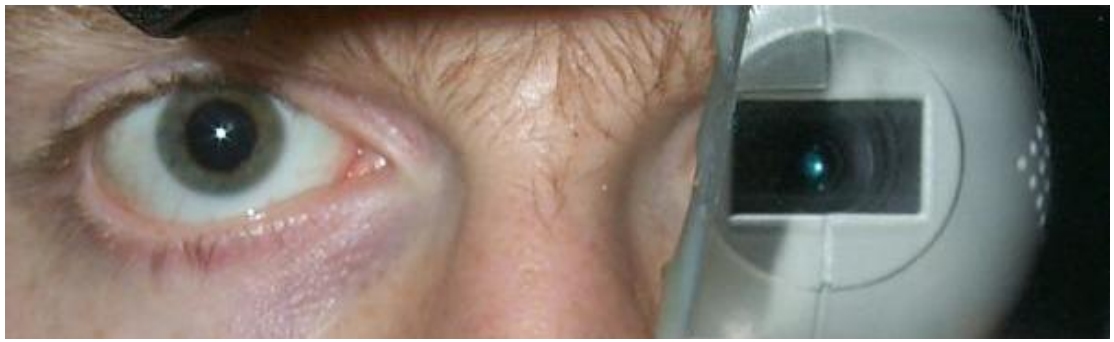
Wearable Computing



Wearable User Interfaces

Hendrik Witt

Recap

- Abstract UI models
  - Device independent description
  - Interaction method independent
  - Modeling dynamics with context information
- Wearable UI
  - Can use Abstract UI models
  - Different to today's interfaces
  - Few Examples

Mobile UI Characteristics

Using almost the same desktop applications while being mobile (Excel, Power Point, etc.)

- Limited I/O capabilities
  - Display size
  - Input devices
- Constant user attention
  - Steve Mann: “Assistant in the coffin”
- Special Software Development Environments
  - Compact .NET, J2ME
  - WIMP based

Wearable UI Characteristics

Wearable UIs have almost the same characteristics as mobile UIs, but require more:

- The wearable computer is secondary
  - Constant user attention can not be assumed
  - I/O devices are different
    - Data-gloves, Twiddler, etc.
    - setup can vary between wearable systems
  - Current focus: professional use

What do we want from a WUI?

- Easy to control (even when being in motion)
  - Don‘t use WIMP?
- Quickly perceiving information
- Unobtrusive when not needed
- Implicit interaction
  - Using environmental and user context information as input
- Situation sensitive
  - “right information at the right time”

Basic things to be aware of first

- UI design issues
  - What designs are possible?
- Interaction styles
  - How can users interact with the computer?
- Fundamentals of sensation and perception
  - E.g. cognitive boundaries
- Evaluation techniques
  - Interruption
  - Usability

UI design issues

- General presentation techniques
  - Visual, audio, tactile, multi-modal
- Quality of Service
  - Response-Time, User productivity, …
- Balancing function and fashion
  - Application appropriate, design for humans
- Information search and visualization
  - Easy to use (e.g. soundex), appropriate color design

Interaction Styles

- Direct Manipulation
  - Visibility of objects and actions of interest
  - Rapid response, reversible actions
  - Replacement of typed command by a pointing action on the object of interest
  - Problem: Requires constant attention
- Menu-Selection
  - Visibility of commands, not syntax recall needed
  - Very fast, rapid response
  - Different complexities: Single, multiple selection
  - Context-aware: E.g. “Context-Menu” on right mouse click
  - Problem: Finding the structure, limited commands at a time

Interaction Styles

- Command-Language
  - Can accomplish a wide range of tasks
    - Text editing, OS control, data base retrieval, ...
  - Once learned users can achieve high performance
  - Problems: User must recall notation and initial actions, text input device needed
- Natural-Language
  - Very natural as similar to human/human communication
  - Command space permanently accessible
  - Problems:
    - Voice recognition is error-prone
    - High computation costs
    - Language dependent
    - Sometimes socially unacceptable

Tool Support for WUI development

There are many tools available to support GUI development for desktop and mobile systems.

Idea

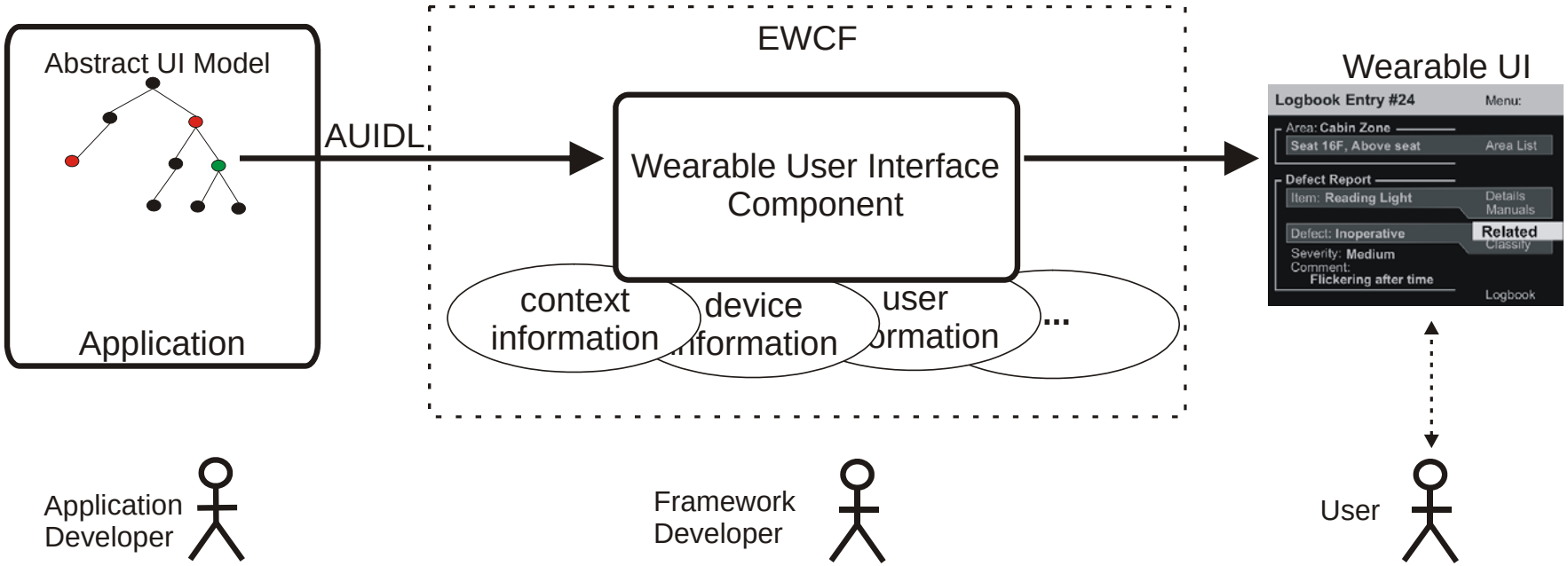
- Facilitate WUI development with reusable components
- Reduce implementation effort and cost
- Allow integration of context information
- Encapsulate expert knowledge about WUIs

Requirements of a WUI-Toolkit

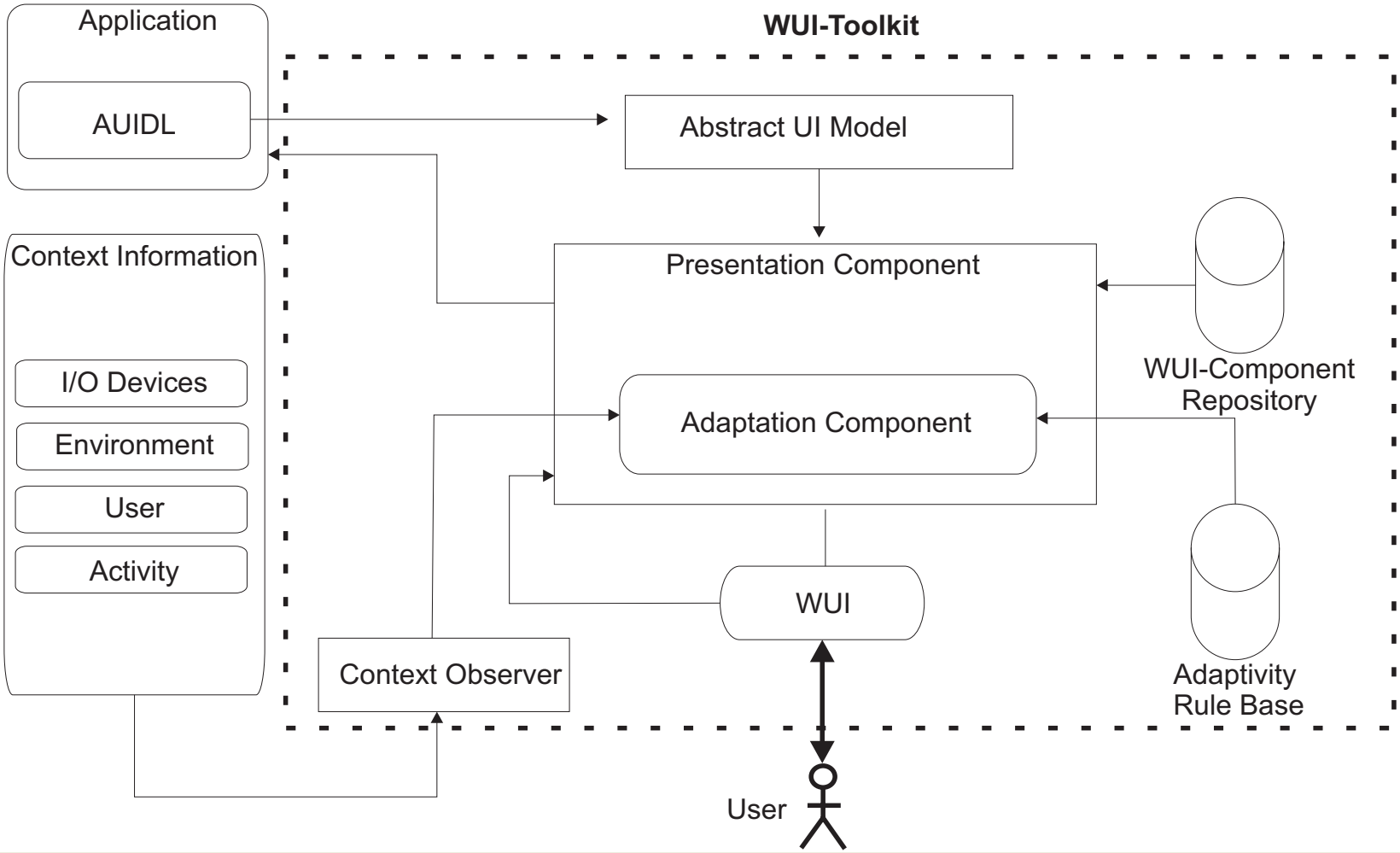
- Easy to use
- Component reusability
- I/O device independent UI description
- Distribution of toolkit components
- Special UI components and interaction concepts
- Support for multi-modal interaction
- Integration of Context
- Extensibility

- Allow non-experts to generated WUIs

WUI Development Process for Non-Experts



Architecture of the WUI-Toolkit



Adaptive WUI

- Use context to *automatically …*
  - Optimize UI control
  - Trigger implicit input
  - Provide situation dependent appearance
- Research Problems:
  - How and what to adapt?
  - What is the best UI for a certain situation?
  - How to evaluate/test adaptive WUIs?

Note: Don’t mix up with adaptable UIs!

What to adapt on a WUI?

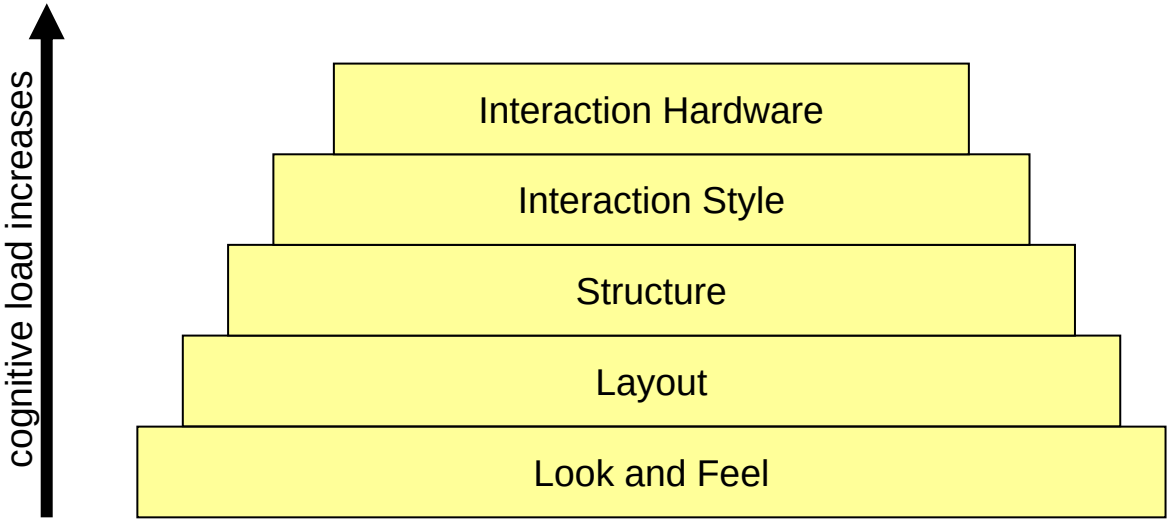
Appearance

- UI can be optimized due to changes in environmental context
  - Light conditions
  - User motion
  - Environmental noise

Interaction

- UI cannot be controlled anymore under current context
  - affected by user activities
  - interaction device failure (e.g. low battery)

Layers of Adaptation



- Layers are not independent!
  - Adaptation on one layer can make adaptation on another layer necessary

  → Constraint Satisfaction Problem (CSP)

Finding Adaptation Rules

- Problem: Finding a simulator to evaluate WUIs in a laboratory environment
  - How to simulate the primary task?

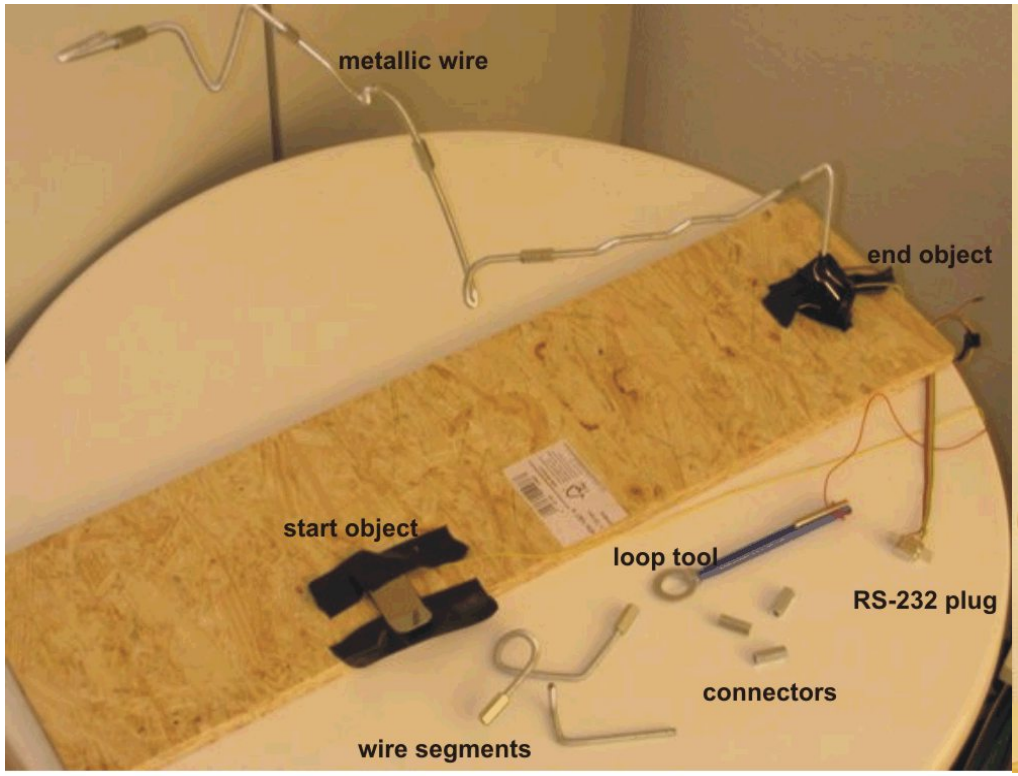
- Two Approaches:

  - Use *virtual* task that requires constant attention
    - E.g. computer game „Bouncing Diplomats Game“ from McFarlane

  - Use *physical* task that requires constant attention
    - E.g. kid‘s game to train motor skills „The Hot Wire“

The „HotWire“ simulator

- Simulation of primary tasks with a physical game

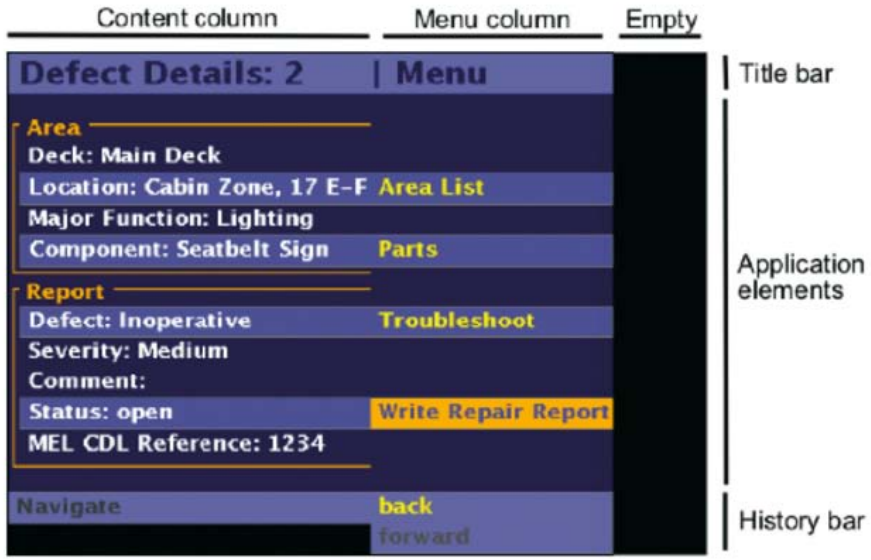


H. Witt and M. Drugge

Wearable UIs by Example | Graphical WUIs

- Menu-based WUIs
  - WUI I: Selection oriented
    - Menu/Submenu structure
    - Small content space
  - WUI II: Content oriented
    - Content presentation and Menu selection
    - HMD optimized

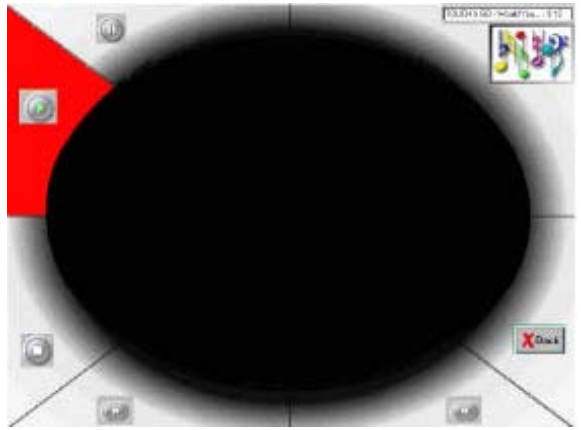
WUI I



WUI II

Wearable UIs by Example | Graphical WUIs

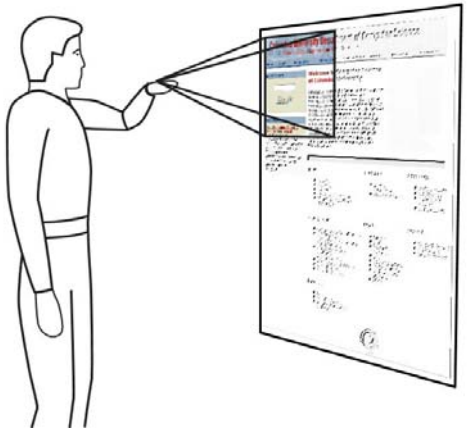
- Bin-ocular HMD:
  - Menu arranged in a circle
  - See trough the middle
  - Applications only possible as overlay

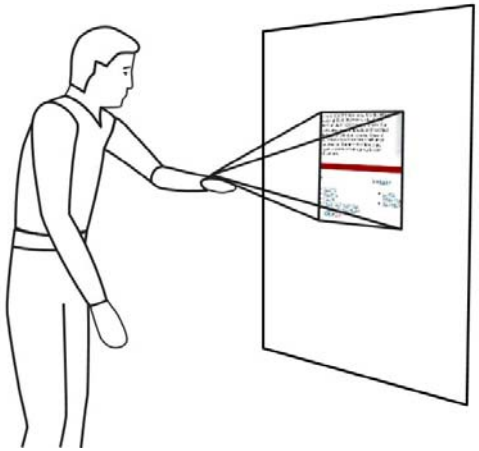


Wearable UIs by Example | Augmented Reality

- Information presentation related to physical space
- High computation costs
- E.g. Nomad Interface
  - Technical descriptions as overlays in car repair
  - movie

Wearable UIs by Example | Wrist-worn WUI





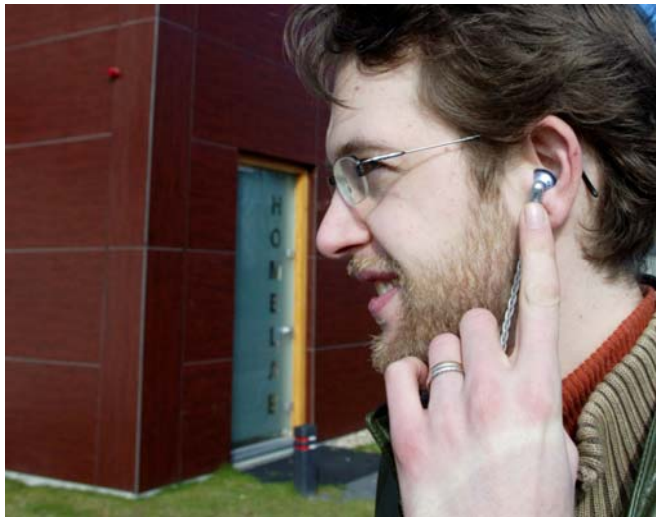
- Wrist-worn projection display
  - Partial visibility instead of complete „screen“
  - Zoom function

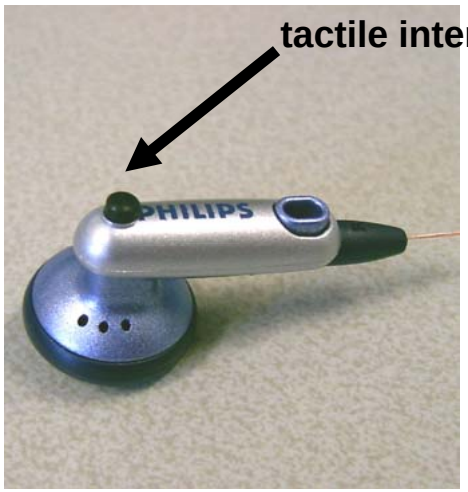
movie

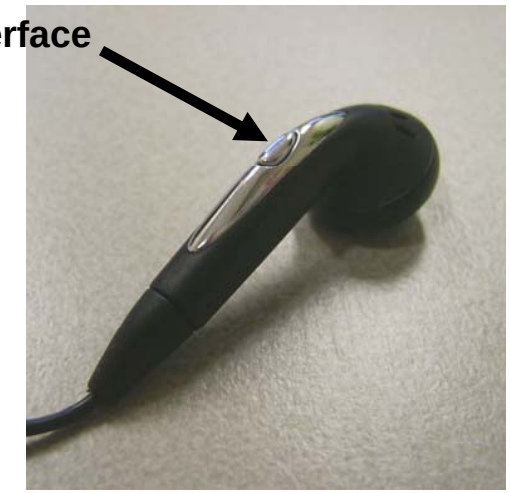
Wearable UIs by Example | Tactile Interface

- Touch Headphones
  - Control a MP3 player by touching the ear-plugs
  - Context aware: ear-plugs „know“ when plugged in the ear
  - Limited interaction: play, stop, back, forward, volume up/down

movie

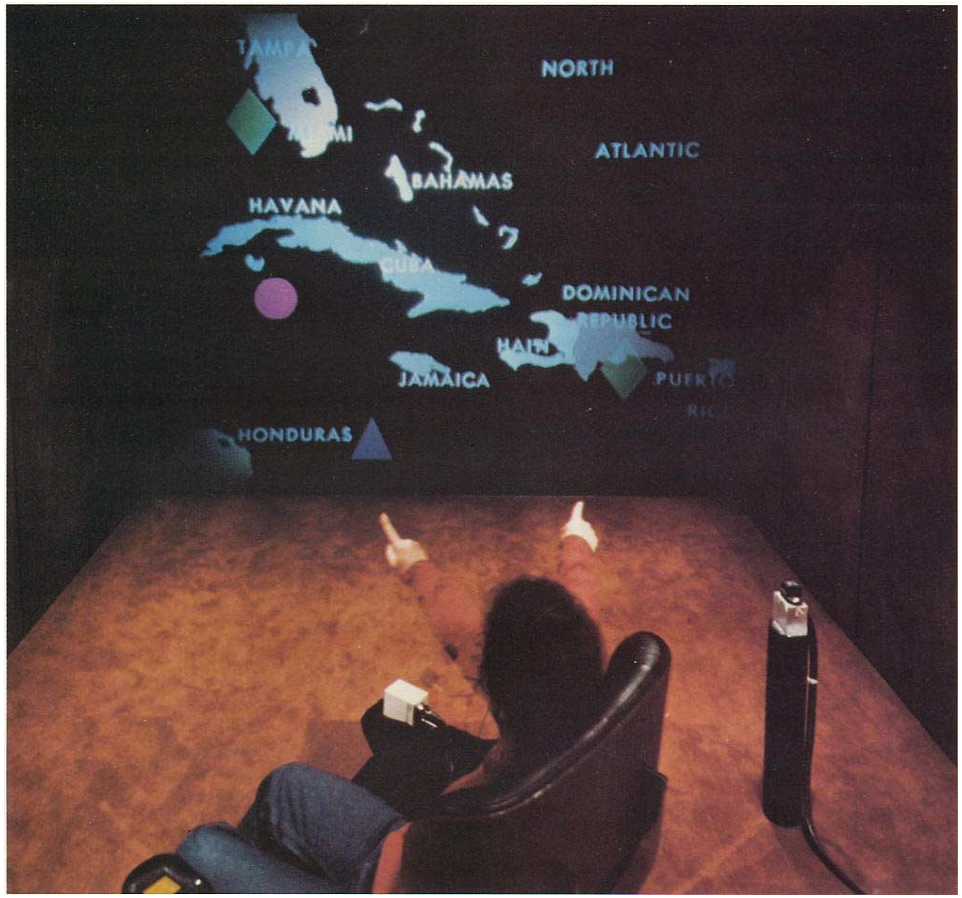






Wearable UIs by Example |Multimodal WUIs

- Original idea by Bolt in 1980: „Put that there: Voice and Gesture at the Graphical Interface“
- Combining two modalities *at the same time* to execute a command
- WUIs often allow only one out of many modalities at a time to execute a command



Bolt

Summary

- WUIs
  - Different to mobile UIs
  - Interdisciplinary knowledge needed for design
  - Tool support may ease the development
    - Approach: encapsulate expert knowledge
- Adaptive WUIs
  - Integrate context information
  - Different layers of adaptation
  - Finding adaptation rules is challenging
    - How to test the interfaces?