Smart Organizations in the Digital Age

Erastos Filos

European Commission, Directorate-General Information Society and Media

Abstract

The chapter aims to present and explain the concept of the smart organization. This concept arose from the need for organizations to respond dynamically to the changing landscape of a digital economy. A smart organization is understood to be both, *internet*worked and knowledge-driven, therefore able to adapt to new organizational challenges rapidly, and sufficiently agile to create and exploit knowledge in response to opportunities of the digital age.

The three networking dimensions of smart organizations, ICT-enabled virtuality, organizational teaming and knowledge hyperlinking are elaborated. This networking capability allows smart organizations to cope with complexity and with rapidly changing economic environments. The paper also shows how managing the smart organization requires a more 'fuzzy' approach to managing smart resources: people, information, knowledge, creativity.

Research is also presented, mainly from the European perspective. It has been key to creating the conditions for organizations to become smart.

Characteristics of the Digital Age

Over the last decades, information and communication technologies (ICT) have been the enabling factor in organizational change and innovation, and there is now evidence on their impact on industrial value chains. Organizations today strive to become agile and to operate profitably in an increasingly competitive environment of continuously and unpredictably changing markets.

The digital age is different from the industrial age in various ways (fig. 1). For example, today ICT represent a substantial – and increasing – part of the added value of products and services. ICT-intensive sectors include manufacturing, automotive, aerospace, pharmaceuticals, medical equipment and agro-food, as well as financial services, media and retail. In the automotive sector, for instance, an estimated seventy per cent of innovations that happened over the last twenty years were related to ICT.

According to recent studies, more than half of the productivity gains in developed economies can be attributed to ICT (OECD, 2003; O'Mahony & van Ark, 2003). The gains stem both

from the production of innovative high value goods and services based on ICT as well as from improvements in business processes through a wider diffusion, adoption and use of ICT across the economy. Their impact on the economy and on society at large has led to remarkable changes.

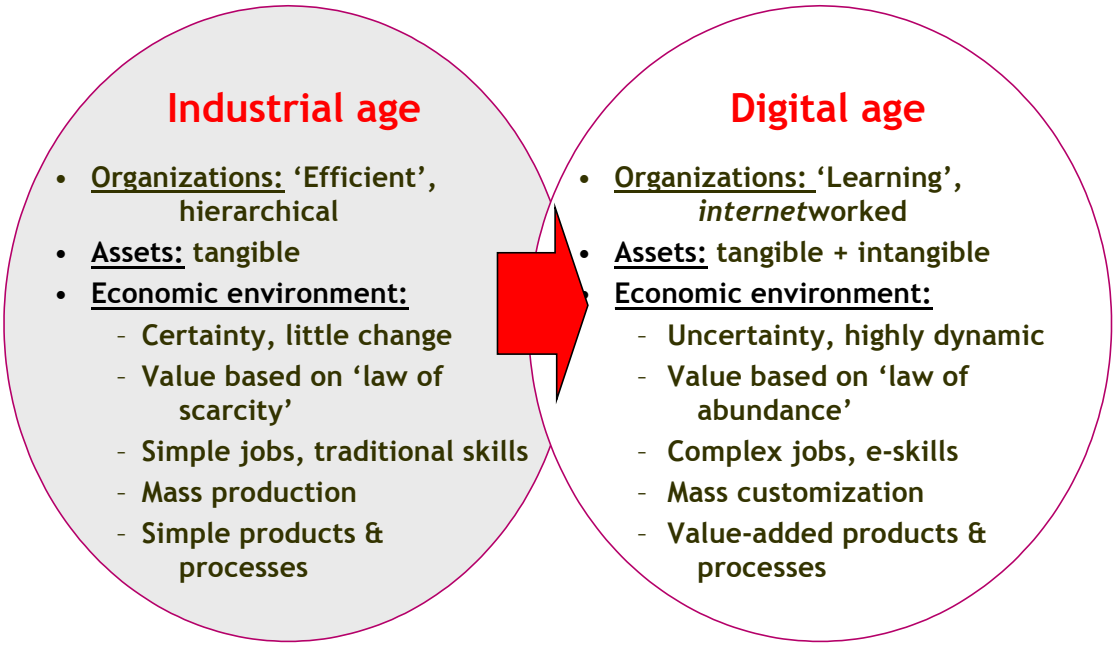

Figure 1: Industrial vs. digital age characteristics

A "Hyperlinked" Economy

The increased networking in a global economy is due to the pervasiveness of ICT and the Internet. Since business success depends on the ability to innovate and since innovation comes from a clash of ideas, networks provide a natural environment for this. The Internet not only facilitates a hyperlinking of documents, but also a hyperlinking of people and of organizations (Levine et al., 2000). The *internet*worked economy (Ticoll et al., 1998) is about the right set of connections between people and organizations in whatever role they may be. In relationships that are fostered via networks, roles become blurred: the seller becomes the "buyer" of valuable feedback on his product. Smart business organizations today see customers, suppliers, regulators, and even competitors as stakeholders who can make valuable contributions to their success.

"Value" Redefined

Individuals and organizations today understand value as something different from value in its traditional sense, e.g. not only attributable to something that is unique or scarce. Value in a networked economy grows with the number of intermediation opportunities (e.g. relationships). Network theory predicts an exponential growth of interactions with a growing number of involved members ("nodes"). The more nodes there are in a network community the more each node becomes an intermediary to all others (Kelly, 1999).

Another reason for the new perception of value is the fact that economic value is not anymore derived from tangible assets alone – e.g. from investments in labor, plants and machinery. "Smart" resources – e.g. information, content, software, knowledge, brands and innovation capability– contribute increasingly to value creation in today's economy.

Intangible Assets

Brands and knowledge are becoming a source of value, not unlike capital. Brands, for example, represent accumulated surplus value turned into client loyalty, which translates into lower marketing costs, higher prices, or larger market share for the owner organization (Davis & Meyer 1998). In digital markets, brands are an invaluable source of trust and orientation to consumers who are looking for quality and security. Many organizations invest heavily in building a reputation that is conveyed through a brand. Some businesses have even outsourced almost all other activities just to maintain their focus on managing the brand. In an *internet*worked economy, knowledge is a key intangible asset that requires effort to develop and to protect.

The Growing Need for Trust

A key question in the digital economy is: "How can you do business with somebody that you do not see"? (Handy, 1995). As business relies more and more on technologies and infrastructures that reduce geographical distance, open communication networks and associated information systems become vulnerable to integrity and security threats. Technologically, trust and dependability must be established and maintained through security technologies such as cryptography and electronic authentication (biometrics, electronic signatures, etc.) and by technologies that enhance privacy and help protect and manage intellectual rights, digital assets and identities. In the socio-organizational context trust becomes an essential element of management.

The Smart Organization

Most organizations are not designed, they evolve. This is why biological analogies may provide an appropriate means to describe organization phenomena. But not all organizations adapt equally well to the environment within which they evolve. Many, like dinosaurs of great size but with little brain, remain unchanged in a changing world. In a digital economy the law

of survival of the fittest will evidence its relevance to organizations as it does in the biological domain.

Handy (1999) sees the old understanding of alliances with suppliers, consultants, retailers and agents changing into a new type, i.e. stakeholder alliances with suppliers, customers and employees, as well as alliances with competitors. As no organization today can afford to remain an "island entire unto itself", every organization is a network of other organizations. No discussion of structure can therefore rest content with the inside of the organization.

Some organizational metaphors include terms like *adhocracy* (Mintzberg, 1980), *cluster organization* (Mills, 1991), *network organization* (Foy, 1980; Imai & Itami, 1984), and *organizational marketplace* (Williamson, 1975). All these concepts share certain common characteristics, like flatter hierarchies, dynamic structures, empowerment of individuals, high esteem of individuals' capabilities, intellect and knowledge. However, although they may gain importance in the digital age, they cannot be considered a panacea to cure all management ills.

Despite the proposed new models, the basic duality between a hierarchical (bureaucratic) and a networked structure remains. In “The Knowledge-creating Company” Nonaka and Takeuchi (1995) argue that while for most of the 20th century organizational structures have oscillated between these two basic types, what is necessary for knowledge-driven organizations today is a smart combination of both. They propose the concept of the hyperlinked organization, which is able to maximise corporate-level (hierarchical) efficiency and local flexibility (networked teams) as it grows in scale and complexity while maintaining its basic capability to create value.

The implications of the above trends for organizations have led to a proliferation of adjectives applied primarily to enterprises, among others, the agile enterprise, networked organization, virtual company, extended enterprise, ascendant organization (Wickens, 1998), knowledge enterprise (Nonaka & Takeuchi, 1995), learning organization (Senge, 1990), ambidextrous organization (O’Reilly & Tushman, 2004). The definitions all have their nuances, deriving from the emphasis on one or another combination of the aspects above. Ultimately, however, they all point to the need to respond to the changing landscape of the digital economy in dynamic and innovative ways.

Within the European Commission’s research program Information Society Technologies (IST, 2002) the term "smart organization" was coined for organizations that are knowledge-driven, *internet*worked, and dynamically adaptive to new organizational forms and practices, learning as well as agile in their ability to create and exploit the opportunities offered in the digital age. Smart organizations involve more than the capability of setting up and exploiting a digital infrastructure or the ability to enter into a virtual collaboration with other partner organizations (Filos & Banahan, 2001B).

The Three Networking Dimensions of Smart Organizations

Smart organizations are networked in three dimensions: the ICT dimension, the organizational dimension and the knowledge dimension (see fig. 2).

Networking at the ICT level enables organizations to move into extended or virtual organizational forms. This may not be enough, though, since the organizational structure and management cultures may need to move beyond steep hierarchies towards leaner business processes organized around flexible cross-functional teams. A further step lies in involving the knowledge dimension into the networking by empowering the individuals in those teams to become dynamically linked to each other and to share information and knowledge (Savage, 1996).

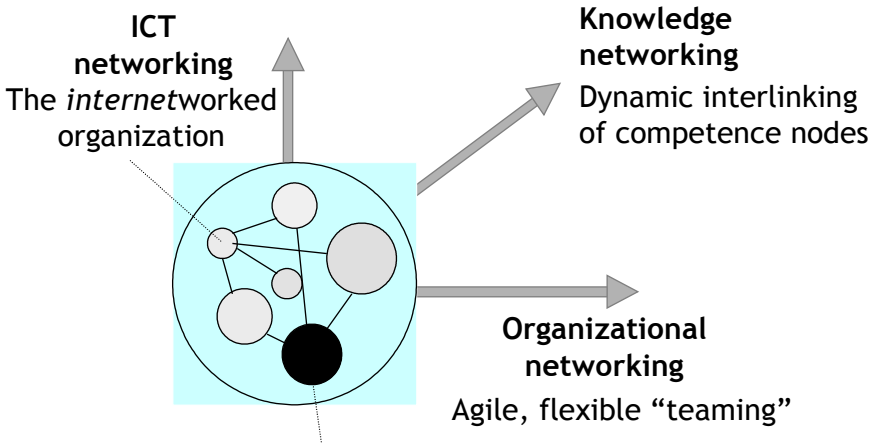

Figure 2: Smart organizations are networked in three dimensions (Filos & Banahan, 2001A)

ICT-enabled virtuality

Smart organizations have the capability to enter into a virtual collaboration with other organizations. Virtual organizational forms are thus an essential characteristic of smart organizations in the digital age (Filos, 2005).

While in the past the aim for organizations was to integrate the supply-chain as tightly as possible, the focus is now shifting from vertical integration towards *internet*worked organizational forms. One characteristic is a focus on "core business" while non-core activities are "outsourced" over the Internet and through e-business exchanges to partners that may have the capability to perform specific tasks better or more cost-effectively.

Organizational teaming

For businesses, large and small, collaborative partnerships have become central to competitive success in fast changing global markets. Since many of the skills and resources essential to an organization's competence lie outside its boundaries, and outside management's direct control, partnerships are not an option anymore but a necessity. Organizations today have to be "smart" in their ability to conceive, shape and sustain a wide variety of

collaborative partnerships. Hence the challenge: the “capacity to collaborate” becomes a core competence of an organization.

Collaborative partnerships are held together because of the added value they offer. Organizations that enter into a co-operation with others do so because of a variety of strategic goals they may pursue (Doz & Hamel, 1998). These can be,

- Resource optimization (sharing investment with regard to infrastructure, R&D, market knowledge and the sharing of risks, while maintaining the focus on one’s own core competences);
- Creation of synergies, e.g. by bundling complementary competences and by offering customers a solution rather than a mere product or a service;
- Attaining critical mass in terms of capital investment, shared markets and customers;
- Achieving increased benefits in terms of shorter time-to-market, higher quality, with less investment.

Goldman et al. (1995), have described four strategic dimensions of agile behavior that are crucial to smart organizations. These are: customer focus, commitment to intra- and inter-organizational collaboration, organizing to master change and uncertainty, and leveraging the impact of people (entrepreneurial culture) and knowledge (intellectual capital).

Knowledge hyperlinking

Nonaka and Takeuchi (1995) see as a basic precondition for the growth of organizational knowledge the creation of a “hyper-text” organization, which is made up by three interconnected layers or contexts, such as the business system, the project teams and the (corporate) knowledge base. The key characteristic of the knowledge-creating company is this capability to shift contexts. The bureaucratic structure efficiently implements, exploits, and accumulates new knowledge through internalization and combination. Project teams generate (via externalization) conceptual and (via socialization) synthesized knowledge. The efficiency and stability of the bureaucracy is combined in this model with the effectiveness and dynamism of the project team. But, according to Nonaka and Takeuchi, these two elements are not sufficient without the third context, the knowledge base, which serves as a "clearinghouse" for new knowledge to be generated inside both, the enterprise and the project team contexts.

This hyperlinked organization has the organizational capability to convert knowledge from outside the organization by being an open system that features also continuous and dynamic knowledge interaction with partners outside the organization.

With the evolution of new organizational forms, such as networks, communities and partnerships, the focus shifts from an ICT-centered to a human-centered perspective of knowledge management (KM). The knowledge sharing process is driven by people who work in a community that shares common interests and objectives. Evans and Roth (2004) elaborate on the basic premises and working principles of collaborative knowledge networks which link

communities together by providing a technical and social infrastructure for collaboration and knowledge management. Organizations that have implemented such environments report significant benefits in terms of knowledge transfer efficiency, response time and innovation (Deloitte, 2002).

Lessons Learned from the Science of Complexity

The digital age is characterized by uncertainty and unpredictability and organizations have to cope with it. This factor is radically changing the ways in which organizations relate, both to each other, to the individuals who provide their core competence, and to their environment.

Sustainable innovation is the result of persistent disequilibrium between chaos and order. The *internet*worked economy resembles an ecology of organisms, interlinked and co-evolving, constantly in flux, deeply tangled, ever expanding at its edges.

In their book "The Complexity Advantage" Kelly and Allison (1999) discuss how six concepts derived from complexity science can be applied to business:

- In *nonlinear dynamics*, small differences at the start may lead to vastly different results. The so-called "butterfly effect" may prove valuable for business particularly at turning points, e.g. the launch of a new product, the starting of a new division or investment in a new line of research;
- An *open system* is one in which the boundaries permit interaction with the environment. A good example for this is the living cell in a biological organism. Many organizations seem only partially open. Businesses, teams, leaders often shut out certain kinds of information and are open only to information that matches only the way in which they see the world. However, it is critical for business organizations to also see the changing nature of their customers of markets and competition in order to be able to offer genuine value;
- A *feedback loop* is simply a series of actions, each of which builds on the results of prior action and loops back in a circle to affect the original state. The final action either reinforces or changes the direction of the status quo. For example, although innovation is an important aspect of business success, an amplifying feedback loop might exaggerate the amount of innovation to the point at which nothing is ever produced or brought to the market. It is essential to identify such amplification and counterbalance it. Feedback loops, whether functional or dysfunctional are a key part of the self-organization that emerges in all business;
- *Fractal structures* are those in which the nested parts of a system are shaped into the same patterns as the whole. Fractals do not define quantity but quality. This self-similarity applied to organizations can make them agile and responsive. For example, in an organization in which self-similarity of values and processes has emerged at all levels and in all geographic areas, effective teams can be assembled very quickly to take advantage of sudden opportunities or handle unexpected threats;
- In evolutionary theory those species survive that are most capable of adapting to the environment as it changes over time. In rapidly changing global markets, the actions of

one player trigger actions and reactions of other players whose actions feed back on the actions of the former. This *co-evolution* is the reason why companies today must run as fast as they can just to maintain their current position;

- *Group self-organization* enables a unity to emerge from individual diversity. Like individuals, work teams and organizations too can develop behavioral patterns.

Organizational Ecosystems

Like complex organisms, smart organizations have a "nervous system" which enables them to thrive on chaos and to guide them through turbulent times. Organizational nervous systems provide the functions sensing and learning, communications - internal and external -, coordination, and memory. In fast moving, unpredictable digital environments, "nervous system" functions are essential to provide the organization with anticipatory, filtering, empathic, learning and adaptive capabilities in real time (Por, 2000).

Secondly, economic activity is fractal, e.g. shows the same structure and obeys the same rules for creating value at the level of the economy, the organization and the individual. Therefore, smart organizations will need to be adaptive to their economic environment, i.e. open, with permeable boundaries, operating at the edge of chaos (Warnecke, 1992; Davis & Meyer, 1998).

Thirdly, the fittest will survive. Smart organizations become fit through variety and diversity of thought, old and new ideas, that breed innovation. Cross-functional, multidisciplinary teams capable of creativity are an essential element to this. Combined with openness, through ideas from the market and inter-organizational exchanges, organizational fitness grows.

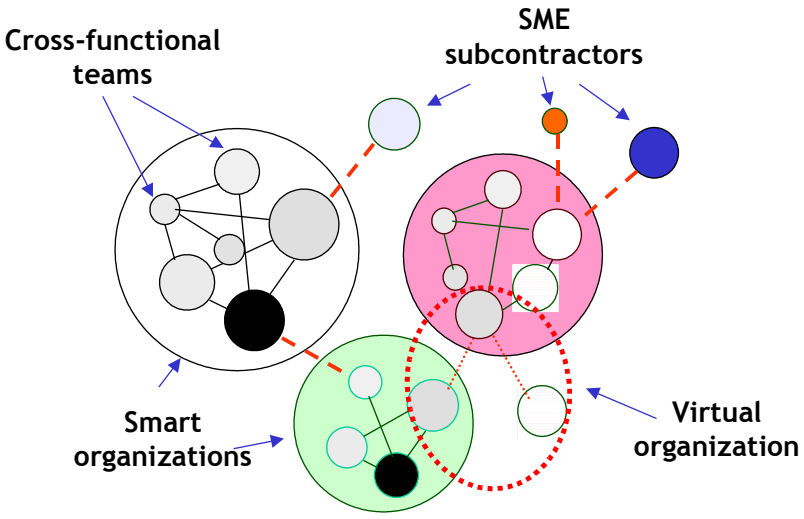

Figure 3: Ecosystem of smart organizations

Fourthly, by being big and small at the same time. The essence of ecosystems is the balance between big and small organisms dependent on one another. Likewise, smart organizations must be big to afford large-scale investments but they also must be small, nimble, unified around a purpose, capable of paying attention to the details of important relationships (ecosystems of smart organizations, see fig. 3).

The smart organizations depicted in fig. 3 are composed of teams (dots) that are linked via ICT-enabled business processes between individuals and teams inside or outside the organization (connecting lines).

Managing the Smart Organization

Organizations in the digital age, unlike industrial age ones, will not seek to control their environments. They will rather adapt to it since they recognize that any attempt to control would at best, fail, and at worst, stifle the creativity and imagination necessary to support innovation. In a globally networked economy participants are free to focus and re-focus their commitment as they see fit. With this in mind, management style is evolving from one, which used to place emphasis on planning, organizing and controlling, to one, which emphasizes providing vision, motivation and inspiration (Kostner, 1996).

Also, in the *internet*worked economy, the roles of "superior" and "subordinate" are becoming blurred and management becomes fuzzy, i.e. more laid-back, less controlling, trust-based (Filos & Banahan, 2001A).

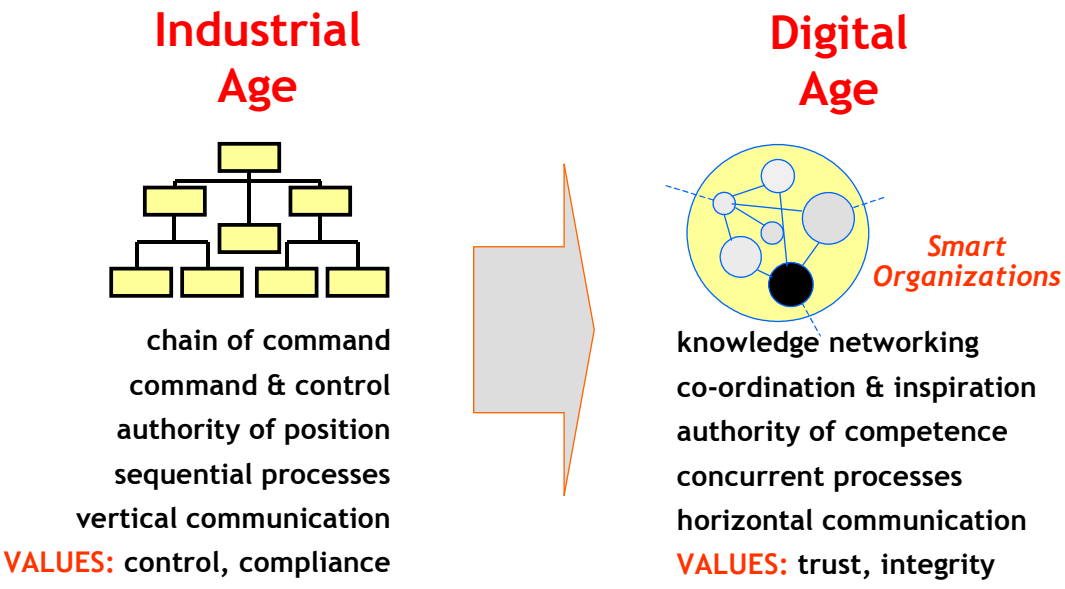

Figure 4: Organizational culture of the industrial vs. the digital age

A bureaucracy is an efficient organizational scheme for tackling recurring tasks in a sequential way. Its static structure guarantees stability and reliability. However, team-based (networked) organizations are better able to handle tasks that are non-routine and which demand a high degree of flexibility and adaptability. They are also able to link expertise that is distributed throughout the organization. The flexible structure of teams thus guarantees a dynamic and competent response to ad hoc tasks (fig. 4).

The organization of work in the *internet*worked economy is shifting from stable, physically co-located functions to dynamic, competence-based virtual teams that create value by synthesizing information across geographical and organizational boundaries. As a consequence to this, organizational culture and management change as well.

The Self-organizing Distributed Team

The face of work is changing, too. As the business world becomes more complex due to demands for flexibility and shorter response times, the nature of work has to keep pace with organizational change. Work in smart organizations is therefore marked by concurrent work practices, flexible and versatile teamwork, creativity and intelligent use of ICT (fig. 5).

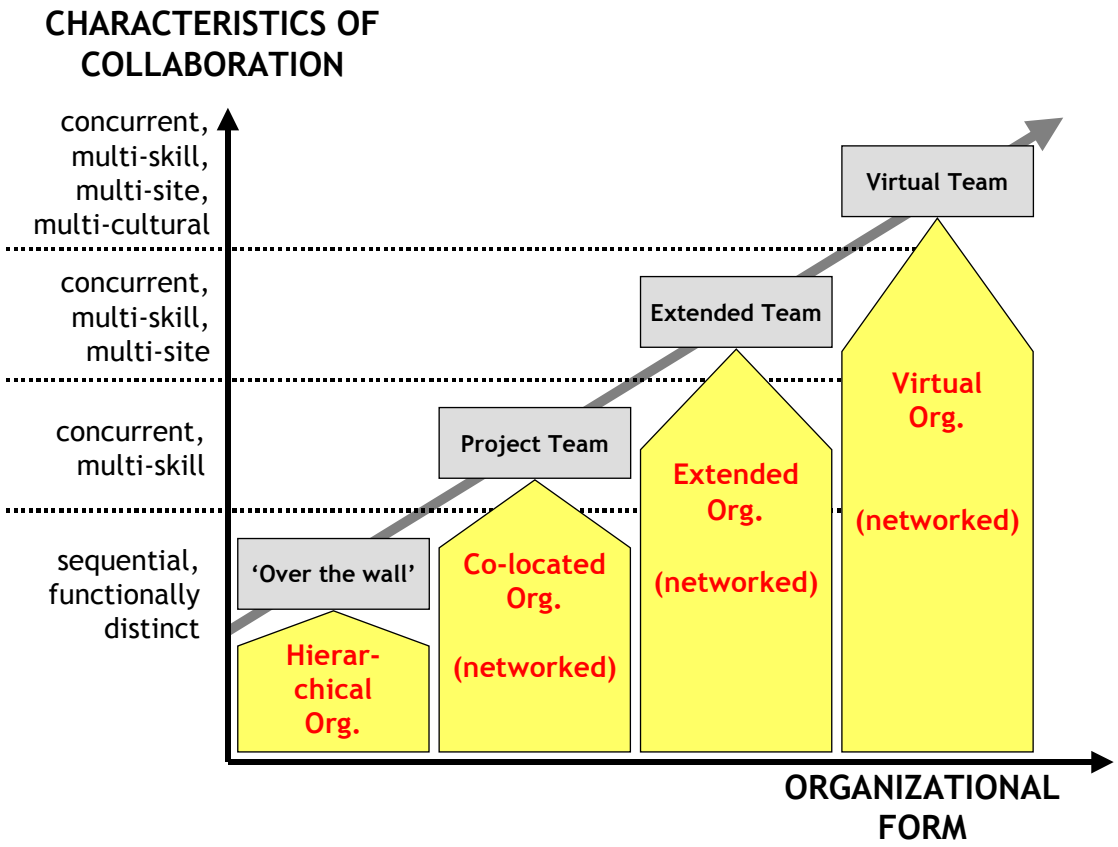

Figure 5: The evolution of collaborative work and the impact of organizational forms

A *virtual organization* is a collection of geographically distributed, functionally and/or culturally diverse entities that are linked through ICT and rely on lateral, dynamic relationships for co-ordination (Camarinha-Matos & Afsarmanesh, 1999; Filos & Ouzounis, 2003). Despite its diffuse nature, a common identity holds the organization together in the minds of its constituents. The virtual organization is managed via teams consisting of geographically dispersed employees, forming a "company without walls", a collaborative network of people working together, regardless of location or who "owns" them (DeSanctis & Monge, 1998). A major distinction between virtual and other organizational models consists in that the former are networked (via ICT), transcend organizational boundaries (Grabowski & Roberts 1998), and should therefore be viewed as metaphors of organization design that is held together, literally, by communication.

A *virtual team* is defined as a temporary, culturally and/or functionally diverse, geographically dispersed, ICT-mediated communicating work group (Jarvenpaa & Leidner, 1998). As virtual teamwork is fast becoming a dominant way of working with many organizations, successful management of virtual teams constitutes a key component to managing virtual organizations. As virtual teams are made up of individuals with human needs for belonging, communicating and togetherness, a radically new approach to and inter-disciplinary understanding of virtual team management is required in order to harness the benefits and to develop the potential of this new socio-economic paradigm.

Virtual team communication

When individuals are working together towards a common goal, the success of their undertaking depends, to a large extent, on the information exchanged which is heavily dependent on the quality of communication between those involved. As communication between human beings involves far more than merely an exchange of information at rational level, factors such as the emotional atmosphere, the social and cultural context as well as non-verbal aspects may not be neglected. Contrary to earlier reservations, computer-mediated communication needs not necessarily have a reductionistic impact on team work, but may rather contribute to "revolutionizing" its potential (Lipnack & Stamps, 1997; Devine & Filos, 2001).

In the traditional team environment, in which individuals are co-located, communication happens via conventional means, e.g. oral or written forms of inter-personal discourse. While written communication is almost exclusively perceived as formal and legally binding, oral communication is differentiated according to the informational settings (formal meetings, or informal social events) in which it is embedded.

On the other hand, communication between individuals of remote teams has to rely, almost exclusively, on ICT. The distinction between the oral and the written, and with it the distinction between formal and informal discourse, may become blurred. Ong (1982) thus speaks of the "secondary orality" of the digital age. As a result, other distinctive features are likely to become important, such as ease of use, interactivity (which allows the user to feel involved), and even the non-interactivity of asynchronous communication tools (e.g. e-mail).

The impact of organizational culture

The very technologies that offer individuals the freedom to work anytime and anywhere may also fray the ties that bind organization members to each other and to their employer. In particular, the cues that pull team members together in traditional organizational settings include dress codes, shared language, shared organizational culture (e.g. routines and processes), office buildings, and co-location. Consequently, since all these factors are less readily available and less indicative of meaning in the virtual context, the links between virtual team members may be less tangible, thus more social and psychological in nature. Wiesenfeld et al. (1998), in their study on the effects of different communication media on the organizational identification of virtual workers, find that electronic media are particularly important to maintain organizational identification due to the strong correlation of the frequency of use with it, whereas face-to-face contact may be more critical for creating it. Research on new organizational forms needs to consider the "system of work" and the "system of meaning", the institutional facets of the organization, specifically the values attached to the work engaged in (Scott, 1991). Organizational identification is a part of the larger construct that has to do with the creation and preservation of the "system of meaning" in new work forms.

Trust in the virtual context

Handy remarks (1995) that virtual teams are run on trust rather than on control. Indeed, the effective coordination and management of the virtual team seems to pose a real challenge. Although team cohesion may suffer from a lack of immediacy in team members' interactions due to geographical dispersion, divergence of expertise levels or a socio-organizational heterogeneity, research results suggest that in cross-cultural virtual teams trust takes on a form of "swift trust" that is based on clear role divisions among members who have well defined specializations (Jarvenpaa & Leidner, 1998). ICT-mediated communication provides the virtual platform for an informal and open sharing of thoughts, expectations, assumptions and values. It offers an opportunity to form alliances of collective responsibility that may be different from the formal hierarchies of management relationships within the parent organizations. The virtual context may thus prove advantageous in providing clarification, sense making and motivation for the individuals involved. This way, the value of team members' contributions is recognized and used better for the good of the community. In the end, high levels of virtually enabled trust, established between team members, may pioneer a strengthening of links between the member organizations partaking in a virtual collaboration (Grabowski & Roberts, 1998).

Leadership conventions

Virtual teams enjoy the freedom to define for themselves the management and task assignment schemes that best suit their specific situation. Indeed, each team can build its own project culture, which can be tailored to its needs and goals, and it is certainly less "bureaucratic" than the culture in team members' organizations. Since the virtual context requires lateral communication and active involvement from each individual it undeniably demonstrates a flat organizational structure, participatory management practices, and novel schemes of shared responsibility (e.g. management tasks performed in rotation).

In traditional teams, the focus on the team leader's role is prone to downgrade the position of the other team members. In that context, the most senior, most experienced, member is appointed as team leader. This hierarchical management scheme, as well as the assumption that teams require a single leader, is called into question in the virtual context as teams here benefit from having different types of leaders performing complementary tasks, depending on project stage. In the virtual team each member is empowered and responsibility is shared. Also, since there is no one person or institution to which all team members are accountable to, penalties for non-compliance to the rules are imposed by the team members themselves (Jarvenpaa & Shaw, 1998).

Coping with overabundant information

In the digital age the great problem may turn out not to be lack of information access but rather an overabundance of information. As Herbert Simon said, "the wealth of information creates a poverty of attention" (Shapiro & Varian, 1999). Even as passive partakers in the Information Society, people unconsciously become active contributors to this surplus of information. This is because ICT can make people vulnerable to access more information than they can “digest”. And this can amount to a threatening drawback for organizational efficiency. Smart organizations will therefore need to manage relationships on the basis of techniques that help win the attention of people.

Weiser and Brown (1998) use human optical vision as an analogy to explain information overload and discuss possibilities to avoid it. ICT through their ubiquitous and voluminous provision of information, must engage a richer periphery. In trying to catch up with an increasing "volume of bits" users may be helplessly overwhelmed. The tools developed and used need to engage the periphery as well as the center. A balanced view must be sought continuously.

Nurturing the Knowledge Process

Managing knowledge is a core competence of the “smart” organization. In the digital economy knowledge becomes the primary raw material and result of economic activity.

The initial challenge in moving towards organizational smartness and in order to leverage the power of knowledge, one must know where to find it and once found, know what to do with it. Knowledge can be either explicit or tacit (Polanyi, 1966). In the case of the former, knowledge is formal and systematic and thus easy to capture, store and communicate. Tacit knowledge on the other hand is personal, a combination of experience and intuition, and as such, the organization’s ability to capture and communicate it is heavily dependent on the individual owner’s commitment to the organization and to its need to generate value from it. In this sense, a great deal of trust and loyalty between the individual and the organization is necessary to leverage organizational knowledge, including its tacit dimension.

It is therefore essential to make a proper distinction between the terms “data”, “information” and “knowledge” (fig. 6). The interchangeable use of “information” and “knowledge” tends to obscure the fact that while it can be easy and quick to transfer information from one place to

another, it may often involve a very difficult and slow process to transfer knowledge. Knowledge is a human capability that can be acquired and expanded through learning. In trying to define knowledge it can be helpful to realize that the human mind is considered capable of two kinds of knowledge, the rational and the intuitive.

In Western thinking, intuitive knowledge has been devalued in favor of rational scientific knowledge. In Eastern thinking however, the tradition has been to recognize the importance of the intuitive. Chinese philosophy has emphasized the complementary nature of the intuitive and the rational and has represented them by the archetypal pair yin and yang.

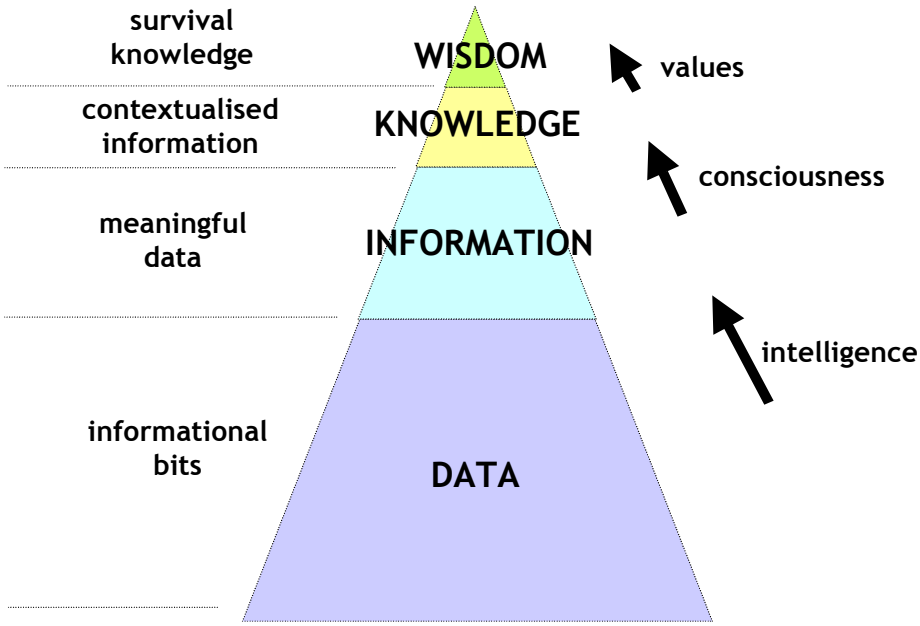

Figure 6: The knowledge pyramid: A tentative approach to explaining "slippery" terms

Recognition of the difficulties inherent in transferring knowledge from one person to another has tended to highlight the importance of tacit knowledge. This heuristic, subjective and internalized knowledge is not easy to communicate and is learned through practical examples, experience and practice. Where explicit, articulate knowledge may be stored in the form of a patent or as documented know-how, tacit, non-articulate knowledge is communicated in social networks, or know-who. Debates over the meaning of knowledge are ongoing, and do not seem likely to end for some time to come. Similarly, there is no 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 disseminating know-how and other content relevant to an organization's business. Knowledge is thus not an explicit tangible "thing", but information combined with experience, context, interpretation and reflection. Also, knowledge involves the full person, integrating the elements of both thinking and feeling. Knowledge management is thus increasingly seen as signaling the

development of a more organic and holistic way of understanding and exploiting the role of knowledge in the process of managing and doing work, and an authentic guide for individuals, teams and organizations in coping with the increasing complexity of modern business environments.

Stewart (1998) uses the term intellectual capital to denote intellectual material – knowledge, information, intellectual property, experience – that can be put to use to create wealth. Intellectual capital is to be seen as an asset for every organization residing in its people (human capital), its structures (structural capital) and its customers (customer capital).

Achieving and Maintaining a High Level of Creativity

Smart organizations embody cross-functional, multidisciplinary teams. Their creativity is based on knowledge networking within and across the organization's boundaries. This openness to ideas drives the creativity of the whole organization.

As Toffler (1981) illustrates, the distinction between producer and consumer diminishes as consumers begin to play an important role, e.g. in the development or the further improvement of a product. Mass customization enables smart organizations to see customers, suppliers, regulators, and even competitors as stakeholders with meaningful contributions.

Redundancy frameworks

Building redundancy is a way to support creative teams. Redundancy comes from intensive communication on a common cognitive ground and the facilitation of tacit knowledge transfer. While team members share "overlapping" information, they can sense what others are struggling to articulate.

One way to achieve redundancy is to organize teams in competition to each other. In one sense, such internal competition is wasteful. However, when responsibilities are shared, information proliferates, and the organization's ability to develop and implement efficient concepts is accelerated.

Another way to enable redundancy is through rotation, especially between different functions such as R&D and marketing. Rotation helps employees understand the business from a multiplicity of perspectives. Changing roles and responsibilities helps create and maintain team spirit and commitment to the team objectives, but most importantly, it may drive innovation within the team, as a result of augmented lateral thinking and knowledge sharing.

Active knowledge sharing

Metes et al. (1997) propose a computer-mediated approach to facilitate knowledge management and creativity of distributed teams. The tool they propose is computer conferencing, also known as "chat" tool. They argue that in contrast to teams using the telephone, fax, e-mail, audio and video conferencing, teams that use computer conferencing create a permanent shared record of their communication. This is specifically important because information is transmitted in its proper contextual setting, including situations,

relationships, assumptions, expectations, history. Adding context to information transforms it into knowledge (see fig. 6).

Investments in intellectual assets, unlike investments in physical assets, increase in value with use. Properly stimulated, knowledge and intellect grow exponentially when shared. If two people exchange knowledge with each other, both gain information and experience. And if both then share their new knowledge with others - each of whom feeds back questions, suggestions and modifications – the benefits can grow exponentially. Once an organization gains a knowledge-based competitive edge, it becomes ever easier for it to maintain its lead and ever harder for competitors to catch up.

Professional intellect (Nonaka & Takeuchi, 1995) of an organization operates on four levels,

- Cognitive knowledge (know-what), the basic mastery of a discipline, achieved through extensive training and certification;
- Advanced skills (know-how), the ability to apply the rules of a discipline to complex real-world problems;
- Systems understanding (know-why), a deep knowledge of the interlinked cause-and-effect relationships underlying a discipline;
- Self-motivated creativity (care-why) consists of will, motivation and adaptability for success. Here lies the reason why highly motivated creative teams often outperform teams with greater physical or financial resources. This level depends on the organizational culture.

The value of professional intellect increases when moving up the intellectual scale from cognitive knowledge to self-motivated creativity. Unfortunately, most organizations focus their training efforts on developing basic skills and only very few invest in developing systems and creative skills.

Research on the Smart Organization

Research and development (R&D) has contributed substantially to the emergence of smart organizations. In Europe for example, successive research framework programs in the last twelve years have supported the development of technologies that facilitated electronic commerce and digital business. In the early nineties, research focused on concurrent engineering (Fan & Filos, 1999), on computer-supported collaborative work and product and process data modeling. The 1997 work program of ESPRIT, the European Strategic Program in Information Technologies, (1997) in the domains High-performance Computing and Networking, Technologies for Business Processes and Integration in Manufacturing supported R&D relevant to the virtual enterprise. Between 1994 and 1998, more than fifty industry-led projects were set up with around hundred million Euro funding (shared cost funding with fifty per cent industrial contribution). In addition to regular consultations with industry, a number

of projects were established which brought together major industrial users of IT and the vendor community. The common aim of these projects was to set long-term research targets for the IT industry in order to meet well-formulated industrial needs. The Advanced Information Technology initiative, for example, dealt with the automotive and aerospace industries (AIT, 2001). It comprised twenty-two R&D projects that also had a major impact on standardization developments. All these projects were operating concurrently within a harmonization framework (Garas & Naccari, 2001). Forty per cent of organizations participating in ESPRIT were user industry enterprises. In total, sixty-five per cent of participants in ESPRIT were industrial companies. Until 1999, R&D support for the "virtual enterprise" in Europe was mainly through ESPRIT and its international co-operation activities under the Intelligent Manufacturing Systems (IMS 2005) framework.

In 1999, the Information Society Technologies program (IST, 1999) emerged as an integrated program from previous programs ESPRIT, Advanced Communications Technologies and Systems (ACTS, 1998), and Telematics (TAP, 1998). In the work program of IST the perspective had changed from "virtual enterprise" to any type of "virtual organization". Under the new program's Key Action II (New Methods of Work and Electronic Commerce), several calls for collaborative research proposals were launched under topics such as "dynamic networked organizations", "smart organizations" and "dynamic value constellations". In parallel, research in learning and cognition had led to the introduction of a new research field "organizational knowledge management".

All these R&D efforts have contributed to a strong research foundation for the development of smart organizations in Europe (Filos & Ouzounis, 2003; Wagner et al., 2004).

Research on the Virtual Organization

In parallel to these European research activities, research relevant to the virtual organization in the United States was undertaken mainly under defense contracts funded by the Defense Advanced Research Projects Agency (DARPA) and through grants of the National Institute for Standards and Testing and the National Science Foundation (Goranson, 1999).

Between 1999 and 2002, under the European IST program, more than two hundred R&D projects were launched on organizations research and on research in e-business and e-work with a total funding of about 450 million Euro. These fall into three sub-areas: ICT; work, business and organizational aspects; and socio-economic issues (Zobel & Filos, 2002; Filos, 2005; Camarinha-Matos et al., 2005).

ICT aspects of virtual organizations

The part of the project portfolio dealing with activities related to the design and development of generic infrastructures to support collaborative business in a networked environment involved issues such as: safe communications, interoperability and tools integration, information and knowledge sharing, repositories, co-ordination mechanisms, and collaborative environments. These projects worked towards the emergence of a general "plug-and-do-business" architecture for interoperability (Bacquet & Naccari, 2002; Doumeingts &

Chen, 2003). Project GLOBEMEN aimed at creating an IT infrastructure to support globally distributed and dynamically networked operations in one-of-a-kind industries (Karvonen et al., 2003), COMMA and BUSINESS ARCHITECT made extensive use of modeling and knowledge sharing to support virtual enterprise process integration.

As far as the characteristics and requirements regarding interoperability and information exchange are concerned, innovative approaches were required. Interoperability was to become a "design principle" while aiming to preserve the diversity, autonomy and heterogeneity of components and environments. For example, project ECOLNET sought to validate different business strategies for independent small and medium-sized enterprises (SME) focusing on their national market, E-COLLEG investigated an infrastructure to establish a backbone for collaborative engineering (Witczynski & Pawlak, 2002), CO-OPERATE focused on co-ordination of manufacturing planning and control activities in supply chain management, and WHALES developed a planning and management infrastructure for distributed organizations working as networks on large-scale engineering projects.

The projects portfolio was strong in demonstrating the feasibility of operating the virtual organization. The technologies used involved the Java framework, CORBA, XML, web services, multi-agents, and modeling tools based on UML. The general aim was to use standards whenever possible. This aspect is particularly clear with respect to de facto standards being proposed by industry groups such as the Object Management Group, the Workflow Management Coalition, the World-Wide Web Consortium (W3C) and the UN Center for Trade Facilitation and Electronic Business (ebXML).

The significance of virtual organization modeling and interoperability of applications arose from the need to model the virtual organization as a means to properly understand and manage it. A problem with existing business process modelers lies in how to translate one model based on one proprietary modeling technique into an equivalent model represented by another. One strategy pursued in Europe was in agreeing on a basic language that makes such transformations possible. Consensus was reached and the Unified Enterprise Modeling Language was defined (UEML, 2004).

Some projects dealt with ontologies, e.g. conceptual information models that describe things that exist in a domain, and whose purpose was,

- To support human understanding and organizational communication;
- To be machine-processable and thus facilitate content-based access, communication and integration across different information systems.

A decade of international research has led to the creation of ontology languages, editors, reasoning techniques, and development guidelines. Various languages for ontology specification and implementation are now available. These languages have built-in reasoning techniques, and they also allow developing special purpose reasoning services.

An area of impact is the Semantic Web, in which computers "find the meaning" of data in automated web services such as functional agents. The DARPA Agent Markup Language (DAML) and the Ontology Inference Layer (OIL) that was developed by the World Wide

Web Consortium and the European OIL community (W3C, 2001), provide a rich set of constructs with which to create ontologies and to mark up information so that it becomes machine-readable. A significant number of European projects addressed knowledge technologies in the context of the virtual organization and business collaboration (Filos, 2002).

Work, business and organizational issues

This sub-area involved reference models and architectures – e.g. the specification of logical reference architectures for new/emerging co-operative organizations by identifying the main functional blocks, interactions, actors and their roles, resources and value systems, as well as the definition and the characterization of collaborative business models, the forms of co-operation in networked environments and means to assess the effectiveness of virtual organizations. Work involved virtual organization reference models, collaborative business models (and related case studies), co-operation methodologies and performance measurement. The projects addressed centralized support services as well as services that are distributed across the virtual organization (Hartel et al., 2002; Kazi et al., 2002; Katzy & Sung, 2003).

Some projects addressed business functions of the various parts of the life cycle of a virtual organization. Research activities included partner registration and search, market place management, e-procurement and negotiation, distributed business process planning and management etc., with a particular focus on domain-independent services covering the various phases of the life cycle of a virtual organization. They also comprised supervision and monitoring, as well as specialized services, such as contract modeling and negotiation, a support infrastructure to help virtual enterprises to address the legal issues involved, as well as a web-based infrastructure for alternative online dispute resolution for SME (Gouimenou, 2001).

Through its IST program, the European Commission also supported a range of projects that aimed to accelerate e-business technology take-up in SME. The concept behind these projects was to transfer leading-edge technologies to industry and other end-users. Under Key Action II, between 1998 and 2002, more than seventy take-up projects were launched which demonstrated the relevance of e-business, e-commerce and e-work technologies for SME. Hundreds of SME throughout Europe participated together with so-called "catalysts" - local or regional organizations that worked with them to help them adapt their business processes towards better ICT use. The SME were able to "re-think" and adapt emerging technologies to their business needs by sharing development effort and jointly achieved results between one another. These take-up projects thus became a means to leverage the results of IST research and to contribute to the implementation of the European Commission's eEurope (2005) initiative at local level, i.e. by supporting SME directly or indirectly.

The 70 million Euro invested in this take-up projects pilot activity represent only a small fraction of the total European investment in e-business. They were essential, however, in demonstrating that investment in R&D and technology transfer can be a useful instrument to help increase SME competitiveness in today's global market places. Twenty-two showcases are presented in a book (eBiz, 2003). They complement European Member States' efforts, such as those under the GoDigital initiative (2002).

The socio-economic perspective

Between 1999 and 2002, socio-economic research within in IST was a significant non-technological research activity that aimed at complementing technology activities. It was implemented through a series of calls for proposals. The primary scope of this research was in methods and tools and in understanding the impact of ICT on the economy and on society at large. The main beneficiaries were the Program's research community, industry, and policy makers (Hayfa & Filos, 2003). More than forty projects addressed socio-organizational or socio-economic issues: industrial and organizational aspects of the digital economy (e-business, e-work) as well as societal aspects; e-business models and intangible assets; impact assessment, mainly at micro-level; corporate social responsibility; statistical indicators. Also a number of key legal and regulatory issues emerged as a result of this research activity. Some of them were explicitly addressed, for example legal aspects of virtual enterprises, contract law (intra-/inter-organizational or that of individuals), alternative dispute resolution, digital rights management, intellectual property rights, consumer protection and related legal aspects (Merz et al., 2001; Hassan et al., 2001; van Schoubroeck et al., 2001; Carter, 2002). All these activities contributed to the definition of a virtual organizations framework (Camarinha-Matos et al., 2004).

Research in Knowledge Management

The European Commission has supported research in knowledge management since the late 1980s, long before knowledge management itself was a recognized term. Early contributions were made in areas such as information management, quality management and the social sciences. The first formal initiative was launched in 1998 under the research theme "Learning and Training in Industry" (LTI), as part of the ESPRIT program. Under the LTI initiative sixteen research projects were launched involving more than hundred research and user organizations. Although the situation has evolved considerably since then, many current projects have their roots in this initial incursion into the realities of organizational learning.

Projects funded under the IST Program reflect a broad spectrum of KM approaches and theories. They can be classified broadly as follows:

First Generation KM

Information portals - tools and methodologies integrating to a greater or lesser extent information necessary for back and front office processes in organizations. These projects mainly originated from the first call for proposals in IST (1999).

Second Generation KM

Knowledge processes to business processes - tools and methodologies linking knowledge and business processes;

Assessment or measurement-type projects - which attempt to measure and benchmark knowledge management implementation within and between

organizations and to manage and measure impact of knowledge lifecycles within the enterprise; *Collaboration and innovation spaces* - tools, methodologies and good practices to accelerate creative exchanges between people working within and across organizations. The end objective of such projects is to support the transition of organizations into knowledge-based communities.
Third Generation KM
Knowledge and innovation ecologies - tools, methodologies and good practices which identify contextual barriers and enablers of absorptive and innovative capacities of organizations and attempt to replicate co-creation abilities across the enterprise or network; *Human-centered knowledge management* - focus on people as unique holders of knowledge, and exchanges between people as primary generators of new knowledge for innovation. *Networks and working groups* - which attempt to build critical mass within and outside the IST program.

Table 1: Knowledge management research in the IST (2002) program

As knowledge management concepts and practices caught the attention of organizations across Europe, European-funded research moved squarely towards supporting the development of solutions that enable individuals to share knowledge within and between organizations as part of the innovation process. The main focus of research has been on supporting multidisciplinary solutions and practices for individuals and corporations to manage knowledge within networked organizations and communities of practice. Specifically, this included aspects such as:

- Integrated ICT platforms, including mobile, to manage the full lifecycle of knowledge (i.e. its capture, organization, maintenance, mining, sharing and trading) in support of both intra- and inter-organizational activities;
- Personalized, context-, task- and role-sensitive functionality for the dynamic provision and sharing of timely and relevant knowledge;
- Solutions to organize and exploit heterogeneous unstructured information sources, using ontologies, self-organization paradigms as well as semantic cross-lingual search, in support of e-work and e-commerce applications;
- Tools and environments for knowledge sharing, collaboration and socialization within and between organizations which build on methodologies from areas such as organizational behavior, cognitive psychology, human factors, man-machine dialogues as well as social and management sciences.

The research activities focused not just on technology development but also on its application. In addition to R&D projects, the European Commission also funded a variety of take-up and

support activities designed to help make knowledge management better known and accepted notably in small and medium enterprises.

Under the IST program the "Knowledge Management Made in Europe" (KMME) initiative was launched after the start of the Fifth Framework Program (1999-2002), with an aim to, "create a strong brand for European KM research and practice" and to "bring into the portfolio quality proposals". The overall goal of the initiative at the outset was to increase European competitiveness, to improve the working life of European individuals and to build on European strengths of languages, cultural diversity and industrial leadership.

One of the major epistemological directions the initiative declared was to pursue the challenge of complexity as a key factor in the knowledge economy, using a holistic approach. The initiative involved 58 research, take-up and cluster projects with a total public investment of approximately 65 million Euro. Projects funded fell into the three categories outlined in tab.1:

The first category, or first set of projects to be funded, were denoted "first generation KM" (under LTI in 1998) and concentrated on themes and concepts such as information portals - tools and methodologies integrating to a large or lesser extent information necessary for back and front office processes in organizations.

The second wave, from 1999 to 2000, aimed at a more holistic treatment of primarily tacit knowledge in organizations and funded projects with concepts and themes such as, linking knowledge processes to business processes, assessing KM implementation and collaboration and innovation spaces.

The third generation KM (2001-2002) represented a movement away from the classical Knowledge Management engineering approach and aimed at funding projects with concepts and themes such as knowledge and innovation ecologies and human-centered KM.

One of the most conspicuous and most mentioned projects with the largest international profile is the European Knowledge Management Forum (EKMF), a cluster project which attempted to "build a sustainable network of Knowledge Management theoreticians and practitioners who are interested in Europe's journey into the knowledge economy, and what Knowledge Management methods and tools can contribute to this journey" (KnowledgeBoard, 2005).

An assessment of the KMME initiative (Sage et al., 2004) to date shows that projects funded in the first wave are indicating a focus on classical, engineering approaches to Knowledge Management. This concentration is typical of early projects in Knowledge Management programs. The same phenomenon was observed in the US in Knowledge Management research. Many of the projects in the first phase were industry or sector specific and helped to solve problems specific to the sector or industry, without addressing issues that were of benefit to different sectors or with impact on the industry value chain.

The second wave marks a shift from the engineering approach to a more centralist best practice approach. In the third wave a significant number of projects were funded that are

advanced on the mathematical complexity scale and address concepts such as intelligent agents and the Semantic Web.

However only few projects address the area of social complexity, which has high potential for KM that is related to the European context of linguistic and cultural diversity. The subject of complexity is not widely recognized within the KnowledgeBoard community.

The phenomenon of divergence between focus areas in Knowledge Management research in Europe and a false dichotomy between human-centered approaches and engineering/mathematical approaches has been observed in the US as well. The opportunity for Europe is to fund and initiate more research that is related to the human-centered approach, but also looks at social complexity.

Conclusions

This chapter aimed to draw a picture of the changing organizational paradigm in the digital age. Successive European R&D programs played a significant part in developing the technologies and concepts that are key to those developments. The research efforts aimed at understanding and improving knowledge management, the virtual organization and digital business processes. While many of the features of digital age organizations are not yet fully understood, there is hope that organizations in the future will become "smart" in various respects. The unprecedented opportunities offered by Information Society for individuals to relate with one another, to work, and to do business in digital environments will change the ways organizations relate to each other and to the individuals that are key to their core competences.

Acknowledgements

The views expressed in this paper are those of the author and do not necessarily reflect the official view of the European Commission on the subject.

References

ACTS (1998). Advanced Communications Technologies and Services program, European Commission, Directorate-General XIII - Telecommunications, Brussels. For further information see: http://www.cordis.lu/acts/

AIT (2001). Advanced Information Technology (Garas & Naccari, 2001). Similar initiatives for the process industries (PRIMA) and the construction (or large-scale

engineering) industries (ELSEWISE, see Mitrovic et al., 1999; McAffer & Garas, 1999). Of similar impact for the furniture industry was FUNSTEP (Jardim-Gonçalves et al., 1999).

Bacquet, J., Naccari, F. N. (2002). 'Plug and Do Business' and the European R&D Programs, in: Camarinha-Matos, L. (ed.), Collaborative Business Ecosystems and Virtual Enterprises, IFIP TC5/WG5.5 Third Working Conference on Infrastructures for Virtual Enterprises (PRO-VE'02), May 1-3, Sesimbra, Portugal; Boston: Kluwer Academic Publishers, ISBN 1-4020-7020-9, 283-292.

Camarinha-Matos, L.M., Afsarmanesh, H. (1999). The Virtual Enterprise Concept, in: Camarinha-Matos, L. M., Afsarmanesh, H., (eds), Infrastructures for Virtual Enterprises. Networking Industrial Enterprises, Boston: Kluwer Academic Publishers, 3-30.

Camarinha-Matos, L. M., Afsharmanesh, H., Rabelo, R. J. (eds) (2001). E-Business and Virtual Enterprises: Managing Business-to-Business Cooperation, Dordrecht: Kluwer Academic Publishers, ISBN 0-7923-7205-0.

Camarinha-Matos, L. M., Afsharmanesh, H. (eds) (2004). Collaborative Networked Organizations. A research agenda for emerging business models. Boston, Dordrecht, London: Kluwer Academic Publishers, ISBN 1-4020-7823-4.

Camarinha-Matos, L. M., Afsharmanesh, H., Ollus, M. (eds) (2005). Virtual Organizations. Systems and Practices. New York: Springer Science + Business Media, Inc., ISBN 0-387-23755-0.

Carter, C. (2002). The Impact of Contractual Support for ICTs on Working Practices, in: Stanford-Smith et al., 2002, 1291-1298.

Cunningham, P., Cunningham, M., Fatelnig, P. (eds.) (2003). Building the Knowledge Economy: Issues, Applications, Case Studies, Amsterdam: IOS Press, ISBN 1-58603-379-4.

Davis, S., Meyer, C. (1998). Blurr - The Speed of Change in the Connected Economy, Oxford: Capstone.

Deloitte (2002). Collaborative Knowledge Networks, New York: Deloitte Consulting and Deloitte & Touche.

DeSanctis, G., Monge, P. (1998). Communication Processes for Virtual Organizations, Journal of Computer-mediated Communication, 3 (4), available electronically under, http://jcmc.indiana.edu/vol3/issue4/desanctis.html

Devine, M., Filos, E. (2001). Virtual Teams and the Organizational Grapevine, IFIP TC5/WG5.3 Second Working Conference on Infrastructures for Virtual Organizations: Managing Cooperation in Virtual Organizations and Electronic Business towards Smart Organizations, 4-6 December 2000, Florianopolis, Santa-Catarina, Brazil, in: Camarinha-Matos et al. (eds.) (2001), 413-424. On simulated reality see Slouka (1995, p. 7); on reduced human contact and informational stress see Soete (1996, pp. 36-37); on the Information Highway as an "impoverished community" see Stoll (1995, p. 47).

Doumeingts, G., Chen, D. (2003). Interoperability Development for Enterprise Applications and Software, in: Cunningham et al. (2003), 207-214.

Doz, Y.L., Hamel, G. (1998). Alliance Advantage. The Art of Creating Value through Partnering, Boston: Harvard Business School Press.

eBiz (2003). European e-Business Showcases, European Commission, Office for Official Publications, Luxembourg, ISBN 92-894-5057-6. Further information available electronically under, http://europa.eu.int/information_society/ecowor/smes/

eEurope (2005). eEurope 2005 – An Information Society for All, European Commission, Directorate-General Information Society and Media, Brussels, available electronically under: http://europa.eu.int/information_society/eeurope/2005/

ESPRIT (1997). European Strategic Program for Research in Information Technologies, Building the Information Society, Work Program 1997, European Commission, Directorate-General III - Industry, Brussels. Information available electronically under, http://www.cordis.lu/esprit/

Evans, S., Roth, N. (2004). Collaborative Knowledge Networks, in: Camarinha-Matos & Afsarmanesh (2004), 289-312

Fan, I.-S., Filos, E. (1999). Concurrent Engineering: Esprit-supported R&D Projects in a World-wide Context, in: Wognum et al. (1999), 177-189.

Filos, E., Banahan, E. (2001A). Will the Organization Disappear? The Challenges of the New Economy and Future Perspectives, IFIP TC5/WG5.3 Second Working Conference on Infrastructures for Virtual Organizations: Managing Cooperation in Virtual Organizations and Electronic Business towards Smart Organizations, 4-6 December 2000, Florianopolis, Santa-Catarina, Brazil, in: Camarinha-Matos et al. (eds.) (2001), 3-20.

Filos, E., Banahan, E. (2001B). Towards the Smart Organization. An Emerging Organizational Paradigm and the Contribution of the European RTD Programs, Journal of Intelligent Manufacturing, 12 (2), 101-119.

Filos, E. (2002). European Collaborative R&D Projects Related to the "Smart Organization". A First Evaluation of Activities and Implications for Construction, in: Turk, Z., Scherer, R. (eds): eWork and eBusiness in Architecture, Engineering and Construction, Sweets and Zeitlinger: Lisse, ISBN 90-5809-507 X, 27-32.

Filos, E., Ouzounis, V. K. (2003). Virtual organizations: technologies, trends, standards and the contribution of the European R&D programs, Int. J. of Computer Applications in Technology, 18 (1-4), 6-26.

Filos, E. (2005). Virtuality and the Future of Organizations, in: Putnik, G. and Cunha, M. M. (eds). Virtual Enterprise Integration: Technological And Organizational Perspectives, Hershey, PA: Idea Group, Inc., ISBN 1-59140-406-1, 32-46

Foy, N. (1980). The Ying and Yang of Organizations, Grant McIntyre.

Garas, F. K., Naccari, F. N. (2001). Assessment of the AIT Initiative, Report to the European Commission, Directorate-General Information Society, Brussels, available electronically under, http://www.cordis.lu/ist/ka2/rptspolicyconf.htm

GoDigital (2002). The 'GoDigital' initiative was an integral part of eEurope 2002. See also, http://europa.eu.int/information_society/topics/ebusiness/godigital/index_en.htm

Goldman, S.L., Nagel, R.N., Preiss, K. (1995). Agile Competitors and Virtual Organizations. Strategies for Enriching the Customer, New York: Van Nostrand Reinhold.

Goranson, T. H (1999). The Agile Virtual Enterprise. Cases, Metrics, Tools, Westport – London: Quorum.

Gouimenou, J. (2001). E-Arbitration-T: An Alternative Dispute Resolution for SMEs, in: Stanford-Smith & Chiozza (2001), 526-531

Grabowski, M., Roberts, K. H. (1998). Risk Mitigation in Virtual Organizations. Journal of Computer-mediated Communication, 3 (4). Available electronically under: http://jcmc.indiana.edu/vol3/issue4/grabowski.html

Handy, C. (1995). Trust and the Virtual Organization. Harvard Business Review, May-June, 25-50.

Handy, C. (1999). Understanding Organizations, 4th edition, London: Penguin.

Hartel, I., Sonderegger, S. Kamio, Y., Zhou, M. (2002). The Information Roadmap of Virtual Enterprises, in: Stanford-Smith et al. (2002), 1380-1387

Hassan, T., Carter, Chr., Seddon, C., Mangini, M. (2001). e-LEGAL: Dismantling the Legal Barriers to ICT Up-Take in Virtual Enterprises, in: Stanford-Smith & Chiozza (2001), 602-608

Hayfa, T., Filos, E. (2003). How ICTs Impact Policy-Making, Thirteen IST Project Examples, European Commission, Directorate-General Information Society, Brussels, ISBN 92-894-5394-X. Report also available electronically under, ftp://ftp.cordis.lu/pub/ist/docs/dir_c/rd_report_en.pdf

Imai, K., Itami, H. (1984). Interpenetration of Organization and Market, International Journal of Industrial Organization (2), 285-310.

IMS (2005). Intelligent Manufacturing Systems initiative, see: http://www.ims.org

IST (1999). Information Society Technologies, Work Program 1999, European Commission, Directorate-General Information Society, Brussels. Available electronically under, http://www.cordis.lu/ist/library.htm

IST (2002). See: http://www.cordis.lu/ist/ist-fp5.html

Jardim-Gonçalves, R., Sousa, P.C., Pimentão, J.P., Steiger-Garcão, A. (1999). Furniture Commerce Electronically Assisted by Way of a Standard-based Integrated Environment, in Wognum et al. 1999, 129-136.

Jarvenpaa, S. L., Leidner, D. E. (1998). Communication and Trust in Global Virtual Teams, Journal of Computer-mediated Communication, 3 (4). Available electronically under, http://jcmc.indiana.edu/vol3/issue4/jarvenpaa.html

Jarvenpaa, S. L., Shaw, T. R. (1998). Global Virtual Teams: Integrating Models of Trust. Proceedings VO-Net Workshop, 27-28 April 1998, 35-51.

Karvonen, I., van den Berg, R., Bernus, P., Fukuda, Y., Hannus, M., Hartel, I., Vesterager, J. (eds.) (2003). Global Engineering and Manufacturing in Enterprise Networks. GLOBEMEN. VTT Symposium, Helsinki, 9-10 December 2002, ISBN 951-38-5739-5, also available electronically: http://www.vtt.fi/inf/pdf/symposiums/2003/S224.pdf

Katzy, B. R., Sung, G. (2003). State-of-the-Art Virtual Organization Modeling, in: Cunningham et al. (2003), 959-966

Kazi, A.S., Hannus, M., Ollus, M. (2002). Layered Architecture for Inter-Enterprise Collaboration, in: Stanford-Smith et al. (2002), 1373-1379

Kelly, K. (1999). New Rules for the New Economy, Forth Estate, London

Kelly, S., Allison, M. A. (1999). The Complexity Advantage. How the Science of Complexity Can Help Your Business Achieve Peak Performance, New York: BusinessWeek Books, McGraw-Hill.

Kostner, J. (1996). Virtual Leadership. Secrets from the Round Table for the Multi-Site Manager, New York: Warner Books, Inc.

KnowledgeBoard (2005). The website of the European Knowledge Management Forum (EKMF): http://www.knowledgeboard.com/

Levine, R., Locke, Chr., Searls, D., Weinberger, D. (2000). The Cluetrain Manifesto. The End of Business as Usual, Perseus: Cambridge, MA.

Lipnack J., Stamps J. (1997). Virtual Teams. Reaching across Space, Time, and Organizations with Technology. New York: John Wiley & Sons.

McCaffer, R. and Garas, F. (eds) (1999). eLSEwise: European Large Scale Engineering Wide Integration Support Effort, Engineering Construction and Architectural Management, Special Issue, 6 (1), ISSN 0969-9988.

Merz, M. et al. (2001). Electronic Contracting in the Construction Industry, in: Stanford-Smith & Chiozza (2001), 595-601.

Metes, G., Gundry, J., Bradish, P. (1997). Agile Networking: Competing through the Internet and Intranets, Upper Saddle River, NJ: Prentice Hall.

Mills, D.Q. (1991). Rebirth of the Corporation, New York: John Wiley & Sons. Quinn Mills sees the effective organization being made up of large number of self-contained "clusters" which may be called projects, business units, task forces etc., coordinated by a central cluster which administers the business as a whole.

Mintzberg, H. (1980). Mintzberg on Management: Inside our Strange World of Organizations, New York: The Free Press. "Adhocracy", a word coined by Toffler, built on theoretically by Mintzberg, is used to denote a challenging array of projects, task groups, committees and experts.

Mitrovic, D., Hunter, I., Male, S. (1999). Characteristics of Networked Enterprise in Global Construction, in: Wognum et al. (1999), 447-454. See also McAffer & Garas (1999).

Nonaka, I., Takeuchi, H. (1995). The Knowledge-Creating Company. How Japanese Companies Create the Dynamics of Innovation, New York: Oxford University Press.

O'Mahony, M., van Ark, B. (2003). EU Productivity and Competitiveness: An Industry Perspective. Can Europe resume the catching-up process?, European Commission, Luxembourg, ISBN 92-894-6303-1.

O'Reilly, C.A., Tushman, M.L. (2004). The Ambidextrous Organization, Harvard Business Review, April 2004, 74-81.

OECD (2003). The Policy Agenda for Growth. An Overview of the Sources of Economic Growth in OECD Countries, OECD: Paris, available electronically under, http://www.oecd.org/dataoecd/47/4/2505752.pdf

Ong, W.J. (1982). Orality and Literacy. The Technologising of the Word, London: Methuen.

Polanyi, M. (1966). The Tacit Dimension. London: Routledge & Kegan Paul.

Por, G. (2000). Knowledge, Intelligence, Wisdom: The New Economic Value Chain and its Enabling Technologies, in: Future Organizations and Knowledge Management, Program Consultation Meeting, European Commission, Directorate-General Information Society, Brussels.

Sage, J., Stanbridge, P., Shelton, R. (2004). Business Knowledge Management: A Study on market prospects, business needs and technological trends, Final Report for the European Commission, DG Information Society, IBM Business Consulting Services, available electronically under: http://europa.eu.int/information_society/doc/library/business_knowledge_management.pdf

Savage, C. M. (1996). 5th Generation Management. Co-creating through Virtual Enterprising, Dynamic Teaming, and Knowledge Networking. Newton, Mass.: Butterworth-Heinemann.

Schapiro, C., Varian, H.R. (1999). Information Rules. A Strategic Guide to the Network Economy, Boston, MA.: Harvard Business School Press.

Scott, W. R. (1991). Unpacking Institutional Arguments. In: Powell, W. W., DiMaggio P. J. (eds.) (1991). The New Institutionalism in Organizational Analysis, Chicago: University of Chicago Press, 164-182. Cit. Wiesenfeldt, B. M. et al. (1998).

Senge, P. M. (1990). The Fifth Discipline. The Art and Practice of the Learning Organization, London: Random House.

Slouka M. (1995). War of the Worlds: Cyberspace and the High-Tech Assault on Reality, New York: Basic Books.

Soete L. (ed.) (1996). Building the European Information Society for Us All. First Reflections of the High Level Group of Experts, Interim Report, European Commission, Directorate General V, Brussels.

Stanford-Smith, B., Chiozza, E. (eds) (2001). E-Work and E-Commerce. Novel Solutions and Practices for a Global Networked Economy, Amsterdam: IOS Press, ISBN 1-58603-205-4.

Stanford-Smith, B., Chiozza, E. Edin, M. (eds) (2002). Challenges and Achievements in E-business and E-work, Amsterdam: IOS Press, ISBN 1-58603-284-4.

Stewart, T. A. (1998). Intellectual Capital. The New Wealth of Organizations, London: Nicholas Brealy Publishing.

Stoll, C. (1995). Silicon Snake Oil: Second Thoughts on the Information Superhighway, New York: Doubleday.

TAP (1998). Telematics Applications Program, European Commission, Directorate-General XIII - Telecommunications, Brussels. For further information see: http://www.cordis.lu/telematics/

Tapscott, D., Lowy, A., Ticoll, D. (eds) (1998): Blueprint to the Digital Economy. Creating Wealth in the Era of E-Business, New York: McGraw Hill.

Ticoll, D., Lowy, A., Kalakota, R. (1998). Joined at the Bit. The Emergence of the E-Business Community, in: Tapscott et al. (1998), 19-33.

Toffler, A. (1981). The Third Wave, London: Pan Books.

UEML (2004). See: http://www.cimosa.de/Modelling/UEML02.html and http://www.rtd.computas.com/websolution/Default.asp?WebID=239

Van Schoubroeck, C., Cousy, H., Droshout, D., Windey, B. (2001). Virtual Enterprise Legal Issue Taxonomy, in: Stanford-Smith & Chiozza (2001), 609-615

W3C (2001). World-wide Web Consortium, Web Ontology Working Group, See also: http://www.w3.org/2001/sw/WebOnt/, and http://www.ontoknowledge.org/oil/misc.shtml#ackn

Wagner, C., Bottermann, M., Freijen, E., Schmidt, L., Simmons, S., Van ´t Hof, Chr., Iverson, J. S., Van Laerhoven, L. (2004). Europe, Competing: Market Prospects, Business Needs and Technological Trends for Virtual Smart Organisations in Europe, Report for the European Commission, DG Information Society, RAND Corporation, MG-195-EC. Report is available electronically under, http://www.rand.org/pubs/monographs/2004/RAND_MG195.pdf

Warnecke, H.-J. (1992). Die Fraktale Fabrik. Revolution der Unternehmenskultur (The Fractal Company), Berlin, Heidelberg, New York: Springer-Verlag, ISBN 3-540-55200-6.

Weiser, M., Brown, J. S. (1998). Center and Periphery. Balancing the Bias of Digital Technology. In: Tapscott et al. (1998), 317-335.

Wickens, P. D. (1998). The Ascendant Organization, revised and updated edition, London: MacMillan.

Wiesenfeld, B. M., Raghuram, S., Garud, R. (1998). Communication Patterns as Determinants of Organizational Identification in A Virtual Organization. Journal of Computer-mediated Communication, 3 (4). Available electronically: http://jcmc.huji.ac.il/vol3/issue4/wiesenfeld.html.

Williamson, O.E. (1975). Markets and Hierarchies. Analysis and Anti-Trust Implications, New York: The Free Press.

Witczynski, M. & Pawlak, A. (2002). Virtual Organizations Enabling Net-based Engineering, in Stanford-Smith et al. (2002), 908-915.

Wognum, N., Thoben, K.-D., Pawar, K. S. (1999). Proceedings of ICE'99, International Conference on Concurrent Enterprising, The Hague, The Netherlands, 15-17 March 1999, Nottingham: University of Nottingham, ISBN 0-9519759-86.

Zobel, R., Filos, E. (2002). Work and Business in the e-Economy. Technology & Policy Issues, 3rd European e-Business and e-Work Conference, Prague, 16-18 October, in: Stanford-Smith et al. (2002), 52-66.