707.009
Foundations of Knowledge Management
„Organizational Knowledge Repositories“

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Overview

Agenda

• Experience Factories
• Case Based Reasoning

In the context of Software Engineering
Overview

Previously:
- Knowledge Organization
- Broad Knowledge Bases
- Knowledge Acquisition

Last week:
- Knowledge Transfer

Today:
- Organizational Knowledge Repositories

Schools of KM
[Earl 2001]

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<th>SCHOOL</th>
<th>TECHNOCRATIC</th>
<th>CARTOGRAPHIC</th>
<th>ENGINEERING</th>
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Markus Strohmaier 2007
KM as risk prevention in Software Engineering


Addressing risks such as

– Loss of knowledge due to attrition
– Lack of knowledge and an overly long time to acquire it due to steep learning curves
– People repeating mistakes and performing rework
– Individuals who own key knowledge become available

What kind of risks can you identify from a KM perspective?

Types of Knowledge Reuse Situations

[Markus 2001]

Four distinct types:

• **Shared work producers**
  – who produce knowledge they later reuse

• **Shared work practitioners**
  – who reuse each other’s knowledge contributions

• **Expertise-seeking novices**
  – who seek advice from experts

• **Secondary knowledge miners**
  – who seek to answer new questions or develop new knowledge
Knowledge Transfer in Software Engineering

Knowledge Transfer Participants


Shared Work Producers:
• „Prosumers“
• Producers of knowledge for their own later reuse

Shared Work Practitioners:
• Producers of knowledge for each other's use
What kind of knowledge is relevant in a Software Engineering context?

Knowledge about:

- Software architecture
- Functional and Non-Functional Requirements
- Design rationale
- Design Trade-offs
- Stakeholders and Stakeholder expectations
- Lessons learned
- ...

Knowledge Repositories

M.L. Markus, Toward a Theory of Knowledge Reuse: Types of Knowledge Reuse Situations and Factors in Reuse Success

Types of Knowledge Repositories:

- Repositories of documents
- Repositories of data
  ➔ Fundamental differences for retrieval
- Repositories that store external knowledge (e.g. Customers, Competition)
- Repositories that store internal knowledge (e.g. Meeting transcripts, mails)
- Repositories containing general knowledge (e.g. scientific knowledge)
- Repositories containing specific knowledge (e.g. context sensitive)
- Repositories containing declarative / procedural / rationale / analytic knowledge
KM functions for document-based Knowledge Repositories

- **Autorenidentifikation**
  - wer hat welches Dokument eingestellt
- **Datenbank-gestützte Verwaltung von Dokumenten**
  - Dokumente finden unabhängig vom Ablageort
- **Versionenverwaltung von Dokumenten**
  - Wer hat wann an welchem Dokument gearbeitet
- **Beziehungen zwischen Dokumenten**
  - Bi-direktionale, konsistente Verweise
- **Automatische Generierung von Abstracts**
- ...

- **Informationsagenten**
  - Informationen über Veränderungen
- **Beziehung zwischen Dokumenten und Personen**
  - Wissensträger mit Wissen bestmöglich verknüpfen
- **Personalisierungsmöglichkeiten**
  - Benutzung entsprechend persönlicher Wünsche gestalten
- **Unterstützung unterschiedlicher Suchfunktionalitäten**
  - Volltext und/oder Metadaten, Ähnlichkeiten, Clustering
- **Groupwarefunktionalitäten** (z.B. Teamworkspaces)
  - Zusammenarbeit mit anderen erleichtern
- ...

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2007
Knowledge Repositories in Software Engineering

Related Concepts:
- Lessons Learned database
- Lessons to Learn database
- Project close-out / post-mortem repositories
- Experience factory
- Knowledge base
- Etc.


Goals of Knowledge Repositories:
- Reduce software defects
- Sharing knowledge about local policies and practices
  - E.g. through Document management
- Capturing knowledge and knowing who knows what
  - E.g. through competence management and expert identification
- Software process improvement
  - Decrease time and cost and increase quality
  - E.g. through software reuse
- Making better decisions
- Accessing domain knowledge
- Supporting learning and feedback

What are different purposes knowledge repositories can serve?
## Skills Management

### Erstellung eines SOLL Profils

**Interviews mit Vorgesetzten zu Stellenanforderungen der Mitarbeiter**

<table>
<thead>
<tr>
<th>Fähigkeit / Fähigkeiten</th>
<th>Kenntnisse für spezifische Aufgaben</th>
<th>Kenntnisse für ganzheitliche Probleme</th>
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<td>Synergie / Knowhow</td>
<td>Ständig auf neue Systeme und Techniken zu</td>
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**Erstellung eines SOLL Profils**

| Management / Exploration | Kenntnisse technischer Systeme, wie Netzwerke, Router etc. | 0 |                   |

**Abstimmung der Profile mit Stelleninhabern**

| Persönliche / soziale Kompetenzen | X | 0 |

### Einschätzung des IST Profils als Selbst- (x) und Fremdeinschätzung (x)

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<thead>
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<td>Kenntnisse der Systeme anzuwenden</td>
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**Abstimmung der unterschiedlichen Sichtweisen**

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<td>Führungsqualität</td>
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**2007**
Barriers to Knowledge Transfer

– Issues with the Knowledge Repositories [7]:
  • Lack of awareness,
  • Lack of trust,
  • Lack of time,
  • Low information quality,
  • Low usage,
  • Preparing entries is time consuming,
  • Expensive maintenance,
  • Context dependency

Three Potential Solutions [Cabrera2002]

A look back to our last class:

1. Restructuring the payoff function
2. Increasing perceived efficacy of individual contributions
3. Establishing group identity and promoting personal responsibility

But organizational knowledge repositories are not necessarily discretionary databases
Improving the software process and product requires the continual accumulation of evaluated experiences (learning)
- in a form that can be effectively understood and modified (experience models)
- into a repository of integrated experience models (experience base) that can be accessed and modified
- to meet the needs of the current project (reuse).

The paradigm implies the logical separation of project development (performed by the Project Organization)
- from the systematic learning and packaging of reusable experiences (performed by the Experience Factory).
The Experience Factory

V. R. Basili and G. Caldiera and D.H. Rombach, Experience Factory

- **Experience Factory** is a logical and/or physical organization that supports project developments by analyzing and synthesizing all kinds of experience, acting as a repository for such experience, and supplying that experience to various projects on demand (Figure 2).

- It packages experience by building informal, formal or schematized, and productized models and measures of various software processes, products, and other forms of knowledge via people, documents, and automated support.

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**Experience Factories (EF) focus on the facilitation of Knowledge Transfer between Software Developers**

- Experience Base
  - “Packages Experiences”

- Goals
  - Knowledge Transfer
  - Knowledge Reuse
The Experience Factory


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- Experience Base
  - “Packages Experiences”
- Goals
  - Knowledge Transfer
  - Knowledge Reuse

Examples: Know-Center Processes, Post-Mortem Process and LL Documents

Knowledge Flow Theory

[Nissen 2004]

Classification of different types of knowledge flows along 3 dimensions
- Explicitness
  - Tacit / Explicit
- Reach
  - Individual, Group, Organization, Interorganization
- Life Cycle
  - Evolve, Apply, Distribute, Formalize, Organize, Create, …

Formalization:
Let \( a = [a_e + a_r + a_l] \)

within the coordinate system \( e = \text{explicitness}, r = \text{reach} \) and \( l = \text{lifecycle} \)

then the goal of e.g. an experience factory can be expressed as the vector \( \vec{AB} \) with \( A = (\text{implicit, group, share}) \) and \( B = (\text{explicit, group, share}) \).
Case Based Reasoning [Aamodt 1994]

- A problem solving paradigm
- Utilizing the specific knowledge of previous experiences

- A new problem is solved by
  - Finding a similar past case and
  - Reusing it in the new problem situation

- An incremental approach to learning –
  - experience is retained each time a problem has been solved

Case Based Reasoning Applications

Example: Salesforce – Customer support by call centre agents


What type of knowledge repository is this system?
Case Based Reasoning [Aamodt 1994]

In CBR terminology

- A **case** denotes a problem situation
- A **past case** denotes a previously experienced situation, which has been captured and learned in such a way that it can be reused in solving future problems (also previous case, stored case, retained case)
- A **new case** (or unsolved case) is a description of a new problem to be solved

Case-based reasoning is a cyclic and integrated process of solving a problem, learning from this experience, solving a new problem, etc

Learning in CBR occurs as a natural by-product of problem solving
When a problem is solved, the experience is retained in order to solve similar problems in the future

CBR favours learning from experience, i.e. Learning from concrete problems
Case Based Reasoning [Aamodt 1994]

Central tasks are

1. Identify the current problem situation
2. Find a past case similar to the new one
3. Use that case to suggest a solution
4. Evaluate the proposed solution
5. Update the system by learning from this experience

A descriptive Framework for CBR systems

The CBR Cycle

1. RETRIEVE most similar case
2. REUSE the knowledge in that case
3. REVISE the proposed solution
4. RETAIN relevant parts of this experience

Fig. 1. The CBR Cycle
Case Based Reasoning [Aamodt 1994]

Example:
Customer Support System

Core problems addressed by CBR researchers:

1. Knowledge representation (How to represent cases?)
2. Retrieval methods (How to identify relevant cases?)
3. Reuse methods (How to translate knowledge from old to new case?)
4. Revise methods (How to improve cases?)
5. Retain methods (How to increase and improve the case base?)

A very broad field of current research:
See, for example, http://www.iccbr.org/iccb07/
Any questions?

Coming up: Two guest lectures

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<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Description</th>
<th>Guest Lecturer</th>
<th>Readings</th>
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<td>Week 9</td>
<td>6.12.2007</td>
<td>Psychology in Knowledge Management</td>
<td>In this class, we will discuss some fundamental psychological concepts in the context of knowledge management, including the example of Knowledge Space Theory.</td>
<td>T. Ley, Know-Center</td>
<td>TBA</td>
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<tr>
<td>Week 10</td>
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<td>Multimedia &amp; Semantics</td>
<td>In this class, we will discuss different forms of semantic annotation of multimedia documents.</td>
<td>M. Lin, Stanford University</td>
<td>TBA</td>
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