Experience Management with Case-Based Assistant Systems

Mirjam Minor

University of Trier,
Department of Business Information Systems II,
54286 Trier, Germany
minor@uni-trier.de

Abstract. In this paper, we present a framework for Experience Management (EM) which is populated with case-based assistant systems for EM. The framework follows the building block model of Probst et al [28] which has been developed as a guidance for knowledge management activities. We taylor the building blocks for the special needs of EM and discuss for each building block the support and automation opportunities by case-based assistant systems based on sample systems from the literature. We take up a holistic point of view, i.e. we regard the psycho-social aspect in an own building block as well as the organizational aspect. The impacts of these efforts are investigated in a case study that has shown significantly increasing access ratios when following some psycho-social findings in the design and organization of a case-based EM system.

1 Introduction

Gilbert Probst demands that knowledge management 'is clearly embedded into an organizational and social context' [27, own translation]. In recent literature [3, 4, 25, 24] case-based reasoning (CBR) has been employed for experience management (EM) to provide technical support by means of assistant systems. Those case-based approaches lack the explicit integration of the social aspect. We follow Probst in our framework for developing, integrating, and maintaining case-based EM systems. We show in an experimental evaluation that it is worth while to consider the socio-psychological aspect of EM systems.

This paper is organized as follows: Section 2 gives a brief intoduction to EM and the holistic point of view. Section 3 reports the building block model for knowledge management from Probst et al. In Section 4, we taylor this model for the special needs of EM, refer to case-based sample systems for the particular building blocks, and discuss the potential for automation. Section 5 contains a case study on the building block *use of knowledge* which deals with the psycho-social aspect of a case-based EM system. In Section 6, we discuss related work and draw a conclusion.

2 Holistic experience management

EM is a special kind of knowledge management that is restricted to experience knowledge [4]. *Experience knowledge* (also called *experiential knowledge*) origins from the experience of an agent in a previous problem solving situation. It is valid for a certain scope of duties like the configuration of mobile phones or like the guidance of project teams. This understanding of experiential knowledge is in opposite to the idea of general knowledge which has a broad coverage of domains or is even universally valid.

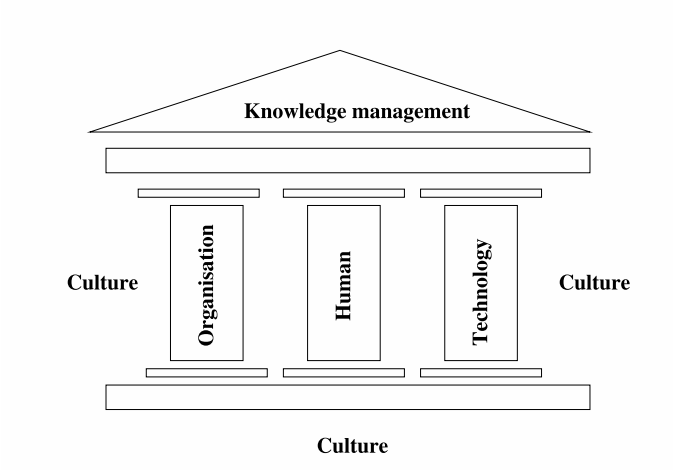

Fig. 1. The three pillars of holistic knowledge management [36].

We will deal with EM in a *holistic* way, i.e. it takes into account not only the technical support of EM but also the organizational and psycho-social aspect. The holistic view is supported by Wolf et al's model of knowledge management [36] in Figure 1. Wolf et al place knowledge management on three pillars: The organization and the human carry the roof together with the technology. If one of the pillars is missing the building is instable. The entire model is embedded into the cultural context of the humans. We transfer the holistic model of Wolf et al. to EM systems. The psycho-social aspect (the human and the culture in Figure 1) is especially important for experiential knowledge as experience is rather personal and revealing it makes the contributor vulnerable.

3 The building block model for knowledge management

Gilbert Probst et al [28] have developed a process model for managers who perform knowledge management activities. It has been derived from several case

studies by an action research approach that combines theoretical and practical issues. The process model provides a hands-on raster that has become a standard work in the German-speaking part.

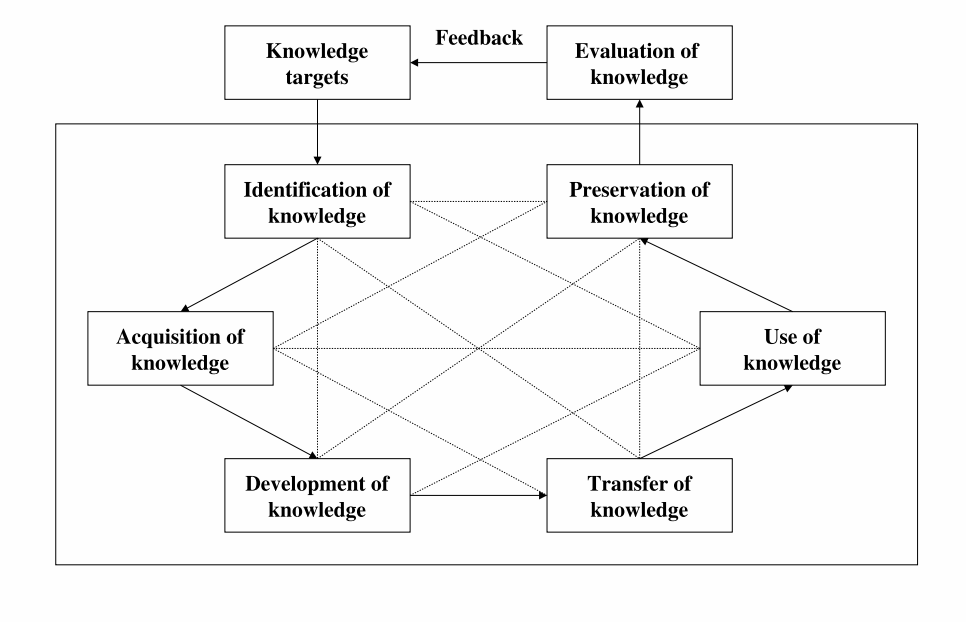

Fig. 2. The building blocks for knowledge management by Probst et al.

Figure 2 shows the six basic building blocks of knowledge management. They build a cycle and are affiliated with each other.

- The *identification of knowledge* aims to make it transparent which knowledge is available. The main task of this building block is to localize useful knowledge within and outside the own organization.
- The *acquisition of knowledge* deals with getting access to external knowledge either by recruiting knowledge carriers, or by acquiring the knowledge of other organizations like customer organizations, or by buying knowledge products.
- The *development of knowledge* focuses on creating new knowledge. This is supported, for instance, by a family-friendly atmosphere, by fault tolerance, and by honoring long-term success. In this way, knowledge may emerge during activities that are normally not supposed to be productive. Probst et al's description of the development building block is in accordance with the well-known knowledge creating approach of Nonaka and Takeuchi[26].
- The *transfer of knowledge* concerns the process of spreading knowledge over the organization. It includes very often the face-to-face contact of individuals.

– The *use of knowledge* is the main purpose of knowledge management. However, it may be restricted by a series of barriers, e.g. the commercial barrier of a missing patent.
– The *preservation of knowledge* results in an organizational memory. It consists of three sub-processes, namely to select the valuable knowledge, to store it appropriately, and to ensure that the knowledge is updated.

Two strategic building blocks close the cycle: To determine the *knowledge targets* should mark the beginning of any knowledge management activities. The *evaluation of knowledge* provides a measure for the success of the learning processes and helps to adjust the course of knowledge management activities by means of feedback. Probst et al's process model gives useful guidance for knowledge management activities in practice.

4 The building block model for EM systems

We have adapted the original model of Probst et al to the special requirements of EM. Figure 3 provides a framework for the development, psycho-social integration, and maintenance of case-based EM systems. It includes the organizational and psycho-social aspect explicitly in the two building blocks *organize* and *maintain*. Furthermore, we discuss for the particular building blocks to what extend they can be supported or even automated by CBR systems.

4.1 Identification of knowledge

The *identification of knowledge* for case-based EM systems is mainly the **identification of knowledge sources** for the contents of the knowledge containers case base, vocabulary, similarity measure, and adaptation knowledge [29]. Knowledge sources may be human beings with a rich treasury of experiences, electronic databases, or even non-electronic material and observed objects or systems as far as there is a mechanism to transform the gained knowledge for the case-based assistant system. We developed the following criteria for the manual selection of appropriate knowledge sources:

– the quality,
– the suitable focus, and
– the topicality of the source

as the three main criteria, and secondarily

– the easy accessibility of the source and
– the networking idea.

The networking idea means - as far as possible – to link the assistant systems with the knowledge sources rather than to copy the contents to the system.

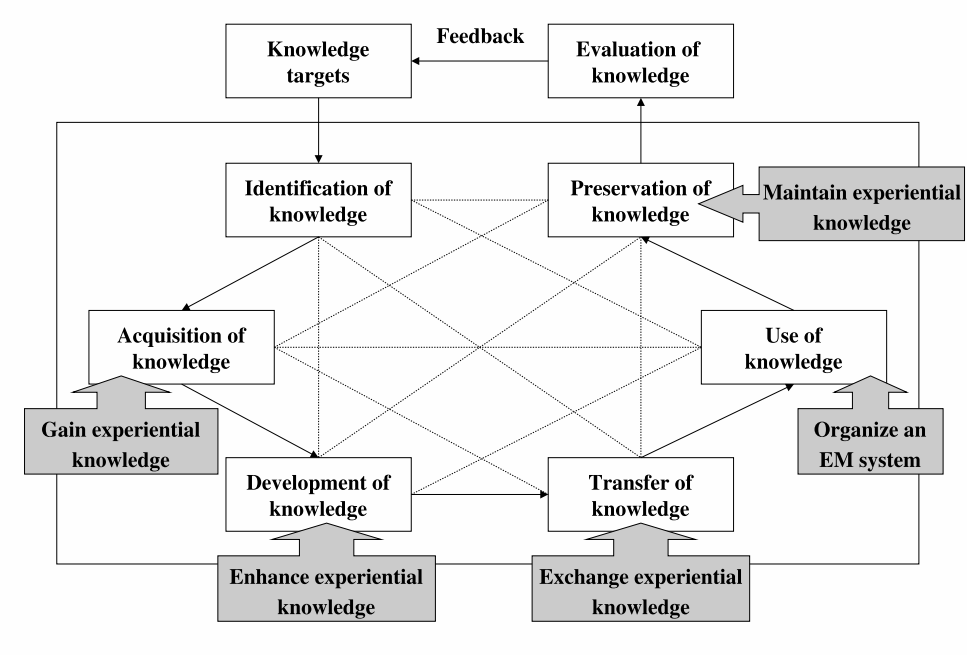

Fig. 3. The building blocks adapted to the special needs of EM.

Potential for automation: We have not found any case-based system in the literature that automatically identifies knowledge sources. But there are other assistant systems in the literature that support the knowledge identification process and automate parts of it, e.g. the ontology-based system *ProPer* [33]. *ProPer* supports the human resource management by means of an ontology on the staff of an organization. The effort to identify knowledge sources automatically is quite high, and it is only possible in case there is a complete and structured directory of potential knowledge sources available.

4.2 Acquisition of knowledge: Gain experiential knowledge

The *acquisition of knowledge* for EM systems is the process of **accessing knowledge sources and integrating them with the system**. The borderlines between the building blocks 'acquisition of knowledge' and 'development of knowledge' are variable. As a rule of thumb, to put something down on paper or to transform it syntactically belongs rather to the acquisition process, while something like machine learning of knowledge or enhancing it in some other way belongs rather to the developing process.

Sample applications in [20, 23] gain vocabulary and components of the similarity measure from electronic sources like WordNet[8] and the on-line dictionary Leo[15]. [19] describes the SimLex approach that generates cases automatically

from emails and continuous texts and cross-links similar cases based on the systems similarity measure.

Potential for automation: The acquisition of knowledge for retrieval purposes can be automated under certain conditions. The required knowledge has to be electronically available, for instance, and the system needs to know which parts of the knowledge should be transformed in what way.

4.3 Development of knowledge: Enhance experiential knowledge

The *development of knowledge* concerning assistant systems may happen in two ways: either **for** the assistant system or **by means of** the assistant system.

The INRECA methodology [5, 4] provides guidance for developing knowledge *for* case-based systems (see Section 6). Ontology learning [22] and other machine learning techniques [32, 6, 11] have been employed to support the development of knowledge *for* case-based systems. [21] describes a life-cycle model for cases and the according case-based authoring support to enhance experiential knowledge. In this way, the humans develop experiential knowledge *by means of* the case-based system.

Potential for automation: The lion's share of developing knowledge for case-based EM systems is still a human task as it includes the externalization of human experience.

4.4 Transfer of knowledge: Exchange experiential knowledge

The *transfer of knowledge* is supported by all case-based systems that let the users share a common case base. More interesting is the **interoperability of case-based systems** that exchange experiential knowledge that is stored in their knowledge containers.

The personal assistant agents in [17] exchange services, i.e. cases, and the according vocabulary and similarity measures to retrieve those services. They perform a shallow kind of ontology mapping to integrate the received knowledge. Agile software development [2] is a prominent – yet non-case-based – example for paying attention on the exchangeability.

Potential for automation: A case-based system can be regarded an agent if it proactively queries another system for knowledge. There is plenty of work on the communication of agents [13] that shows the high potential for the automation of knowledge exchange. There is still much work to be done in CBR research on such agile methods.

4.5 Use of knowledge: Organize an EM system

To boost the *use of knowledge* means for case-based EM systems to design and organize the system in a way that it is accepted by the users. The **barriers**

against the use of a case-based EM system are mainly organizational and psycho-social barriers.

The work on CBR and business processes [10, 5] deals with the organizational aspect. Section 5 describes a new approach to take care on the psycho-social aspect.

Potential for automation: Only small parts of a promotional policy can be automated at the moment.

4.6 Preservation of knowledge: Maintain experiential knowledge

To select and to store valuable knowledge within a case-based EM system are the first steps to *preserve this knowledge*. To keep the experiential knowledge valuable, it has to be **maintained carefully**.

Wilson [35] gives a useful review of the CBR literature on maintenance until 2001. The SIAM methodology [30] is a useful hands-on guidance for maintenance (see Section 6). Ferrario and Smyth [9] automate the organization of maintenance processes for structural cases by means of a scoring system. [12] transfer this work to textual CBR. Competence measures [31, 7] may support the humans who have to judge experiential knowledge.

Potential for automation: Parts of the organization of maintenance can be automated. However, the execution requires the effort of humans. It may be supported by automatic quality measures.

5 Case study with empirical evaluation

We have performed a case study for our framework that focuses on the building block *use of knowledge*, i.e. on the organizational and socio-technical actions to boost the use of the case-based EM system. An *organizational action* for an EM system means an action that concerns the integration of the system with the organization. A *socio-technical action* is a technical modification of the system to realize some psycho-social findings.

5.1 The application scenario

We took the **ExperienceBook II** [18] as an application scenario for our case study. The ExperienceBook II is a case-based assistant system that supports students of computer science in their daily problems. This includes computer science related problems like how to use a certain software but also issues of student life like the best pubs on the campus. Meanwhile, the case base contains about 60 textual cases on the following topics:

- UNIX problems,
- Linux problems,

– Prolog problems,
– problems with the network dial-in at the university's,
– questions concerning the exercise and examination management system Goya,
– the lecture 'Practical computer science I', and
– general problems and questions.

The representation and retrieval of cases follows Lenz et al's approach of textual case-based reasoning [14]. The students may ask questions to retrieve their commillitones' experience. The case-based part of the system is integrated with a discussion forum for the same community of users. The navigation between the two parts is per mouse-click. The ExperienceBook II has been employed at Humboldt University, Berlin, for more than two years. It is on-line accessible for the members of Humboldt's computer science department[1].

5.2 The psycho-social findings

We have developed a catalog of organizational and socio-technical actions to boost the use of our sample application. It relies on a psychological study on the main reasons for the failure of knowledge management by Meyer and Scholl[16] which results in three recommendations:

1. **Requirements analysis**: Make a requirements analysis to identify the kind of assistance and the contents that the users really need.
2. **Attitude**: Exert influence on the users attitude towards the system.
3. **Organizational barriers**: Avoid organizational barriers that may prevent the users from using the system.

We followed the first recommendation by the early and continuing participation of the users. This included discussions with students before, during, and after the launch of the system as well as interviews to gain written feedback. Additionally, we got hints for the knowledge demand of the students by analyzing the queries that have been posed to the system.

The second recommendation is especially crucial for EM systems as people circulate their personal experience only when they trust the receiver, i.e. the receiving system and the other users of the system. For instance, the fear of being controlled via a system leads to a negative attitude. We exerted influence on the users' attitude towards the system by informing and motivating them on several promotional channels. Our results show that promotion has a measurable impact on the access ratio (see below). This indicates a reduction of the organizational barriers '*fear of control*' and '*lack of motivation*'.

We identified '*unsatisfying contents*', '*defensive attitude*', and '*system not tightly integrated with the working environment*' as further organizational barriers. Paying regard to these barriers resulted in an improvement of the system measured by the access statistics (see below). Meyer and Scholl mention '*to small resources for knowledge management*' and '*restrictive conventions*' as further organizational barriers; they do not apply in our case study.

[1] Feel free to send an email to the author for a guest account.

5.3 The results of the activities

Table 1 contains the organizational and socio-technical activities that we have taken to follow the above recommendations. We used the following catalog of methods for it:

- discussions,
- oral and written interviews,
- talks,
- links to the system from other Web pages,
- written group work,
- email communication, and
- Web logfile analysis.

A written group work in a seminary provided us with an initial case base and some further topics of interest for which the cases had still to be written. We created some more cases from teaching material and from the Web pages of the system administration group. The whole initial case base contained two dozen cases what has been a first step against the organizational barrier '*unsatisfying contents*'.

The advertising activities informed the students on several channels: per email, per links from the Web page of the lecture 'Practical computer science I', and via face-to-face communication by discussing in meetings of the students' self-administration and by giving a talk in the lecture. The access statistics (see below) showed that the face-to-face advertisement has been the most successful promotion as each discussion and talk was followed by a peak of accesses. We used all meetings also for the requirements analysis. We developed a communication-friendly design of the system to motivate the students to contribute their experience. The design includes text fields for the author and an email contact address in the cases, a commentary field to extend a case, the right to edit cases for every user, and the integration of the case-based part of the system with the discussion forum.

We decided to abstain from extrinsic motivation like giving the students extra scores for writing a case, for instance. The usage of the system and the authoring of new cases is voluntary, the motivation is intrinsic and has to be done by convincement only. Together with our privacy policy, the intrinsic motivation aims to avoid a '*defensive attitude*'. The privacy is preserved as the system is only accessible for members of the department: There is free access from inside the department's network and password protected access from outside the network. Furthermore, the retrieval is anonymous and the query data is stored not individual-relatedly.

The analysis of the Web log files some weeks after the introduction of the system showed 1,453 accesses (see the value for October 2003 in Figure 4). However, only two authors had written new cases while the discussion forum got many new entries during the same time period. Oral feedback and a discussion of authoring support requirements confirmed that the students felt it difficult to write new cases due to a lack of ideas for topics. They asked for an extra Web

	Requirements analysis	**Attitude**	**Organizational barriers**
before the start of the system (Sep 2003)	written group work to determine topics of interest for cases		initial case base to avoid '*unsatisfying contents*'
		advertising activities (emails, links, discussions, talks), communication-friendly design	avoid '*lack of motivation*'
		only intrinsic motivation, privacy policy	avoid '*defensive attitude*'
some weeks after the start of the system (Oct 2003)	Web log analysis and oral interviews for getting feedback, discussion of authoring support requirements		Web page with a list of open cases, new cases from the discussion forum to avoid '*unsatisfying contents*'
some months after the start of the system (Jan 2004)	Web log analysis and questionnaire for getting feedback		
before the second turn of the system (Sep 2004)		advertising activities	avoid '*fear of control*'
			link from 'GOYA' to avoid that the system is '*not tightly integrated with the working environment*'
some months after the second start (Mar 2004)	Web log analysis for getting feedback		new cases from lecturers to avoid '*unsatisfying contents*'

Table 1. The organizational and socio-technical activites in chronological order.

page with open cases. Since, we have filled this page regularly with topics from the query log files. Additionally, the discussion forum contributed material for some new cases.

Some months after the introduction of the system, the number of accesses was rapidely decreasing (see the values for December 2003 and January 2004 in Figure 4). We sent a questionnaire to the students of the lecture 'Practical computer science 1'. The return rate was low (15 of 298 students, i.e. about 5%), but the results were rather informative: The target community had installed an own discussion forum meanwhile that was stored outside the university. The students did not mention the reasons for this relocation. They assessed the usability of the system as good. They asked for more cases from the lecturers. The most students knew the system from the lecture. This confirms our above observation that the face-to-face communication is the most effective promotional channel.

For the second turn of the system in October 2004, we repeated our advertising activities with a new generation of students. We put special emphasize on the organizational barrier 'fear of control' and recurred to say that the lecturers are not reading the students' queries nor the comments and new cases.

We linked the ExperienceBook II from the Web page of the GOYA system to integrate it further with the students' working environment. Since, about a third of all accesses come from the GOYA page.

The analysis of the Web log file had again the result that the users performed little authoring activities. As a countermeasure, we asked lecturers for help. They wrote cases on open topics at the special Web page.

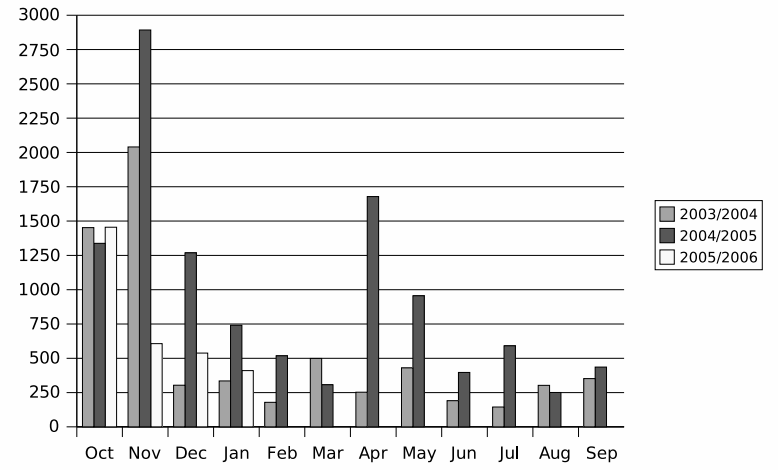

Fig. 4. The access statistics of the ExperienceBook II.

Meanwhile, we have a case base with 59 cases: 8 of them have been written by 5 named students, 5 anonymously, and 46 by 3 different lecturers. 10 comments have been written and 11 cases have been edited. Over 60 authors contributed to the case base and the discussion forum. The contents of the case base are still a bit unsatisfying as such an amount of cases is manageable without any retrieval, e.g. within a catalog structure.

Figure 4 shows a peak of accesses in April 2004 after the new contributions from the lecturers and minor peaks around the examination in July 2005 and at the beginning of the new academic year with the third generation of users in October 2005. In 2005, only mouth-to-mouth communication made promotion for the system.

6 Discussion of related work and conclusion

The INRECA methodology [5] is for the development of industrial applications of CBR. It describes process models on three levels: on the common general level that covers many applications, on the cookbook level for certain kinds of applications, e.g. the class of help desk systems, and on the specific project level. A process is decribed by input values, output values and a set of different methods that can be used to implement it. INRECA is compliant with the ISO 900x standard. It is a powerful framework for huge projects that requires some effort for integrating a case-based EM system with the business processes of the target company. For non-commercial projects, this effort is not achievable sometimes even for lack of specified business processes. However, taking care on the organizational and the psycho-social aspect following our building block model can be done with little effort. We learned from the INRECA methodology that it is important not to be restricted on the technical aspect of a case-based EM system only.

The SIAM (Setup, Initialization, Application, Maintenance) methodology [30] is a framework for case-based systems. SIAM extends the originally four processes of Aamodt and Plaza's CBR cycle [1] by two processes for the application and maintenance of the system. SIAM has been integrated with INRECA and operationalizes a maintenance policy on the general, cookbook, and specific project level. Like SIAM, our framework aims on a systematical approach for the organizational aspect. In addition to SIAM, we allow also light-weight maintenance policies as in [9] and [12].

Weber at al [34] give a survey of knowledge management systems that deal with experiential working knowledge. As one of the first authors they state that such systems, although well-intentioned, are rarely used. They give a categorizing schema that aims to guide the development of improved systems. The scope of this work is still limited to technological and organizational issues.

In this paper, we proposed a framework of EM that is applicable for the development, integration, and maintenance of case-based EM systems in the following way: The designers and managers may select the most important (or

all) building blocks for a particular application and take guidance from the referred sample systems how to realize it.

As our results of a case study show, it is measurably worth while to take care on the psycho-social aspect.

7 Acknowledgments

The author acknowledges the Humboldt University, Berlin, for providing the computational environment for the case study.

References

1. A. Aamodt and E. Plaza. Case-Based Reasoning: Foundational Issues, Methodological Variations , and System Approaches. *AI Communications*, 7(1):39 – 59, 1994.
2. The agile manifest. Internet: http://www.agilemanifesto.org, 2006. [last visited: Feb 2006].
3. K.-D. Althoff, B. Decker, S. Hartkopf, A. Jedlitschka, M. Nick, and J. Rech. Experience management: The fraunhofer iese experience factory. In P. Perner, editor, *Data Mining, Data Warehouse and Knowledge Management. Proc. Industrial Conference on Data Mining*, Institut für Bildverarbeitung und angewandte Informatik IBai Report, pages 12 – 29, Leipzig, Germany, 2001. Institute for Computer Vision and applied Computer Sciences.
4. R. Bergmann. *Experience Management: Foundations, Development Methodology, and Internet Based Applications*. LNAI 2432. Springer-Verlag, Berlin, 2002.
5. R. Bergmann, S. Bree, E. Fayol, M. Göker, M. Manago, S. Schmitt, J. Schumacher, A. Stahl, S. Wess, and W. Wilke. Collecting experience on the systematic development of cbr applications using the inreca methodology. In P. C. Barry Smyth, editor, *Advances in Case-Based Reasoning. Proceedings of the Fourth European Workshop on Case-Based Reasoning (EWCBR-98)*, LNAI 1488, pages 460 – 470, Berlin, 1998. Springer-Verlag.
6. S. Brüninghaus and K. Ashley. The role of information extraction for textual cbr. In D. Aha and I. Watson, editors, *Case-Based Reasoning Research and Development, Proceedings of the ICCBR'01*, LNAI 2080, pages 74 – 89. Springer-Verlag, 2001.
7. S. J. Delany and P. Cunningham. An analysis of case-base editing in a spam filtering system. In P. Funk and P. A. González-Calero, editors, *Advances in Case-Based Reasoning, 7th European Conference, ECCBR 2004, Madrid, Spain, August 30 - September 2, 2004, Proceedings*, LNCS 3155, pages 128 – 141. Springer-Verlag, 2004.
8. C. Fellbaum. *Wordnet: An Electronic Lexical Database*. The MIT Press, Cambridge, Mass., 1998.
9. M. A. Ferrario and B. Smyth. Collaborative maintenance - a distributed, interactive case-base maintenance strategy. In E. Blanzieri and L. Portinale, editors, *Advances in Case-Based Reasoning: 5th European Workshop, EWCBR 2000*, LNAI 1898, pages 393–405, Heidelberg, September 2000. Springer-Verlag.

10. M. H. Göker, T. Roth-Berghofer, R. Bergmann, T. Pantleon, R. Traphöner, S. Wess, and W. Wilke. The development of homer: A case-based cad/cam helpdesk support tool. In B. Smyth and P. Cunningham, editors, *Advances in Case-Based Reasoning, 4th European Workshop, EWCBR-98, Dublin, Ireland, September 1998, Proceedings*, LNAI 1488, pages 346 – 357. Springer-Verlag, 1998.
11. K. M. Gupta and D. W. Aha. Knowledge extraction for conversational case-based reasoning. In D. W. Aha, K. M. Gupta, and S. K. Pal, editors, *Case-Based Reasoning in Knowledge Discovery and Data Mining*, page to appear. John Wiley & Sons, 2005.
12. A. Hanft and M. Minor. A low-effort, collaborative maintenance model for textual cbr. In R. Weber and K. Branting, editors, *Workshop Proceedings of the 6th International Conference on Case-Based Reasoning*, pages 138 – 149, Chicago, Illinois, 2005. DePaul University.
13. The ARPA-sponsored Knowledge Sharing Effort. Internet: http://www.csee.umbc.edu/kse/, 2006. [last visited: Feb 2006].
14. M. Lenz, A. Hübner, and M. Kunze. Textual CBR. In M. Lenz, H.-D. Burkhard, B. Bartsch-Spörl, and S. Weß, editors, *Case-Based Reasoning Technology — From Foundations to Applications*, LNAI 1400, Berlin, 1998. Springer-Verlag.
15. Link everything online. Internet: http://dict.leo.org/, 2005. [last visited: September 2005].
16. B. Meyer and W. Scholl. A Comparison of Paradigmatic Views in Knowledge Management: An Empirical Case Study on Shortcomings in KM. In O. K. Ferstl, E. J. Sinz, S. Eckert, and T. Isselhorst, editors, *Wirtschaftsinformatik 2005: eEconomy, eGovernment, eSociety, 7. Internationale Tagung Wirtschaftsinformatik 2005, Bamberg, 23.2.2005 - 25.2.2005*, pages 1003–1022. Physica-Verlag, 2005.
17. M. Minor. Assistant agents with personal ontologies. In J. van Diggelen, V. Dignum, L. van Elst, and A. Abecker, editors, *Agent Mediated Knowledge Management Workshop*, pages 41 – 51, Utrecht, 2005. Universiteit Utrecht.
18. M. Minor. Introduction strategy and feedback from an experience management project. In K.-D. Althoff, A. Dengel, R. Bergmann, M. Nick, and T. Roth-Berghofer, editors, *Professional Knowledge Management. WM 2005 post-conference proceedings.*, LNAI 3782, pages 284 – 292. Springer-Verlag, 2005.
19. M. Minor and C. Biermann. Case acquisition and semantic cross-linking for case-based experience management systems. In D. Zhang, T. M. Khoshgoftaa, and M.-L. Shyu, editors, *Proceedings of the 2005 IEEE International Conference on Information Reuse and Integration (IRI-2005)*, number 05EX1058, pages 433 – 438, Las Vegas, 2005. IEEE Systems, Man, and Cybernetics Society.
20. M. Minor and J. C. Del Prado. Multilingual textual case-based reasoning. In H.-P. Schnurr, S. Staab, R. Studer, G. Stumme, and Y. Sure, editors, *Professionelles Wissensmanagement: Erfahrungen und Visionen*, pages 281 – 282, Aachen, 2001. Shaker-Verlag.
21. M. Minor and A. Hanft. The life cycle of test cases in a cbr system. In E. Blanzieri and L. Portinale, editors, *Advances in Case-Based Reasoning: 5th European Workshop, EWCBR 2000*, LNAI 1898, pages 455 – 466, Berlin, 2000. Springer-Verlag.
22. M. Minor and K. Schmidt. Automatic transformation and enlargement of similarity models for case-based reasoning. In *Proceedings of the Modellierung 2006*, to appear.
23. F. Müller. Integration von TFBS-Systemen und Ontologien. Diplomarbeit, Institut für Informatik, Humboldt-Universität zu Berlin, Berlin, 2005.

24. M. Nick. *Experience Maintenance through Closed-Loop Feedback*. PhD thesis, Technische Universität Kaiserslautern, 2005.
25. M. Nick, B. Snoek, and T. Willrich. Supporting the it security of eservices with cbr-based experience management. In K. D. Ashley and D. G. Bridge, editors, *Case-Based Reasoning Research and Development, 5th International Conference on Case-Based Reasoning, ICCBR 2003, Trondheim, Norway, June 23-26, 2003, Proceedings*, LNAI 2689, pages 362 – 376. Springer, 2003.
26. I. Nonaka and H. Takeuchi. *The knowledge creating company*. Oxford University Press, 1995.
27. G. Probst. Ganzheitliches Wissensmanagement: Trends und kritische Reflexionen, Eingeladener Vortrag auf der WM 2003. Internet: http://wm2003.aifb.uni-karlsruhe.de/invitedtalk_probst.pdf, 2003. [last visited: November 2004].
28. G. Probst, S. Raub, and K. Romhardt. *Wissen managen: Wie Unternehmen ihre wertvollste Ressource optimal nutzen*. Gabler-Verlag, Wiesbaden, 1999.
29. M. M. Richter. Fallbasiertes Schließen. In G. Görz, C.-R. Rollinger, and J. Schneeberger, editors, *Handbuch der Künstlichen Intelligenz*, chapter 11, pages 407 – 430. Oldenbourg-Verlag, München, 2000.
30. T. Roth-Berghofer. *Knowledge Maintenance of Case-Based Reasoning Systems - The SIAM Methodology*. PhD thesis, Universität Kaiserslautern, 2003. DISKI 262, infix-Verlag.
31. B. Smyth and E. McKenna. Modelling the competence of case-bases. In B. Smyth and P. Cunningham, editors, *Advances in Case-Based Reasoning, 4th European Workshop, EWCBR-98, Dublin, Ireland, September 1998, Proceedings*, LNAI 1488, pages 208 – 220. Springer-Verlag, 1998.
32. A. Stahl. Learning similarity measures: A formal view based on a generalized cbr model. In H. Muñoz-Avila and F. Ricci, editors, *Case-Based Reasoning, Research and Development, 6th International Conference, on Case-Based Reasoning, ICCBR 2005, Chicago, IL, USA, August 23-26, 2005, Proceedings*, LNCS 3620, pages 507 – 521. Springer-Verlag, 2005.
33. Y. Sure, A. Maedche, and S. Staab. Leveraging Corporate Skill Knowledge - From ProPer to OntoProPer. In U. Reimer, editor, *Proceedings of the Third International Conference on Practical Aspect s of Knowledge Management (PAKM 2000)*, volume 34 of *CEUR Workshop Proceedings*, Basel, Switzerland, 2000. CEUR-WS.org.
34. R. Weber, D. W. Aha, and I. Becerra-Fernandez. Categorizing intelligent lessons learned systems. In D.W.Aha and R. Weber, editors, *Intelligent Lessons Learned Systems: Papers from the AAAI 2000 Workshop*, pages 63 – 67, Menlo Park, 2000. CA:AAAI Press.
35. D. C. Wilson. *Case-Based Maintenance: the Husbandry of Experience*. PhD thesis, Indiana University, 2001.
36. T. Wolf, S. Decker, and A. Abecker. Unterstützung des Wissensmanagements durch Informations- und Kommunikationstechnologie. In A.-W. Scheer and M. Nüttgens, editors, *Electronic Business Engineering, 4. Internationale Tagung Wirtschaftsinformatik*, pages 745 – 766, Heidelberg, 1999. Physica-Verlag.