KI 2012 Tutorial: Designing Ambient Intelligence Environments

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KI, September 24-27, 2012, Saarbrücken, Germany
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Who we are?

Chair in Information and Service Systems (ISS) at Saarland University, Saarbrücken, Germany

- Wolfgang Maass → full professor and chair in Information and Service Systems (ISS)
- Sabine Janzen → research assistant and PhD candidate at chair in Information and Service Systems (ISS)

Research focus: intelligent information systems that lead to adaptive real-world environments, called Ubiquitous Information Systems (UIS)
What's the Tutorial about?

MemTable (Patie Maes, MIT Media Lab)

Intelligent Cheese Counter (Antonio Krüger, Innovative Retail Lab at DFKI)

FlirtBar (Patrick Olivier, Culture Lab at Newcastle University)

Pillow Talk (Patie Maes, MIT Media Lab)

Aware Home (Gregory Abowd, Georgia Tech)
What's the Tutorial about?

Copyright: Corning, Video "A day made of glass2"
• **Highly volatile** environments developed by experts from different domains

• **Objective of this tutorial:** Getting familiar with **methodical approaches** for development of Ambient Intelligence environments
Agenda

1. Welcome and opening remarks by organizers  
   
2. Challenges in designing Ambient Intelligence Environments (AIE)  
   15 min

3. Design methods for AIE
   15 min

4. Design your AIE (hands-on)
   a. Getting in touch with diverse types of design knowledge
   b. Translating design knowledge
   app. 2 hours

5. Discussion  
   15 min
An AIE is an AIE is an ...

- Information systems can be conceived as compounds of social systems, information spheres, and service systems that use information technology infrastructures for realization of desired situations (Lamb & Kling, 2003; Lechner & Schmid, 2001; Orlikowski, & Barley, 2001)

- AIE does not exclusively depend on technical issues → aspects concerning users, social interactions, physical surroundings

  AIE must be understood “in the context of communication and the larger network of equipment and practices in which it is situated.” (Winograd & Flores, 1986, pp. 5)

- Unpredictable regarding suddenly occurring events and entities in the physical space
• In extension to information systems → AIE need means for representing physical entities

• Abstract Information System Model (AISM) → four conceptual classes that characterize key conceptual entities of AIE

① **Social system** = set of roles available with a set of attributes, such as rights, obligations, and prohibitions etc.

② **Information sphere** = set of information objects used within the realm of an AIE

③ **Service system** = set of all digital and physical services available within all situations in which an AIE can be used

④ **Physical object system** = set of physical entities available within all situations in which an AIE can be used
Challenges in Designing AIE

• “What is an AIE?” → different answers from experts involved in the design process - developers, knowledge engineers, sales persons, managers (Winograd & Flores, 1986)

• Challenge: **translation of their implicit understandings** of the intended AIE into explicit assumptions understandable for the whole design team
Factors for Failure

- Factors for failure of information system (IS) projects (Geneca 2011 - 600 U.S. business and IT executives and practitioners)
  - < 50% of requirements are captured in business-relevant IS projects
  - < 20% describe the requirements process as the articulation of business needs
  - 43% think that there is often confusion around what business stakeholders are asking for
  - 46% frustrates most: getting business to clearly state and commit to project objectives
  - 75% think that projects are usually “doomed” from their onset (goals, roles, or accountability)

“I’d like a set of stairs that leads up to a bridge.”
Factors for Failure

- Practical projects typically show
  - Poor quality of requirements
  - Misunderstandings between members of an IS design team
  - Insufficient communication between team members
  - Fuzzy business objectives
Challenges in Designing AIE

- Research on risks in information system development projects
  - Especially in complex IT projects as represented within AIE scope → (1) capturing requirements, and (2) problems in expressing and managing knowledge between members of design team are considered as main reasons for failing projects (Schmidt et al., 2001)
  
  - Out of the top ten of project risks → five are related to expressing and managing knowledge between members of a design team (Schmidt et al., 2011)
  
  - Completeness and accuracy of design knowledge communicated between members of design team = central influence factor for success of AIE project (Larsen & Naumann, 1992)

Shared understanding in design teams is one of the most pressing issues for predictable and successful information systems (IS) projects.
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Design Methods for AIE

• How to sail round these traps when designing AIE?

• Which design method represents a sufficient approach for developing this innovative class of Artificial Intelligence systems?
Design methods used in Artificial Intelligence

- pure technical and implementation-driven approaches without focusing on system requirements or specific design knowledge (Russell & Norvig, 1995; Negnetvitsky, 2005)

Design methods used in HCI

- User-Centered Design (UCD) methodology, Participatory Design and also “wild-west” design amongst others
- User-Centered Design (UCD) methodology = multi-staged problem solving process that tries to optimize intended system regarding users can, want, or need to use it
  - Four phases are specified around multidisciplinary teams: (1) analysis phase, (2) design phase, (3) implementation phase, and (4) deployment phase
  - no description regarding the character of design knowledge that is documented in each phase or how it is translated from one phase to another, e.g., the translation of documented user scenarios of the analysis phase into user performance requirements (UPA, 2000)
• **Participatory Design** extends UCD approach by implying active involvement of people to design for as well as other stakeholders in design work with stronger focus on users (Brandt, 2006) ! Participatory Design makes no statement concerning the design knowledge developed during design process

**Design methods used in Software Engineering**

• Waterfall Model, Spiral Model, iterative models, agile development methods

  ! **Waterfall and Spiral model** neither (1) specify translation of design knowledge from requirements specification to software design phase nor (2) defines form of design knowledge that have to be documented in all phases (Royce, 1987; Boehm, 1988)

  ! Interdisciplinary teams \(\rightarrow\) waterfall approach simplifies: “To give the contractor **free rein** between requirement definition and operation is **inviting trouble.**” (Royce, 1987, p. 335)
Design methods used in Software Engineering

• **Iterative development methods**, e.g., Rational Unified Process → development of **initially small but even-larger portions of software** in iterative cycles
  - do not give hints concerning form of design knowledge generated and translated during whole process (Larman & Basili, 2003)

• **Agile development processes**, e.g. SCRUM method → iterative approach but more people-centric viewpoint
  - SCRUM = framework that helps developers to address complex adaptive problems (Schwaber & Sutherland, 2011)
  - Transparency concerning **common understanding in team**: “A common language referring to the process must be shared by all participants.” (Schwaber & Sutherland, 2011, p. 4) → but SCRUM teams cover a principal, a project manager and the development team → not interdisciplinary from the tutorials point of view
  - SCRUM does not specify analysis or design phase, but focuses on implementation based on predefined and also evolving system requirements
• **Improper focus** of traditional software engineering and HCI development → designing AIE requires consideration of handling of design knowledge within interdisciplinary teams and design of physical environments (Yoo, 2010)

**Objectives:**

• Understanding *AIE development process as a knowledge transformation system* (Patnayakuni et al., 2006)

• Design process concludes when design **knowledge** is **transformed into representations** that can be **directly realized** by appropriate matter, i.e. metal, software, humans, etc.

**Research Focus:**

Knowledge translation processes of individual understanding into explicit conceptual models during innovative AIE development projects
Justified Design

• **Evaluation** $E_i$: consistency, compatibility, business fit, functional fit, and technology fit.

• **Translation** $T_i$ allow derivation of an artifact $A_j$ represented in a language $M$ from an individual or set of artifacts.

• **Feedback** $F_i$ to previous artifacts, in particular, backward-compatibilities

An individual designer mentally conceives implicit artifacts while explicit artifacts are based on semantics that are shared in a community and expressed by syntactical structures that are used by a community.
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Design your AIE!

→ Design an AIE for “Birds of a Feather (BoF)”-sessions at KI 2012
  → Opportunities for working together on a specific topic
  → Getting to know members of BoF
  → Storing and distributing results

What means BoF?

• Informal discussion group, formed in an ad-hoc manner
• BoF session = informal meeting at conferences, where attendees group together based on a shared interest and carry out discussions without any pre-planned agenda
• BoFs can facilitate networking and partnership formation among subgroups, including functionally oriented groups or geographically oriented groups
• BoFs allow more audience interaction than panel discussions, but discussions are not completely unguided → discussion leader

(wikipedia.org)
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Summary

• Incremental design of innovative information systems, such as an AIE

• Justified design decisions

• Three translations of design knowledge

• Formal conceptual models tend to become part of computational design knowledge

• Pattern-based conceptual modeling languages improve modeling quality

• Maass, W., Kowatsch, T., Janzen, S., Filler, A. Applying Situation-Service Fit to Physical Environments Enhanced by Ubiquitous Information Systems, 20th European Conf. on Information Systems (ECIS 2012), Barcelona, Spain, 2012.

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