The Fraunhofer IESE Experience Management System

Andreas Jedlitschka, Klaus-Dieter Althoff, Björn Decker, Susanne Hartkopf, Markus Nick, Jörg Rech

Fraunhofer Institute Experimental Software Engineering (IESE),
Sauerwiesen 6, D-67551 Kaiserslautern
{jedl|althoff|decker|hartkopf|nick|rech}@iese.fhg.de

Abstract: Experience Management (EM) is an area that is increasingly gaining importance. Its roots lie in Experimental Software Engineering ("Experience Factory"), in Artificial Intelligence ("Case-Based Reasoning"), and in Knowledge Management. EM is comprised of the dimensions methodology, technical realization, organization, and management. It includes techniques, methods, and tools for identifying, collecting, documenting, packaging, storing, generalizing, reusing, adapting, and evaluating experience, as well as for development, improvement, and execution of all knowledge-related processes. The main difference between experience and more general knowledge is the fact that normally, a (more or less) continuous "stream of knowledge" must be processed. Within this contribution, we present the Fraunhofer IESE Experience Factory as a practical example for an experience management system, which is in operation for more than two years.

1. Introduction

"Knowledge is no good if you don't apply it," said Goethe. In all emerging areas of business and engineering science, there is normally a lack of explicit knowledge about their underlying processes, products, and technologies. Usually, such knowledge is built up through individual learning from the experience of the people involved. Additionally, we can identify a similar problem for tacit knowledge residing in expert brains. The area of organizational learning, as one part of knowledge management, tries to increase the effectiveness of individual human learning for the whole organization. Besides improving internal communication (group learning) [GV+01], organizational learning also includes documenting relevant knowledge and storing it (for reuse) in an organizational, corporate memory [AB+98, vH+96]. The learning goal for a learning organization is to enable its members to effectively quarrel situational requirements taking past experience into account. Providing a higher number of alternative decisions or proceedings to employees than they would have had based on their individual repertoire characterizes a learning organization [Klu99].

An approach known from software engineering called Experience Factory (EF) [BCR94] goes one step further. Knowledge (in the form of processes, products, and technologies) is enriched by explicitly documented experience (e.g., lessons that were learned during the practical application of the knowledge). The EF approach includes capturing, documenting, storing, and disseminating of such experience. These "experience packages" are stored in an experience base (EB), which is an organizational memory for relevant knowledge and experience. The EF approach tries to explicitly rebuild human "learning from experience" to further support organizational learning. EF has to be supplemented on a technical system implementation level to realize the EB. One specific technology from artificial intelligence, which has its roots in the knowledge-based systems as well as in the machine learning subfield, is case-based reasoning (CBR) [Alt01, Kol93]. We call the research area dealing with both the organizational and the technical support for "learning from experience" Experience Management (EM), which is in accordance with similar suggestions from literature [Tau00, Ber01].

EM deals with the identification, storage, and reuse of multifaceted knowledge of the members of an organization, who acquired this knowledge through learning from a (more or less) continuous stream of experience.

Within this article we first (Sec.2) give an introduction to our in-house EF. After presenting the maintenance part of the EF (Sec.3), we outline some future trends for for further improvement of our EF (Sec.4&5). Finally, a short summary is given (Sec.6).

2. Fraunhofer IESE Corporate Information Network: The Experience Factory

The EF is a logical and/or physical infrastructure for continuous learning from experience, including the experience base (EB) for the storage and retrieval of knowledge. As practice shows, it is substantial for the support of organizational learning, that the project organization and the organizational unit responsible for learning are separated [BCR94, ABT00]. The Corporate Information Network (CoIN) team [Tau00] runs such a separate organizational unit for the Fraunhofer IESE. Such a separation is the main feature of the EF. It is based on the Quality Improvement Paradigm, which is a goal-oriented learning cycle for experience based improvement and evaluation of project planning, project execution, and project analysis [BCR94].

The EF deals with the typical problem that the main experience of an organization resides in the brains of a few experts. With the fast growing of our institute this problem has increased, because these experts were and are rarely accessible because of their involvement in many different tasks. Therefore, this small group of experts became a scarce resource as information providers. Hence, it has become increasingly important (a) to provide the less experienced people with default processes and guidelines to jump-start them, (b) to build up their expertise more quickly, and (c) to facilitate experience sharing among all IESE employees. Since the size of our institute does not allow any more to talk to all people on a weekly basis, experience sharing on a personal basis does not work. To bridge this gap is one responsibility of the CoIN project. Additionally, CoIN is used as a real project environment for the development and validation of techniques and methods for goal-oriented experience management including knowledge elicitation, processing, dissemination, presentation, maintenance, and evaluation. It consists of three main parts: the EB, the CoIN team, and an intranet representation (CoIN-Portal).

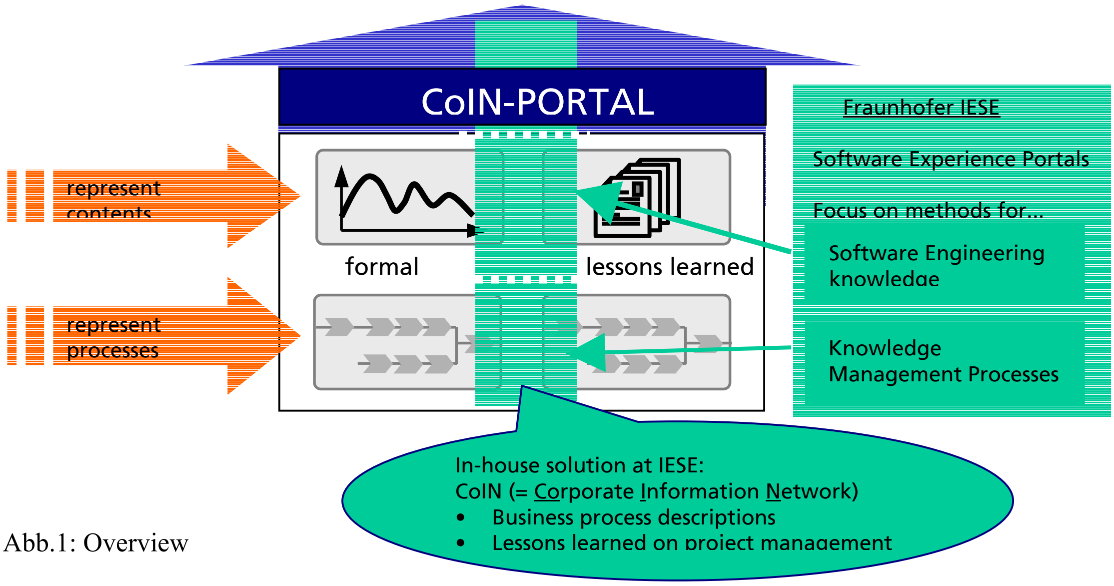

Abb.1: Overview

Within the EB included in CoIN, all kinds of experience necessary for our daily business are stored (e.g., projects, business processes, document templates, guidelines, observations, improvement suggestions, problems that occurred and problem fixes that were applied). Defined processes (e.g., structured interviews within project touch-down meetings) populate this EB systematically with experience typically needed by our project teams. Dedicated improvement processes analyze problems that have occurred, devise improvement actions to avoid their recurrence, and implement strategic decisions by the institute's leadership. However, elicitation, distribution, and integration of process descriptions and lessons learned need an investment of effort [DA+01].

The current focus is on two major subject areas: business process descriptions (see [DA+01] for more details) and lessons learned. The lessons learned are in the form of guidelines, observations, and problems. The guidelines act as solutions or mitigation strategies for the problems. An observation describes the results of an application of a guideline. Besides this, many different kinds of experience like artifacts developed during projects are to be stored in the EB. Each is called an experience package. In addition, these experience packages are highly interrelated. For example, projects produce deliverables in the form of slide presentations and reports. Slide presentations may be summaries of reports. Observations and problems are gained during a project while a particular business process was performed, that is, we have to deal with context-sensitive experience. Such kind of experience is unique in the sense that exactly the same context will not recur. Therefore, people will be searching for experience that has been gained in *similar* contexts. Both, the requirement for supporting different kinds of interrelated experience packages and the need for context-sensitive, similarity-based retrieval, demand a specialized technical infrastructure for the EB.

These are common requirements for an EB [Tau00]. Our solution to meet these requirements is INTERESTS (Intelligent Retrieval and Storage System) [AB+00]. It consists of a general purpose browser for accessing and presenting the EB contents using a standard web browser, an EB server synchronizing (and logging) access to the EB, and a commercial CBR tool (orenge from empolis knowledge management), which is used for the actual EB. Each experience package is implemented as a "case" based on a structural CBR approach [BB+99].

This includes a domain ontology for modeling the different types of case concepts, formal and informal case attributes together with the respective similarity measures, as well as relations between cases.

Within an experiment the benefits of this EB approach have already been demonstrated [Tau00]. Until now we have gathered more than two years of operational experience in maintaining CoIN, and we have successfully adapted CoIN to partners/customers (e.g., [BE+01]. Based on this experience we have widened the requirements of CoIN towards an organization-wide information and knowledge management system. Other applications not yet considered (e.g., human resource and educational systems) may deliver valuable information, too. Additional information can lead to a more precise and better aggregation and adaptation of knowledge to users needs, but also requires the integration of the respective applications. More details on CoIN (e.g., on lessons learned and business process descriptions) can be found in [AD+01].

3. Maintenance

The value of a corporate information system tends to degrade with time, caused by external impacts on the organization's environment or by changes within an organization (e.g., the development of a new product). This is particularly true if case-specific knowledge (experience) is stored in the information system, as is typically done in CBR systems, EB systems, lessons learned systems, or best practice databases, because such knowledge is gained almost continuously in daily work [AW00].

Maintenance is of particular importance for EM, because a (more or less) continuous stream of experience has to be processed [BB+99, NAT01]. For instance, since 1999 the EB within CoIN has grown annually by 550 lessons learned and we expect an annual growth of 500 lessons learned for the next years. In addition, our EB also includes best practice descriptions on business processes and information on projects as well as the links among these different knowledge and information types. Because the EB should be maintained with low effort and the EF staff as maintenance team can work only part-time for the EF/EB, tool support is highly regarded [NAT01].

High quality of the retrieved knowledge is a main requirement from the users' point of view. The respective quality criteria should be related to organizational goals [Tau00, NF00].

All this demonstrates that maintenance has a certain complexity for such systems and is a knowledge-intensive task. Thus, guidance and decision support for maintenance is almost essential to successfully maintain and improve such a system. Due to the variety and number of the knowledge in an EB system, authoring support has to combine human- and computer-based maintenance activities. However, the maintenance knowledge for decision support and specific maintenance tasks is rather acquired "by chance" during continuous operation (so far). Thus, it might take long to learn the required maintenance knowledge for decision support. The problem is that existing methods such as INRECA [BB+99] or DISER [Tau00] only fill the "standard" knowledge containers of CBR/EB systems.

Based on DISER, we are developing - in the context of maintenance - the EMSIG framework, presented in [NAT01], for authoring support for EB/CBR systems. EMSIG combines human- and computer-based maintenance activities and respective decision support. EB and authoring support tools are implemented in an integrated system using CBR technology. The EMSIG framework includes an integrated technical solution that operationalizes the support for EB maintenance regarding cases and conceptual model using specific maintenance knowledge.

4. New Strategies for Capturing, Process, Disseminate and Exchange Knowledge

Knowledge is actually identified as "fourth factor of production"[1]. Therefore, unstructured, not personalized flooding with information can be counterproductive for building up and exchanging knowledge. For an improved support of IESE's employees, we are (a) moving from a "pull" to a "push" strategy in the sense of providing the right information at the right time (just-in-time), (b) developing more flexible and faster mechanisms for sharing information by introducing Communities of Practice (CoPs), and (c) developing a concept for aggregation and adaptation of information to users' context and needs based on a two-step CBR-approach for user-modeling (further details can found in [JA01]).

[1] Besides work, capital, raw material

5. Data Mining in Experience Bases

In our effort to optimize and improve an EF like CoIN we are currently evaluating the basic techniques of data mining [ES00]. This includes clustering, classification, association rules, and generalization.

Clustering makes it possible to find similar sets of data in large multi-dimensional databases. It can be used to detect unexpected clusters in groups of experiences, how close those experiences are related or what types of deviations from clusters exists. *Classification* is a technique to categorize new experiences into an existing hierarchy of classes. As a side effect to the construction of the classification process it collects data about the borders between classes of experiences. The third technique — *association rules* — is used to find patterns in transaction data. These rules are represented in the form "if ... then ..." and are typically used to predict customer buying behavior. Last but not least *generalization* is used to generate summaries of numerical data or to apply other data mining techniques on more abstract descriptions of the data.

Another important aspect in an EB with almost exclusive textual data is *text mining*. With techniques from this field we can automatically extract "hard" data from experiences and pre-process it for any of the data mining techniques. This "hard" data consists mostly of extracted words from the experience itself and can be used to create values for attributes of a classification.

All these techniques can be used to analyze, generalize, and process the experiences within CoIN, as well as to support the construction and usage of an EB. To improve CoIN, we are in the process to develop (a) concepts to discover new knowledge in experiences, (b) a method to support the construction and evolution of EB's, (c) concepts to support CoIN users, and (d) methods to detect and improve the "quality of knowledge". Beside these application areas, data mining can be used to support the other presented strategies like "aggregation & adaptation" or CoPs (further details are described in [RDA01])

6. Summary

In this paper, we shortly introduced the Fraunhofer IESE Experience Factory as an example application within the emerging field of experience management (EM). Among others, the roots of EM lie in experimental software engineering (experience factory), artificial intelligence (case-based reasoning), and knowledge management. EM deals with all kinds of techniques, methods, and tools for knowledge handling as well as the respective knowledge-related processes. The main difference between EM and knowledge management in general is that for EM a (more or less) continuous stream of experience/knowledge has to be processed. From an artificial intelligence perspective this opens up for various intelligent mechanisms supporting learning from experience.

References

[AB+98] Abecker, A.; Bernardi, A.; Hinkelmann, K..; Kühn, O.; Sintek, M.: Towards a Technology for Organizational Memories, IEEE Intelligent Systems 1998.

[AB+00] Althoff, K.-D., Birk, A., Hartkopf, S., Müller, W., Nick, M., Surmann, D. & Tautz, C. (2000). Systematic Population, Utilization, and Maintenance of a Repository for Comprehensive Reuse. In G. Ruhe & F. Bomarius (Eds.), *Learning Software Organizations - Methodology and Applications*, Springer Verlag, Lecture Notes in Computer Science, LNCS 1756, 25-50.

[ABT00] Althoff, K.-D.; Bomarius, F.; Tautz, C.: Knowledge Management for Building Learning Software Organizations, Information Systems Frontiers 2:3/4, 349-367, 2000; Kluwer Academic Publishers.

[AD+01] Althoff, K.-D., Decker, B., Hartkopf, S., Jedlitschka, A., Nick, M. & Rech, J. (2001). Experience Management: The Fraunhofer IESE Experience Factory. In P. Perner (ed.), Proc. Industrial Conference Data Mining, Leipzig, 24.-25. Juli 2001, Institut für Bildverarbeitung und angewandte Informatik.

[Alt01] Althoff, K.-D. (2001). Case-Based Reasoning. To appear in: S.K. Chang (Ed.), Handbook on Software Engineering and Knowledge Engineering. Vol.1, World Scientific (40 pages).

[AW00] Aha, D., and Weber, R., editors. Proceedings of the Workshop on Intelligent Lessons Learned Systems at 17th National Conference on AI (AAAI-00), 2000.

[BB+99] Bergmann, R., Breen, S., Göker, M., Manago, M., and Wess, S. (1999). *Developing Industrial Case-Based Reasoning Applications - The INRECA-Methodology*. Springer Verlag, LNAI 1612.

[BCR94] Basili, V.R.; Caldiera, G.; Rombach, D.: Experience Factory; In Marciniak, J.J. ed., Encyclopedia of Software Engineering, vol 1, 469–476; John Wiley & Sons; 1994.

[BE+01] Brandt, M., Ehrenberg, D., Althoff, K.-D. & Nick, M. (2001). Ein fallbasierter Ansatz für die computergestützte Nutzung von Erfahrungswissen bei der Projektarbeit. In: H. U. Buhl, A. Huther & B. Reitwiesner (Hrsg.*), Information Age Economy*, Heidelberg: Physica Verlag.

[Ber01] Bergmann, R. (2001). *Experience management - foundations, development methodology, and internet-based applications*. Postdoctoral thesis (Habilitationsschrift), Department of Computer Science, University of Kaiserslautern (submitted).

[DA+01] Decker, B.;Althoff, K.-D.; Nick, M.; Tautz, C. (2001). Integrating Business Process Descriptions and Lessons Learned with an Experience Factory. . *In: H.-P. Schnurr et al. (Hrsg.),* Professionelles Wissensmanagement - Erfahrungen und Visionen. Aachen: Shaker Verlag, S.54-58; also: http://SunSITE.Informatik.RWTH-Aachen.DE/Publications/CEUR-WS/Vol-37/Decker.pdf.

[ES00] Ester, Martin; Sander, Jörg: „Knowledge Discovery in Databases: Techniken und Anwendungen“, Berlin: Springer-Verlag, 2000, ISBN: 3540673288

[GV+01] Gordon, T.F.; Voss, A.; Richter, G.; Märker, O.: *Zeno: Groupeware for Discourses on the Internet;* in Künstliche Intelligenz, Heft 2/01, Seiten 43-45, ISSN 0933-1875, arendtap Verlag Bremen, (2001)

[JA01] Jedlitschka, A.; Althoff, K.-D.: Using Case-Based Reasoning for User Modeling in an Experience Management System. *Proc. Workshop "Adaptivität und Benutzermodellierung in interaktiven Systemen (ABIS01)", GI-Workshop-Woche „Lernen – Lehren – Wissen – Adaptivität (LLWA01)“,* 8.-12. Okt. 2001, Universität Dortmund, Forschungsbericht Nr. 763 2001

[Klu99] Kluge, A.: Erfahrungsmanagement in lernenden Organisationen;Verl. für angewandte Psychologie; Göttingen 1999;

[Kol93] Kolodner, J.L. (1993). *Case-Based Reasoning*. Morgan Kaufmann Publishers

[NAT01] Nick, M.; Althoff, K.-D. & Tautz, C. (2001). Systematic Maintenance for Corporate Experience Repositories. Computational Intelligence 17(2), 364-386

[NF00] Nick, M., and Feldmann, R. Guidelines for evaluation and improvement of reuse and experience repository systems through measurement programs. In 3rd European Conference on Software Measurement (FESMA-AEMES 2000), Madrid, Spain, Oct. 2000.

[RDA01] Rech, J., Decker, B. & Althoff, K.-D (2001). Using Knowledge Discovery Technology in Experience Management Systems. *Proc. Workshop "Maschinelles Lernen (FGML01)", GI-Workshop-Woche „Lernen – Lehren – Wissen – Adaptivität (LLWA01)“,* 8.-12. Okt. 2001, Universität Dortmund, Forschungsbericht Nr. 763

[Tau00] Tautz, C.: Customizing Software Engineering Experience Management Systems to Organizational Needs; Ph. D. diss., Dept. of Computer Science, University of Kaiserslautern, Germany; 2000; Stuttgart: Fraunhofer IRB Verlag

[vH+96] van Heijst, G., van der Speck, R., and Kruizinga, E. 1996. Organizing corporate memories. In *Proceedings of the Tenth Banff Knowledge Acquisition for Knowledge-Based Systems Workshop*, SRDG Publications, Department of Computer Science, University of Calgary, Calgary, Alberta, Canada T2N 1N4.