UPGRADE
The European Online Magazine for the IT Professional
http://www.upgrade-cepis.org
Vol. III, No. 1, February 2002

UPGRADE is the European Online Magazine for the Information Technology Professional, published bimonthly at http://www.upgrade-cepis.org/

Publisher
UPGRADE is published on behalf of CEPIS (Council of European Professional Informatics Societies, http://www.cepis.org/) by Novática (http://www.ati.es/novatica/) and Informatik/Informatique (http://www.svifsi.ch/revue/)

Chief Editors
François Louis Nicolet, Zurich <nicolet@acm.org>
Rafael Fernández Calvo, Madrid <rfcalvo@ati.es>

Editorial Board
Prof. Wolffried Stucky, CEPIS President
Gloria Nistal Rosique and
Rafael Fernández Calvo, ATI
Prof. Carl August Zehnder and François Louis Nicolet, SVI/FSI

English Editors: Mike Andersson, Richard Butchart, David Cash, Arthur Cook, Tracey Darch, Laura Davies, Nick Dunn, Rodney Fennemore, Hilary Green Roger Harris, Michael Hird, Jim Holder, Alasdair MacLeod, Pat Moody, Adam David Moss, Phil Parkin, Brian Robson

Cover page designed by Antonio Crespo Foix, © ATI 2002

Layout: Pascale Schürmann

E-mail addresses for editorial correspondence: <nicolet@acm.org> and <rfcalvo@ati.es>

E-mail address for advertising correspondence: <novatica@ati.es>

Coming issue:
"**eXtreme Programming**"

Knowledge Management and Information Technology

Guest Editors: Christopher Lueg, Xavier Alamán

Joint issue with NOVÁTICA and INFORMATIK/INFORMATIQUE

Communication-oriented Computer Support for Knowledge Management

Volkmar Pipek and Markus Won

In this contribution we discuss possible approaches to exploring new directions in support for knowledge management with computers. We consider networked computers in their role as communication media, and look at three perspectives on communication support for knowledge management: communication on information artifacts, (persistent) communications as information artifacts, and communication on infrastructures for information artifacts. We describe some basic ideas as well as providing some examples of possible functionality from the literature.

Keywords: Knowledge Management, Computer-Mediated Communication, Negotiation Support, Discourse Support, Expertise Management

1 Introduction

Computers manage knowledge within organizations in many different ways. As "computing devices", they offer new methods for detecting useful information in large data sets, as supported by data mining and information retrieval methods. As "storage devices", they support storage and fast, flexible access to large volumes of information (data warehousing). Following the differentiation of data, information as "meaningful" data, and knowledge as "interpreted, contextualized and understood" information, these solutions operate below the level of producing knowledge.

As a "medium", networked computers offer support for presentation, cooperation and communication within knowledge management:

- The development of computers as multi-media tools now allows for very sophisticated ways of presenting information. This permits other people to interpret and understand new information more easily.
- Cooperation support for knowledge management allows localized information repositories to support workgroups, and provides other cooperative means such as co-browsing tools (browsing the web with a group of distributed users), recommender systems (systems that support the rating of information within a group of "peers") and expertise finders (systems that help to find the right expert within an organization).
- Communication support for knowledge management cannot be clearly distinguished from the former point, since cooperation to some extent requires communication. But the role that communication tools themselves play in the knowledge management process can be improved. This contribution aims to discuss this issue and highlight some existing approaches.

As we will see with some of the examples, the combination of the categories described above also provides numerous opportunities to improve current approaches.

Knowledge Transfer: Environment and Process

In an impressive study of the work undertaken at a telephone helpline, [Ackerman/Halverson 98] showed that the classical metaphor of knowledge management as maintaining an "organizational memory" as the guiding line of computer support for knowledge management falls short when discussing support for "knowledge work". We prefer to use the metaphor of "knowledge landscapes" when referring to the organizational environment where knowledge work takes place. We feel this metaphor clarifies several aspects:

Volkmar Pipek received a masters degree in Computer Science from the University of Kaiserslautern. Since 1997 he works with the Research Group Human-Computer-Interaction and Computer-Supported Cooperative Work at the University of Bonn in projects on organizational and technological change processes related to groupware tools. Since 2000 he heads a project on Organizational Learning in Virtual Organizations, which especially focuses on questions related to Knowledge Management and Qualification Processes. Further research activities include Community Systems, Computer-Supported Cooperative Learning and Electronic Democracy. <pipek@cs.uni-bonn.de>

Markus Won received his master degree in Computer Science at the University of Bonn in 1998. Since then he works at the Research Group Human-Computer-Interaction and Computer-Supported Cooperative Work (ProSEC) at the Institute of Computer Science III at the University of Bonn. In several projects he did research in the areas of groupware and computer-supported learning. At the moment, he is project member of the OlViO project. Moreover he participates in a project concerned with the setup of a virtual course of study. There he works on a textual and graphical communication tool that is integrated in a cooperative learning en-vironment. <won@cs.uni-bonn.de>

- Knowledge representations (information artifacts) are not located or even stored in one particular form in one particular place.
- Knowledge lives. Different fields of knowledge (i.e. its real and virtual representations) are not only distinguished by their content or topic, but also by their structure, their degree of persistence and their growth. Fields of knowledge may merge and stimulate each other's development. The usefulness also depends on their maintenance ("gardening").
- As in landscapes, the presence and visibility of relevant aspects of the knowledge environment are important to provide orientation and quick access.
- Knowledge workers are *situated* in a knowledge landscape. They have a specific perspective on the knowledge representations of their work context, which they also change according to the work they do. Knowledge representations are not restricted to digital storage media. There is a smooth transition between the virtual and the real environment of knowledge work. It is especially important to realize this for a task-oriented perspective on the processes of knowledge work.

Our perspective also is closely related to the notion of communities as groups of people with a shared issue or interest, and an ability and interest to communicate regarding that issue. In many organizations, communities are informal but important promoters of knowledge transfer. Knowledge landscapes (with a focus on representations of knowledge) and knowledge communities (with a focus on people and processes) are the key concepts for this contribution.

But what is the role of communication within knowledge management?

Managing knowledge also means providing people with opportunities to learn. [Nonaka/Takeuchi 95] described a knowledge transfer based on knowledge externalization along information artifacts as a process of de-contextualization (abstraction) during the creation of an information artifact, and of re-contextualization through the perception and interpretation (in a new problem context) of the information artifact. Usually, re-contextualization work is left to the knowledge seeker. But communication support can connect the knowledge seeker to an expert, to someone who knows an expert, or simply to someone who is also interested in the problem.

Another important aspect to mention is the establishment of trust as the crucial point in knowledge management. Larry Prusak, Director of IBM's Institute for Knowledge Management, pointed out the social tasks someone has to perform in the process of gaining knowledge from someone else[1]:

- Who has knowledge related to my problem? Can I trust his or her expertise? Expertise finding also is a social task.
- How do I make him/her lent me his/her time? Negotiating this is a social task.
- How do I make him/her care for me and my problems? This is also to be negotiated.
- Can I expose my vulnerability, i.e. not knowing something I maybe should have known, to him/her? Establishing this level of trust is deeply related to the personalities of both parties.

These are points we cannot solve by system design (maybe not even by mediated communication), but integrating communication channels gives users the chance to explore the possibilities here.

So, communication support can help to improve efficiency. We describe possible directions of research (and first examples) in three ways:

- Support for communication *in knowledge landscapes*: Communication with others can help people to locate, interpret and understand electronically stored information artifacts. Support for this kind of communication is also part of the co-browsing idea, and it is also the aim of "expert finders" to initiate communication.
- Support for communication *as part of a knowledge landscape*: Communication, made persistent, can result in information artifacts that are both easy to create and easy to understand.
- Support for communication *about knowledge landscapes*: Communication support for discussing the structures and processes of the knowledge infrastructures themselves.

The baseline of the scientific challenge here is how to integrate and combine the spheres of communication and the information artifact storage and presentation. In the following, we will discuss that, addressing some work already done here.

Before starting, we want to point out that we are well aware of the preference for face-to-face communication, especially for knowledge-related communication. But especially new forms of organizations with their differing degrees of virtualization call for new approaches to knowledge transfer support where face-to-face communication is not possible.

2 Communication in Knowledge Landscapes

Several approaches already exist, with varying emphases on supporting communication in knowledge landscapes. The BSCW system <http://bscw.gmd.de/>, the different implementations of the "Answer Garden" idea (e.g. [Ackerman/McDonald 96]), the D_E-environment [Sumner/Shum 98] and the ZENO-tool [Gordon/Karacapilidis 97], are well-known examples, as well as several tools which have been used for computer supported cooperative learning (CSCL), [Stahl 00].

All attempts to tackle the problem have common features: they can store information artifacts like electronic documents, texts, etc. or collections of these, and also allow communication *related to* the information artifacts. In the D_E-environment it is possible to refer to sections and lines. These are then visualized together with the communicated statement. In the BSCW system, the discussion forums are stored in the same directory as the files they belong to. The ZENO-system allows relations to spatial data in contributions for online-discussions [Rinner 99]. More generally, it is possible here to speak of a connection and visualization of articulations to context information.

1. These bulletpoints are taken from an invited talk L. Prusak gave on the ECSCW'2001 conference in Bonn. This example may also be found in [Cohen/Prusak 01].

Similar systems have been developed for synchronous communication (e.g. for persistent chats related to document paragraphs, see [Churchill et al. 00].

Text-based communication is common to all these approaches, though. In times of growing bandwidths one has to consider whether multi-media communication is to play a role. First attempts have already existed for some time in the field of synchronous video communication by application sharing functionality [Iacucci et al. 98], sporadically also in the field of asynchronous multi-medial communication (e.g. [Sgouropoulou et al. 00]).

Besides the exploration of the opportunities multi-media support offers, mobile devices have to be integrated as well. First approaches also exist here, e.g. [Fagrell/Johannesson 02] report on the use of mobile devices in the work of radio journalists. The information available on the mobile device not only covers the text and pictures of published articles and reports of collaborating journalists, but also information on the articles' author (i.e. contact information). Contact can be established via mobile phone, and because the knowledge management system enables both to refer to the same information artifact (the article/radio feature), explaining details of the article is much easier. Further exploration of the role played by mobile equipment such as laptops, organizers/PDAs and mobile phones and how contextualization takes place could be supported here.

We believe research in applied computer science is faced with the following questions:

- How to improve the representation of contexts of communications?
- Which automatisms (search agents, navigation agents, notification agents) might ease communication?
- Can any common rules for *communication ergonomics or discourse ergonomics* be found? Easier reference to relevant (parts of) information artifacts and to earlier contributions to a discussion are a first challenge.
- Will the efforts made actually result in the level of socialization needed to support the building of trust on the base of a computer based communication? How will success be measured?

3 Communication as a Content of Knowledge Landscapes

The text-based communication in the tools described in the last section – made persistent – may also be used as a resource. Observing a discourse (a goal-directed discussion) allows following argumentation lines in a natural way, and may ease the understanding of information artifacts. Examples of the particular value of this kind of communication are the "Frequently Asked Question" concept often found on the Internet, as well as the various examples of using "socratic dialogue" and its derivates in education. Normally, technical support for this kind of communication only permits navigation along the process of the discussion or a full-text search to obtain information. Some approaches try to achieve improvements here.

In the Answer Garden architecture, the communication between the person seeking advice and the expert, which is established within the system when the information seeker does not find sufficient information in the "organizational memory", becomes itself a new information artifact in the organizational memory. While in the first version the expert's answer was just stored "as is", in the second version, possibilities for further editorial treatment of the communication have been added [Ackerman/McDonald 96].

Other approaches focus not only on the contents of the communication, but also on the visualization of communication structures in order to supply orientation and navigation possibilities.

The most widespread approach here is that of *Issue-Based Information Systems*, which were invented in a discursive design approach by [Rittel/Kunz 70] in order to solve "whicked" problems (problems with several complicating features). The crucial point of the paper consists of the classification of discourse contributions into "issues", "positions" and "arguments". Issues will start a discussion thread, related positions may then be expressed, which are proved (pro) or denied (contra) by arguments. Thus a discussion structure is built that is organized not just temporally, and whose categories may be helpful when navigating within it. The IBIS approach has been transposed by computer science into a series of tools (e.g. gIBIS – [Conklin/Begemann 88], ZENO – [Gordon/Karacapilidis 97]). In ZENO, an improvement has been added which allows calculating statements about the current state of a discussion thread ("dead" discussion thread, "decided" discussion thread). Criticism arose from the unrealistic expectations of users towards the IBIS approach [Isenmann/Reuter 97], from observed objections of users to categorizing their contributions, and a principally critical view of the restrictive influence of given categories [Suchman 93]. A benefit justifying these costs for an extended categories system may only result from a large number of participants in a discourse, when providing an overview of the discourse becomes problematic.

Another approach of visualization of communication is the Babble-prototype [Erickson et al. 99], which not only visualizes discussion structures (in persistent chatrooms), but also conversation constellations (the persons participating) of a chat. The single participants of a chat are visualized more or less centrally depending on their communication intensity. Chats are stored together with the conversation constellation and it is also intended to permit searches for special conversation constellations.

In the concept of the ArguMaps [Rinner 99], in the context of computer supported discourses in urban planning, information about the state of the discussions is displayed according to the regions they refer to (districts, other areas) in a three-dimensional visualization of these regions. Further geographical data may be added to the visualization.

Another important idea is that of not only making past communication available, but also stimulating new, further communication. This is done by a respective visualization of and access to communication partners. If, in the Answer Garden, someone searching for help can't find help in the organizational memory, an expert belonging to this section will be integrated as a communication partner. Other approaches generally sup-

port locating experts (see [Yimam/Kobsa 02] for approaches in this regard).

Obviously the above mentioned approaches of using "stored" communication as an information artifact are always compromises between the effort required by treatment (e.g. editorial) over and above pure storage, and the potential profit generated by further use. The key question for these approaches is: Which one is the "right" compromise? We have described above how users rejected classifications of discussion contributions in order to simplify navigation when reusing them. The cognitive cost of categorization was estimated to be higher than the benefit of easier navigation. Possibly more subtle graduations of such treatments (here: categorization as an act of formalizing with a subsequent benefit) may be a way to find the "right" compromise. [Selvin/Buckingham Shum 00] take this road with their "Rapid Knowledge Construction" method of solving the problem of computer support for meetings. Several levels of formalization when storing meeting contents (from simple videotaping to hypermedial work- and visualization methods) may be employed variably. To date, however, there has been no broad experience within the application fields.

We believe the projected cost-benefit equation is the main issue. This results in the following research challenges:

- What would a good cost-benefit relationship look like?
- The costs often appear at the workplace level, whereas the benefit only appears at the team or organization level. How could transparency be improved to reveal these contexts to the single user? Which visualizations of such a "knowledge logistics" support would make sense?
- Which organizational measures (building of conventions, etc.) could ease this problem?

4 Communication about Knowledge Landscapes

The communication *about the categories, representations and processes* related to stored information artifacts, which is part of the communication about the knowledge landscape as a whole, takes on a special role. For this purpose, it has already been suggested that methods for participatory design (PD) for the construction and reconfiguration of information structures [Buckingham Shum 97] should also be used.

The primary motivation of PD-approaches was improving system design, i.e. the quality of work and computer use. When designing knowledge landscapes, a certain affinity regarding their perception and interpretation by the persons supported is also indispensable for an efficient support of knowledge exchange processes (in the simplest case e.g. shared naming conventions for directories and files in repositories). [Shipman/Marshall 99] have pointed out that even apparently fixed category systems are continually re-interpreted and used according to the new interpretations. It is inherent to these dynamics that "bottom-up" or "participatory" approaches are the only choice. Category and representation systems which are not flexible enough to support these processes tend to be ignored by users. An ongoing communication and an explicit alignment of categories and interpretations (as a maintenance effort for the knowledge landscape) is especially important in work contexts with a heterogeneous member structure (e.g. in virtual organizations).

Appropriate visualizations of (parts of) the knowledge landscape or useful abstractions of it can be valuable information artifacts for supporting these discussions. These could also be manipulable to illustrate how new proposals would change them. The Ontolingua Server [Farquhar et al. 97], which allows ontologies to be collaboratively built and modified (although in this case these are made for automatisms, not for humans), could serve as an example here.

So the research challenges here are:

- How can the topologies of knowledge be visualized for a heterogeneous user group? How can they be manipulated and extended?
- To what degree should the tools used be tolerable for end users?
- The (re-)configuration of a knowledge landscape usually does not belong to the primary work task of its users/inhabitants. Again we have a cost-benefit-balance to explore.
- In the process of (re-)configuration, the necessary modes of cooperation and coordination must also be explored.

5 Conclusion

In this contribution we have described a direction of research on computer support for knowledge management that we expect to be very fruitful in the near future. By considering computer-mediated communication as an integral part of system support for knowledge landscapes, we can complement current ideas in knowledge management (characterized by terms like "Organizational Learning" (e.g. [Argyris/Schön 96], "Social Capital" (e.g. [Cohen/Prusak 01]), and "Knowledge Communities" (e.g. [Lesser et al. 00]) in their tendency to stress the social dimension of processes of knowledge transfer. The goal of our concept is to tear down the artificial border that history has placed between existing information and communication spaces.

We have described three dimensions of the role that computer-mediated communication can play in knowledge management:

- Communication integrated in knowledge landscapes can help by providing a communication channel to an expert who can help to apply the information stored in documents to the current problem.
- Communication, made persistent, as an information artifact in a knowledge landscape can result in easy to produce and easy to understand information artifacts.
- Communication on knowledge landscapes can support retaining a reflective level with all participants in knowledge management processes. This is necessary for maintaining a shared understanding and perspective of the artifacts in the knowledge landscape.

When computer-mediated communication is related to knowledge management, it is important to explore what we call "communication ergonomics", that means that the communication should be as easy as possible, e.g. by allowing easy reference to the content of the information artifacts shared by both parties.

In describing theses ideas, we also describe the road we are taking in our research project "Olvio" ("Organizational Learning in Virtual Organizations", http://www.olvio.de/), where we follow these trajectories in the context of virtual organizations in the fields of consulting and IT-services.

Literature

[Ackerman/McDonald 96]
M. S. Ackerman and D. W. McDonald: Answer Garden 2: Merging Organizational Memory with Collaborative Help. in *Int. Conf. on CSCW'96*, (Boston, MA, 1996), ACM Press, pp. 97–105.

[Ackerman/Halverson 98]
M. S. Ackerman and C. Halverson: Considering an Organization's Memory. in: Int. *Conf. on CSCW'98*, (Seattle, WA, 1998), ACM Press, pp. 39–48.

[Argyris/Schön 96]
C. Argyris and D. A. Schön: *Organizational Learning II*. Addison-Wesley, Reading, MA, USA.

[Buckingham Shum 97]
S. Buckingham Shum: Negotiating the Construction and Reconstruction of Organisational Memories. *Journal of Universal Computer Science* (Special Issue on IT for Knowledge Management), 3 (8). 899–928.

[Churchill et al. 00]
E. Churchill, J. Trevor, L. Nelson, S. Bly and D. Cubranic: Anchored Conversations: Chatting in the Context of a Document. in *CHI'2000: The future is here*, (The Hague, Netherlands, 2000), ACM Press, 454–461.

[Cohen/Prusak 01]
D. Cohen and L. Prusak: *In Good Company – How Social Capital Makes Organizations Work*. Harvard Business School Press, Boston, MA.

[Conklin/Begemann 88]
J. Conklin and M. L. Begemann: *gIBIS: A Hypertext Tool for Exploratory Policy Discussion. in Conference on Computer Supported Cooperative Work*. (Portland, Oregon, USA, 1988), ACM, 140–152.

[Erickson et al. 99]
T. Erickson, D. N. Smith, W. Kellogg, M. Laff, J. T. Richards and E. Bradner: Socially Translucent Systems: Social Proxies, Persistent Conversation, and the Design of "Babble". in *CHI'1999*, (Pittsburgh, PA, USA, 1999), ACM Press, 72–79.

[Fagrell/Johannesson 02]
H. Fagrell and E. Johannesson: Newsmate: Providing Timely Knowledge to Mobile and Distributed News Journalists. in Ackerman, M.S., Pipek, V. and Wulf, V. (eds.): *Sharing Expertise: Beyond Knowledge Management*, MIT Press, Cambridge, MA, 2002.

[Farquhar et al. 97]
A. Farquhar, R. Fikes and J. Rice: The Ontolingua Server: a tool for collaborative ontology construction. in: *Int. Journal on Human-Computer Studies* (46). 707–727.

[Gordon/Karacapilidis 97]
T. F. Gordon and N. Karacapilidis: The ZENO Argumentation Framework. in *Int. Conf. on Artificial Intelligence and Law (ICAIL'97)*, (Melbourne, Australia, 1997).

[Iacucci et al. 98]
G. Iacucci, R. Peters, O. Stiemerling, V. Wulf: Telecooperation Systems in Engineering Companies Supplying the Metallurgy Industry: The Experience of the OrgTech Project, in: Jacucci, G; Olling, G. J.; Preiss, K.; Wozny, M. J. (eds): *Globlization of Manufacturing in the Digital Communications Era of the 21st Century – Innovation, Agility, and the Virtual*, Kluwer, Dordrecht 1998 S. 107 – 119

[Isenmann/Reuter 97]
S. Isenmann and W. D. Reuter: IBIS – a convincing concept but a lousy instrument? in *Designing Interactive Systems: Processes, Practices, Methods and Techniques*, (Amsterdam, The Netherlands, 1997), ACM Press, 163–173.

[Lesser et al. 00]
E. L. Lesser, M. A. Fontaine and J. A. Slusher (eds.): *Knowledge and Communities*. Butterworth-Heinemann, Oxford, UK.

[Nonaka/Takeuchi 95]
I. Nonaka and H. Takeuchi: *The Knowledge-Creating Company.* Oxford University Press, New York, USA.

[Rinner 99]
C. Rinner: Argumaps for Spatial Planning. in: *First International Workshop on Telegeo-processing*, (Lyon, France, 1999).

[Rittel/Kunz 70]
H. W. J. Rittel and W. Kunz: *Issues as elements of information systems*, Institut für Grundlagen der Planung, University of Stuttgart, Stuttgart, 1970.

[Selvin/Buckingham Shum 00]
A. M. Selvin and S. Buckingham Shum: Rapid Knowledge Construction: A Case Study in Corporate Contingency Planning Using Collaborative Hypermedia. in: *Proc. KMAC'2000: Knowledge Management Beyond The Hype*, (Aston University, Birmingham, UK, 2000).

[Sgouropoulou et al. 00]
C. Sgouropoulou, A. Koutoumanos, P. Goodyear and E. Skordalakis: Acquiring Working Knowledge through Asynchronous Multimedia Conferencing. *Educational Technology & Society*, 3 (3). pp. 105–111.

[Shipman/Marshall 99]
F. M. I. Shipman and C. C. Marshal: Formality Considered Harmful: Experiences, Emerging Themes, and Directions on the Use of Formal Representations in Interactive Systems. in: *Journal on Computer Supported Cooperative Work*, 8. 333–352.

[Stahl 00]
G. Stahl: Collaborative Information Environments to Support Knowledge Construction by Communities. in: *AI & Society*, Vol. 14, Springer, London, pp. 71–97.

[Suchman 93]
L. Suchman: Do Categories Have Politics? The Language/Action Perspective reconsidered. in *3rd Europ. Conf. on Computer Supported Cooperative Work (ECSCW'93)*, (Milan, Italy, 1993), 1–14.

[Sumner/Shum 98]
T. Sumner and S. B. Shum: From Documents to Discourse: Shifting Conceptions of Scholarly Publishing. in *CHI 1998: Human Factors in Computing Systems*, (Los Angeles, CA, USA, 1998), ACM Press, New York, 95–102.

[Yimam/Kobsa 02]
D. Yimam and A. Kobsa: Expert finding systems for organizations – Problem and Domain Analysis and the DEMOIR approach. in: Ackerman, M.S., Pipek, V. and Wulf, V. (eds.): *Sharing Expertise: Beyond Knowledge Management*, MIT Press, Cambridge, MA, 2002.

