

# Evaluation of User Experience

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# Outline

- User centered design and user experience sampling
- Context-awareness and personalization
- Framework of evaluation methods
- Case study: designing mobile context-aware interfaces for police officers



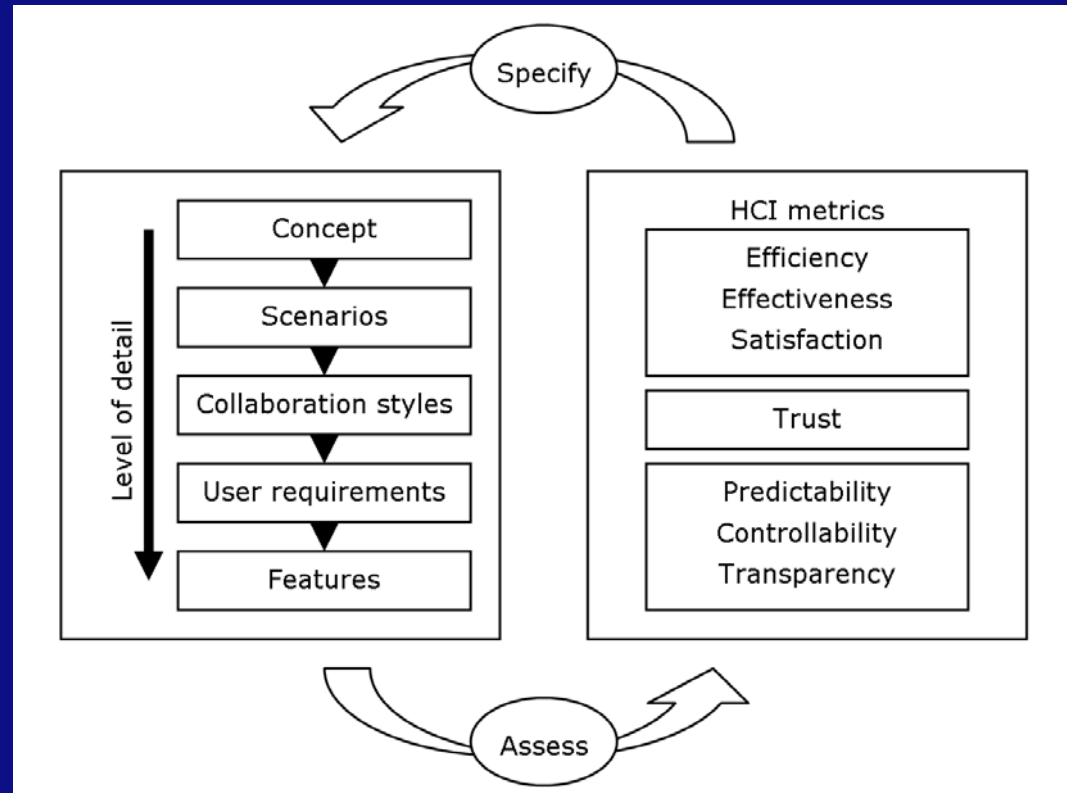
# User Centered Design & Evaluation

## WHY?

- Ensure design meets user requirements
- Adjust design when necessary
- Improve user experience

Iterative process!

In assessment:  
Selection of evaluation  
method is not  
straightforward



# User Experience Sampling

## Central idea

- Man-Machine Interaction is influenced by rich context, user characteristics and specific tasks → effect on user experience.
- “Measuring” user experience tells us something about the appropriateness of the design
- Key issue: Choosing the right evaluation method



# Context-awareness and adaptive systems

Static systems	Adaptive systems
always same system behavior, e.g. classic windows UI	adapting the system behavior across contexts

## Goal of context-awareness

Use knowledge from the **user, tasks and context** to

- achieve more appropriate interaction
- avoid overload, distraction and errors

How to realize this?

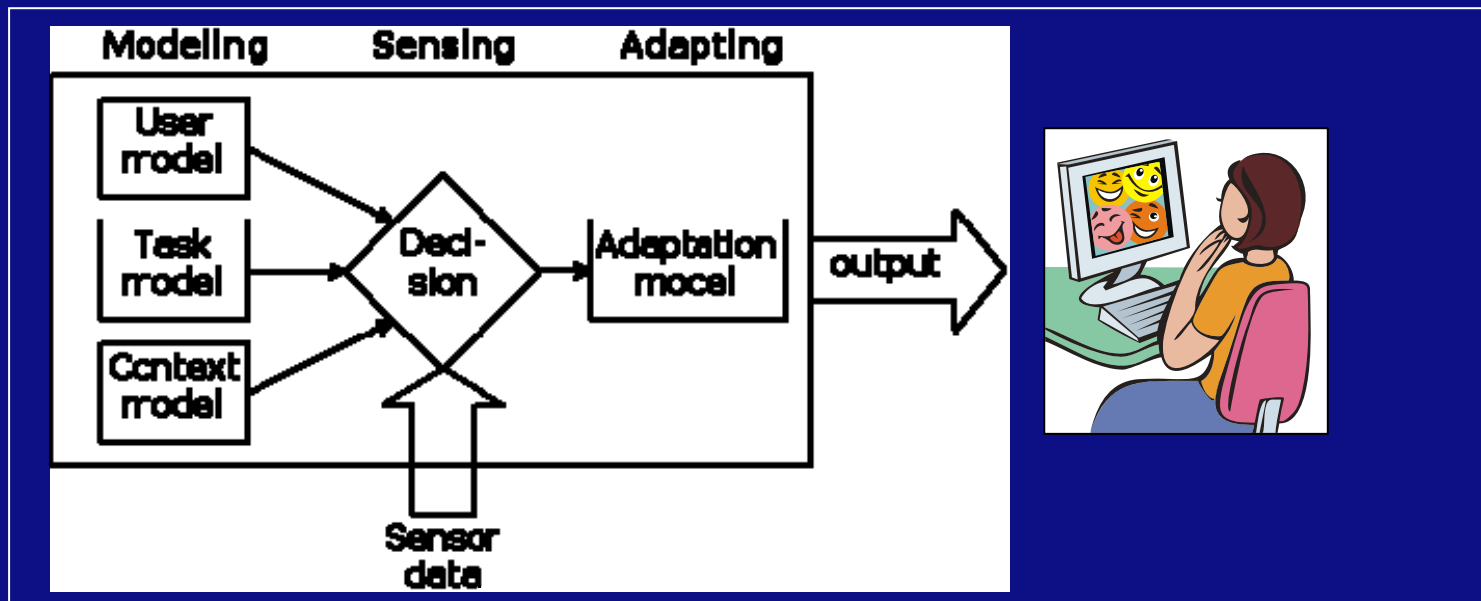


# Context-awareness and adaptive systems

**Modeling** user, task and context variables

**Sensing** the variables in the model

**Adapting** the human-system interaction



# Modeling user, task and context

## Modeling and sensing:

<b>User characteristics (<i>people</i>)</b>	<b>Task elements (<i>activities</i>)</b>	<b>Context factors (<i>contexts</i>)</b>
<ul style="list-style-type: none"><li>• Gender, age, etc.</li><li>• Interests</li><li>• Relevant expertise</li><li>• Cognitive (Dis)abilities</li><li>• Workload</li><li>• Physical (e.g. diabetics)</li></ul>	<ul style="list-style-type: none"><li>• Task characteristics (e.g. time pressure, task switches)</li><li>• Need for information</li><li>• Need for support (e.g. notification)</li><li>• User actions</li></ul>	<ul style="list-style-type: none"><li>• Location, time</li><li>• Transportation</li><li>• Environmental factors (light, noise, etc.)</li><li>• Professional context (e.g. police context)</li></ul>



# Adaptation

Based on model and sensed data → adaptation of content, dialogue and screen layout

e.g. High workload → less information

e.g. User frustration → simple dialogue

Adaptation examples:

- Navigation support: Highlight hyperlinks based on personal interests
- Task allocation: based on user availability
- Notification: presenting notifications to relevant information
- Attention: Present information in center of screen or in periphery





# Mobile adaptive systems

## Mobile use context

- Changing context over time and place
- Changing user needs for information



## Example: Location based services (LBS)

### Information about sightseeing

- Where am I?
- What's around me?
- Where to go?

### More pleasurable tourist experience



# Mobile adaptive systems

Military domain: *Command Information Module*

- Navigation
- Localisation

Future: Workload, task switches



Thales Nederland



# Personalization

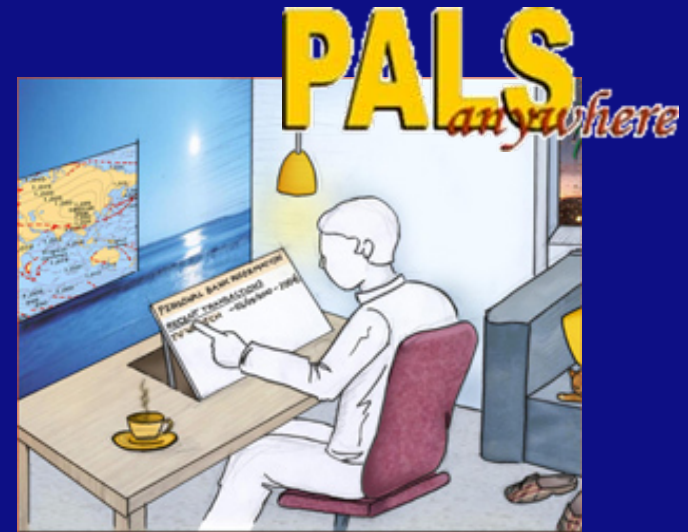
Personal Assistant for onLine Services

**Knowledge** about:

- Interests → (e.g. watches)
- Context → (e.g. shopping street)
- Schedule → (e.g. calendar)

Based on this knowledge:

Notify user to interesting jewelry shop



# Evaluating adaptive systems

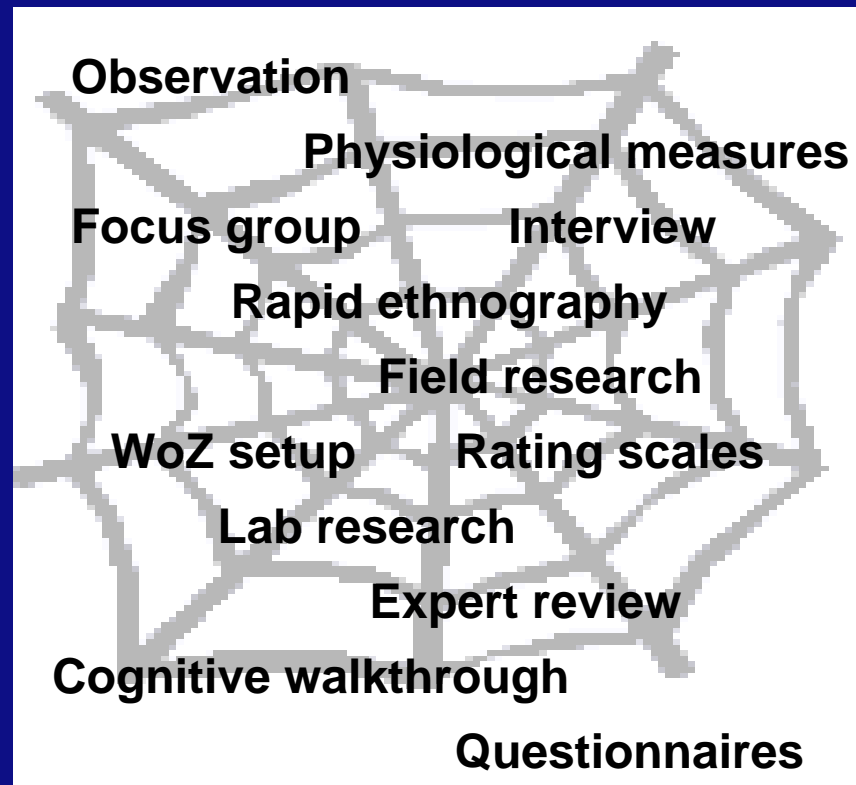
Evaluating the user experience of adaptive systems requires a different approach than “classic” UI’s:

- Adaptive behavior → predictability, controllability, comprehension
- “Human in the loop” problem → adaptive human behavior
- Over longer periods of time → increased experience with system
- Control condition → compare to what?



# Which method?

Many different evaluation methods and techniques:



# Framework of evaluation methods

When selecting combinations of evaluation methods:

## Stage

- Analysis, Design, Implementation
- Different stage, different focus

## Purpose

- Guide design or assess impact
- Formative or summative techniques

## Complexity

- Adaptive system = complex design
- Evaluate complex designs within the use context



# Framework (continued)

## Participants

- Involve end-users or representatives
- Actual end-users have domain knowledge

## Setting

- Control over external variables
- Evaluate in use setting or use simulation

## Duration

- Short, extended or longitudinal
- Trust and user experience develop over time

## Cost

- Time and resources
- Costs are high for field and lower for simulation studies



# Case study: mobile interfaces for police

- BSIK - MultimediaN project  
**Mobile Information Delivery**
- Research objectives of this project
  - **Guidelines, models and methods** for the development of mobile adaptive user interfaces
  - Designing and field-testing **Attentive Services** for police officers

- Project partners:



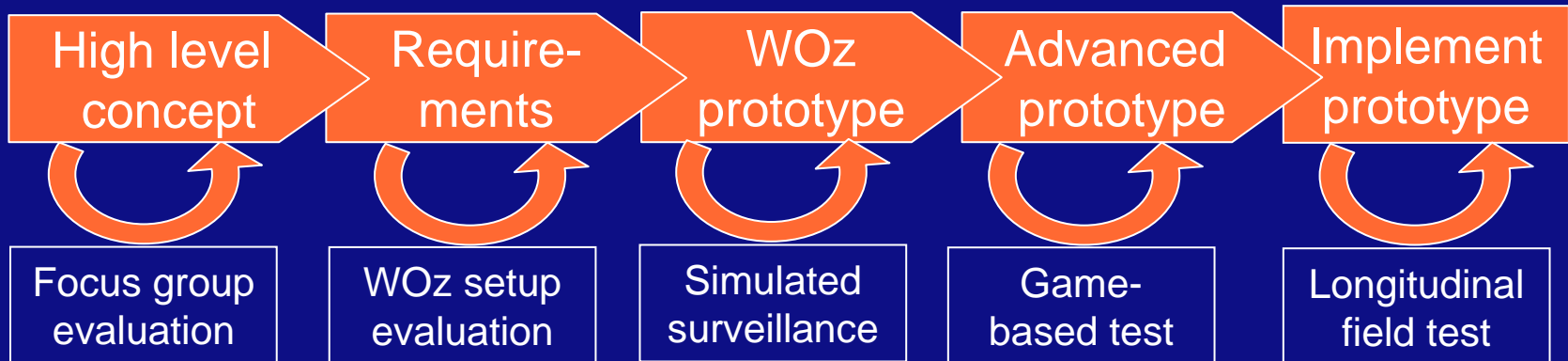


# Approach

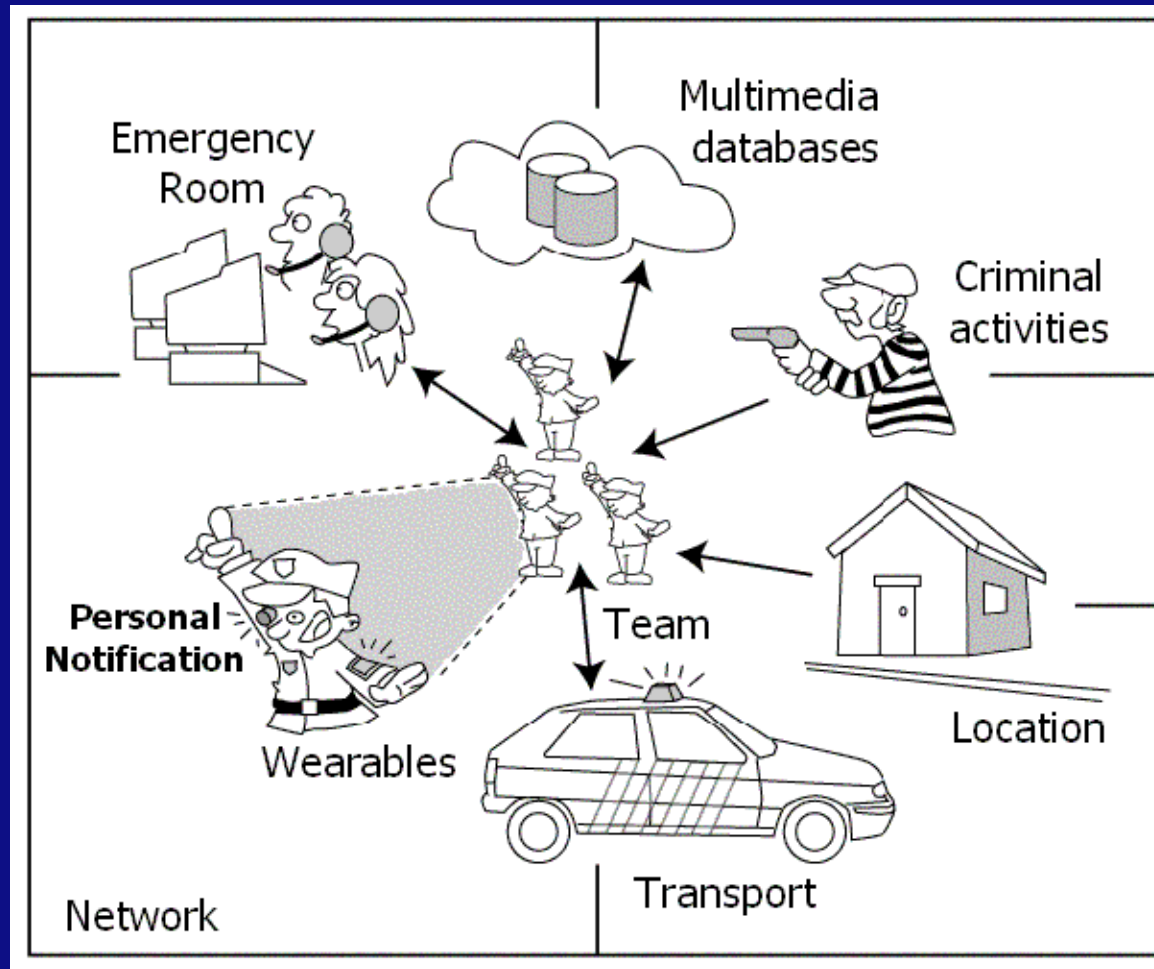
**Starting out:** Literature review and domain analyses

- HCI literature on context-aware mobile systems
- Task analyses and observation of police officers
- Resulted in a **concept** of notification system for police officers

**Continuing:**



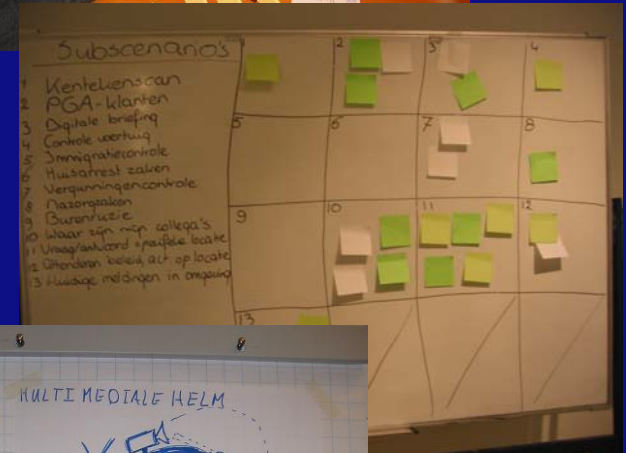
# Mobile services for police officers



# Method 1: Focus Group

To evaluate high level concept:

**Stage:** early analysis stage  
**Purpose:** innovative concept;  
formative  
**Complexity:** high-level concept of  
adaptive system  
**Participants:** thirty police personnel  
with diverse backgrounds  
**Setting:** outside use environment  
**Duration:** short; one half day  
**Costs:** high in resources  
low in time



# Impression from police domain



Video courtesy of Dutch Police CIP

# Context-aware interfaces in the police domain

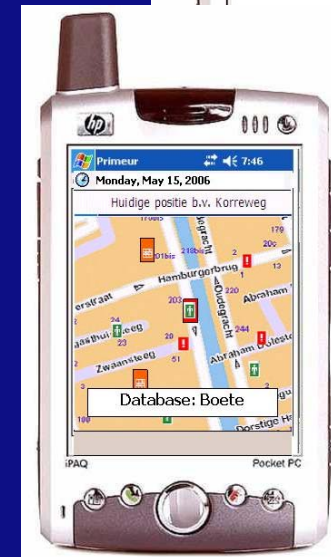
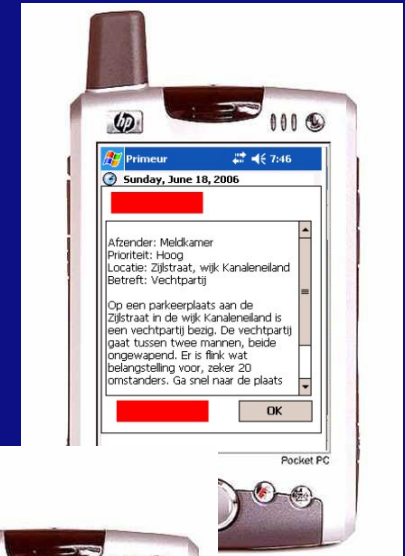
## “Challenges”

- Information at the right time and place to the right person
- Support task performance and situation awareness

## Solution to meet challenges:

Design adaptive mobile notification system

1. **Notification styles** based on message priority and user workload
2. **Adaptive timing** of notifications based on availability, location and priority
3. **Which team member** to present the notification



# Designing Notification Styles



Rule-based adaptation  
Priority → notification salience  
Workload → information density

## Examples

- Low workload, High message priority
- High workload, Low message priority



# Method 2: Wizard of Oz

To evaluate the **notification styles**

<i>Stage:</i>	intermediate design stage
<i>Purpose:</i>	validate design solution; formative
<i>Complexity:</i>	(simulated) adaptive functionality
<i>Participants:</i>	twenty representatives
<i>Setting:</i>	Wizard of Oz lab experiment
<i>Duration:</i>	short; two hours
<i>Costs:</i>	low in both time and resources



# Method 2: Wizard of Oz

## Wizard of Oz setup:

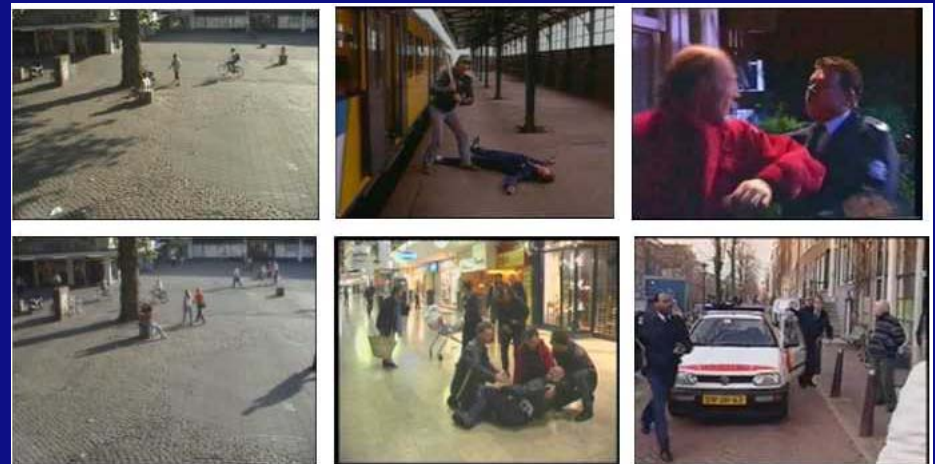
Participants watched police videos

Test leader sent the notifications

Compared adaptive notification (priority and workload) to uniform notification

## Measures

- Task performance
- Mental effort
- Preference
- Interruptiveness





# Method 2: Wizard of Oz

## Results

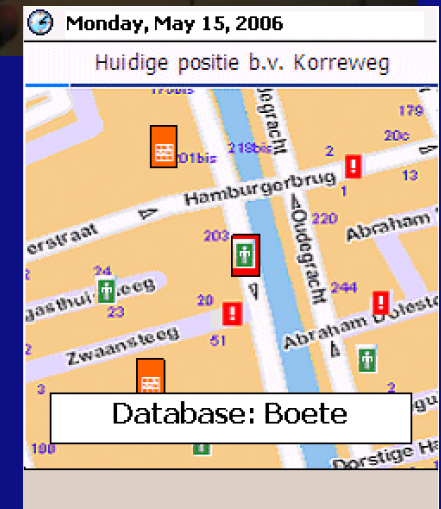
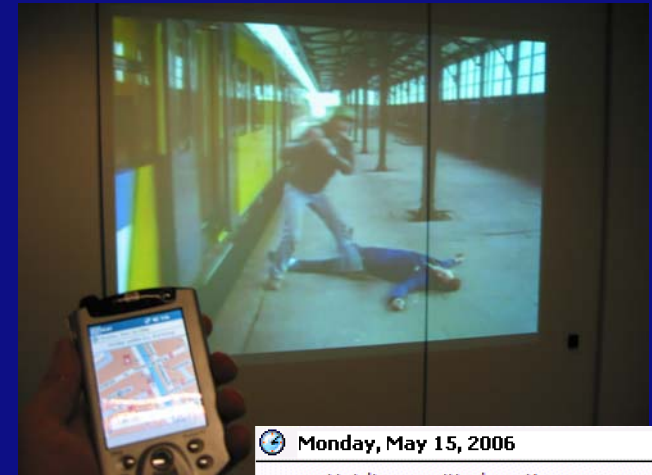
Adaptive notification:

- ✓ Higher efficiency, same effectiveness
- ✓ Less interruption
- ✓ Higher preference for adaptive notification
- ✗ No difference in experienced mental effort

Adapting notification styles resulted in successful task support and less interruption

## Benefits

Allowed testing of requirements / principles  
BUT “static” task environment



## Method 3: Simulated surveillance

To evaluate adaptive notification in simulated but real world environment:

<i>Stage:</i>	intermediate design stage
<i>Purpose:</i>	evaluate adaptive notification; summative
<i>Complexity:</i>	(simulated) functionality
<i>Participants:</i>	Thirty-two representative users
<i>Setting:</i>	semi-controlled experiment; real-world environment
<i>Duration:</i>	short; two hours
<i>Costs:</i>	low in both time and resources



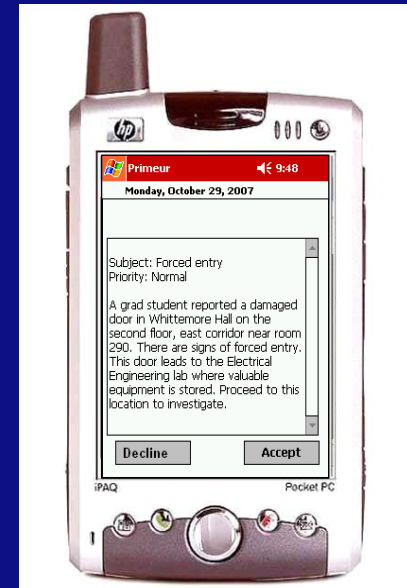
# Method 3: Simulated surveillance

## Timing of notifications

- Notify directly or postpone notification

## Rules on location, activity and priority

- *When user close to incident location and available, notify to all messages.*
- *When user in transit, postpone low priority messages.*
- *When user busy, postpone all but high priority messages.*
- *Etc.*



# Method 3: Simulated surveillance

Effects of adaptive **timing of notifications** on task performance, mental effort and interruptiveness?

## Method

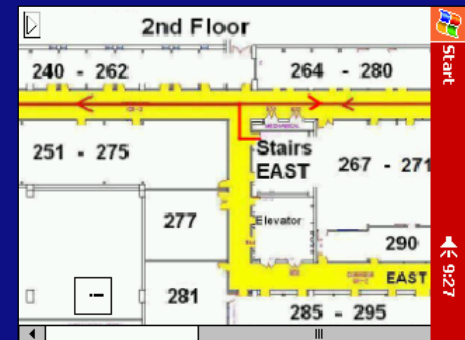
- Participants: 32 participants (non-police)
- Dual task: Building surveillance
- Conditions: Adaptive vs. Postpone vs. Uniform
- Measures: Efficiency & effectiveness, message interruptiveness, mental effort, preference



## Manipulation

User activity: available, in transit or busy

Message priority: high, medium or low



# Method 3: Simulated surveillance

Movie

## Results

- ✓ Better task performance with adaptive notification
- ✓ Postponing notifications: attentional trade-off
- ✗ Higher mental effort

Study indicated user activity and message priority as appropriate context factors for adaptivity.

Simulated surveillance allowed accurate measures and task-flow.



# Method 4: Game-based evaluation for teams

To evaluate adaptive task allocation for teams:

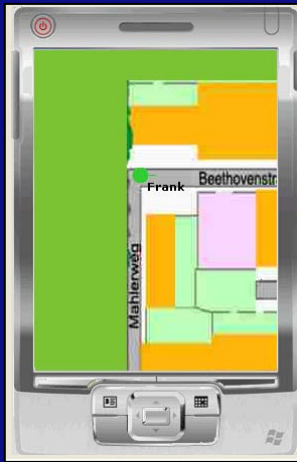
<i>Stage:</i>	intermediate design stage
<i>Purpose:</i>	evaluate adaptive task allocation; summative
<i>Complexity:</i>	(simulated) advanced functionality
<i>Participants:</i>	ten teams of three police end-users
<i>Setting:</i>	lab experiment; virtual game-based environment
<i>Duration:</i>	extended; four hours
<i>Costs:</i>	low in both time and resources



# Method 4: Game-based evaluation for teams

Will adaptive task allocation support teams of police officers?

- System selects officer based on location, availability, and workload
- Solving police incidents in a virtual environment, Unreal Tournament, e.g. car crash, youth-hotspot, etc.





# Method 4: Game-based evaluation for teams

Compare adaptive to non-adaptive task allocation support system

## Measures

- Team task performance
- Mental effort
- Situation Awareness
- Preference, interruptiveness

## Techniques

- Logfile analysis
- Questionnaires
- Rating scales





# Method 4: Game-based evaluation for teams

Movie

## Results

With adaptive task allocation:

- ✓ Increased team performance (less decision errors, less communication necessary)
- ✓ Lower interruptiveness, appropriate response times

## Benefits of game-based evaluation

- Multi-player, interactive environment
- Create task flow
- Accurate logging

BUT: abstraction from real world



# Method 5: Field research

To evaluate adaptive notification prototype in the field

<i>Stage:</i>	final implementation stage
<i>Purpose:</i>	summative; validate functioning of prototype
<i>Complexity:</i>	full system functionality
<i>Participants:</i>	thirty end-users
<i>Setting:</i>	natural use environment
<i>Duration:</i>	longitudinal; three months
<i>Costs:</i>	high in both time and resources



# Method 5: Field research

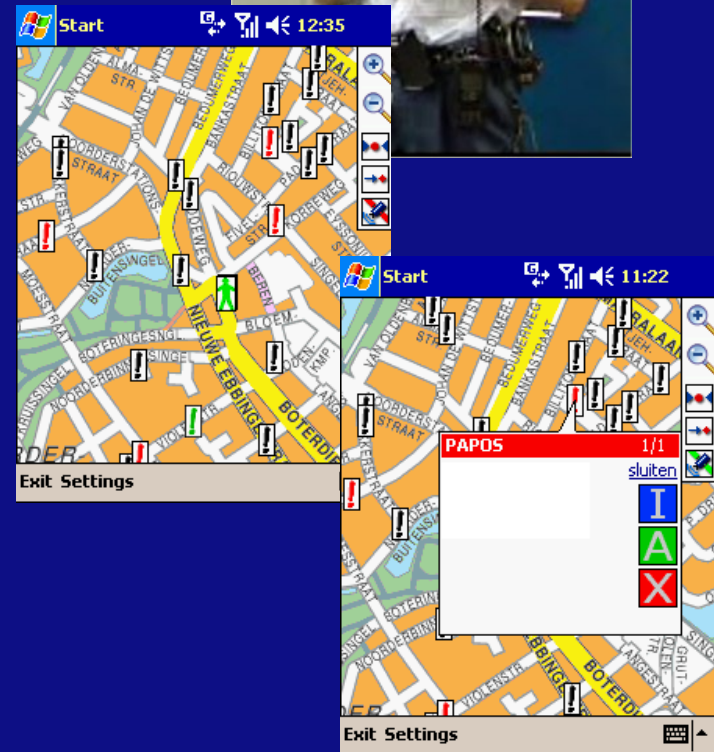
Implemented adaptive notification system for police officers

## Measures

- Efficiency and effectiveness
- Impact on work processes
- Usability, acceptability

## Techniques

- Observation and interviews
- Log-file analysis
- Online questionnaires



# Method 5: Field research

## Results

- ✓ Police officers better informed
- ✓ System usability is sufficient
- ✗ Notifications often interruptive of work process
- ✗ Notifications not always relevant / necessary

Shows need for context-aware filtering of notifications

**Benefits** of field study:

Adaptive system in real use environment with real end-users

BUT diminished participation by police officers



# Lessons learned

Applying the framework:

- Allows selection between different methods based on 7 factors
- Tuning to task and domain specific evaluation criteria
- Incorporates users in every stage of the process

Establishing guidelines for evaluation of mobile context-aware interfaces



# Guidelines

		Focus group	Wizard of Oz	Game-based	Field
Stage	Analysis	+	-	--	++
	Design	+	+	++	++
	Implementation	-	-	++	+
Purpose	Formative	+	+	++	+
	Summative	-	-	++	++
Complexity	Low	+	-	--	-
	Medium	-	+	++	-
	High	+	-	++	+
Participants	Representatives	-	+	++	-
	End-users	++	++	++	+
Setting	Independent	+	-	--	-
	Natural	-	++	--	++
	Artificial	-	+	++	-
Duration	Short	+	+	++	+
	Longitudinal	-	-	--	++
Costs	Time	+	+	++	-
	Resources	-	+	++	-



# Conclusions

Evaluating user experience ensures appropriately designed context-aware systems

## Framework:

- Helps to select appropriate evaluation methods
- Generates generic design knowledge across domains

## Stresses the need

- to incorporate end-users in the evaluation
- to take the use context into account



# Questions?

Thank you for your attention!

More information:

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