trading partners
- ⇒ Convincing industry leaders to use standard capabilities and relinquish current advantage

The complex capabilities that proved difficult to enable in a public exchange environment are now being implemented with compelling results through private collaborative commerce networks. Unlike their public counterparts, private network capabilities can be tailored specifically to companies' unique value chain needs and opportunities, can be built rapidly, and can allow companies to retain uniqueness and competitive advantage in collaborative commerce. Companies can build and scale private networks covering a narrow scope of one process or covering a broad scope of multiple processes. Companies can also control and scale integration of trading partners—linking only the largest key trading partners or integrating hundreds or thousands. Companies building private

networks can also sequence the build-out of capabilities to provide scalable Return on Investment at short intervals.

The recent take up of private networks has allowed companies to share knowledge more effectively because they offer the:

- (a) required deep collaboration between buyer and seller;
- (b) speed and flexibility required for timely provision of critical, sensitive knowledge products;
- (c) privacy and control needed to create trusted relationships; and
- (d) quality of service that is a prerequisite for customer satisfaction.

The positioning of knowledge assets center stage in private networks is in line with the recent trend in the strategic management that positions knowledge as the primary resource (Drucker, 1994), that is the primary assumption in the Knowledge-Based-View of the firm (Eisenhardt and Santos, 2001). The specific knowledge base, the ability to make use of the available knowledge determines the competitiveness of organizations in the emerging knowledge society (Franke, 2000). Such theories are unraveling traditional accounting procedures that can not account for new factors of production such as knowledge capital, intellectual capital and intangible assets. (Malhotra, 2000). A detailed account of these concepts is available in Stewart (1997).

Knowledge assets are different from other firm resources; see e.g. (Glazer, 1991) and (Day and Wendler, 1998). They are not easily divisible or appropriable. This means that the same information and knowledge can be used by different economic entities at the same time. Moreover, knowledge assets are not inherently scarce (although they are often time-sensitive). This implies that they are not depletable [\(???\)](#).

Knowledge assets are essentially regenerative. This means that new relevant knowledge may emerge from a knowledge-intensive business process as additional output besides products and services. They may not exhibit decreasing returns to use, but will often increase in value the more they are used. This characteristic is of crucial importance for senior management; see e.g. den Hartigh and Langerak (2001). Most assets are subject to diminishing returns, but not knowledge. The bulk of the fixed cost in knowledge products usually lies in creation rather than in manufacturing or distribution. Once knowledge has been created, the initial development cost can be spread across rising volumes.

Network effects can emerge as knowledge assets are used by more and more people. These knowledge-users can simultaneously benefit from knowledge and increase its value as they add to, adapt, and enrich the knowledge base. In traditional industrial economics, assets decline in value as more people use them. By contrast, knowledge assets can grow in value, as they become a standard on which others can build.

A more detailed analysis of the factors that have an impact on the value of knowledge can be found in Apostolou et al. (2002).

A TYPOLOGY OF KNOWLEDGE NETWORKS

Knowledge flows between organizational units, such as individuals, teams, companies or other types of organizations. These kind of communities can be restricted to actors with specific access rights or can be open to everybody. Knowledge networks can be subdivided into those which are open to everybody or restricted to actors with certain rights. Typically these rights are defined by access rights such as a membership identification which might be gained by expertise, religious belief or political conviction.

On the other side it is also required that an actor complies with the obligations which are defined by the community for a particular role taken by the actor. From a strategic viewpoint we distinguish knowledge networks by the nature of the community in terms of access rights whether it is a closed or an open community.

Because knowledge is a scarce resource it has an intrinsic value which can be assessed by economical terms. In altruistic communities the value is the property of the whole organization whereas in other communities knowledge is exchanged on individual or group level. In these cases the return for providing knowledge is valued by financial, e.g., money or stocks, or communicational, non-financial equivalents, e.g. reputation or decorations. This dimension of knowledge networks is represented by the “nature of business”.

Our empirical research on knowledge networks and knowledge trading marketplaces shows that six basic types can be classified. Basic types can be merged to hybrid types. For instance, parts of a knowledge network might be open to the general public and others are restricted to members, e.g. NetAcademy (www.netacademy.org).

In the following section, five such knowledge networks types (or generalizations) are described in more detail.

Figure 1: Classification of Knowledge Networks in the Extended Enterprise Context

Open Knowledge Source

An open knowledge source is a non-commercial and open knowledge network.

Knowledge assets can be readily available or be created by its member by answering to a knowledge need. Access rights are granted to everybody and in general actors do not have to comply with specific obligations. Typically there are services, which allow for searching and browsing based on some categorization or ontology. Benefits for the members include unrestricted access; knowledge users will benefit from a potentially high number of information objects and expertise, which are readily available. This attracts new participants and offers the opportunity of fast community building. Experts

providing their knowledge will usually be motivated by expected reciprocity, a gain in reputation or even by altruism. The network operator can earn revenues by means of advertising or co-branding the website. Another opportunity is to offer added value services. Examples for open knowledge sources are [ISO-ICQ](#) and Google. Languages used in open knowledge source communities and there the information richness of accessible information objects are in general quite heterogeneous. The value of these types of communities is derived from the free and anonymous access.

Intra-Organizational Knowledge Networks

Intra-organizational knowledge networks are closed and non-commercial communities. In organizations people search for knowledge because they expect it to help them with their work. Within organizations cash is usually not involved in these transactions, but that should not disguise the fact that a market price system exists and “payment” is made or assumed. The intra-organizational knowledge market, like any other, is a system in which participants exchange a scarce unit for present or future value. Basically it's reciprocity. "I'll help you because you'll help me in the future." Some altruism exists, but generally the market principles are pretty strong. (Davenport and Prusak 1998).

As an organization indirectly benefits the knowledge sharing platform if its participants do, it can spend resources for running the market and improve its quality and efficiency by adding knowledge reviewers and brokers.

Due to the non-commercial nature of the community, sources of revenue are based on outsourcing gains of technical operations (outsourcing concept and Community operations and quality management (outsourcing concept) which are paid by the organization. Simplistic forms of intra-organizational knowledge trading communities are

intranets like ShareNet at Siemens. A more elaborated form of closed, non-commercial knowledge network are Open Source initiative such as Apache Software Foundation. These kind of knowledge networks consist of hierarchical organizational structures with clearly defined rights and obligations for each role. The language is highly specialized. Financial benefits are generated outside the knowledge network but in association to the network.

Membership-based Knowledge Networks

Membership based knowledge trading communities are closed communities with a varying degree of commercialization. Information objects can be either covered by the membership fee or can be charged additionally. In an English club newspapers are covered by the club fee whereas a subscriber of the newspaper Frankfurter Allgemeine Zeitung (FAZ) has to pay additionally for the archive.

Revenues are gained by a membership fee per period. Pay per use, pay per user, pay per information objects, pay per period are possible models. An academic journal like Electronic Markets Journal (www.electronicmarkets.org) is a traditional means of subscription based knowledge distribution. Organizations with high expertise in specific domains offer membership-based access of their expertise to client organizations; examples include Research and Technology Organizations like The Welding Institute, or business and market research organizations such as Nielsen. One of the key challenges for traditional membership-based organizations to charge their subscribers for certain kinds of information objects. The well-accepted rule that everything is for free needs to be overcome. In cases that the additional value does not exist and / or it is not communicated in a proper way to the community, the approach to move a membership-based community

from a non-commercial to a commercial either fails or even threatens the whole business model.

Knowledge Supply

Similar to modular supplies of goods, knowledge can be supplied by standardized channels. This knowledge network is implicitly well-known by companies which established a strong relationship to a specific consultancy. Access rights, obligations and the language between the company and the consultancy are well-established which supports an efficient exchange of knowledge.

A knowledge supply has fewer actors in form of suppliers and buyers than an open market, but they have a closer mutual relation. There are some reasons why a closed network like this may be a better means of supplier-buyer interaction than open markets:

- ⇒ It may be too difficult to select the best supplier in cases of an over-abundance of suppliers and networks thus serve to reduce search costs.
- ⇒ It may be difficult to detect who may be interested in the knowledge products outside the lines of known people.
- ⇒ The intangible nature of many knowledge products complicates with price formation and ownership.
- ⇒ Stable knowledge networks as provided by knowledge supply channels establish trusted relationships which also encompass a mutual understanding of the domain and expertise.

Knowledge supplies can be found in areas with formalized and codified languages (type A), such as engineering, computer science and business audits but also in areas with informal languages such as traditional consulting (type B).

In type A we find again well-established, specialised languages which are used to exchange complex knowledge. In particular engineering has developed formal codes which are the basis for describing and solving problems. These codes are learned over years at universities. Engineering associations are important links so that also people on the job keep inside the moving scope of the language. Examples for type A knowledge suppliers are The Welding Institute for engineering, e-institute for electronics, Apache Software Foundation for computer science, and Caliso Consulting for ISO9000.

Consulting companies tried over years to establish a common language which gives enough freedom for differentiation but gives enough logical structure so that companies can unleash transferred knowledge. Nevertheless consulting is still a people-oriented knowledge network so that knowledge supplies are attached to single experts which transfer their trustworthiness to additionally supplied consultants. In more formalized areas of economics, business consulting can provide knowledge supplies in the sense of type A. Examples are know how on procedures for the evaluation of mergers & acquisitions and other controlling areas.

Direct sources of revenue for knowledge supply networks are beside others pay per use, pay per user, pay per information object, pay per period, technical operations (outsourcing concept), community operations and quality management (outsourcing concept). If knowledge will be used in a problem solving context, revenues could also be charged on a success-basis. For instance, this could be used in product design and developmental scenarios.

Knowledge suppliers can either operate independently or in conjunction with others. In the latter case marketplace functions are required. Additionally they can integrate, syndicate, or meliorate knowledge services of suppliers as it is known from the newspaper industry.ⁱ

The demand for knowledge suppliers in sense of type A is rising as the market for expertise gets more transparent. This will nurture fractal and distributed organizational structures which temporarily in-source high-level expertise as known from the pharmaceutical industries for product development. This requires a industrialization of knowledge-based organisations.

General Knowledge Trading

The general knowledge trading network is an open and commercial marketplace. The idea of an open marketplace with many different buyers and suppliers implies that price and volume are the most important determiners of for supply and demand (Wijnhoven 2001), which is the case for commodity goods. Applied to knowledge markets this may happen when many suppliers offer similar products. Two different kinds of knowledge commodities require diversity in the markets services:

- ⇒ Homogeneous knowledge commodities. These commodities consist of clearly identifiable (highly codified) knowledge products, like books. These knowledge commodities consist of information objects, supplied one at a time.
- ⇒ Data packs. In comparison to homogeneous commodities these data packs are more flexible in shape and have larger opportunities of meeting specific information needs, because much of the information is unbundled. The buyer may be given the

opportunity of specifying his information need, and as such create his own information bundles. Examples of this kind are market information services and news agency services, which enable their customers to buy a selection of data from the larger resources available.

⇒ Procedural Knowledge Packs. Problem solving can be seen as a step-by-step procedure which allows to ensure a desired goal situation. In formalized areas, these procedures can be packaged and sold. Examples are certain types of due diligence methods or credit risk procedures. They can be applied by buyers if they are able to understand the logical structure which contains the necessary roles, required expertise, and step-by-step behavior of the procedure. An example are the Best practice guides provided by TWIⁱⁱ.

The experts and knowledge publisher benefit from an additional outlet and by means of this an increased demand for their knowledge products, which is the basis of their revenues. Examples of general knowledge trading networks are: www.knexa.com and www.hotdispatch.com.

Learning Networks

The term learning network does not refer to networks where learning simply happens as it is the case with Communities of Practice – groups of people who share a concern, a set of problems, and who deepen their knowledge and learn by spontaneously interacting on an ongoing basis (Wenger, 1998). On the contrary, learning networks are inter-organizational networks, formally established to increase the participants' knowledge and innovative capability. Learning networks are formally established and defined; have a

structure for operation with boundaries defining participation; have a primary learning target; have formally developed processes that can be mapped on the learning cycle; have practical learning outcome that can be measured.

Examples of learning networks include professional associations (Institute of Mechanical Engineers, UK), sector based associations of firms with common interests in the development of the sector (Automotive Cluster of Styria, Austria), industry research and technology networks (TWI, UK), supply-chain initiatives (particular firms supplying to a major customer - e.g. Toyota – Kyokoryku, Japan), region based networks (3rd Italy), government-promoted networks (London Innovation and Technology Counselor's network, UK).

Learning networks exploit the widely used approach termed “action learning”: the active participation, challenge and support of groups of employees facing similar problems. The whole idea of action learning is based on the combination of personal example (the action dimension) with the notion of learning community. This concept stresses the value of experiential learning and the benefits which can come from gaining different forms of support from others in moving around the learning cycle. Self-learning within a group has much to offer to organizational learning and competitive advantage; the experience of regional clusters of small firms provides one important piece of evidence in support of this. It has been increasingly recognized that organizational knowledge results from complex and multi-faceted interactions among different individuals.

ENABLING TECHNOLOGIES FOR KNOWLEDGE NETWORKS

Technologies used as media for communities of knowledge networks need to capture social, semantic, organizational and process-oriented structures. Knowledge worker, such as in open source communities meet for specific beliefs, intentions and desires. For instance, tools are required to support open and democratic communication between all members of the group. On the semantic level a community defines meanings which are codified in signs and symbols. The technology should provide means for learning, exploring and apply the semantics on the basis of services. For instance [e-Mail](#) is based on the semantics of traditional mail. Therefore a user needs services for sending and receiving e-mails as well as an e-mail box. On the organizational level technologies for knowledge networks need to provide sufficient means for creating roles. For instance, a class room requires the role of a teacher and a student. Knowledge media such as knowledge networks demand clear role sets so that every participant understands his / her role and the role of others. Also in this case, open source communities provide excellent cases for organizational structures for knowledge networks. Finally, the technology needs to provide means for implementing process on top of services. The requirement for synchronous communication in collaboration situations can be implemented on top of instant messaging, IRC or even Wiki. The implementation of the process will differ but the requirement on social, organizational and semantic level to be fulfilled stay constant. Furthermore technologies supporting collaborative knowledge networks must operate efficiently in open environments with practically no geographical, temporal, cultural, and technical limits. This type of environment is characterized by the fact that participants are

autonomous, i.e. they can come and go, and act independently and self-contained. For a specific purpose they may be willing to participate in loosely coupled communities, taking some role and responsibility and/ or providing some services. In such communities, they may negotiate and fix some agreements, perform some tasks, provide and/ or access some information, and access or offer some resources, while others are restricted to their own use. Consequently technologies used in such environments must support loose coupling, autonomy, and flexibility on the one hand, and agreement making, trust and security on the other hand (Tschammer, 2001).

Nonaka and Takeuchi (1991, 1995) in their reference study about knowledge creation in the Japanese industry are distinguishing two types of knowledge flowing in any kind of knowledge transaction: explicit and tacit. *Explicit knowledge* is formal and systematic and thus, easy to communicate and share; it is knowledge that is transmittable in a formal language and can be stored in databases, libraries, etc. *Tacit knowledge* is personal knowledge that is hard to transmit; it consists of mental models, beliefs and perspectives that can not be easily articulated and shared.

Accordingly, four types of interactions (or modes of knowledge conversion) can occur during knowledge transactions: From tacit to tacit (Socialization), from explicit to explicit (Combination), from tacit to explicit (Articulation), and from explicit to tacit (Internalization); see also Figure 2. It is important to notice that although the modes of knowledge conversion were initially proposed by Nonaka and Takeuchi as the basic patterns for knowledge creation and management within organizations, they can be equally applied to model and understand knowledge transactions in the extended enterprise or at the supply chain level. Understanding the flow of tacit knowledge and how tacit knowledge can be transferred or converted to explicit knowledge is of immense

importance for the design of appropriate IT supporting tools for collaborative Knowledge Networks.

Figure 2: Modes of Knowledge Conversion

In order to understand how information technology can support knowledge transactions it is convenient to focus on each one of the four modes of knowledge conversion. A classification of existing information technology tools according to the four modes of knowledge conversion is presented below; see also Table 1.

Mode	Support required for	Examples of tools
Socialization	informal communication on-line discussions during work question raising information discovery	e-mail, discussion lists, collaborative hypermedia, multimedia conferencing, brainstorming applications
Internalization	search for methods & lessons-learned process documentation knowledge sharing knowledge interpretation	lessons-learned databases, information retrieval, process history tracking, case-base retrieval, data warehouses
Externalization	concept mapping tacit knowledge: categorization / representation organizational memory creation personalized pathways	semantic annotations, ontologies, publishing tools, push technologies agent technologies issue-based argumentation

Combination	knowledge sharing decision co-ordination	computer-mediated communication, searching and filtering, document management, workflow systems, group decision support systems
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Table 1: ICT support and example of tools for each mode of knowledge conversion

Knowledge Socialization

Knowledge socialization generates new tacit knowledge by sharing and exchanging know-how and past experiences. Socialization can receive direct support from information technologies that make users communicate without imposing any particular structure on their interaction. A more structured approach, like workflow management can also powerfully support knowledge management by enabling the interaction between communities associated with different functional domains of the organization.

Collaborative knowledge management software must support the creation of communities or networks within the corporate network and beyond. This requires an environment that supports knowledge sharing and knowledge capture. A collaborative environment must offer the flexibility to support a range of projects and applications, as well as a robust framework that is integrated with the corporate infrastructure for communication and information management.

The functions that a collaborative environment should offer include:

⇒ synchronous communication – synchronous messaging allows users to set up a conversation in real-time over the network. Associated services include the ability to identify colleagues who are available online. In future, net video and net telephony will be integrated with collaboration environments, as an alternative means of linking users in real-time over the network.

- ⇒ net spaces – tools, such as Microsoft's NetMeeting and Lotus's Sametime are enabling users to work together in real-time over a network. Users can work together on documents and hold conferencing and white-boarding sessions via an intranet or the Internet. Such services need to be supported by appropriate security and management functions (for example, integrated versioning and locking of documents).
- ⇒ e-mail and beyond – functions such as synchronous communication and the provision of net spaces take the basic tools provided by e-mail to a new level. The other advance concerning e-mail will be to integrate it with the knowledge repository in a much more flexible and transparent way. Threaded discussion groups should be easy to define and administer. E-mail and discussion groups also need to be integrated with the repository, so that discussion, annotations and comments are available as part of the network memory.
- ⇒ the ability to form communities and linking users to knowledge – this depends on a comprehensive directory of resources. Improvement in the integration of directory services, based on the take-up of LDAP and improved automation of expert profiling and discovery, will make it easier to find the right person across the network.

Knowledge Internalization

Knowledge internalization maps explicit knowledge into internal knowledge.

Internalization happens when individuals, exposed to other's people knowledge, make it their own. People internalize knowledge by doing, but also by looking at what other people have done in a similar context and by example. Information technology tools can record explicit knowledge and make it available to potentials users and enable them re-experience what other people have done in similar situations, help them familiarize

themselves with analogous situations, etc. Indicative information technologies supporting this mode are data warehousing, data mining, Computer Based Training (CBT), etc.

Knowledge Externalization

Externalization involves structuring knowledge and making it available to other users.

This is a crucial step in the knowledge life-cycle that leads to the creation of the network *organizational memory*. Knowledge externalization has been traditionally supported by a number of artificial intelligence-based technologies such agent-based technologies and semantic enrichment of information mainly through the use of ontologies.

Ontologies have been recently introduced (Davies et. al. 2003) in information technology, as the working model of entities and interactions in some particular domain of knowledge or practices, such as welding of materials. In this usage, an ontology is a set of concepts - such as things, events, and relations - that are specified in some way (such as specific natural language) in order to create an agreed-upon vocabulary for exchanging information. Loosely coupled, autonomous entities, which have to collaborate in an open environment, need ontologies to define a common language and a common set of terms for the environment wherein they have to collaborate.

In order to cope with the great complexity of the knowledge exchanged in the context of such networks, a knowledge-rich formalization of knowledge assets and the domain of application seems an appropriate backbone of the knowledge network system. This approach is becoming increasingly important for information retrieval tasks in digital libraries or Internet information search (see McGuinness, 1999).

Another important technology that is exploited mainly to support knowledge externalization is Software Agents. Software Agents are autonomous software entities that automate a set of tasks delegated to them either by people or other software

processes. An agent has its own state, behavior, thread of control, and an ability to interact and communicate with other entities - including people, other agents, and legacy systems, in an autonomous, intelligent and proactive way. The agent paradigm is different to the traditional client-server approach. Agents can interact on a peer-to-peer level, and mediate, collaborate, and co-operate in order to achieve their goals and objectives (Tschammer, 2001).

Knowledge Combination (or Systematization)

Knowledge combination generates new knowledge by combining pre-existing explicit knowledge and bringing it together to produce new insight. Systems that provide access to distributed explicit knowledge (such as distributed databases and workflow applications) are typical supporting tools for knowledge combination.

Peer-to-peer is a communications model in which each party has the same capabilities and either party can initiate a communication session. In recent usage, peer-to-peer has come to describe applications in which users can use the Internet to exchange filesⁱⁱⁱ with each other directly or through a mediating server. On the Internet, peer-to-peer (referred to as P2P) is a type of transient Internet network that allows a group of computer users with the same networking program to connect with each other and directly access files from one another's hard drives. Napster and Gnutella are examples of this kind of peer-to-peer software. Virtual communities are already exploring the advantages of using P2P as a way for sharing information and knowledge resources without the expense involved in maintaining a centralized server and as a way for businesses to exchange information with each other directly (see for instance the SWAP project, swap.semanticweb.org).

Knowledge Process Modeling is the task of describing all relevant aspects of a knowledge process. Modeling of inter-organizational knowledge processes – as required in

collaborative e-commerce - must cover aspects that are specific to processes that cross enterprise boundaries, including business rules, security roles, distributed transactions, and exception handling.

On the back-end, technology integration standards such as XML Schema, SOAP, and J2EE enable the convergence of legacy infrastructures toward process-oriented enterprise computing. On the front-end, emerging protocols such as ebXML, RosettaNet, and BizTalk support the process-level collaboration within a knowledge network.

In the following two sections we examine two specific ~~toolsets~~[toolkits](#) for inter-organizational knowledge networks that were built by adopting some of the previously mentioned technologies.

WIT: KNOWLEDGE SHARING AT THE SUPPLY CHAIN LEVEL

Introduction

Although firms work hard to invent and improve processes themselves, they also at times want to share process or product knowledge among firms. For example, knowledge sharing within a supply chain has become a common practice because it promises to enhance the competitive advantage of the supply chain as a whole (Bell et al., 2002). It is sometimes the case that companies even require that their suppliers implement inter-organizational information systems to improve organizational coordination and product quality (Holland, 1995). In other cases it is the introduction of such systems that is

triggering the formation of new organizational entities to resume the role of the information broker (Sakkas et al., 1999), and in effect re-shape the tradition supply chain.

The WIT [toolsettoolkit](#) provides an infrastructure based on the Internet to support the collaborative enterprise paradigm in the wood / furniture supply chain, focusing primarily in the field of design, sales, and marketing. This [toolsettoolkit](#), addressing the main functions required within the targeted supply chain, operates partly locally on the end-user's computer and partly in collaboration with remote entities (WIT-servers). The architecture of the client as well as the server applications allows for the possible modification of the existing tools or the extension of the basic tool set by integrating other functions. This approach, along with the careful design of the infrastructure allows WIT to be adopted and used in the domain of other supply chains, outside the wood industry.

WIT Architecture and functionality

Technically speaking, the WIT infrastructure is based on a 3-layer service architecture, where the main elements are: (1) WIT-N layer, its main purpose being to provide directory services, which will help clients navigate themselves to the correct sites, where meaningful (to their purpose) product information might be hosted; (2) WIT-server layer, hosting three kinds of services (and the respective data, naturally): User administration, product data delivery and a “point of contact” service (collaboration brokering); and (3) WIT-client layer, consisting of an applet that provides an integrated user interface to the WIT functionality. (The end-user may search for furniture products, thereby building up his own customized product catalogue, build interior designs with the chosen products,

negotiate prices or other details and finally, place orders.) The applications of the WIT [toolsettoolkit](#) are presented in Table 2:

Application	Description
WIT.Project	As the user (architect) usually organizes his work by projects, it is natural to follow this strategy within the client software. The so-called Project Manager part of the client software lets the user define what kind of space has to be furnished, how it is divided into rooms, who is the end-customer, how much money might be spent on furnishing, and so on. The definition of the project provides guidelines for the remainder of the functions.
WIT.Query	The user must be able to find furniture that best matches the project requirements, which is a core functionality also from the vendors viewpoint. In the Query Tool, the user specifies values for a number of attributes, for which WIT-servers can search in their databases. Results are displayed on the same screen, so that interactive refinement of query attributes is possible.
WIT.Space Planner	To give a best possible impression of how a certain combination of furniture would look like in a room, a 3D composition tool is included in the client software. The goal of the SPACE PLANNER (Figure 3) is visualization of such a composed design, rather than precise planning for construction. The emphasis here lays on good graphics performance and ease-of-use.
WIT.Quotation WIT.Order	Both quotations and orders are managed by a tool called the Quotation Builder, which helps the user in preparing requests for quotations and in dispatching orders. It is possible for an end-user to go through an interactive cycle where a series of parameters may be settled before placing an order.
WIT.Collaboration	The user is enabled to get into personal contact with service people on the server side using collaboration mechanisms, such as video-conference. These may be sales people or technical support staff, depending on the kind of questions that may arise. This capability provides companies with a more efficient and competitive customer support strategy. The collaboration tool is flexible enough to also be used as a training tool, e.g. for introducing new products and best practice cases. With collaboration, it is possible for the company to have geographically dispersed expertise, thus making better use of its human resources.
WIT.Server Query	This part of the client system sends out calls to the directory service provided by the WIT-N server. If a user is unsure, which WIT-server to contact, he performs a kind of meta-search and gets back a list of WIT-servers that provide the kind of products the user is looking for.

Table 2: WIT applications

Figure 3: The WIT Space Planner Tool

A graphical representation of the WIT [functionalities-functions](#) is shown in Figure 4. For a more detailed presentation of the WIT architecture see Sakkas et. al. (1999).

Figure 4: The WIT functional architecture

How WIT Supports Knowledge Transactions

In this section we discuss how the different tools of the WIT [toolset/toolkit](#) provide support for enacting the four types of knowledge transactions.

Knowledge Socialization

WIT uses a structured approach, supporting a virtual work environment for design and training between communities associated with different functional domains within the same or between different organizations. *WIT.Collaboration* supports the creation of virtual work environments to discuss and agree on different aspects of furniture design, construction and application. A WIT client can interact with other WIT clients and server (s) in order to optimize the exchange of ideas and information between architects,

decorators and customers. In summary, a collaboration session consists of audio/video conferencing, whiteboard functionality and application sharing.

Knowledge Internalization

Company-specific knowledge on products and services, such as product information, best practices, training material in multimedia formats, can be codified, stored and made available through *WIT.Query*. This tool concerns itself with providing access to the value supply chain knowledge assets. The WIT searching mechanism is characterized by the ability to post requests to the whole network or to parts of the network. The first type resembles the well-known, WEB engine type of searching while the second provides a map to the product and other information residing in the WIT servers. The user posts can traverse the whole WIT network and select appropriate servers based on domain or product characteristics, such as country, product range, price range, etc.

| Clustering of results based on the meta-data categories defined in the product data model enables the user to quickly drill down to or mine the most relevant knowledge assets.

Knowledge Externalization

WIT provides the *3Dcatalogue* application to support this mode. The 3D electronic catalogue presents for each WIT server the wood products organized by product lines, furnished model rooms, price lists, availability indication, etc. The catalogue presents for each product information such as parts structure, geometry allowed adjustments, materials, colors, textures, dimensions, finishing, assembly details, maintenance details. The 3D electronic catalogue extends with advantage the 2D paper catalogue, of great use in the specific sector. The electronic version can be kept updated in product line, availability and price list without the fixed costs associated with paper publications. This is the most powerful facility to support the design decisions. The creation of a virtual

space, the ability to visualize 3D objects and spaces as well as the impact of different finishing, colors, textures, and lighting, can expedite drastically the project concept decision. In addition *WIT.SpacePlanner*, allows to visualize 2D spaces and 3D models. The space planner is a composition tool that replaces the free-hand sketch drawer by the architect to illustrate a solution and includes the legal, technical and best practice constraints that are specific knowledge of the project designer. Additionally it allows to populate the office space with different versions of furniture, converging to the full satisfaction of the client under the designer guidance.

Knowledge Combination

WIT.Project provides a repository of information related to the client furnishing project decision process, the project negotiation process, the capturing of user requirements and the project start-up. The decision to develop a new office project is a complex process with multiple drivers as well as constraints. It might be a decision taken inside a corporation who develops clear terms of reference, or only develops the project idea in dialogue with the office design specialist. In both cases WIT can provide different room models exemplifying different styles and applications. WIT supports the project definition with a number of predefined **scripts** allowing users to define office space area, business organization characterization, type of business, business strategy, evolution plans, number of users, budget target, and project schedule.

Discussion

A significant benefit of “knowledge supply chain” type of knowledge networks such as the WIT one, is that they help increase the sector’s “surface area”, or the number of points at which it has access to knowledge. Companies that participate in such networks are

much more likely to stay in the knowledge flow than those that do not (media richness theory, TAM, ...). Such access is as important in continuously refreshing knowledge as it is in acquiring it in the first place.

The WIT infrastructure in particular leverages the existing business model of wood sector companies to move beyond the static, product-oriented environment of today, into the community and conversation environment where knowledge provision is a key enabler factor. In this environment, a designer will visit the WIT virtual world to see and read about a new product of company X or she can search among the WIT servers for a product that fits her needs. She will then be able to discuss with other users (architects, designers, etc.) or with the manufacturer itself about product ~~functionalities~~functions, best practices or see will be able to see successful installations. In a way, WIT has the capabilities of fostering an organic community. Clearly, the technology is seen only as an enabler; it is the community members that will maintain the ties that bind them together. The role of the technology - and of the broker providing and maintaining it - is to further facilitate the growth of that community by assuring that value chain members enjoy closer contact with each other and with the knowledge sources.

KNOWLABORATION: KNOWLEDGE APPLICATIONS FOR COLLABORATIVE LEARNING NETWORKS

Introduction

The potential of knowledge networks for the distribution of explicit knowledge, i.e. knowledge which is pinned down verbally in writing or electronically and can therefore

be communicated and distributed, is undisputed. However, what is also required is an integrated approach which includes both explicit and tacit knowledge. Tacit knowledge can be conceptualized as processing a technical and a cognitive dimension (Seufert et al., 1999). Whereas the technical dimension contains informal, personal abilities and skills, the cognitive dimension includes mental models, influenced by beliefs, values and convictions (Nonaka and Takeuchi, 1995). For this reason and in order to make effective use of knowledge, a network must be built up in which the knowledge and experience of employees are available (Seufert et al., 1999).

| The KNOWLABORATION ~~toolset~~[toolkit](#) was developed specifically with these objectives in mind: to provide an infrastructure based on the Internet to support the advancement of knowledge as well as the learning of the participating employees. It exploits the widely used approach termed “action learning”: the active participation, challenge and support of groups of employees facing similar problems (Pedler et al., 1991).

Figure 5: Main functions and roles of a Learning Network

The **KNOWLABORATION** [toolset/toolkit](#) is developed to support five^{iv} main categories of users (figure 5):

- (a) The managers of the broker - organization, which co-ordinates or wish to co-ordinate the knowledge network.
- (b) The managers of the collaborating organizations who have decision making responsibilities within the network; the number of managers with such responsibilities vary from a few people representing all members to one representative from each collaborating organization.
- (c) The employees who participate in actual learning and knowledge sharing sessions of the network.

- (d) The employees who do not participate in specific learning sessions of the network; usually members appoint specific persons to follow the learning sessions of the network who however find it difficult to convey the learning content of the sessions to the rest of the organization.
- (e) The employees of associated members (if existing) who can also reap the fruits of learning that is taking place within the network, if the network decides to allow access to the shared knowledge base; this is the case of members which pay reduced subscription and have limited participation and access to the network. Depending on the specific case, a learning network may allow access to unregistered Internet users.

Figure 6: Architecture of the KNOWLABORATION [Toolset Toolkit](#)

Figure 6 shows the several subsystems that constitute the KNOWLABORATION [toolset toolkit](#) which are described in Table 3. Figure 8 presents the [functionalities functions](#) that the [toolset toolkit](#) provides to the five categories of users.

Subsystem	Description
1. Knowlaboration Portal Server	This is the core engine of the system. The Knowlaboration Portal Server provides Content Management facilities, Document Management facilities, a Personal File Manager, a Project Workspace, Search Facilities and a Reporting and for auditing the usage of the system.
2. Knowlaboration Job Server	Manages all the system's content by accessing different data sources. It also performs standard jobs in order to update the contents and the index that will be later used for searching the system.
3. Knowlaboration Security Engine	Manages all the system's security.
4. Collaboration Tools	These tools allow the collaboration of the users in several ways (synchronous / asynchronous) The Collaboration tools are: E-Maile-mail , Forums, SMS messaging, Chat engine, Instant messaging, Video conferencing / Audio conferencing.
5. Personalization Engine	This engine allows the filtering of information to the user in such way that it meets personal criteria given by him/her. The personalization can extent to user groups (channels) or each user according to the level of IT knowledge each one carries.

Table 3: Knowlaboration Subsystems

Figure 7: KNOWLABORATION home page

BASIC APPLICATIONS FOR ALL USERS <ul style="list-style-type: none"> •Portal Interface •Organization Structure •Network Time •Users On line •Notes •Search 	USERS <ul style="list-style-type: none"> •Participating employees •Non-participating employees •Associated members •Managers with decision making responsibilities •Broker
GROUP LEARNING ORIENTED APPLICATIONS <ul style="list-style-type: none"> •Group Area •Forum •Chat •Web Calendar •Polls 	USERS <ul style="list-style-type: none"> •Participating employees •Managers with decision making responsibilities
ADMINISTRATION APPLICATIONS <ul style="list-style-type: none"> •Permission Management •Platform Management •Applications Management 	USERS <ul style="list-style-type: none"> •Broker

Figure 8: KNOWLABORATION ~~functionalities~~ functions supporting the five categories of users

How KNOWLABORATION Supports Knowledge Transactions

Knowledge Socialization

Various collaborative tools (~~E-Mail~~ e-mail, Forums, SMS messaging, Chat engine, Instant messaging, Video conferencing / Audio conferencing) support knowledge socialization. These tools allow the collaboration of the users in both synchronous and asynchronous modes. What is important to note though is the non-IT support that these types of networks provide to the participating members. Face-to-face collaboration is encouraged through the organization of physical meetings, factory visits, seminars and workshops.

Knowledge Internalization

One of the most usual problems of learning networks is the restriction of the learning and knowledge gained during the formally organized real-time, collaborative sessions of the network. If an individual member is unable to follow one session due to time or work restrictions, he/she has no way to access the missing part of his learning trajectory. To support this “knowledge internalization” process , the KNOWLABORATION [toolsettoolkit](#) records these session (using various tools such as lessons learned techniques, multimedia archives, etc.) can enable collaborating members to minimize their losses from missing particular sessions. This way the KNOWLABORATION [toolsettoolkit](#) can help the network to increase both the duration and the efficiency of the knowledge and learning. For instance, it supports (using structured, facilitated discussion forums) follow-up sessions that expanded knowledge internalization in between the formally organized learning sessions.

Knowledge Externalization

A very important barrier for increasing the efficiency of learning networks is related to the difficulty of the individual members who participate in the network to pass the gained (tacit) knowledge to the rest of the organization. The KNOWLABORATION [ToolsetToolkit](#) learning sessions’ archive and recording facilities allow more people from the organizations to access the issues discussed during the learning sessions effectively reducing significantly the diffusion barrier.

These facilities are useful also for members that join the network at a later time that otherwise could not benefit from previous learning that had been taken place in the network, missing a valuable part of the learning trajectory. The training services provided

by the [toolsettoolkit](#) support lately joined members enabling them to cover part of the lost ground.

Knowledge Combination

Decision-making in collaborative learning networks is critical for their success since decision-making results to the specification of a variety of issues related to the knowledge captures and exchanged and to the learning process and content. The KNOWLABORATION tool follows and supports a participative decision-making process, to capture the opinion of as many members as possible, with an increased interaction between them before the actual decision-making sessions. This collaborative platform has the potential to facilitate the decision-making process and allow the intensive communication among a large number of individuals and organizations.

Discussion

From our experience and interaction with a “learning network” type of knowledge networks, we have derived a constructive set of recommendations for effectively deploying IT in such networks. These design principles are not recipes, but rather embody our understanding of how modern IT can help learning networks.

The first recommendation highlights the need to support the three main learning network management processes: (1) The initiation phase, that concerns itself with the setting up of the learning network. The IT tools should provide: a detailed checklist with which potential community-initiators, mechanisms to identify the type of members that such a community would require and planning facilities to ensure the workability of the community. (2) The maintenance and improvement phase, that concerns itself with sustaining the momentum of the community that has been set up and sustain active

knowledge sharing within the community. The IT tools should provide: facilities to support the maintenance and growth of the network and member management facilities that will help users integration for the main activities of the network. Typical features of the kind include synchronization of calendars and synchronous events. Other useful facilities aiming at promoting and marketing the network to relevant stakeholders include invitations, minutes of recent events and hot topics. (3) Facilities during the operation phase should monitor if the individual members can see benefits for themselves and their business.

The second recommendation is referring to the integration of the system with existing business processes. Participation in a learning network usually competes with other priorities in the lives of members. It is crucial to make participation as easy and efficient as possible. ICT therefore should make participation easy, provide time and attention management, through ~~functionalities~~ functions such as personalized knowledge/application portals, subscriptions, tours of new activity and archiving of interactions, integration with work systems.

The third recommendation clarifies that the learning network system should address the issues of presence, visibility and motivation. Personal identities are a crucial aspect of participation. Members bring their identities to the community and their participation both develops and shapes their identities. IT can help with features such as member profiles, ranking and preferences and presence awareness. A collaborative community such as a learning network has also a sense of communal identity that is primarily formed by cultivating “alive and real” relationships between the members. The use of personal profiles in the ICT system can reveal relationships, support private interactions and interpersonal and mentoring relationships.

Fourthly, a learning network should thrive to deliver value both to their members as well as to the stakeholders and the network as a whole. In the short-term, members need to find immediate value in their participation. Preserving the time of experts within the network is for instance an important concern. The IT system should provide mechanisms for asking questions, lists of FAQ's, databases of answers, intelligent access to experts and brainstorming facilities. The value that the network delivers also has a long-term dimension. It derives from a sense of accumulation over time. In order to define "best practices" the IT system should provide repositories for artefacts, taxonomies, search mechanisms and learning agenda.

The value of belonging to a learning network derives not only from having access to peers, but also from having access to the leading edge in the broader world. Therefore as a fifth recommendation, we stress the need for IT facilities that assist in the direction of providing connections to the world include: what is happening, what is hot in the field, new developments, new technologies, evaluation and reviews, external experts, reference material, news and announcements of external events, directory of external experts, links to other sites and library of references.

Learning networks usually have members who take an active role in cultivating the community and may participate in the decisions that affect the operation of the network. The sixth recommendation is about offering a variety of administrative tools to monitor and configure the use and effectiveness of the network space. Typical features of this kind include: logs and statistics for monitoring, polling and voting facilities, assessment tools and surveys, performance indicators and finally switches and policy enforcement algorithms.

FUTURE TRENDS IN KNOWLEDGE NETWORKS

We have outlined in this chapter various types of inter-organizational knowledge networks and discussed in detail two of them (knowledge supply chains and learning networks). In these two types of knowledge networks, knowledge assets are exchanged in order to increase the efficiency of the supply chain and learning and competencies of the participating organizations. But, what other ways are there for an organization to exploit its knowledge assets? Can firms sell knowledge assets, creating "smart" offerings that embed such assets, or develop knowledge-based products that embody knowledge assets? Which are the most appropriate pricing mechanisms for these offerings? How can they be promoted? How can they be organized and sold in an electronic marketplace? Which are the points of view of the customer (needs met) and the supplier (return on investment) as well as the impacts such an approach to products has on its related processes?

These are some of the questions we explore in a recent research programme on knowledge asset trading network development; see Apostolou et al. (2002). Our research attempts to extend the traditional Internet-based marketplaces (e-marketplaces), which improve overall market efficiency, reduce transactional costs by integrating sourcing, purchasing, and billing; provide wider choices of buyer & selling trading partners, centralize access to information; and allow for pricing that better reflects supply & demand; see Mohan (2000), (Schmid: On electronic markets) Archer et al (2001), McKinsey (2000) and Aberdeen Group (2000). The research explores the development of knowledge trading marketplaces, i.e. marketplaces which provide the digital community context where knowledge-seekers can find knowledge-providers; see e.g. Kaieteur Institute (2001).

Despite related research work, current virtual knowledge trading marketplaces exhibit major limitations. They emphasize the explicit dimension of knowledge assets, thereby ignoring the complex context and content features, which determine the applicability and usefulness of knowledge in a given situation. Moreover, they do not consider fact that the real power of electronic marketplaces lies not in copying ways of working already known from traditional business, but in exploiting the strength of synchronous and asynchronous community-building. Finally, they limit their focus to the technical issues and do not take into account business matters like customer relationship, advanced revenue models, alternative pricing mechanisms, etc.

Further research should aim to address the above shortcomings. For instance we have initiated an effort to build a solution for knowledge trading, which spends due diligence to both technological and methodological developments and investigates long-term issues like creation of trust and customer satisfaction.

The first research stream refers to the explicit description of supply and demand, and the matchmaking between both. Since knowledge is by definition highly context-dependent, all explicit representations (at the seller side) will necessarily de-contextualize it to some extent. In addition, in a knowledge e-marketplace we need sophisticated representations of products and customer needs, which should also express aspects like knowledge quality and knowledge actuality, which can hardly be dealt with in a general manner. In our approach we use a knowledge-rich, ontology-based formalization of knowledge objects (information objects?) and the domain of application as the backbone of our matchmaking system; see e.g. McGuiness (1999).

A second research direction refers to the analysis of the knowledge network as a medium of interacting agents. Although the Nonaka and Takeuchi knowledge management

approach used herein models sufficiently the interactions (or modes of knowledge conversion) that occur during knowledge transactions within Knowledge Networks, it is not sufficient for modeling Knowledge Networks as media of interacting actors that exchange knowledge over space and time. It is neither capable of providing a methodological basis for modeling the community of the network, the business processes of the network and for developing the infrastructure required for the operation of the network. (Introduction into recursive, interoperable knowledge media: reference to Maass et al 2003) To address these shortcomings we may consider a Knowledge Network as a medium in between a sender and a recipient which enables communication between these two parties. In order to structure and describe aspects and components that have to be taken into consideration for Knowledge Networks as e-media we are working towards integrating the Nonaka and Takeuchi model with the Media Reference Model (see Schmid, 1998; Apostolou et al., 2002) for describing e-media. According to the e-media approach of Knowledge Networks, agents interact with the medium in order to exchange knowledge assets. This interaction process can be referred to as a market transaction. This market approach brought in by the Media Reference Model is useful in order to model the knowledge transactions as market transactions between market participants in various roles. Furthermore the market approach is particularly suitable for modeling Knowledge Networks with a commercial dimension, as per figure 1.

EPILOGUE

The new knowledge-based economy necessitates increasingly the collaboration between different organizations. Despite the recent upsurge in e-learning and knowledge

management systems, the vast majority of these systems focus on either individual users or individual organizations. This chapter introduced the concept of knowledge networking at the inter-organizational level, demonstrated how the different modes of knowledge conversion can be supported by IT systems developed specifically to support inter-organizational knowledge networking, and provided a constructive set of recommendations for using IT to support learning and knowledge sharing at the network level.

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- ⇒ WIT: Enabling Data Sharing And Business Interactivity Across The Wood Sector Value Chain By Developing A Custom Set Of Internet Based It Tools;
- ⇒ INKASS: Intelligent Knowledge Asset Sharing and Trading; and
- ⇒ KNOWLABORATION: Knowledge Applications for Collaborative Inter-Organizational Networks.

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ⁱ Consulting business itself intrinsically contains this concept of integration, syndication and melioration of knowledge. Most of the concepts provided by consultancies have their origin in academic sources. Consulting firms translate, package and apply these types of knowledge in problem spaces and languages of companies and organizations.

ⁱⁱ www.twi.co.uk

ⁱⁱⁱ P2P networking has the capability to facilitate sharing of resources that include human expertise, insight, rules-of-thumb and lessons learned, not just files (Tiwana, 2003). They can potentially support the “socialization” mode as well, although we are not aware of any applications that exploit p2p networks to support exchange of tacit knowledge.

^{iv} The sixth stakeholder of Learning Networks (policy makers) is currently not supported by KNOWLABORATION