Human Centered Design and Evaluation (IP2 of IM2 Phase 3)

D. Lalanne[1], A. Popescu-Belis[2], P. Dillenbourg[3], J. Sauer[1]

[1]University of Fribourg, [2]Idiap, [3]EPFL

September 13th, 2010
Summer Institute, Gstaad

FNSNF
Fonds national suisse
Schweizerischer Nationalfonds
Fondo nazionale svizzero
Swiss National Science Foundation

IM Interactive Multimodal Information Management

Objectives of IP2

Overall goal:

- Generalize and validate the technologies developed through research in phases I & II of IM2
- Provide feedback and guidance to research in IP1

Means:

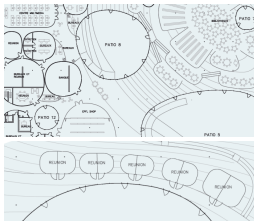
1. Develop new lightweight applications, mainly oriented towards teamwork spaces and learning
   - Augmented Teams
   - The CBoard
2. Formal user-centered evaluation of new applications and IM2 multimodal technologies

New competencies for IM2 Phase 3

- Complete user-centered design approach
  - Take into consideration full usability engineering lifecycle
  - Including “mid-tech” prototyping, closer to the applications
- Novel user evaluation methodologies
  - Field observations
    - Distributed cognition and CSCL (*P. Dillenbourg*)
  - Usability studies
    - Cognitive ergonomics (*J. Sauer*)

Context

- EPFL Rolex Learning Center
  - Bubbles: 10 closed spaces, 4-6 people doing teamwork
  - Open spaces for ~800 students doing individual work



- Evaluation
  - Real-world operational context: EPFL RLC and other sites
  - Laboratory context: UniFr Cognitive Ergonomics

The Communication Board (CBoard)

Denis Lalanne, Juergen Sauer
University of Fribourg

September 13th, 2010
Summer Institute, Gstaad

FNSNF
Fonds national suisse
Schweizerischer Nationalfonds
Fondo nazionale svizzero
Swiss National Science Foundation

IM INTERACTIVE MULTIMODAL INFORMATION MANAGEMENT

The Cboard application

- Aim: design and implement a large interactive display surface to encourage communication and collaboration in semi-public settings such as within companies or educational institutions
- Characteristics
  - Big screen
    - A lot of information represented
    - Information represented large-scaled
  - Interaction of multiple users

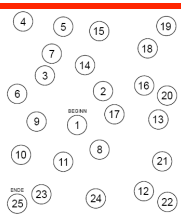
Cboard evaluation (by Cognitive Ergonomics group)

- Participants
  - 40 ad-hoc groups of 3 students
- Independent variables
  - Cboard vs. Paper&pencil (between measure)
  - Task complexity (within measure)
- Dependant variables
  - Group performance measures
  - Satisfaction (team climate inventory, Anderson & West,1996)

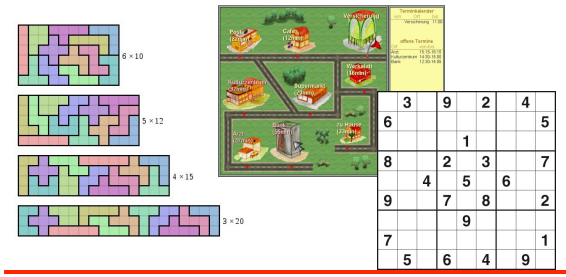
Cognitive tasks

Tasks

1. Sensori-motor task (connecting dots)
2. Spatial reasoning (placing jigsaw pieces into a figure)
3. Coordination & planning (planning a day)



(Oswald & Roth, 1978)



(Tewes, 1991)

Cboard - experiment

Participants: 40 ad-hoc groups of 3 students

Outcome measures

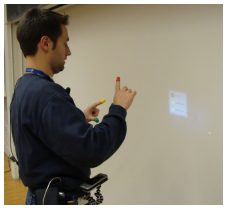
- Group performance (task completion time, etc.)
- Frequency of interaction with system
- Team satisfaction
- Subjective evaluation of team performance

⇒ The findings suggest that the use of the CBoard is beneficial for collaborative group work

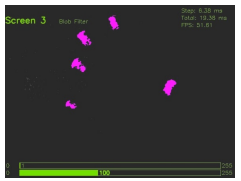
⇒ The next experiment will build on this work by examining more closely communication patterns between group members that influence group performance and satisfaction.

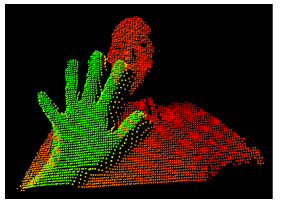
Example of Integration of IP1 results

- Development of a recognizer for an economic gestural HCI (IP1)
  - Precise & effortless
- Requirements and Evaluation (IP2)



PyGmI

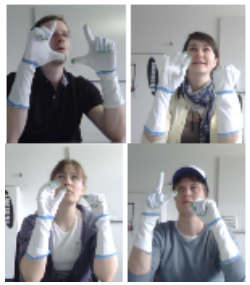




SwissRanger 4000 of Mesa Imaging

WoZ of Gestures (DIVA & Cognitive ergonomics groups)

- Aim: Study 2 sets of gestures with regard to the comprehensiveness, comfort and learnability
- 12 test participants (6 male, 6 female)
- 2 conditions: standing vs sitting
- Different tasks (e.g. moving the focus of a map of GoogleEarth from Europe to Australia).
- Performance data (completion time, error rates) + usability questionnaire ISONORM 9241/10



- Results indicated:
  - Very high usability ratings
  - Performance measures do not differ between the two conditions
  - Users mentioned the risk of fatigue after long duration (standing)

CBoard – Chosen application

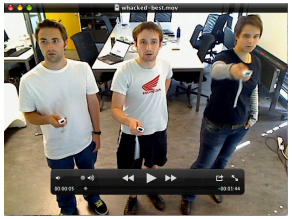
- Multi User Mindmap
- Textual, audio, video, image can be used to input and store information
- Can be used:
  - In collocation
  - Remotely
  - Asynchronously
- Using various input modes:
  - Gesture, voice, 3D devices (wii), phones, etc.

Cognitive ergonomics contribution

- Research questions:
  - Effects of hierarchy and control
  - Shared vs. Individual interaction possibility
  - Co-presence vs. remote-collaboration
  - Comparison with classical groupwork

- Envisioned research outcomes
  - Suggestions for improvement of IM2 technologies
  - Identification of suitable tasks and user groups for CBoard
  - Recommendation for the design of mediated teamwork
  - Identification of factors that may have an undue influence on usability test outcomes (e.g., low-fidelity prototypes)

IM2 technology helps user evaluations



- Use IM2 technology to facilitate teamwork analysis
- Simple statistics of features that can support teamwork analysis
  - Speech: Prosody, number of words per participants
  - Focus of attention
  - Body language, gestures: communicative or interactive (towards board)
  - Similar to meeting browser → Evaluation browser

Augmented Teams

Andrei Popescu-Belis, Idiap
Pierre Dillenbourg, EPFL

September 13th, 2010
Summer Institute, Gstaad

FNSNF
FONDS NATIONAL SUISSE
SCHWEIZERISCHER NATIONALFONDS
FONDO NAZIONALE SVIZZERO
SWISS NATIONAL SCIENCE FOUNDATION

IM INTERACTIVE MULTIMODAL INFORMATION MANAGEMENT

New domain and context

- Educational environment
  - support teamwork in a learning context: EPFL/RLC
  - similarities and differences with business meetings
    - human interaction, but less goal-driven, no scenario
    - natural occurrences, potentially high use and high visibility
- EPFL Rolex Learning Center
  - Bubbles: 10 small spaces for 4-6 people / glass walls
  - activities: course exercises or revision, report writing, brainstorming, decision making for projects, etc.
  - constraints:
    - public space / cannot modify architecture / controlled access

Impression of Augmented Teams

Interactive table

Documents
(course material, websites, …)

Words
(or keywords, concepts, …)

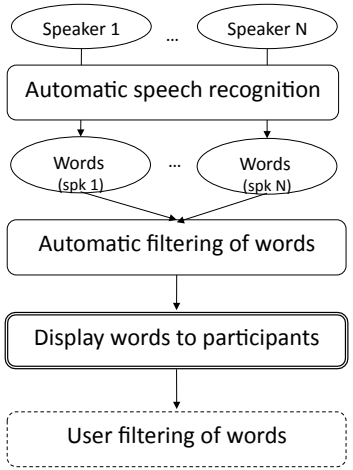
Current scenario of use

1. Words recognized in the discussion by automatic speech recognition (ASR) appear on the table
2. Participants can manipulate words: keep, move, organize e.g. to build a mind map, and indicate which words are important for search
3. At regular intervals, searches are triggered by the Content Linking device (ACLD), or can be done on demand
4. The repositories that are searched can be modified
   (e.g., the Web, Wikipedia, EPFL, course material)
5. Results are also projected on the table, where they can be consulted, organized, and stored

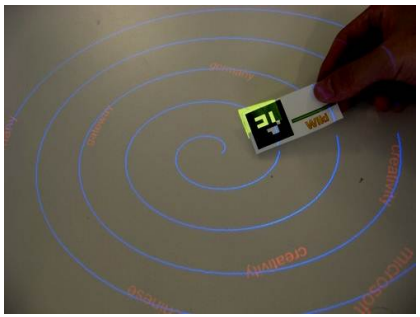
Architecture and requirements

1. Automatic speech recognition (ASR)
   - from Idiap, real-time speaker-independent system for English
   - requirements for use of far-field microphone
   - microphone array so that the speaker/zone is recognized
2. Automatic word filtering
3. User interface 1: view and manipulate words on the table
4. Document search and retrieval
   - use an evolved version of the ACLD
   - improve search thanks to semantic disambiguation
   - additional functionalities as needed
5. User interface 2: view and manipulate documents + control

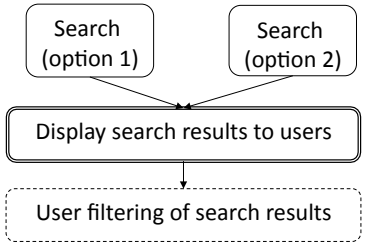
First stage: capture → UI1



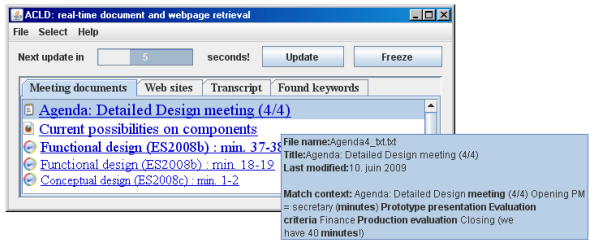
Current UI1 (Nan Li)



Second stage: words → UI2



Current UI2 (ACLD)



User interfaces and experiments

- PhD topic of Nan Li (CRAFT/EPFL)
  - started June 2010
  - *see poster presentation*
- Hardware
  - adapt the CRAFT TinkerTable lamp
  - video-projector above table
  - detection of gesture by a co-located camera
    - use of 2D tags in a first stage

IM2 technologies of potential use

- Core technologies: processing and infrastructure
  - automatic speech recognition + keyword detection
  - microphone arrays: beam forming, speaker localization, diarization
  - multimodal recognition of visual focus of attention
  - MMM media file server
  - Hub client/server architecture to integrate modules
  - technology for capture used in Smart Meeting Rooms
- Building-block applications (related to IM2.IP1)
  - Automatic Content Linking Device
    - just-in-time document and website retrieval based on speech
  - browsing interfaces: for media (MMM) and annotations
  - document/hand tracking on meeting table
  - multimedia retrieval using relevance feedback

Challenges and method

- Challenges in adapting IM2 technology to RLC Bubbles
  - robustness of capture / signal processing / content analysis
  - integration into room
  - start/stop procedure
  - reduced knowledge of interaction context
- Research method: series of *prototyping cycles*
  - design lightweight applications
  - test them with users in real contexts & formal experiments
  - enrich them afterwards with new functionalities
- How can IM2 technology improve teamwork?

Side contribution: user evaluation of the ACLD GUI

- As a precursor to the Augmented Teams system
  - evaluated in the Usability course at UniFr (A. Sonderegger)
- Method
  - 9 subjects watched an AMI/IM2 meeting using the ACLD
  - performed simple operations using the GUI, when instructed
- Measures and results
  - task completion time → average of 45-75 seconds per task
  - answers on Survey Usability Scale → *acceptable usability*
    - 68% score on 10 statements such as "I found the system easy to use"
  - free-form feedback → simplify menus and layout, do keyword highlighting is enough on transcript, high interest for meetings or course recordings.

Wrap Up

- 2 novel applications:
  - Communication Board
  - Augmented Teams
- Encourage researchers from IP1 to provide technologies to:
  - Improve applications
  - Help analyzing interaction sessions with applications