Human-Computer Interaction 2

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Chapter 4: Interactive Environments

- Rules & Theories for Interaction in Int. Environments
  - Size categories of devices
  - Bimanual interaction
  - Orientation and territoriality on horizontal surfaces
  - Territoriality in space: Proxemics & F-formations
  - Limited Attention
Size Categories: tabs, pads and boards (first mentioned in the Xerox ParcTab project)
Xerox ParcTab (1995)

- Infrared network
  - Base stations in the ceiling
- Each base station was controlled by a IR gateway
- Each tab represented by a SW agent (tab agent)
- Applications written in
  - modula-3
  - Tcl/TK
  - Using MacTabit (~VNC)
- various types of interaction:
  - across multiple displays
  - context-dependent interaction
  - voting in presentations
Tabs, pads...

• Tabs, inch-sized (1 Inch = 2.54 cm)
  – small handheld networked devices

• See also Active badges
  – specialized tabs, enable localization

• Pads, foot-sized (1 Foot = 30.47 cm)
  – mixture of laptop, palmtop, sheet of paper

• Introduced the concept of a disposable computer, (20 years ago!): no identity, impersonal

• Provided a solution to the lack of space on windows based systems
...and boards

• Boards, yard-sized (1 Yard = 0.914 m)
  – used as chalk boards, TVs, display boards

• Power of Ubicomp stems from the interaction of all devices.

• Ubicomp can „awake“ lifeless things (books, overhead slides, etc.)

• Problem: today it‘s easier to read a book than to sit down at a complicated Personal Computer

• Transition will happen in small steps
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Bimanual interaction

• symmetric: the two hands have the same role
• asymmetric: the two hands have different roles

http://www.lecker.de/media/redaktionell/leckerde/backen_1/weihnachten_10/plaetzchenbacken/hbv_1382/muerbeteig-ausrollen_img_308x0.jpg
Kinematic Chain Theory (KC)

"Under standard conditions, the spontaneous writing speed of adults is \textit{reduced} by some 20\% when instructions \textit{prevent the non-preferred hand} from manipulating the page”

Literature: Yves Guirad (1987). Asymmetric Division of Labor in Human Skilled Bimanual Action: The Kinematic Chain as a Model
Kinematic Chain Theory

• Guiard’s principles
  – Right-to-left spatial reference
    • The non-dominant hand sets the frame of reference for the dominant hand
  – Left-right contrast in the spatial-temporal scale of motion
    • Non-dominant hand operates at a coarse temporal and spatial scale
  – Left hand takes precedence in action

• Kinematic chain
  – Each limb is considered a motor if it contributes to the overall input motion.

• Kinematic chain theory
  – Although separated, the two hands behave like being linked within the
Two-handed Interaction Example

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Territoriality on tables (Scott 2004)

- Studies on how people use the space on a table
  - puzzle, game, Lego activities + room planning on round tables
- Different areas on the table surface
  - personal space (directly in front of person)
  - group space (reachable by all members)
  - storage space (in the periphery)
- Boundaries between areas are flexible
Territoriality on tables (Scott 2004)
Mini-Brainstorming: Orientation

• What is the problem at all?
  – multiple users!
  – sitting around the display, not in front of it...

• Ideas how to solve it?
  – round objects ;-) 
  – automatic rotation towards the user
  – objects freely rotatable

• Does orientation also communicate anything?
  – showing something to somebody
  – making something private
Space and Orientation on tables (Scott 2004)

• Design Implications:
  – Provide visibility and transparency of action
  – Provide appropriate table space
  – Provide functionality in the appropriate locality
  – Allow casual grouping of items and tools in the workspace
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Challenge: Social interaction & awareness

• Instrumented environments are no longer single user
  – users might collaborate locally
  – users might compete for resources locally
  – users might collaborate remotely

• Users need to be aware of technology
  – discoverability: How do I see what I can do?

• Technology aware of users
  – Example: proxemic interactions
  – Example: group mirrors

http://www.smart-future.net/13.html
Do you notice anything?

Literature: Marquardt N. et al: Cross-Device Interaction via Micro-mobility and F-formations, UIST’12
A spatial model for social interactions: F-formations

- Images taken from Nicolai Marquardt's PhD thesis:
Proxemic interactions based on F-formations

• extend spatial relationship concept to machines
  – F-formations between humans and Displays
• see proxemic media player shown later...
Proxemics

- coined by anthropologist Edward Hall in the 60s.
- human use of space within the context of culture
  - unconscious internalization of cultural patterns used for communication through the use of space.
    - intimate space: ‘bubble’ surrounding a person, for close friends and intimates.
    - social space: people feel comfortable conducting social interaction with acquaintances and strangers.
    - public space: area beyond which people perceive interaction as impersonal or anonymous.
Proxemics

• proxemics: people’s use of personal space to mediate social interactions
  – interpersonal physical distance = social distance
  – estimation of people’s desire to communicate with one another via devices they carry

• dimensions of proxemics relationships
  – **position**: spatial relationship between two entities
  – **orientation**: facing direction of entities (person’s eyes, tip of a pencil)
  – **movement**: understand changes of position and orientation of entity over time (e.g. person approaching particular devices or object)
  – **identity**: uniquely describe entities in space, categories of objects, group affiliations etc.

Literature: Marquardt N. et al: Cross-Device Interaction via Micro-mobility and F-formations, UIST’12
F-formations and Micro-mobility

• **F-formations**: distance and relative body orientation among multiple users reveals when and how people position themselves as a group
  – physical arrangement that people adopt when engaging in conversations.

• **Micro-mobility**: how people orient and tilt devices towards one another to promote sharing during co-present collaboration

Literature: Marquardt N. et al: Cross-Device Interaction via Micro-mobility and F-formations, UIST’12
...between user and device

Implicitly switching to full screen view when sitting down
...between multiple users
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Challenge: limited attention resources

• We will see change blindness as an example
  – limited visual attention
  – reasons physiological and cognitive

• Attention is generally a limited resource
  – various parts of the environment may compete for our attention
  – how does the mind decide what to pay attention to?

• Visual stimuli might be out of sight

• Acoustic stimuli might drown each other out
  – cocktail party effect may help us
Negative Example (from Minority report)

http://www.youtube.com/watch?v=7bXJ_obaiYQ
A Model of Human Attention

- [http://books.google.de/books?id=dIagIraXHPUC](http://books.google.de/books?id=dIagIraXHPUC)
SEEV model of influencing factors


S: Salience: The bottom-up attention capturing properties of events, bright flashes, sounds, etc. The salient runway line in the Singapore Airlines crash.

Ef: Effort: Inhibits the movement of attention across longer distances: bigger scans, head movements. Failure of drivers to “check the blind spot” before lane changing.

Ex: Expectancy: The likelihood of seeing an event at a particular location: a top-down cognitive factor that is calibrated to the bandwidth (frequency of occurrence) of events that occur at that location.

V: Value: The importance (value) of tasks served by the attended event, as well as the relevance of the event to a valued task. Also top-down

Probability of attending \( P(A) = s*S - ef*EF + \frac{ex*EX + vV}{(ex*EX * vV)} \)

Which one?
Example: unexpected warnings

- F. Lauber, A. Butz: In-Your-Face, Yet Unseen? Improving Head-Stabilized Warnings to Reduce Reaction Time, CHI 2014
- driving scenario with a secondary visually demanding task
- warnings in HUD and HMD
- Warnings in the main field of view (HMD) were not faster than in the constant location (HUD)
- After introducing a visual maker for the place where warnings would appear (expectancy), they were faster!
Example: notification in ambient soundscapes

- known effect: we recognize known sounds
  - even when they are played in the background
  - crosses the border from subconscious to conscious

- idea: use this to notify people of events
  - play an ambient piece of music
  - to notify, mix in a motif known to that person
  - ...or a specific instrument

- effect: remains unnoticed to other people
Notification in Ambient Soundscapes
[Butz, Jung, IUI 2005]
Notification in Ambient Soundscapes
[Butz, Jung, IUI 2005]

- Core music always present
- Notification in a musically fitting way
  - Learned by target person
- Crosses the border to conscious perception by the target person
- Ignored by other people
- Quantitative user study
  - Audio Workshop at Pervasive 2005