Multimodal Interaction for the Non-Desktop User

Technische Universität Darmstadt

Telecooperation

Prof. Dr. Max Mühlhäuser

CONTENT

- Introduction: Ubiquitous Computing, Telecooperation lab
- Layer 1: talk & touch (briefly)
- Layer 1: tangible interaction, focus: paper centric computing
- Layer 2: proactivity & context awareness
- Layer 2: device federation (1 slide)
- Layer 3: model driven interaction
- Layer 0: integration, sensing
- Summary

Motivation

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Non Desktop Users --- Ubiquitous Computing:

Mainframe Era:	PC Era:	UbiComp Era:
1:N	1:1	N:1

?: Major problems solved re. …:

1. … gadgets (devices)?
   don‘t worry – global ‚race‘
2. … interaction i.e.
   human centered …: NO
3. … integration i.e
   cooperation (‚systems‘): NO

Research Fields:

1. *Integration / Cooperation:*
   integration of (& synergy among) people, computers, things?
2. ***Interaction:***
   multimodal Uis, ease-of-use for beyond-desktop users & groups
3. *Protection:*
   privacy/trust/security in the face of UbiComp – protection by means of UbiComp

Research Fields → Project Areas

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Cooperation (Integration)

- **Peer-to-Peer Networks** (Adaptivity, Resilience, Code Mobility; Emergency Response, SocialTV)
- **Smart Environments** (Middleware & Tools, Context&Location, Internet-of-Services)
- **Ambient Learning & Knowledge Work** (Digital Lecture Halls, Global Team Work, Algorithm Visualization)

Interaction

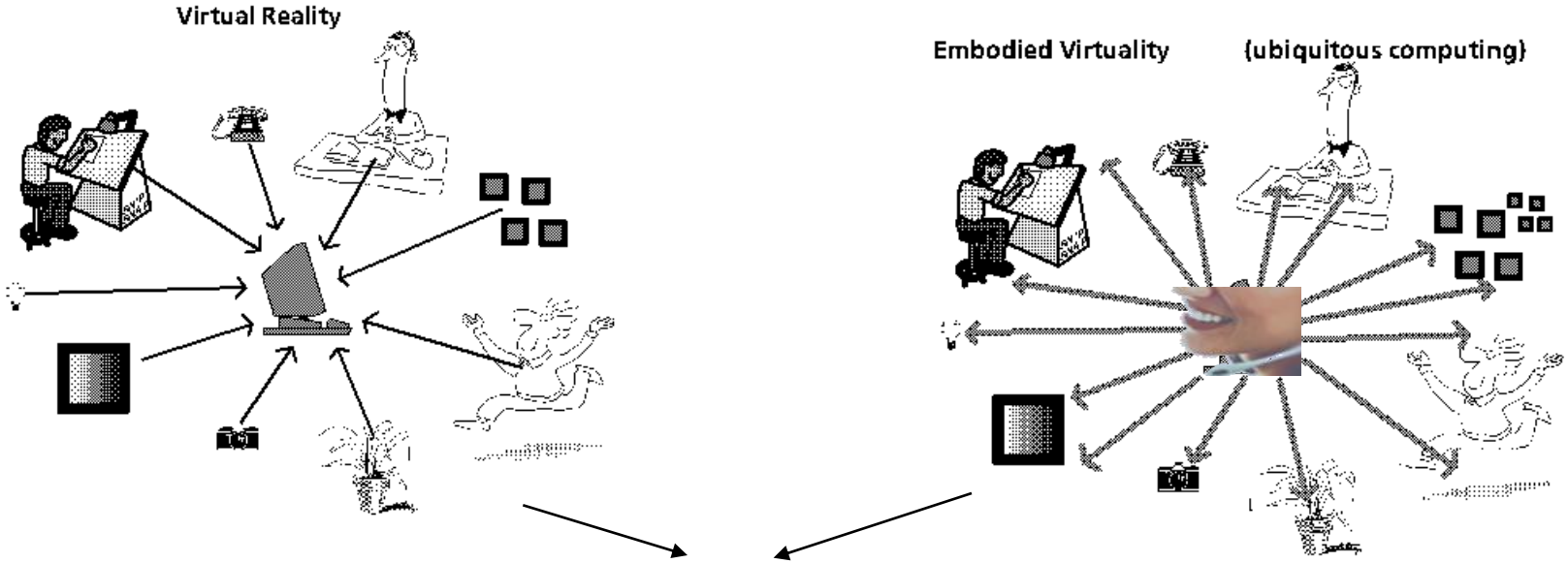
- **Smart Interaction** (proactive federated interaction w/ smart products & processes)
- **Model Driven Interaction Design** (…for multimodal UIs)
- **Talk'n'Touch Interaction** (voice centric & multi touch Uis; ‚Knowledge-Venue')
- **Tangible Interaction** (paper & pen UIs, hybrid interaction)
- **Media&Sensor Interaction** (sensor assisted & non-linear AV interaction; activity modeling)

Protection

- **Security in UbiComp** (ID-proof pseudonyms, trusted mobile devices as secure key to UbiComp)
- **Trust & Privacy Models** (trusted compu-ting for Internet of Services)
- **Public Security** (command center interaction & cooperation, roll-out incident sensors & infrastructures)

No UbiComp w/o Mark Weiser ☺

- Virtual reality: world → computer
- Embodied virtuality: computer → world – room for *human* @ center



note: both views reconciled today, „digital and physical worlds merge“

“The Human in The Center” – How?

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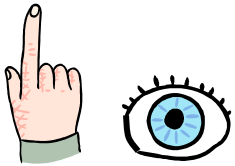
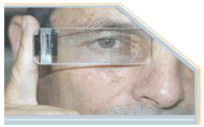
- Keyboard & Screen?

… in cell phone size???

hands&eyes-devices for *mouth&ears*-function!





tangible vs. wearable

Ubiquitous Computing: Interaktion

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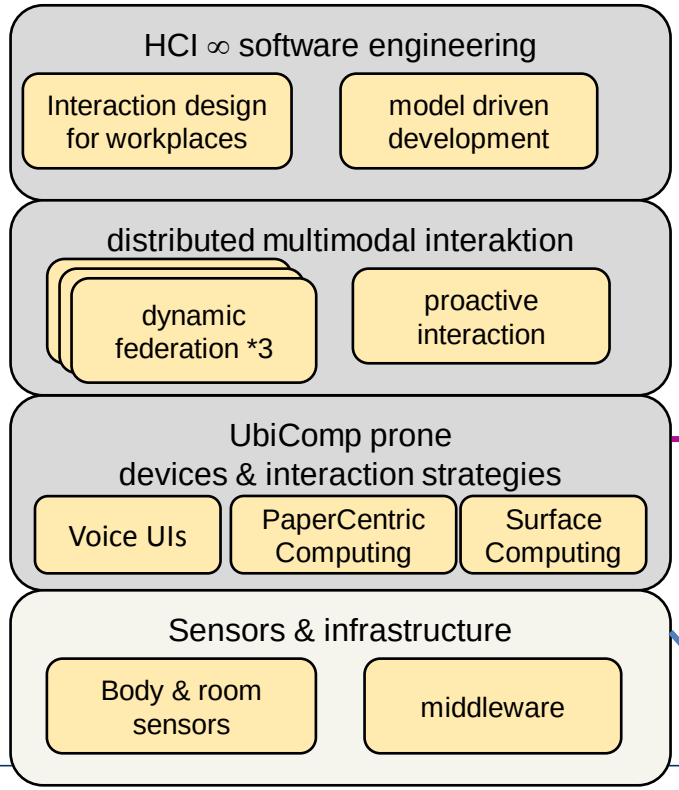
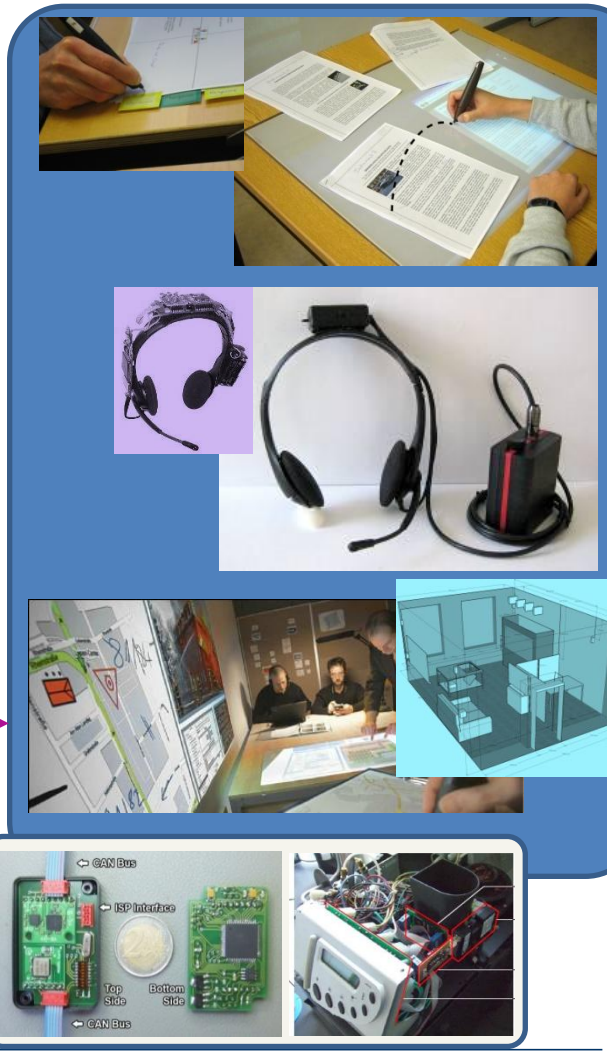
- 1st time in Computer Science history: *no* dominating interaction paradigm!
- 3 “Layers”:
  - ‘abstract interaction’ (SW Engineering) model driven // related to work place & primary task
  - ‘better’ interaction: context aware, proactive, federated, ‘natural’
  - new interaction styles: paper centric, tangible, tabletop, voice, …





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Voice UIs: Past Research @ TK
(In Essence: Everything ‚Beyond Recognition‘)

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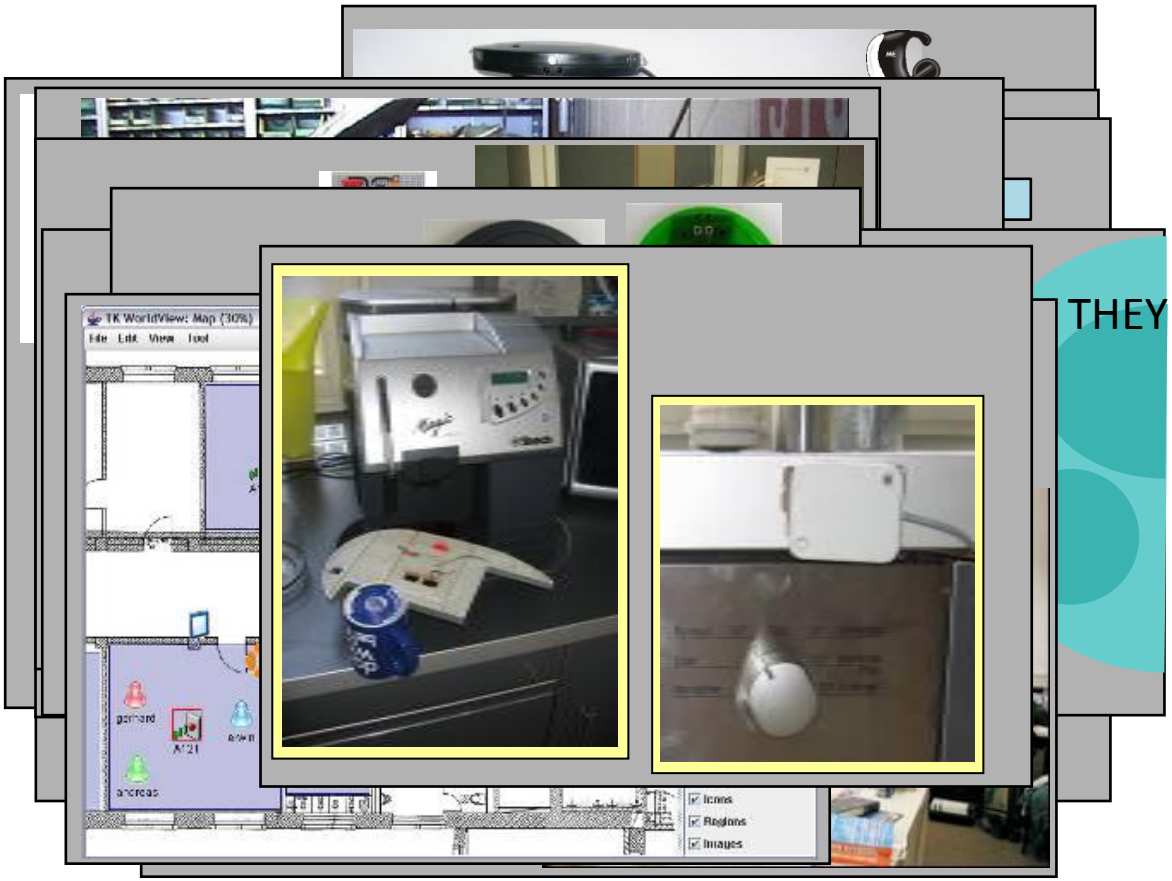
- Talking Assistant: voice centric wearable w/ context & ID mgmt.
- voice to its full potential:
  - STAIRS Audio Web/Doc browser
  - mixed initiative: patterns
  - task switching / recovery
- domain appropriation: e.g., 3 x automotive
- federation: secure adhoc
- security/trust: cf. ‘ME’
- location awareness: multiple sys. (ctx server)
- attention awareness: orientation, smart env.
- … in smart environment pub/sub integration
- … in smart environment w/ smart products



Voice UIs: Current Research @ TK

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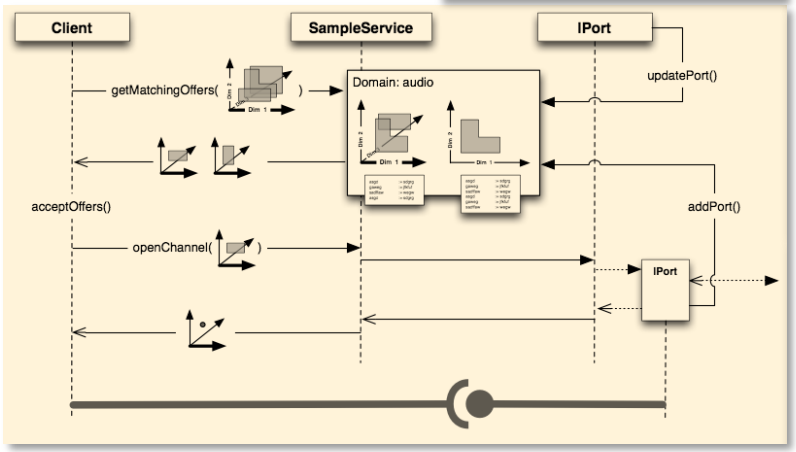
- Focus 1: interacting with smart *environments*
  - Basis: Mundo Speech API → *dynamic* voice channels
  - Experience (evaluation): „voice I/O indeed helpful, …“
  - Requirements („, …but:“)
    1. heterogeneous devices → homogeneous UI
    2. context awareness crucial
    3. user awareness crucial
       - in face of multi-speaker situations
       - in face of human-human talking
    4. device awareness crucial
       - in face of heterogeneous voiceTech
         - mike arrays: recognition? headsets: usability?



- Focus 2: federation w/ other modalities
  - currently emphasizing multitouch

WIMP for wall-size touchscreens

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Advantages of large (touch)screens

➔generally improved productivity

➔improved spatial orientation

➔allow multi user/collaborative interaction

Challenges:

- Multi-user interaction:
  Exploit the potential of collaborative interaction
- Distal access:
  Easier access to remote locations/objects on the screen
- Workspace management:
  Adapt to the potentially larger number of active items/windows and increased screen real estate

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Paper Centric Computing

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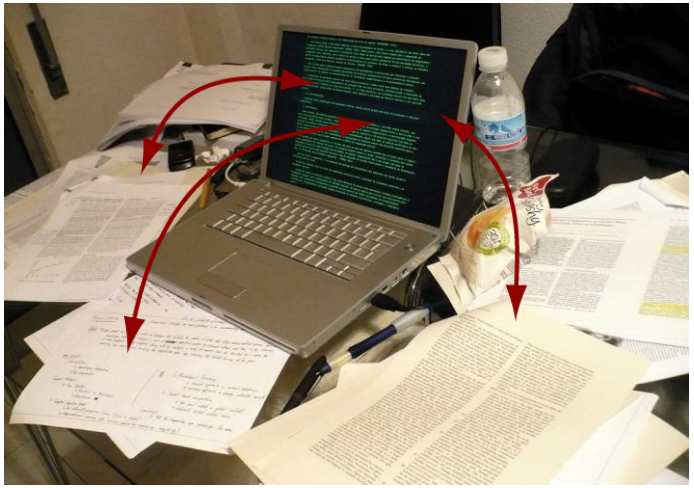
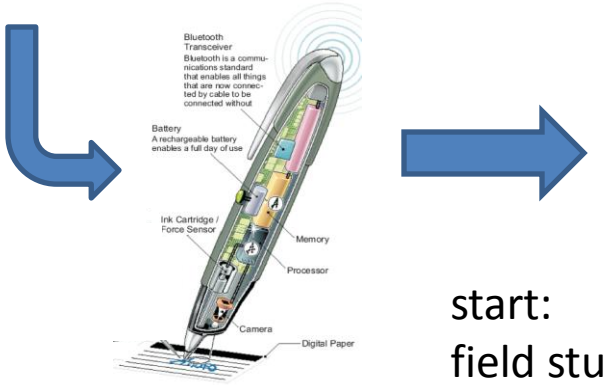
Paper remains ‚ubiquitous'

for knowledge work





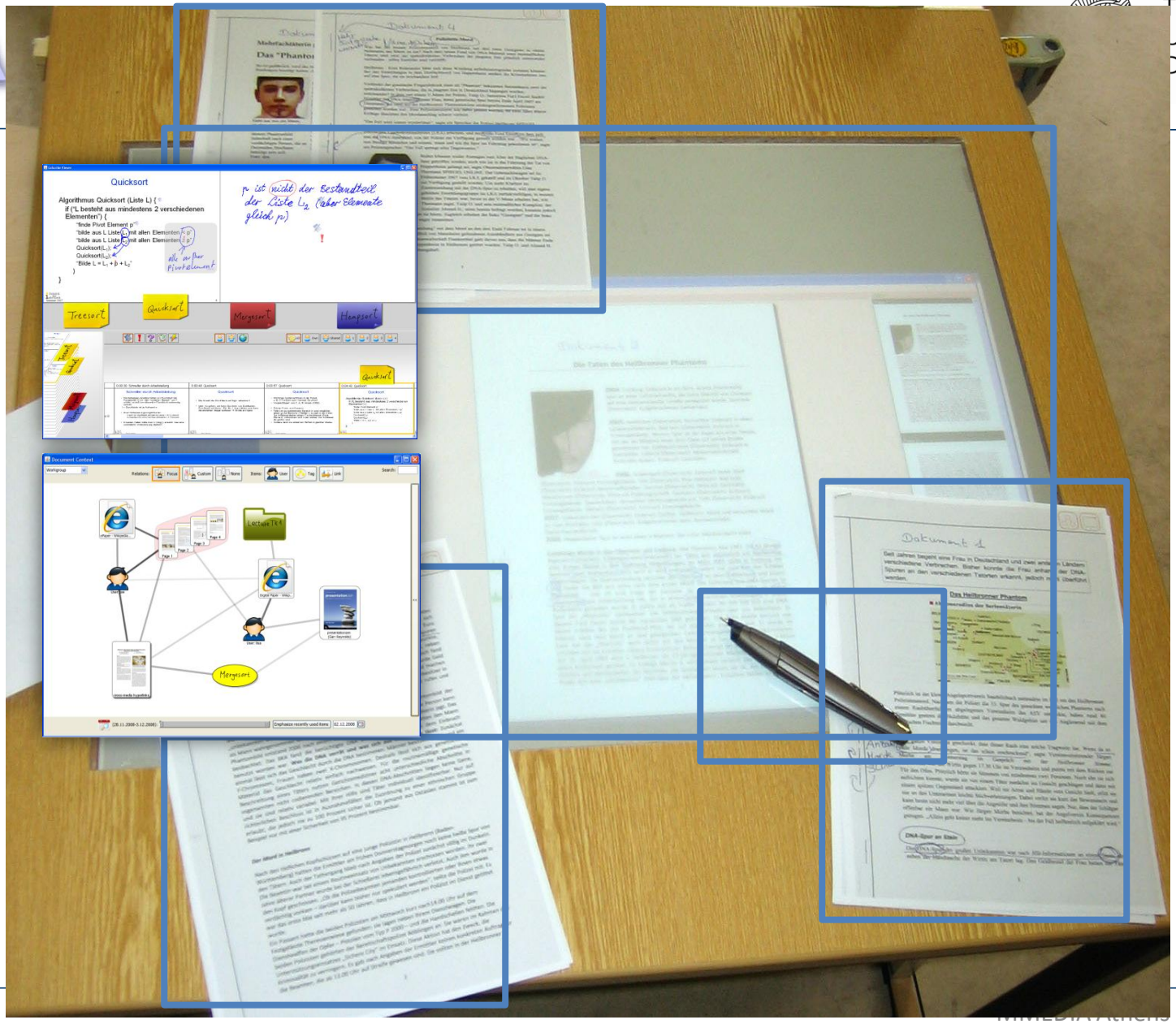
start:
field studies

hybrid document space
⇒unified interaction

many established practices
⇒reliable, manifold, simple, interaction

diverse actions
⇒adaptability (despite paper)

document centric collaboration
⇒support for doc centric collab
⇒overall:
information ecology
- *not* trad. UI work


Quicksort
Algorithmus Quicksort (Liste L) {
if ("L besteht aus mindestens 2 verschiedenen Elementen") {
"finde Pivot Element p"
"bilde aus L Liste L1 mit allen Elementen < p"
"bilde aus L Liste L2 mit allen Elementen > p"
Quicksort(L1);
Quicksort(L2);
"Bilde L = L1 + p + L2"
}
}
p ist (nicht) der Bestandteil der Liste L2 (aber Elemente gleich p)
Treesort
Quicksort
Mergesort
Heapsort
Mergesort

unified interaction

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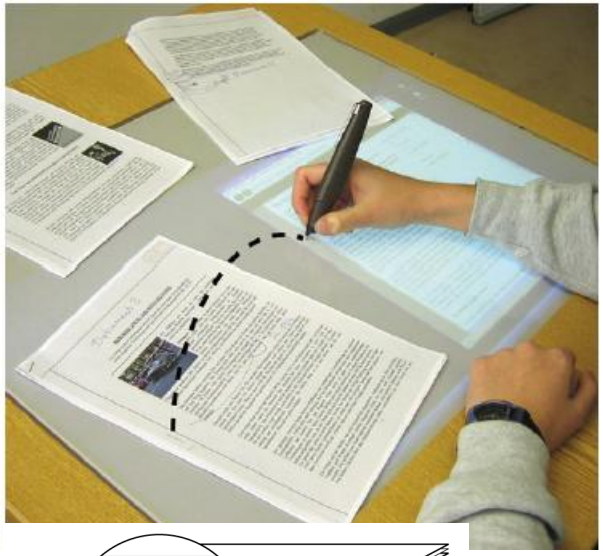
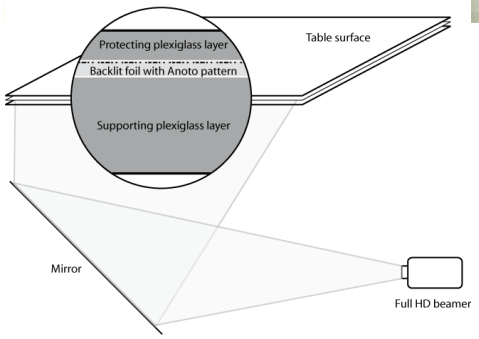
One Pen for …

Paper

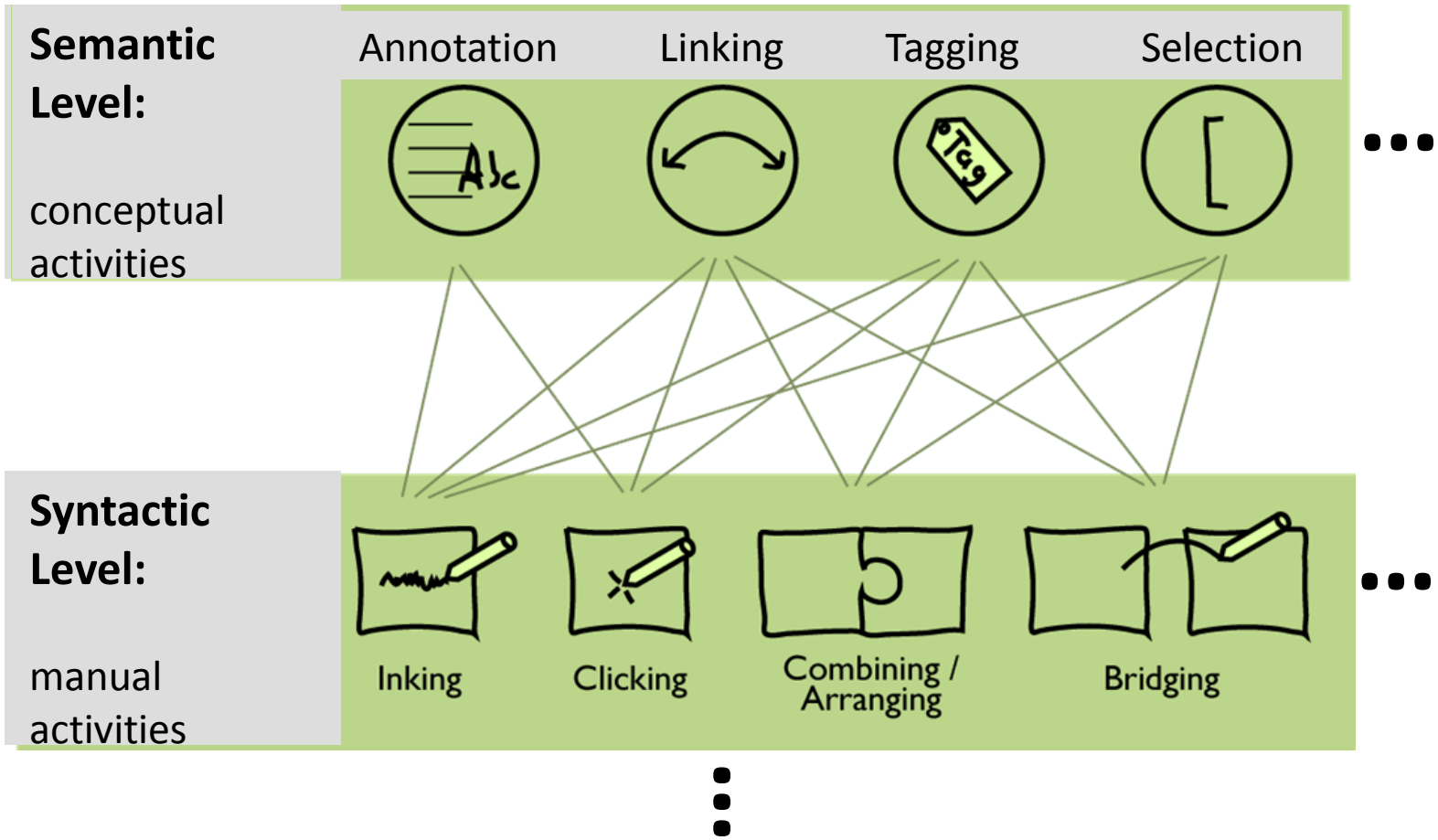
tabletop display

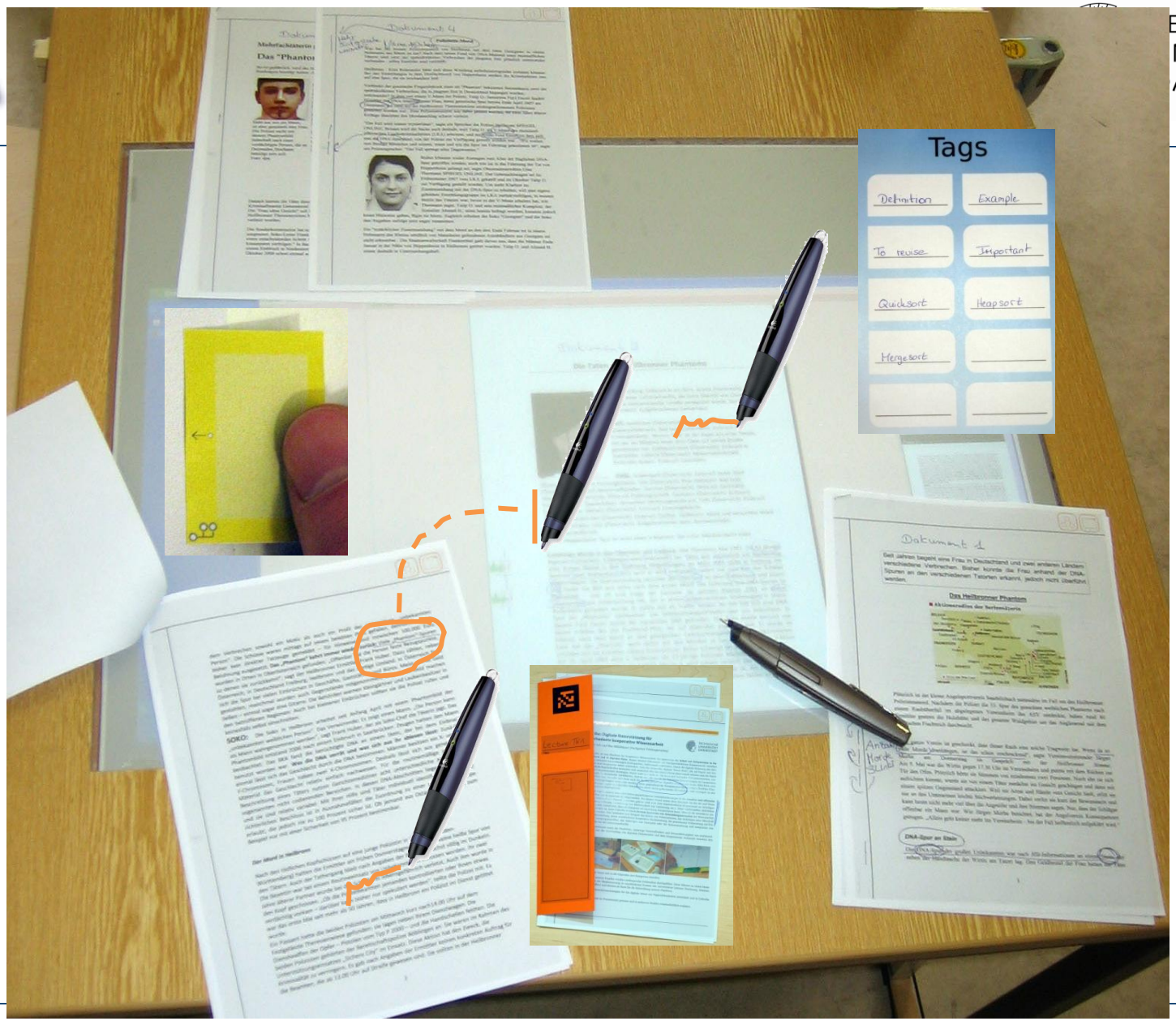
paper + display





simple … manifold interaction



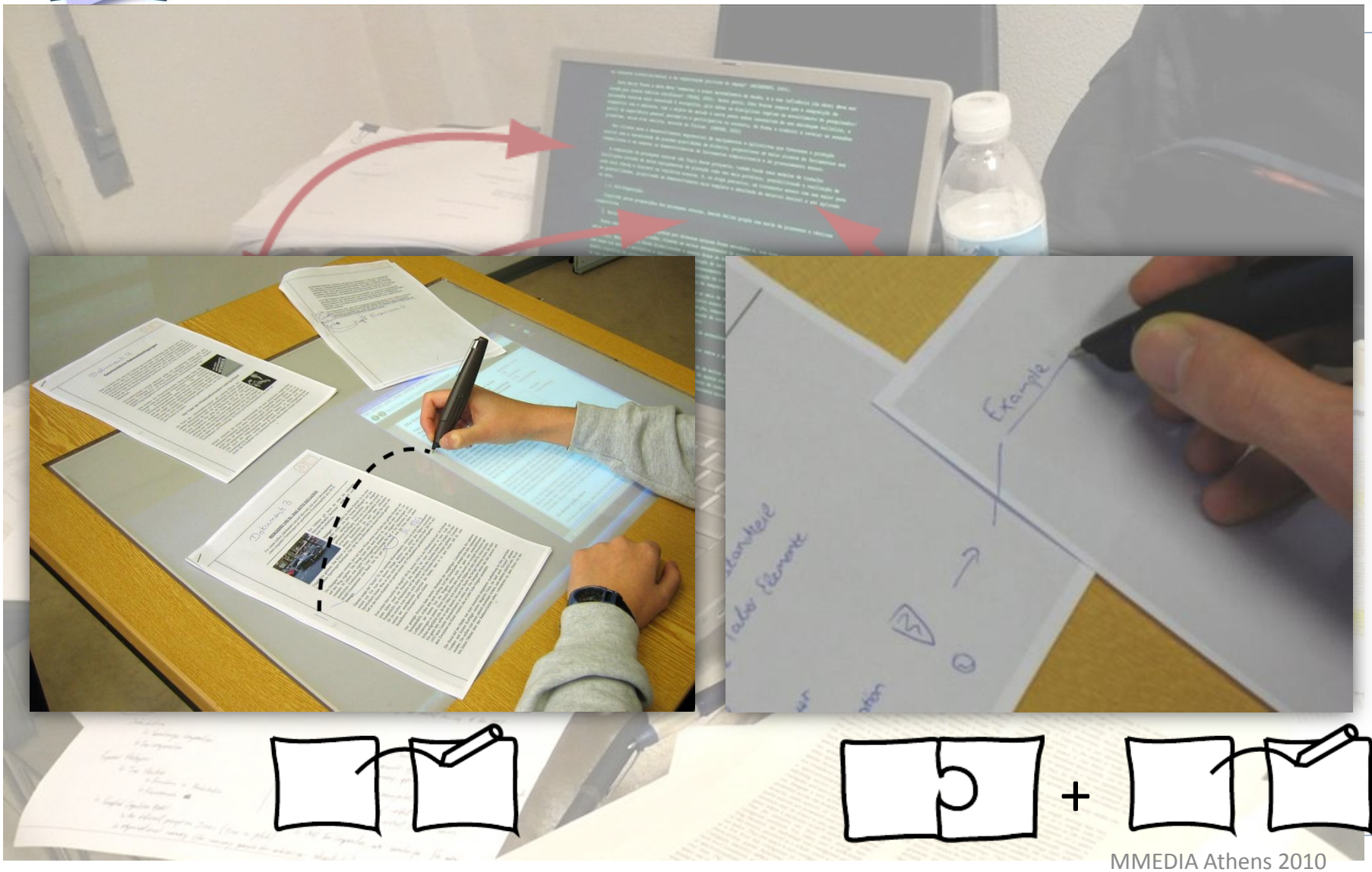


annotation

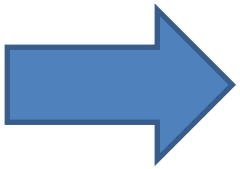
linking

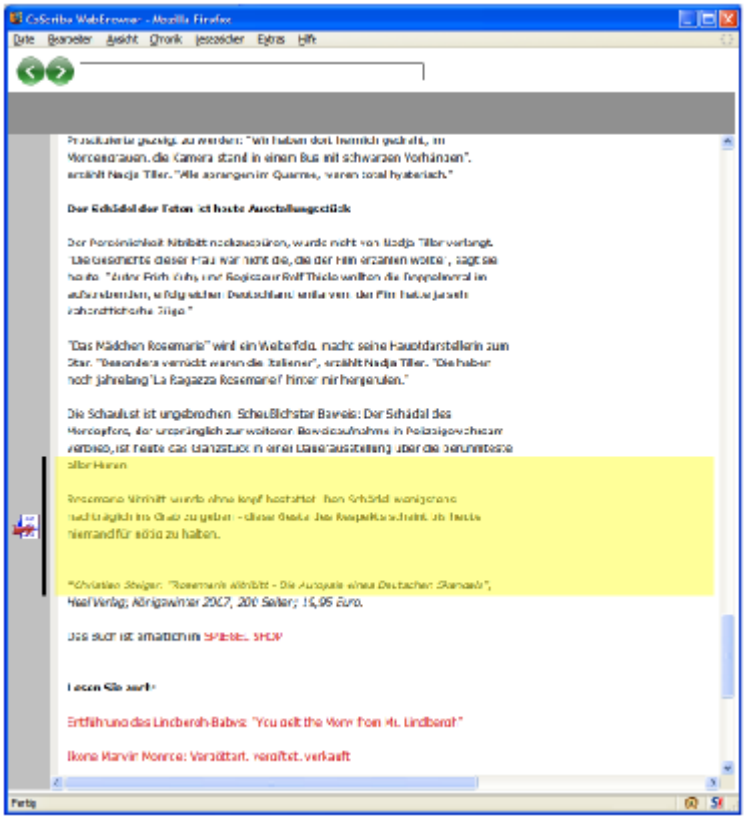
tagging

cross media hyperlinks



cross media hyperlinks





cross media hyperlinks

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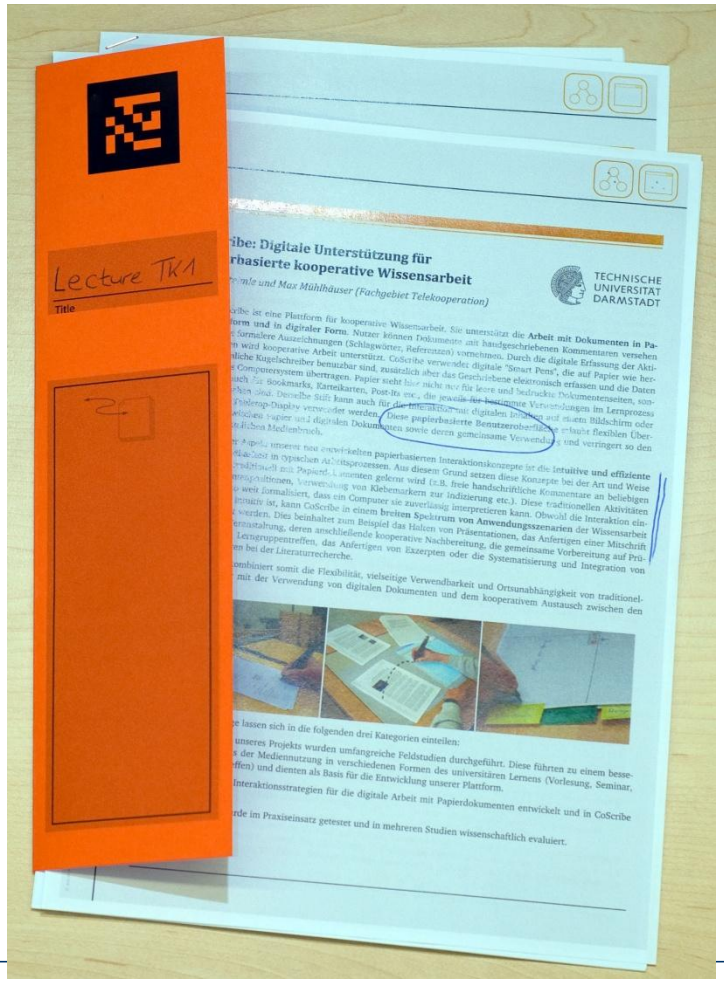
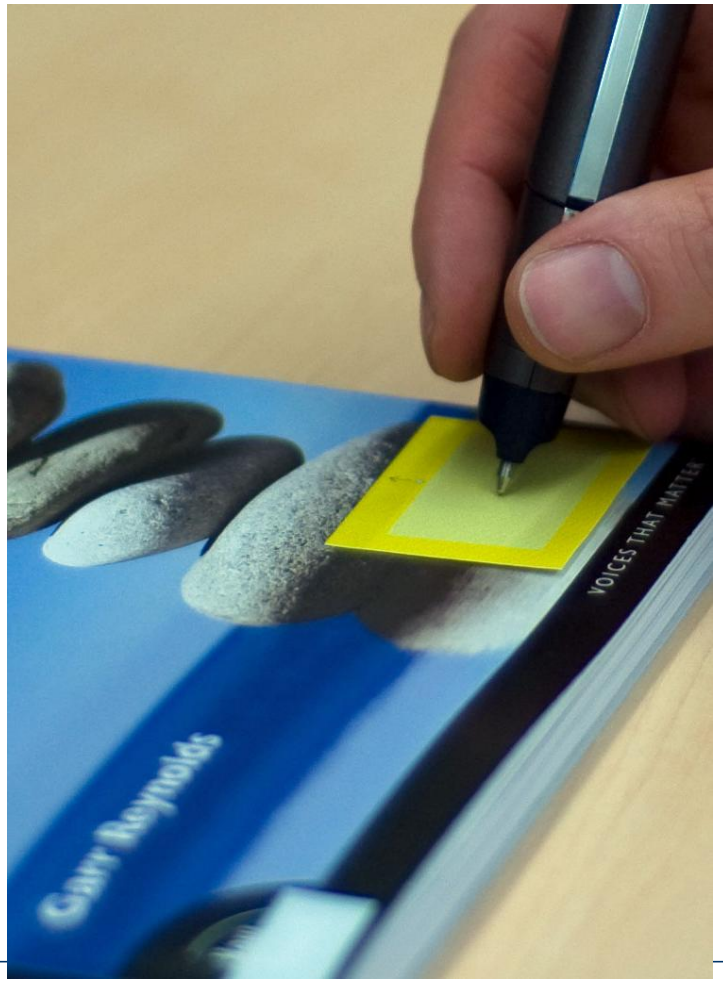
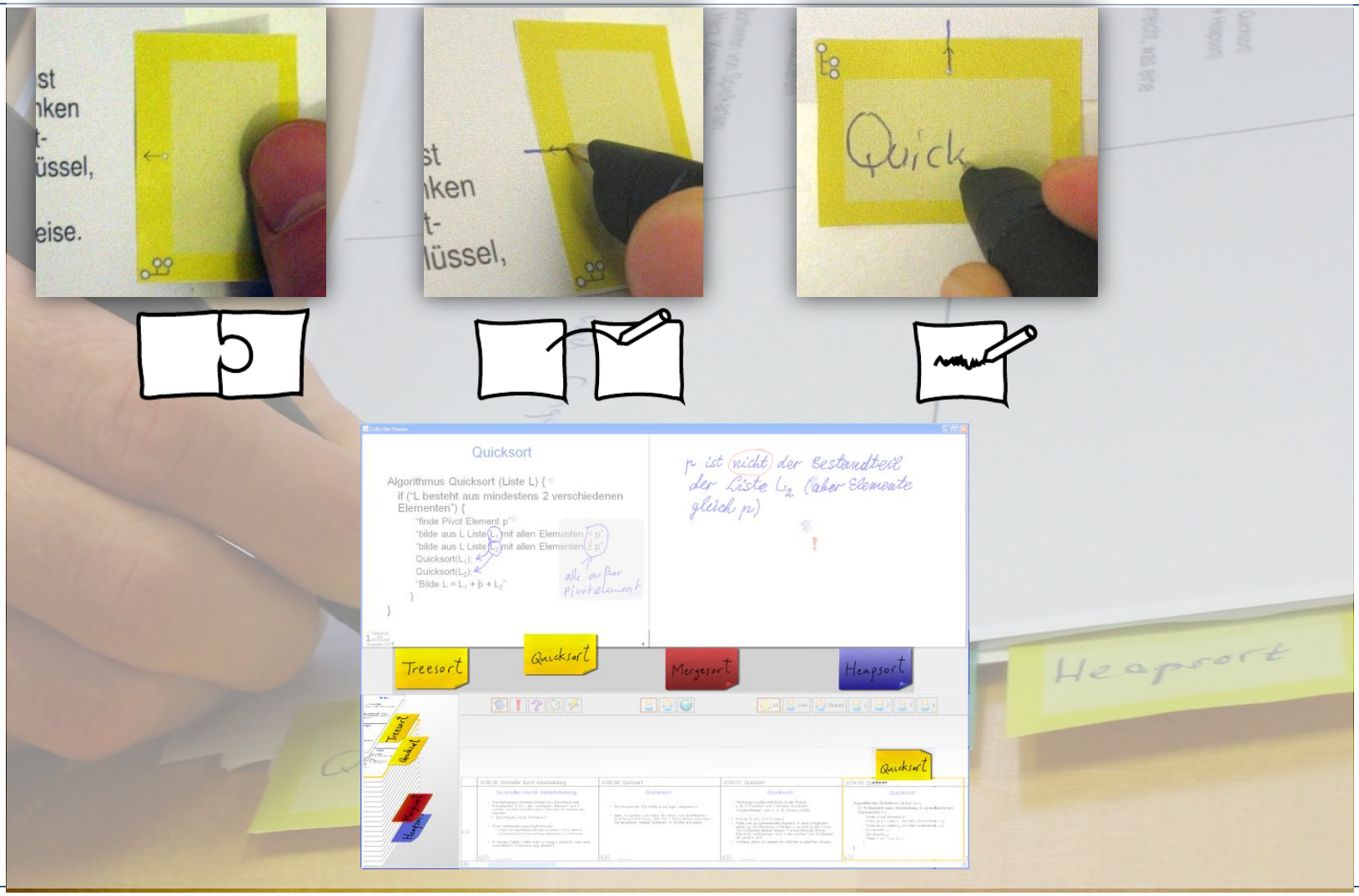
document collections



books



Digital Paper Bookmarks

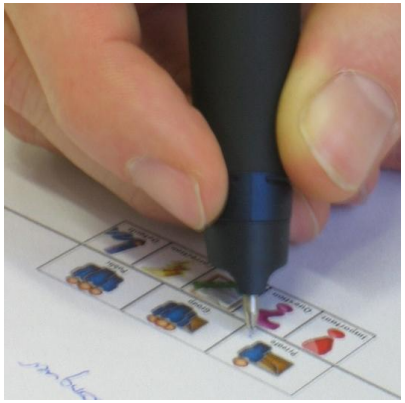


Further Interaction Techniques

hand written annotations

tagging using menue cards

button tagging



process tagging using physical objects

note: UI-on-paper

adaptable paper UI

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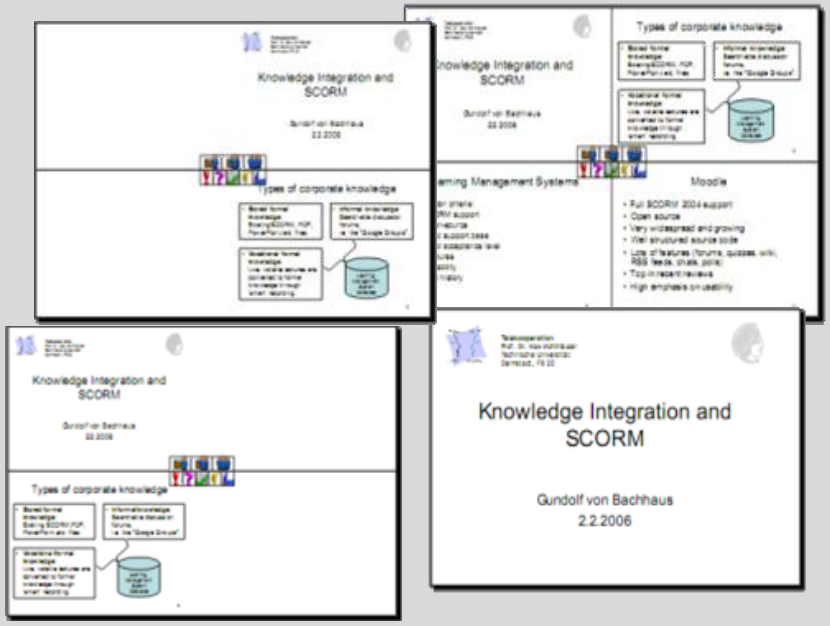
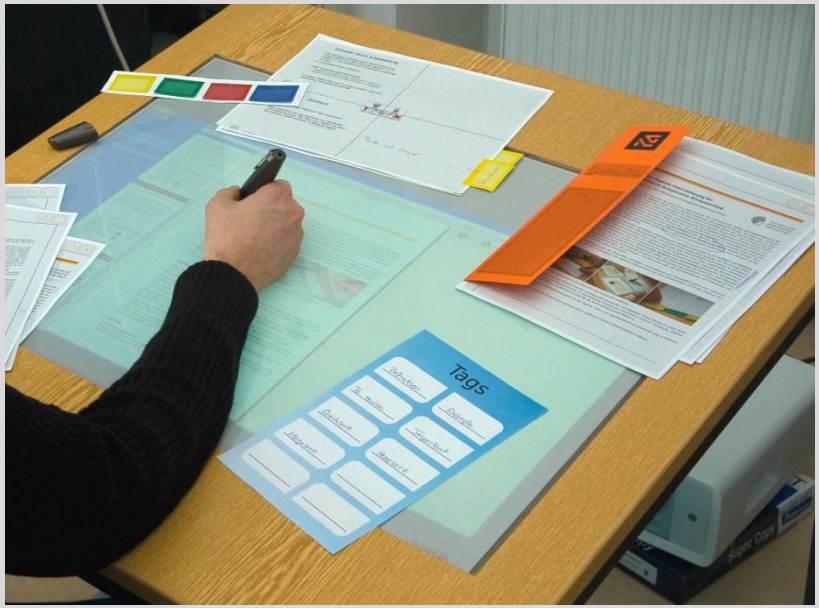
Problem: paper is static ≠ GUI

adaptable print layout



composite UI: dynamic combination of UI components



collaborative visualizations

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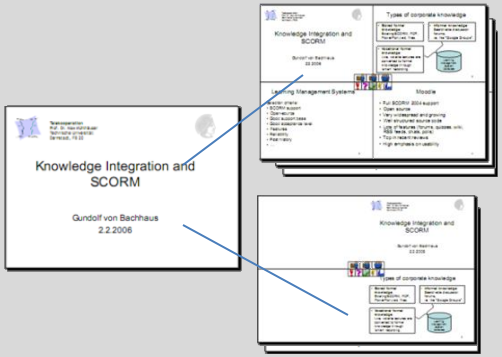
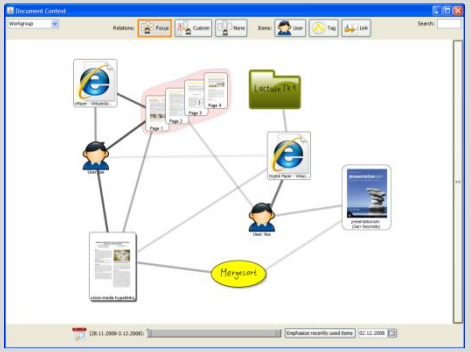
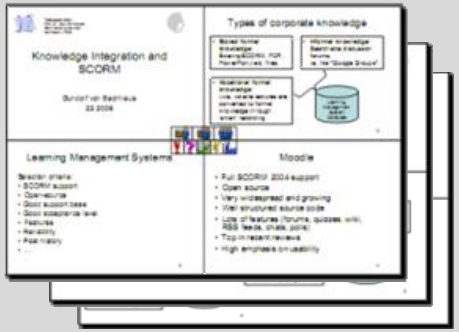
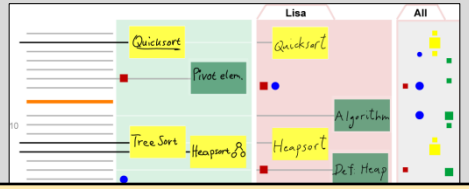
information ecology



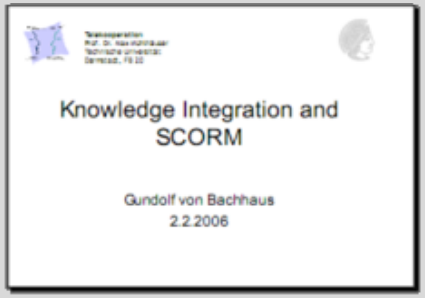


document structure

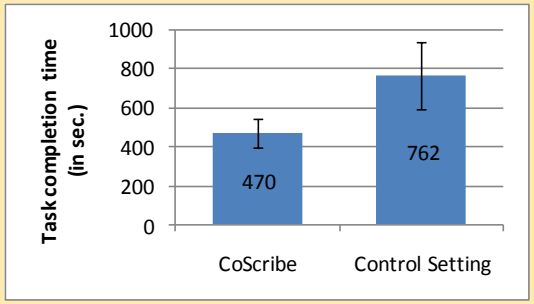




details



Evaluation: series of studies (within-subject) measurements & interviews; example: performance (‚browsing' in hybrid hypertext)



(N = 16, $p < 0.01$)

Hybrid Document Piles on Tabletops

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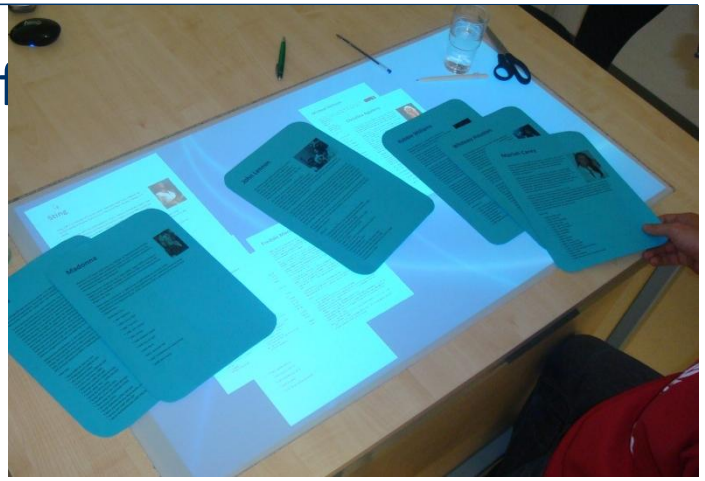
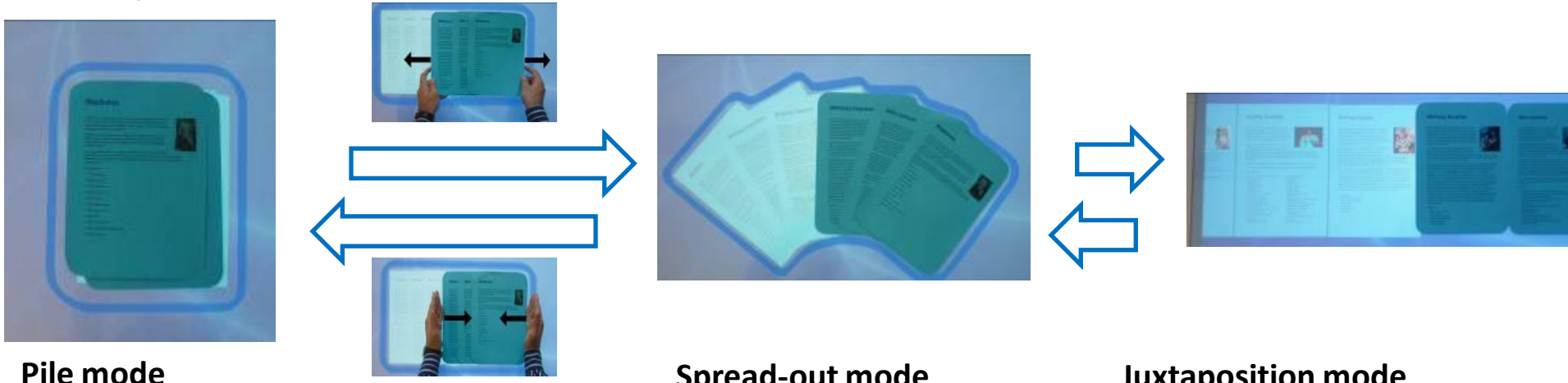
- Intuitive tangible interaction techniques f **creating and managing hybrid piles** of printed and digital documents



- Example: **Flexible transitions** between representations



Pile mode
e.g. for storage, hand-over

Spread-out mode
e.g. for overview, sorting

Juxtaposition mode
e.g. for detailed comparison

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Proactive Context Aware IUIs

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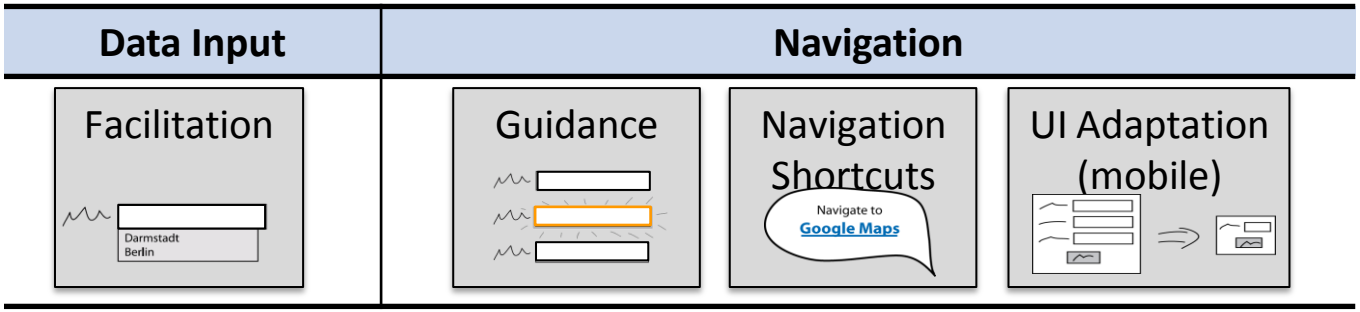
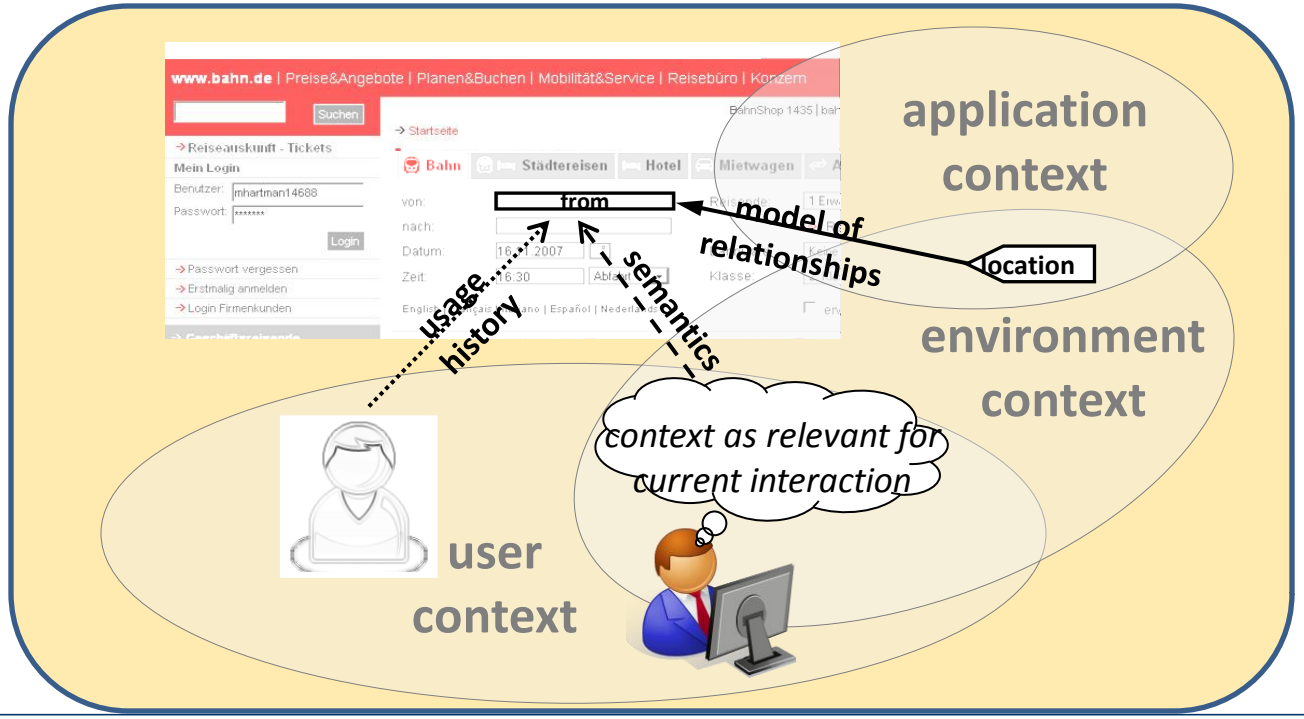
types of support In IUIs



relevant Types of context



Augur: application spanning IUI

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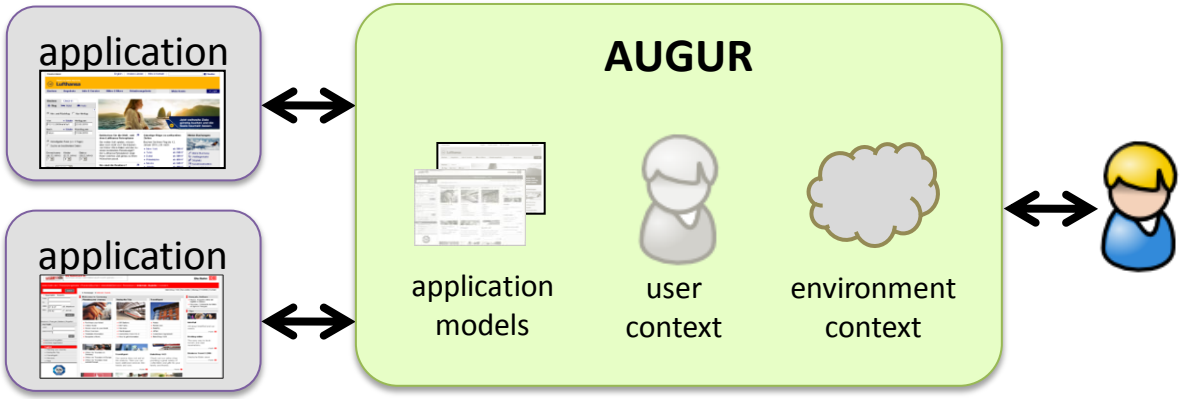
- application independent → ctx *across* applications
- for Web apps: augment existing applications without modification



wrt. application modeling:

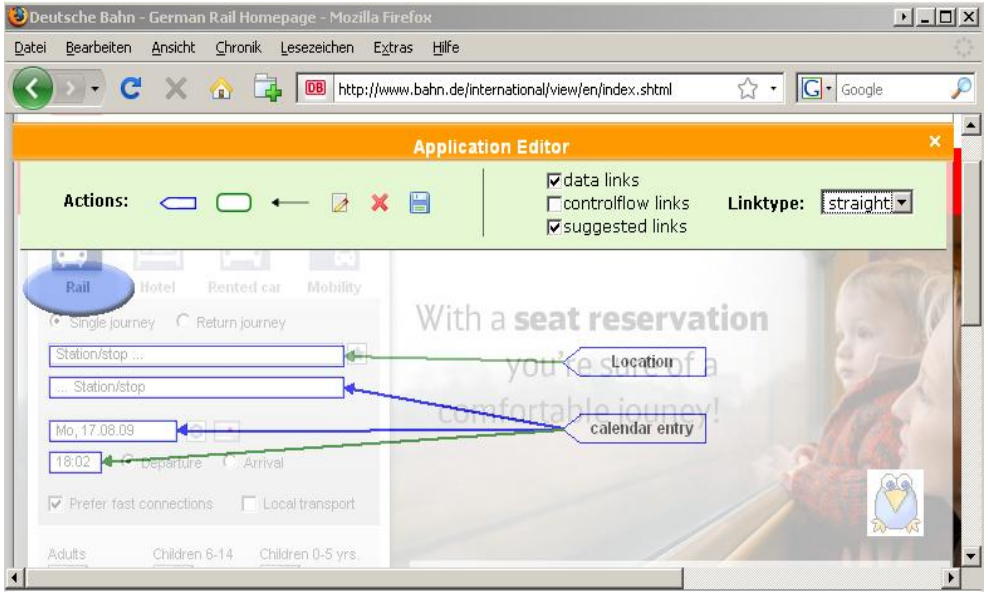
Approaches \ Requirements	low modeling effort	user control over models	support from the start
knowledge based IUIs	-	-	+
end user programmable IUIs	-	+	-
learning IUIs	+	-	-

Application modeling language ATML

- models context – application relationships
- models relationships to exististing UI

both not well supported up to now

→ ATML ApplicaTion Modeling Language




```
<!ELEMENT atmlModel (states | activities
|
          wrappingNodes | relations)*>
<!ELEMENT activities (activity)*>
<!ELEMENT activity (#PCDATA)>
<!ATTLIST activity
    id         ID           #REQUIRED
    ref        CDATA        #REQUIRED
    label      CDATA        #IMPLIED
    automate (true|false) #IMPLIED
>
<!ELEMENT wrappingNodes (#PCDATA |
context |
    uiContent)*>
<!ELEMENT context (#PCDATA | filter |
rule)*>
<!ATTLIST context
    id   ID    #REQUIRED
    type CDATA #REQUIRED
>[…]
```

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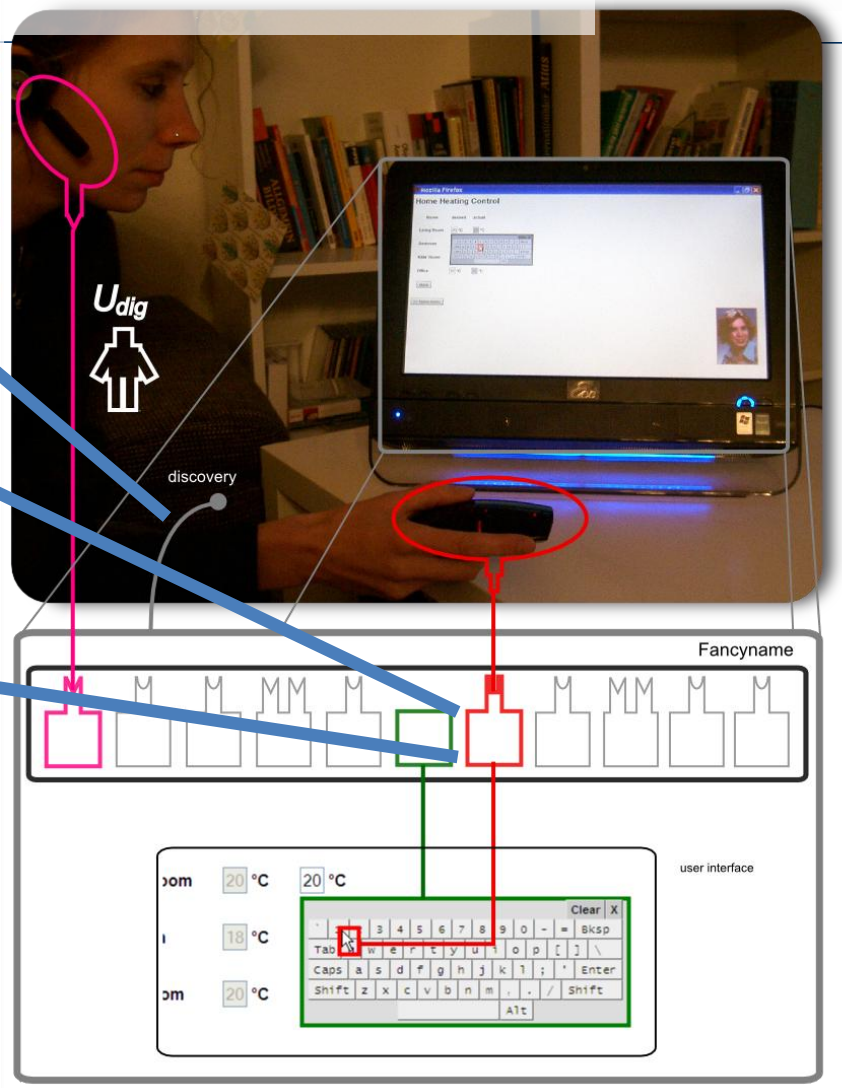
Just 1 Slide About Federated Interaction

1. Discover interaction resources in the environment
   → MundoCore discovery
2. Match them to available interaction strategies
   → MundoMonkey
3. Interaction strategies translate events from interaction resources to Webpage and vice versa

→ **user personalizes interactive space to his needs and prefs!**



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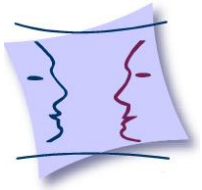

Mapache: MDDUI Research Plattform

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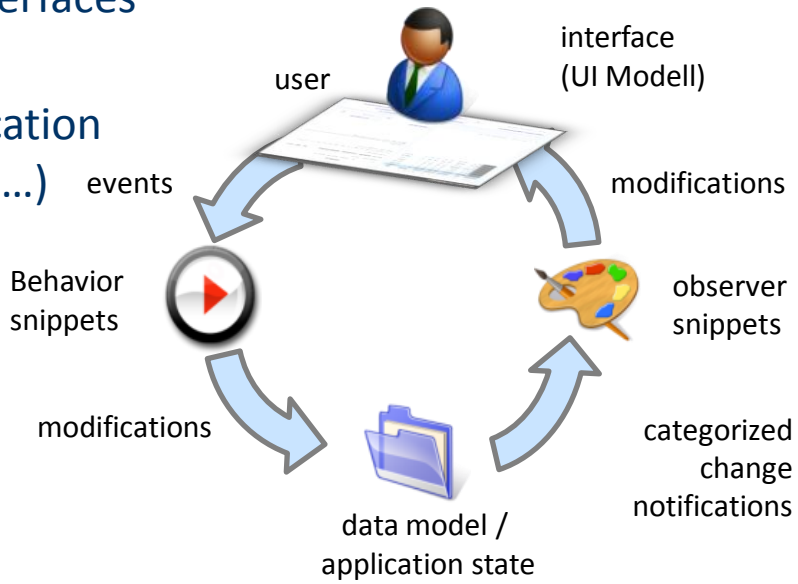
MDDUI: Model Driven Development of User Interfaces

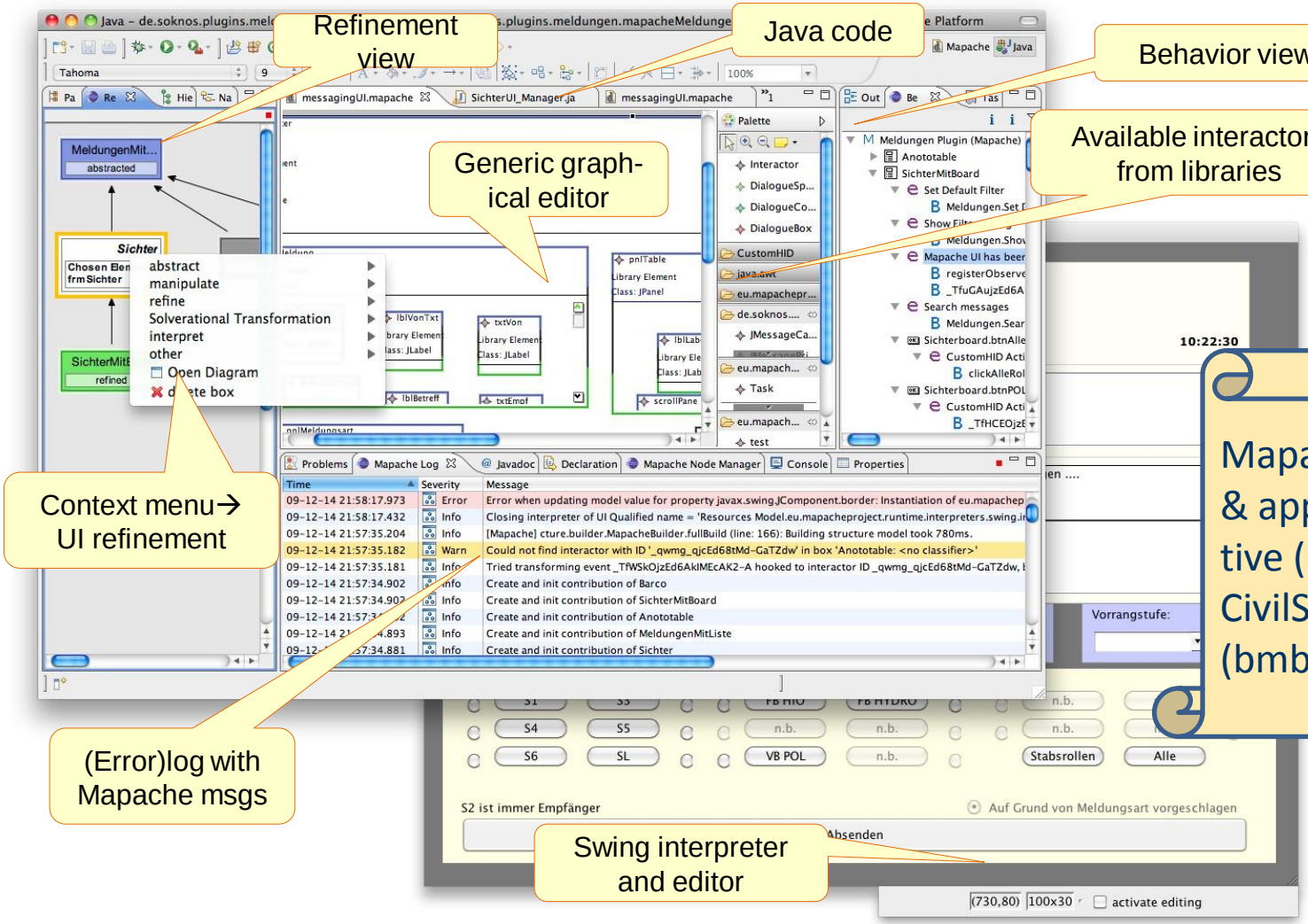
Challenge: leverage model driven approaches
in face of increasing diversity of UIs per application
(proliferation of modalities, devices, contexts …)

Contributions:

- Modeling concept
- UI framework and programing concept
- Integration of layout *and* behavior
- Specialized adaptations tools
- Integration of (automatic) transformations:
  cf. **Solverational** transformation approach below
- Eclipse-based (EMF/Ecore, views, code integration)



Mapache (condensed) screenshot



Telecooperation

Prof. Dr. Max Mühlhäuser

CONTENT

- Introduction: Ubiquitous Computing, Telecooperation lab
- Layer 1: talk & touch (briefly)
- Layer 1: tangible interaction, focus: paper centric computing
- Layer 2: proactivity & context awareness
- Layer 2: device federation (1 slide)
- Layer 3: model driven interaction
- Layer 0: integration, sensing
- Summary

Ubiquitous Computing: Integration

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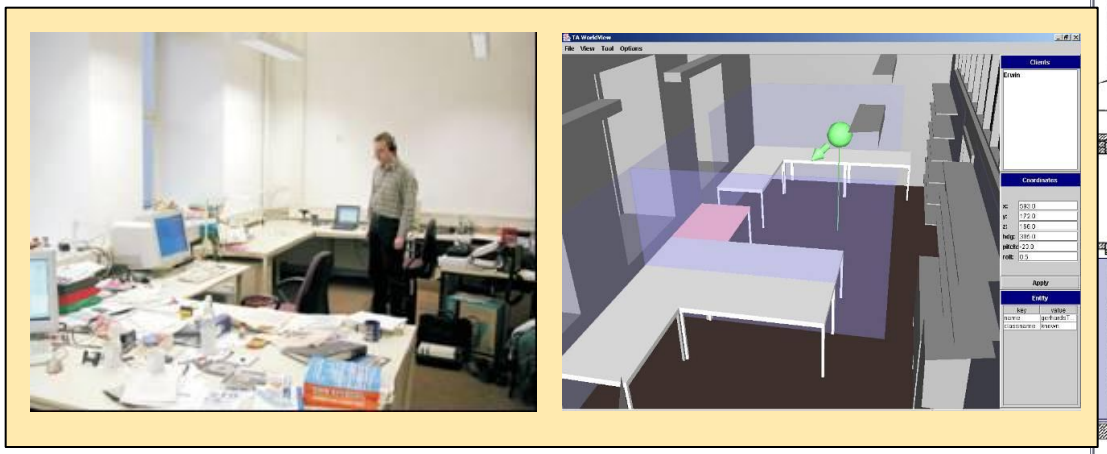
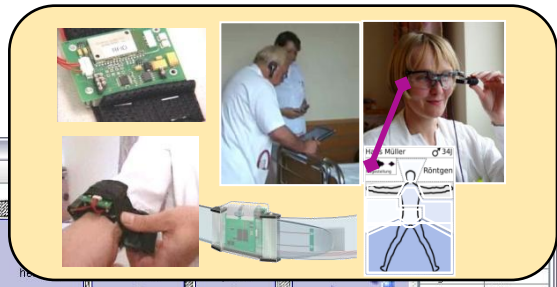
… an issue of systems support

- Middleware: basis - Publish/Subscribe, borrow from Peer2Peer networks, …
- Basic services: location&navigation, context awareness, self organization
- Cooperation support: ECA rules→ processes → ‘intelligence’
- Tools for ‘visual programming’ in 2D, 3D
- Integration of devices (sensors, RFIDs, …)





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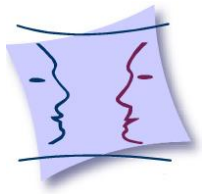

For your long term memory

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- **Interaction** and cooperation i.e. **integration** remain grand challenges in UbiComp
- interaction on the move with varying modalities:
  - quest for advancement of each modality: cf. voice, paper, …
  - quest for advancement of UIs on the move: federation, context, IUI
  - quest for new engineering approaches! (*)
- integration in smart objects → environments → worlds
  - quest for middleware, development support, **services**