

4 – User Interfaces for Ubiquitous Computing

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resources/](http://www.hcibook.com/e3/chaps/ch4/resources/)

Some of the slides in this lecture are very closely based on the slides for the HCI Book, Chapter 4, so have a look at the original: <http://www.hcibook.com/e3/chaps/ch4/resources/>

Which Computers / Programs Did You
INTERACT with already today?

Days and Topics

March 11	Intro
March 16	Designing Interactive Systems – Assignment 1 Published in Detail
March 23 (10-13)	Prototyping + Evaluating Interactive Systems - Paper Presentation and Discussion (Assignment 1) – Assignments 2-4 Published in Detail – Android Sensing Tutorial Day will be Announced!
April 20	Presentation Assignment 2/3
April 27	Presentation Assignment 2/3 – Submission Assignment 4
May 4	User Interfaces for Ubiquitous Computing - Assignment 5 Published in Detail
May 11	Context-Aware Computing - Details on Final Paper
May 18	Presentation Assignment 5
June 1	Presentation Assignment 5
June 8	Submission Final Paper

Recap

1. UbiComp Definition, Vision, History
2. Methods of Designing Interactive Systems:
 - Storyboards
 - Stakeholder Analysis, Context Diagrams, Work Modelling
 - Prototyping
3. Evaluation Methods
 - Overview
 - Cognitive Walkthrough
 - Heuristic Evaluation

Forward: Technology

- 1. Ubiquitous User Interfaces**
2. Context-Aware Computing

Today

Interaction Paradigms

- Ubiquitous Computing
- Metaphor
- Direct manipulation
- Action vs Language
- Multimodal Interaction

What is an interface?

The Human – Perception and Communication Channels

Ubiquitous User Interfaces – Challenges and Examples

Learning Goals and Motivation

After today's lecture you should

- Understand the concepts
 - Metaphor-based interaction
 - Direct manipulation
 - Action-based vs language-based interaction
- Understand different communication channels that are relevant for humans (and hence in HCI)
- Understand challenges for designing ubiquitous user interfaces
- Know classes of ubiquitous use interfaces
- Be able to give examples for systems that make use of different communication channels, or constitute different UUI classes



Helps you to systematically think through options when you design a new application!

What is an interface?

Interface

Interface: Boundary between 2 Actors

Interactive Systems: Humans and Computers

- Traditionally: 1 Human, 1 Computer
- Increasingly: x Humans, x Computers (CSCW)
- UbiComp: 1 Human, n Computers – x Humans, m*x Computers

Communication mediated by interface

Actors have channels for communication (input/output may blur, e.g., eyes/sight)

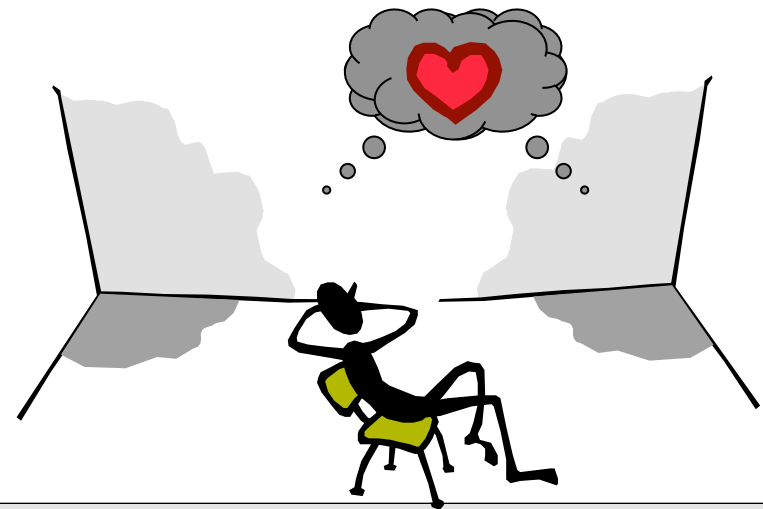
What is a Paradigm?

Example Paradigm Shifts

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- Batch processing
- Timesharing
- Networking
- Graphical display
- Microprocessor
- WWW
- Ubiquitous Computing

A symbiosis of physical and electronic worlds in service of everyday activities.



User Interface Paradigms

Metaphor

Direct manipulation

Language vs. Action

UI Paradigm: Metaphor

Relating computing to other real-world activity is effective teaching technique

- LOGO's turtle dragging its tail
- file management on an office desktop
- word processing as typing
- financial analysis on spreadsheets
- virtual reality – user inside the metaphor



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Problems

- Users understand the metaphor but not the system (what happens when a file is moved?)
- Metaphors may prevent the implementation and understanding of inherently new functionality
- Cultural bias

Reference List: Metaphorical Contexts

- **Desk:** Drawers, files, folders, papers, paper clips, stick-on note sheets
- **Document:** Books, chapters, bookmarks, figures; newspapers, sections; magazines, articles; newsletters forms
- **Photography:** Albums, photos, photo brackets/holders
- **Television:** Programs, channels, networks, commercials, viewer guide
- **Music:** Compact disk, cassette, record, tracks, jukeboxes
- **Deck of cards:** Cards, piles
- **Games,** game rules, game pieces, game boards
- **Film:** Rolls, slide trays, shows, reels, movies, theaters
- **Containers:** Shelves, boxes, compartments
- **Tree:** Roots, trunk, branches, leaves
- **Maps:** Networks, diagram, map: nodes, links, landmarks, regions, labels, base (background), legend
- **Cities:** Regions, landmarks, pathways, buildings, rooms, windows, desks

<http://dl.acm.org/citation.cfm?id=153670>

Reference List: Functions

- **Move** (purposeful traversal): navigate, drive, fly
- **Browse** (low goal-oriented review of options): Rapid replacement, scanning text lines, window shopping, thumbing through books,
- **Scan** (very rapid browsing): fast review of scrollable items, fast review of buildings, objects, people, billboards on highway at high speed
- **Locate**: point, touch, encircle item(s)
- **Select**: touch item, poke item, **grab item, lasso item, place finger on item and slide**
- **Create**: add (new), copy
- **Delete**: throw away, destroy, lose, recycle, shred. Delete (temporary or permanent) sometimes consists of dragging a file icon to a trash can, garbage can, refuse truck, black hole, or a goat.
- **Evaluate**: Rotate knob, slide pointer, twist, spin
- **Pour, flow**: water (pipelines, rivers), electricity.

<http://dl.acm.org/citation.cfm?id=153670>

UI Paradigm: Direct manipulation

Direct manipulation (Shneiderman, 1982)

- visibility of objects
- incremental action and rapid feedback
- reversibility encourages exploration
- syntactic correctness of all actions
- replace language with action



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The interface is a world in which the user can act

UI Paradigms: Language versus Action

Direct Manipulation – interface replaces underlying system -> user carries out “actions” on objects



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Language paradigm

- User tells computer what to do (e.g., search, programming)
- The more intelligent interpretation of user input needs to be, the more this goes towards agent-based interfaces (e.g., natural language based questions)

Ubiquitous User Interfaces

What's new?

Multi-modal: Multiple communication channels

- Increased focus on input via speech, gaze, body movement
- Increased focus on output via

Implicit / invisible interaction: Context-aware, intelligent systems

Challenges

Novel interfaces: Outside known “interface language” (metaphors, icons, terminology...)

Disappearing interfaces: How to interact with an invisible system?

Technology Driven Design: Beyond being cool, what existing problem is solved?

Costs: How expensive will a widespread use of the system be?

The Human

Human Perception

Five senses

- Sight (fast, most accurate in the center of focus, sensitive to movement in the periphery)
- Sound (fast, effective in the background, e.g., selective hearing, noticing changes)
- Touch – temperature, pressure, pain (slow, different body parts have different sensitivity/resolution of receptors)
- Smell (slow)
- Taste (slow)

Other

- Equilibrium
- Kinaesthetic sense (relative position of body parts)

Communication Channels

Visual (Eyes - Text, Icons, Images, Movies, Gestures)

Acoustic (Ears – Mouth, Spoken Language, Music, Noise)

Chemical (Taste, Smell - ???)

Tactile (Touch, Temperature, Kinaesthetic, Balance, Pain – Vibrating Devices, Haptic Interfaces)

.... A view on Communication Channels fro Biology

Examples: Tactile

Mobile phone vibrations

Braille

ActiveBelt:

Koji Tsukada and Michiaki Yasamura. 2011. ActiveBelt: Belt-type Wearable Tactile Display for Directional Navigation. In *Proceedings of Ubicomp 2004*

- For navigation
- For making users aware of ubicomp information
- For reminding users of valuables left behind
- For moving in sync with music, or transmitting rhythmic vibrations to others

Example: Meta-Cookie as Pseudo-Gustatory Display

Takuji Narumi, Shinya Nishizaka, Takashi Kajinami, Tomohiro Tanikawa, and Michitaka Hirose. 2011. Augmented reality flavors: gustatory display based on edible marker and cross-modal interaction. In *Proceedings of SIGCHI 2011* <http://doi.acm.org/10.1145/1978942.1978957>

UUI Classes

Tangible User Interfaces

1. User manipulates a physical object
2. System senses this
3. ... and provides some feedback

TUI Example

Tangible User Interfaces

Embodiment: How far is the output from the object the user manipulates? (input=output, output is near, around or far from the user)

Metaphor: How is the object related to the real-world (not at all, the object's look, the interaction gesture, both, object=physical system)

Surface User Interfaces

Self-illuminated surface via which computation is controlled

- Smartphones, tablets, ambient interactive displays
- Input device: stylus, fingers...
- Often similar interaction paradigms than in traditional GUIs
- Via smartphones, touch-based interfaces have become very widespread, and a touch-gesture language has appeared (tap, double-tap, swiping, zooming)

Ambient User Interfaces

- ... are ignoreable or glanceable
- ... don't always incorporate input and output – or input may be very implicit

Other

Audio Interfaces, both input and output (e.g., Memento
– audio input)

Gestures as input

Sensors as implicit input (e.g., FitBit)

Communication Channels and UUI Classes

	Visual	Acoustic	Chemical	Tactile
Tangible	X			X
Surface	X	(X)		X
Ambient	X	(X)	(X)	(X)
Speech-based / Audio		X		
Sensors as Input	(X)	(X)	(X)	X
Gestures as Input	(X)	(X)	(X)	X

CONCLUSION

Recap

- Interaction Paradigms: Metaphors, Direct Manipulation, Action vs. Language based, multimodality
- Communication channels and their usage in ubicomp systems (visual, acoustic, tactile, olfactory)
- User interface classes and input modalities (tangible, surface, ambient, audio/speech, gestures, implicit/sensor-based)

Readings

Key readings:

- Dix et al., Human-Computer Interaction, Chapter 1 “The Human” and Chapter 4 “Paradigms for interactions”
www.hcibook.com
- Krumm, Ubiquitous Computing Fundamentals, Chapter 6
“From GUI to UUI: Interfaces for Ubiquitous Computing”

Others:

- Human Information Processing Capacity: Miller’s number (7±2) - <http://www.musanim.com/miller1956/>