

# Experience-based Information Systems

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## Overview

- Defining research program on intelligent information systems
- Integration of Artificial Intelligence (AI) and Software Engineering (SE) approaches
- Example:
  - Learning from experience
  - AI: Case-based reasoning
  - SE: Experience factory
  - Status in the mid 1990s
  - Integration of CBR and EF
  - Experience-based information systems (EbIS)
  - Evaluation
- Lessons learned
- Future goals

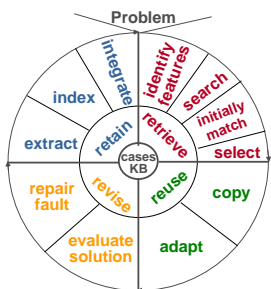


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## Case-Based Reasoning (CBR) Systems

An approach to solve new problems by adapting solutions of similar past problems.

Problem: **Initial problem description defines new case**  
 Retrieve: **New case is used to find a similar case in the case base**  
 Reuse: **Combination of new and retrieved case provides solved case**  
 Revise: **Evaluation of the suggested solution**  
 Retain: **Learning of useful experience through adapting the case base and/or the general domain knowledge**



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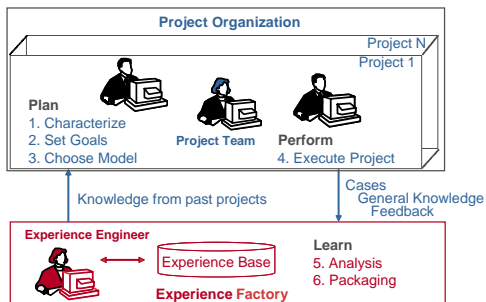
## Case-Based Reasoning: Status in 1996

- In 1996, the CBR community had effected a focus of knowledge-based systems on experience.
- The orientation of CBR towards Schank's dynamic memory theory [Schanck 1982] guaranteed the "situatedness of the approach" and often resulted in a good user acceptance.
- As a consequence, several commercial tools existed and many real-life applications had been built [Althoff 1997].
- **Problems** at this stage were:
  - How to systematically develop CBR systems?
  - How to operate CBR systems and how to embed them into industrial environments?
  - How to evaluate CBR applications?



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## Experience Factory (EF)



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## Experience Factory Roles

- **Manager**
  - Der Manager stellt **Ressourcen** bereit, definiert strategische Ziele und initiiert Verbesserungsprogramme.
  - Er bestimmt **Struktur und Inhalt der Fallbasis** und kontrolliert ihre **Qualität**.
- **Supporter**
  - Der Supporter ist verantwortlich für die **Dokumentation neuer Erfahrungen** und die **Unterstützung der Projekt-Teams**.
  - Er sammelt und qualifiziert Artefakte aus den Projekten gemäß der Wiederverwendungskriterien und Ziele des Engineers.
  - Er unterstützt das Projekt-Team auf Anfrage beim Retrieval sowie der Modifikation des Erfahrungswissens.
- **Engineer**
  - Der Engineer ist verantwortlich für **Verpacken und Analysieren existierender Erfahrungen**.
  - Zusammen mit dem Manager identifiziert er neue **Wiederverwendungskriterien** und akquiriert darauf basierend **neue Fälle**.
  - Er analysiert die Fallbasis, um (weiteres) **Verbesserungspotential** zu entdecken.
- **Librarian**
  - Der Librarian ist verantwortlich für **technische Aufgaben** wie Aufbau und Wartung der Fallbasis.
  - Er speichert und publiziert neue Fälle.



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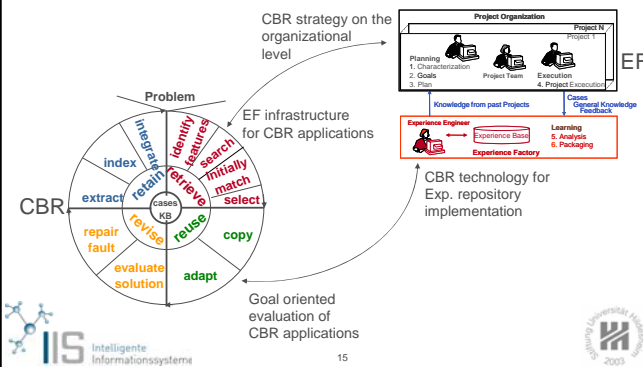
## Benefit

- Development method **DISER** generalizes from **Case-Based Reasoning Systems to Experience based Information Systems (EbISs)**
  - EbISs are information systems containing experiences
  - An EbIS has to handle a (more or less) **continuous „stream of experience“**.
- DISER explicitly considers that an experience base information system is embedded into a "lived" process
  - Here DISER goes beyond other methods for CBR system development/maintenance (e.g., Inreca [Bergmann et al. 2003]).
  - Such approaches strictly stay within the "CBR domain":
    - They do not open up for other AI technologies, and
    - They do not explicitly consider the task of embedding the developed software system into the respective business processes (e.g., maintenance approaches remain on technical level only).
    - DISER treats this business process with much more precision than these other CBR system development methods do

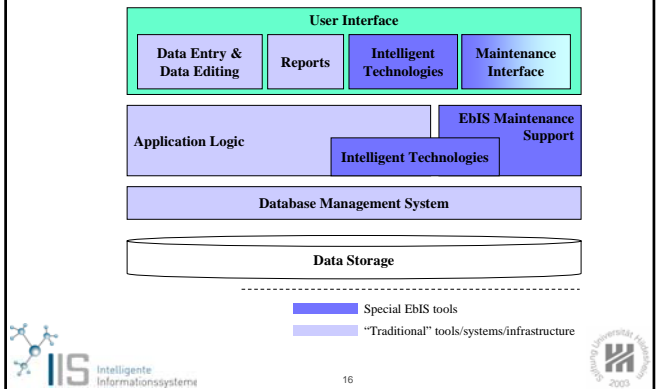
## Benefit

- DISER includes a goal-oriented evaluation approach:
  - a variant of the goal-question-metric GQM approach for knowledge bases
  - in contrast to other CBR approaches that mainly use classification accuracy oriented evaluation approaches from machine learning
- Having a concrete reference technology clarifies the semantics of the method
  - DISER helps systematizing software knowledge reuse approaches
  - DISER helps relating the SE/EF, AI/CBR, and the KM/EM communities
- German CBR and knowledge management communities merged and started the international Experience Management Workshop series in 2001
- Learning Software Organization international workshop series started in 1999

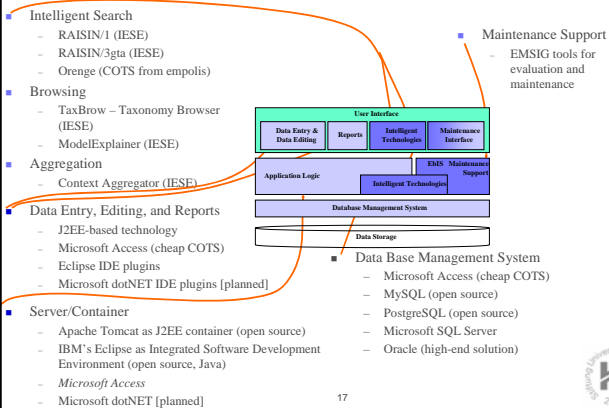
## Experience Factory & Case-Based Reasoning



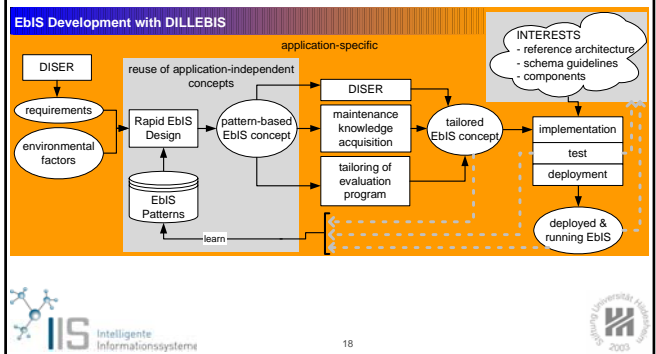
## EbIS-Product-Line Architecture



## Components of EbIS Product-Line

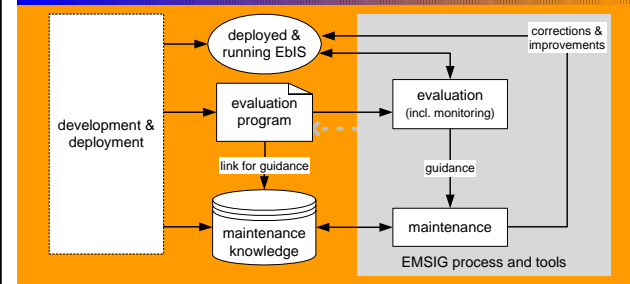


## EbIS Development Process



## Running an EbIS

### Running an EbIS with DILLEBIS



## Benefit - Applicability within Projects

- **Broad applicability of EbIS method/tool** := Occurrence in successful EbISs in real-world projects
  - EbISs of different size and project type (→ "breadth")
  - EbIS successful
    - Status „accepted“ (usage  $\geq$  1 year) OR
    - Status „deployable“ and EbIS tightly integrated
      - **Assumption** for tight integration: Acceptance and correct usage of the tool that supports the business process

Status	#	Size of EbIS (#User, #Cases)		
		Small	Medium	Large
Successful	8	SKe-Pilot, ISI, SLI-EB, IPQM, KM-PEB, CBR-PEB	indiGo/ColN	ESERNET
Implementation	1			T-Com SR
Status unknown	1		Project A	
#successful	6		1	1(+1)

## Action

- Research agenda on
  - Realizing software product-lines as EF
  - Synthesizing the knowledge focus of software product-lines from multiagent systems
  - Realizing intelligent agents as CBR systems
  - Embedding each CBR system agent in an EF
  - Operationalizing the EF roles via software agents
  - Using machine learning and systematic evaluation and maintenance activities for improving the case base/experience base

## Outlook

- Software platform (tool) for integrating workflow support, different inference schemes, and an agent framework
- Multiagent system based simulation of the company launching process
- Book project
  - "How to Support Experience Management with Evaluation - Foundations, Evaluation Methods, and Examples for Case-Based Reasoning and Experience Factory"
- GI Workshop Days **LWA 2006** (Learning, Knowledge, Adaptivity) will take in place in Hildesheim in October 2006, organized by IIS
- **Dagstuhl Symposium** on „Critical Assessment of CBR Research“ in 2007 (planned), co-organized by IIS
- 9<sup>th</sup> European Conference on Case-Based Reasoning (**ECCBR 2008**) in Germany (Trier), co-organized by IIS