Research Overview

(Physical & Tangible User Interfaces)

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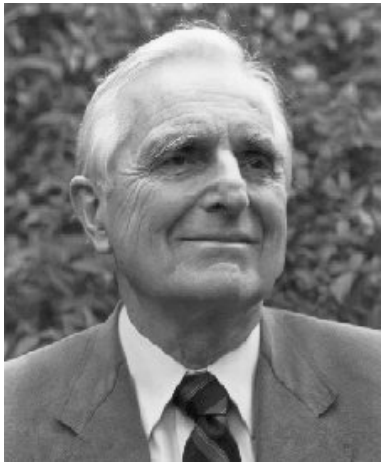
Mouse and other input devices
Douglas Engelbart

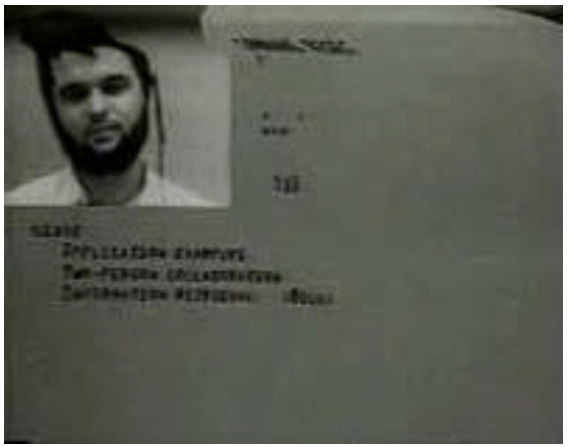
Inventing the Mouse

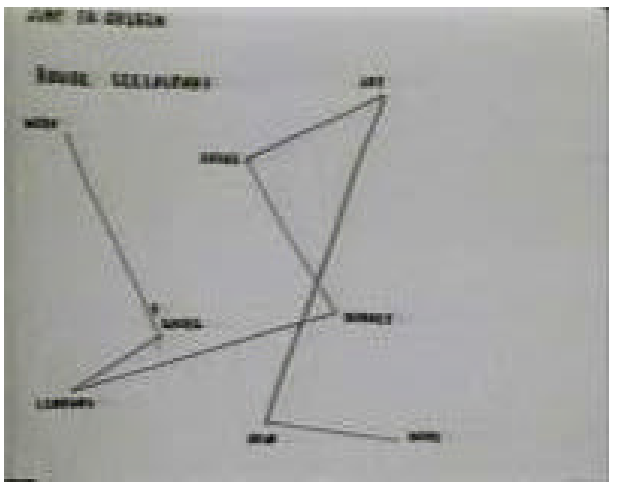
http://www.superkids.com/aweb/pages/features/mouse/mouse.html



Mouse and other input devices
Douglas Engelbart (cont.)

http://sloan.stanford.edu/mousesite/1968Demo.html
(videos)





Mouse and other input devices
Douglas Engelbart (cont.)

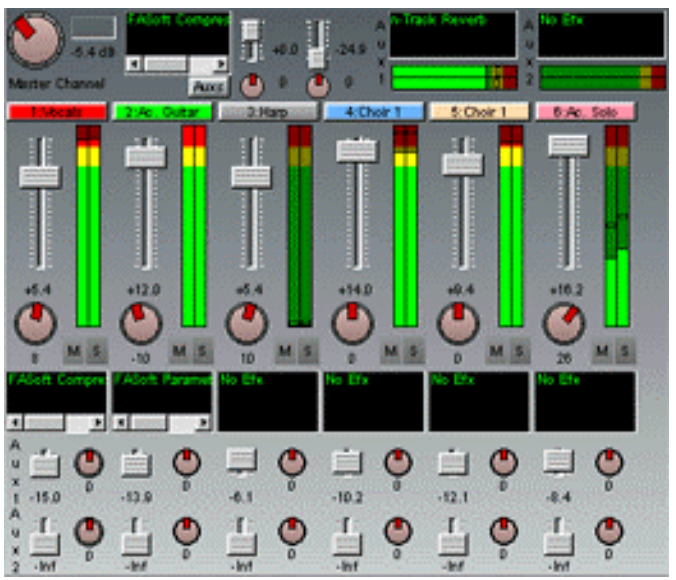
- Douglas Engelbart
  - Mouse
  - Two handed input
- Methodology? – Demo!
- Devices design has implications on user action
  - Two wheels → lift one an go straight
  - Wheels that keep going → accelerate, lift and put down to stop
- Input devices and output devices have implications on the applications possible
- Was a really novelty that allowed major advances in HCI
- Has been perfected since…

Some 35 years later …

Throw away your keyboard and mouse.

(Cooperstock et al., 97)

- So what is the problem with mouse & keyboard?
  - Time multiplexing is implied!
  - One operation at the time (e.g. slider can be only be moved sequentially with the mouse)



Experiment: Reactive Environment

(Cooperstock et al., 97)

- Further problem: traditional UIs overload the user
  - User has to map icons or text labels to functionality
  - Often the association is not clear
  - Every detail has to be controlled
- Goal of their research „... reduce cognitive load of the user by allowing the system to make context- sensitivereactions...“
- Result: computer-augmented video conferencing environment
- Design principles:
  - invisibility
  - manual override
  - feedback

Design Principles

(from Reactive Environment, Cooperstock et al., 97)

- Invisibility of UI
  - Intuitive usage: taking a pen results in the centring of the video view on the whiteboard
  - System maintains awareness through sensors (e.g. micro-switches, or image algorithms)
- Manual Override
  - Needed when technology behaviour differs from user‘s intention
  - „still want to switch off the lights“
    - Without reading instruction (light switch must still be the light switch)
  - Override interface must be simple, e.g. button-and-light module
- Feedback
  - Problem: users repeatedly press a button until something happens
  - Signal the user that the system is working, Assure that the user is not the problem
  - Visual (LEDs) and audio („beep“) feedback

Reactive Environment

- Cooperstock, J., Fels, S., Buxton, W. & Smith, K.C. (1997).*Reactive environments: Throwing away your keyboard and mouse.* Communications of the Association of Computing Machinery (CACM), 40(9), 65-73.

Graspable and Tangible User Interfaces

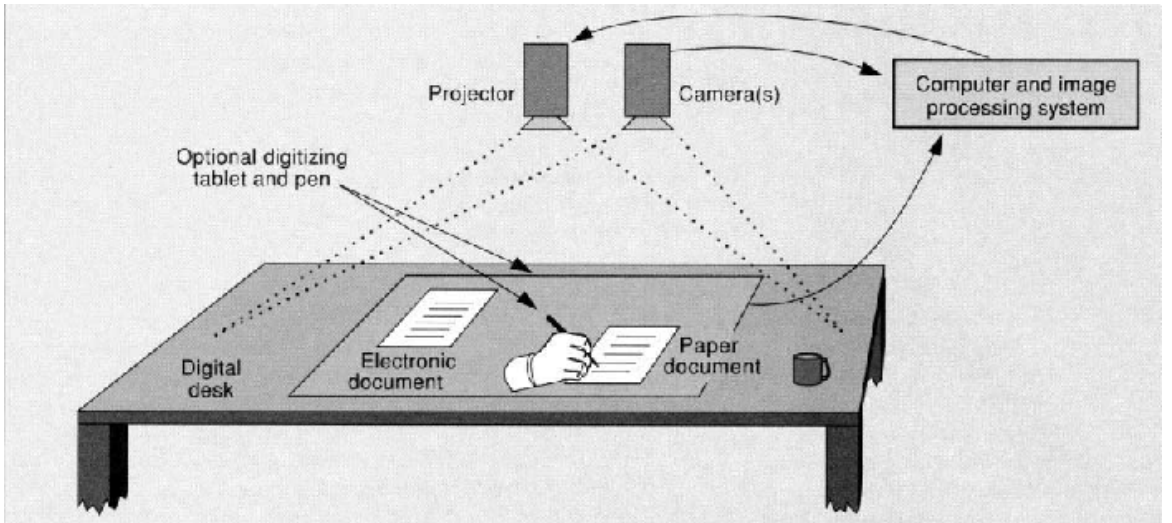
- The real world becomes the interface
- Coupling of digital information with objects in the real world

Marble Answering Machine

- Concept and Design of a Tangible answering machine
  - Durrell Bishop, RCA
  - Marbles represent calls
  - Interact with marbles to
    - play message
    - to call back

Wellner's Desk

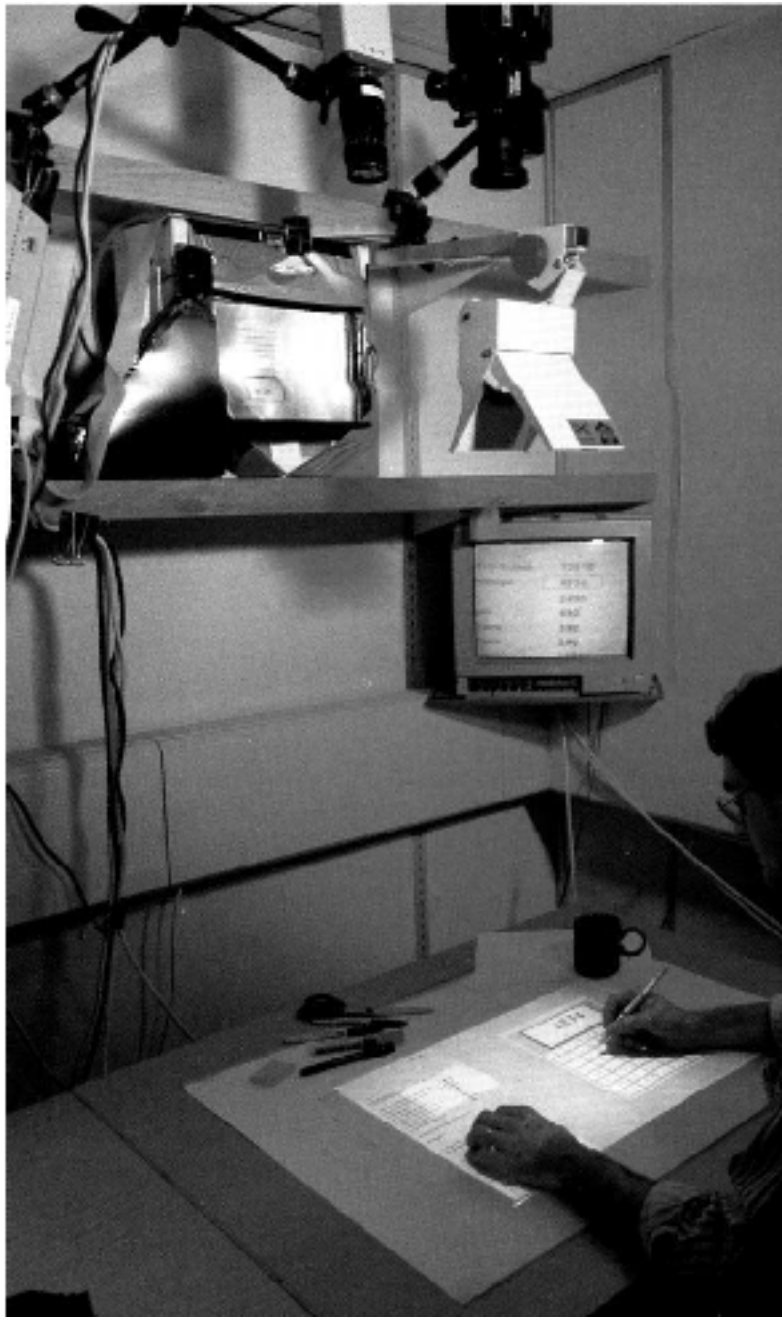
- Desk with top-projected video
- Camera tracking from above
- Digitizing tablet



Wellner. The DigitalDesk Calculator: Tangible Manipulation on a Desk Top Display UIST'91.
http://www.ics.uci.edu/~jpd/NonTradUI/p27-wellner.pdf

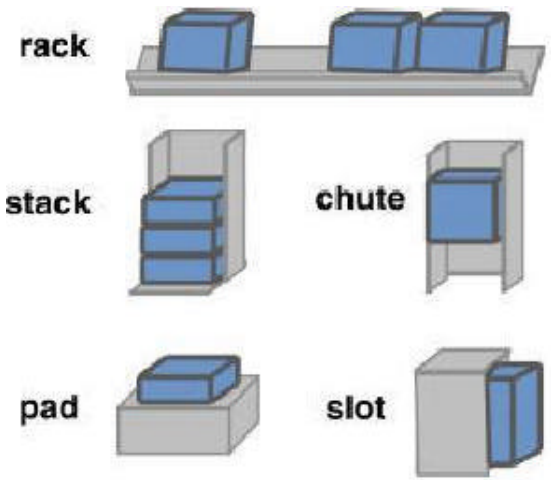
Wellner's Desk (Cont.)

- Interact with real paper
  - Digitize with camera
  - recognize action & gestures
  - Overlay with video
- **Video (8 min)**
  http://www.ics.uci.edu/~jpd/ddesk.mov



Tangible mediaBlocks

- http://tangible.media.mit.edu/
- mediaBlocks are electronically tagged wooden blocks serving as physical icons (phicons)
  - containers for digital information
  - Physical controller (media sequenzer)



Media sequencer - physical constraints, used in combination with mediaBlocks as physical controls

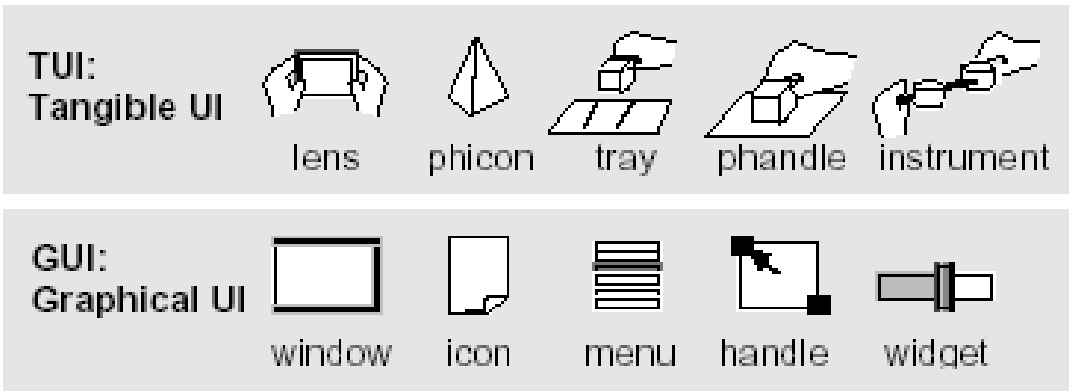
- MediaBlock Papers & **Video (4min)**: http://tangible.media.mit.edu/projects/mediaBlocks/mediaBlocks.htm

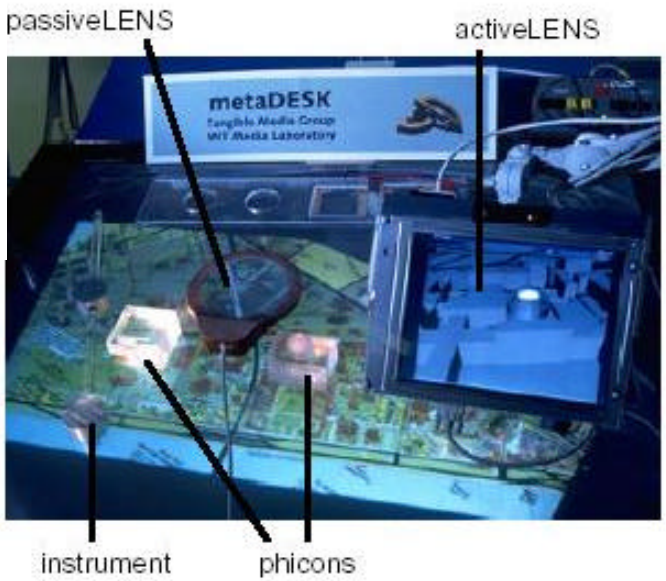
Tangible Bits (Ishii, Ullmer) CHI‘97

- „grasp & manipulate“ bits by coupling bits with everyday objects
- **Goal:** bridge the gaps between virtual+physical world
- Interactive surfaces, e.g. metaDESK
- Coupling of bits with objects, e.g. transBOARD
- Ambient media, e.g. ambientROOM

Tangible Bits - metaDESK

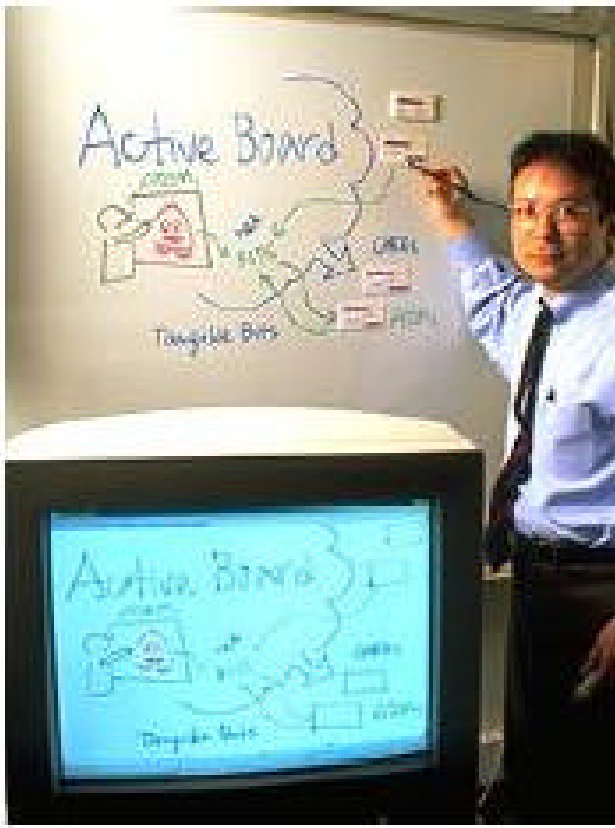
- Push the GUI back into the physical world
- Paper&Video:
  http://tangible.media.mit.edu/projects/metaDESK/metaDESK.html





Tangible Bits - transBOARD

- One-Way interactive surface absorbing information from the physical world (strokes) and transforming it into bits
- Strokes are stored digitally on „hyperCARDs“
- „hyperCARDs“ are the physical representation of the stored data



Tangible Bits - ambientROOM

- Ambient media (light, shadow, sound, airflow, waterflow) as carrier of information at the periphery of human perception
- Present website hits as rain sound or water ribbles projected on the ceiling
- Change in the background media attracts user‘s attention

Tangible Bits

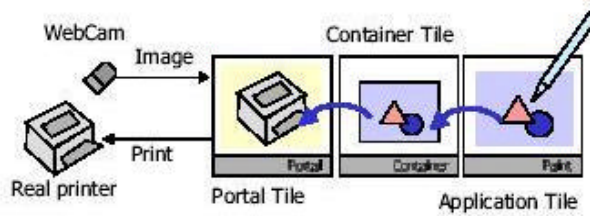
- Ishii, H., Ullmer, B. *Tangible Bits. Towards Seamless Interfaces between People, Bits and Atoms*. CHI 97, March 22-27, Atlanta, GA.
- Ullmer, B., Ishii, H., Glas, D. mediaBlocks: Physical Containers, Transports, and Controls for Online Media. SIGGRAPH 98, 19-24 July 1998, Orlando, Florida.

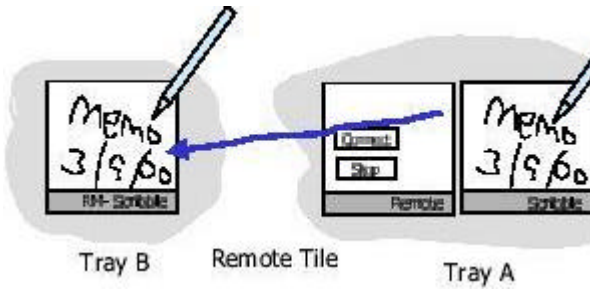
Data Tiles
(Rekimoto et al., 2001)

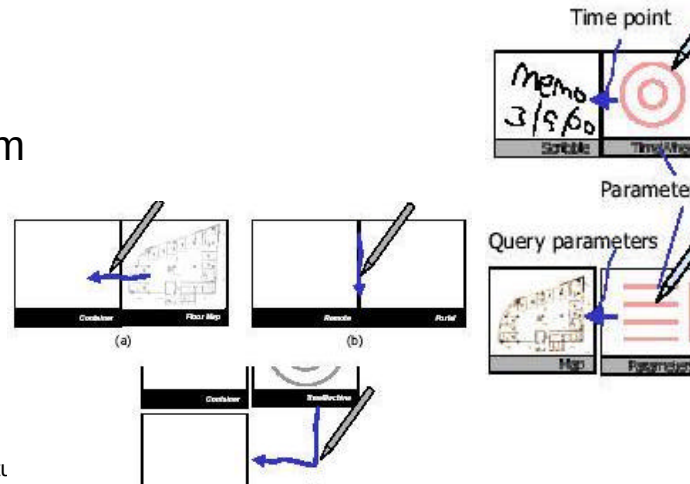
- ...RFID tagged transparent tiles working like a window for digital information and trigger action
- Interaction Ideas:
  - Tagged transparent objects as interaction modules
  - Mixed physical and graphical interaction modules
    - fuse printed images with dynamic displayed graphics
    - Digitizer pen (mouse and widget control)
    - Engraved grooves
  - Combination of multipletiles creates complex interaction possibilities
- Paper & Video:
  http://www.csl.sony.co.jp/person/rekimoto/datatile/

Data Tiles (2)

- Combination of multiple tiles creates complex interaction possibilities
  - Adjustment/Control functionality (parameter tiles)
  - Select video/printer output (portal tiles)
  - Display dynamic content, e.g. weather, broadcasts (application tiles)
  - Record content of other tiles (container tiles), e.g. for concatenation
  - Connect distributed tile trays, i.e. workplaces using tiles (remote tiles)
- Adjacent placing connects 2 tiles (implicit)
  - Depending on neighbour tile, the placed tile has different meaning, e.g. time-wheel tile works as movie playback controller or scrolls past webcam images
- Inter-tile gestures (pen) connects multiple tiles (explicit)







Data Tiles - References

- Jun Rekimoto, Brygg Ullmer, and Haro Oba, *DataTiles: A Modular Platform for Mixed Physical and Graphical Interactions*, CHI2001, Seattle, WA. March 31 - April 5, 2001.

Ambient Media

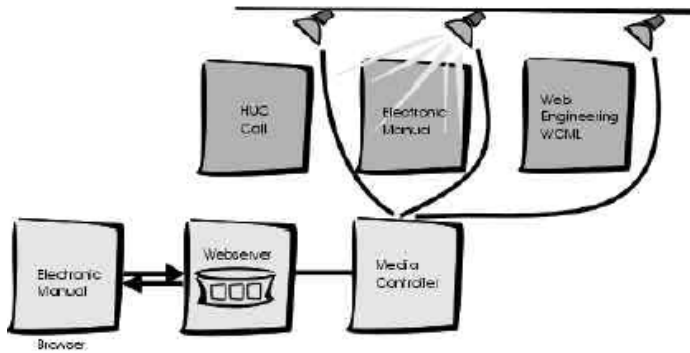
- Idea: make invisible processes in the virtual world „visible“ in the real world
- „visible“ means noticeable in an ambient way
  - No exact statements about virtual processes
  - Create impression of what and how much is going on
  - Ambient information is consumed subtly, i.e. with a wink
  - Observer‘s attention can change between foreground and information in the background/ periphery
- Examples: light, sound, smell, movement, ...

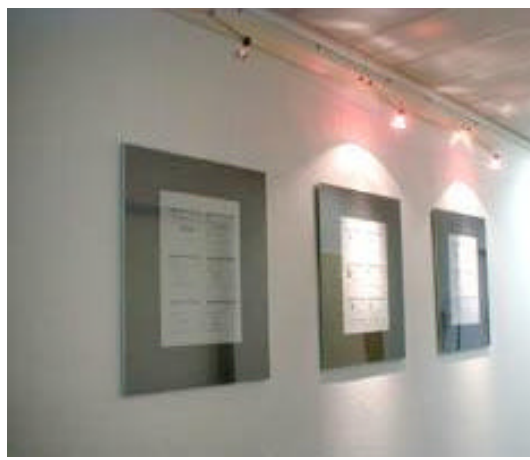
Ambient Media - Examples

- **Dangling String** (Natalie Jeremijenko, Xerox PARC)
  - Motor with a 2.4m string
  - Electrically connected to an Ethernet cable
  - Each bit causes a tiny twitch
- Let observer discriminate between heavy and low network traffic

Ambient Media - Examples

- **TrafficLights** (Schmidt et al., TecO)
  - Light bulbs in front of posters indicate web accesses on topics shown on posters
  - Light intensity changes according to hits/time period
- Passing observer can discriminate between web accesses on various topics

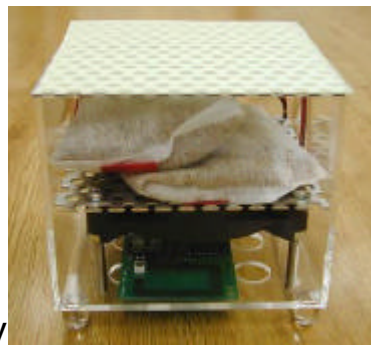




Ambient Media - Examples

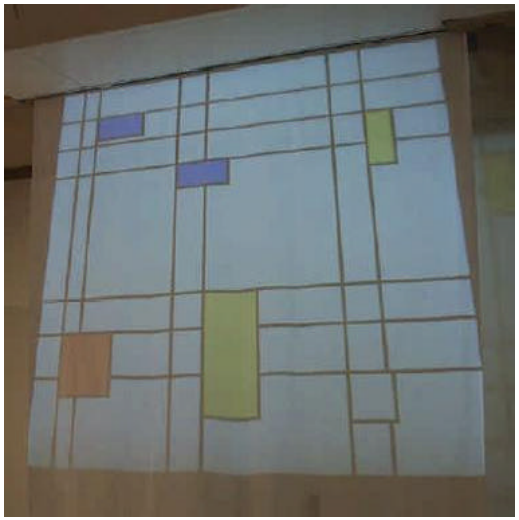
- **Meeting Pot** (Siio et al., Tamagawa Univ.)
  - „If the coffee machine is turned on, it transmits the aroma to remote locations“
  - Kitchen: coffee machine knows it state and transmits any change to remote locations
  - remote locations: coffee aroma generators are installed (coffee powder+fan)
- Transmit a smell beyond it natural distribution area
- Informal communication, e.g. meeting request

Coffee maker + RF transmitter

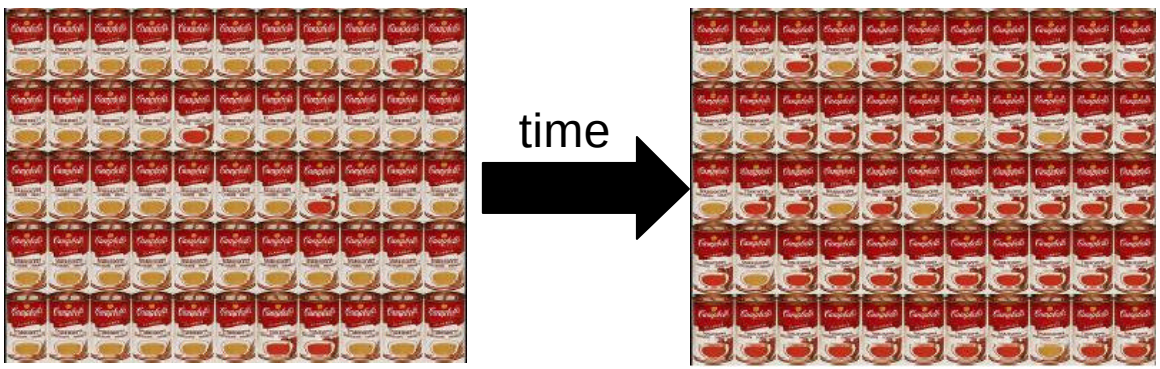

Coffee aroma display

Ambient Media - Examples

- **Informative Art** (Holmquist et al., PLAY)
- Aggregate different information like weather data form several loaction in a changing representation of an artwork



Add colored rectangles in a Mondrian‘s artwork according to temperatures i several cities

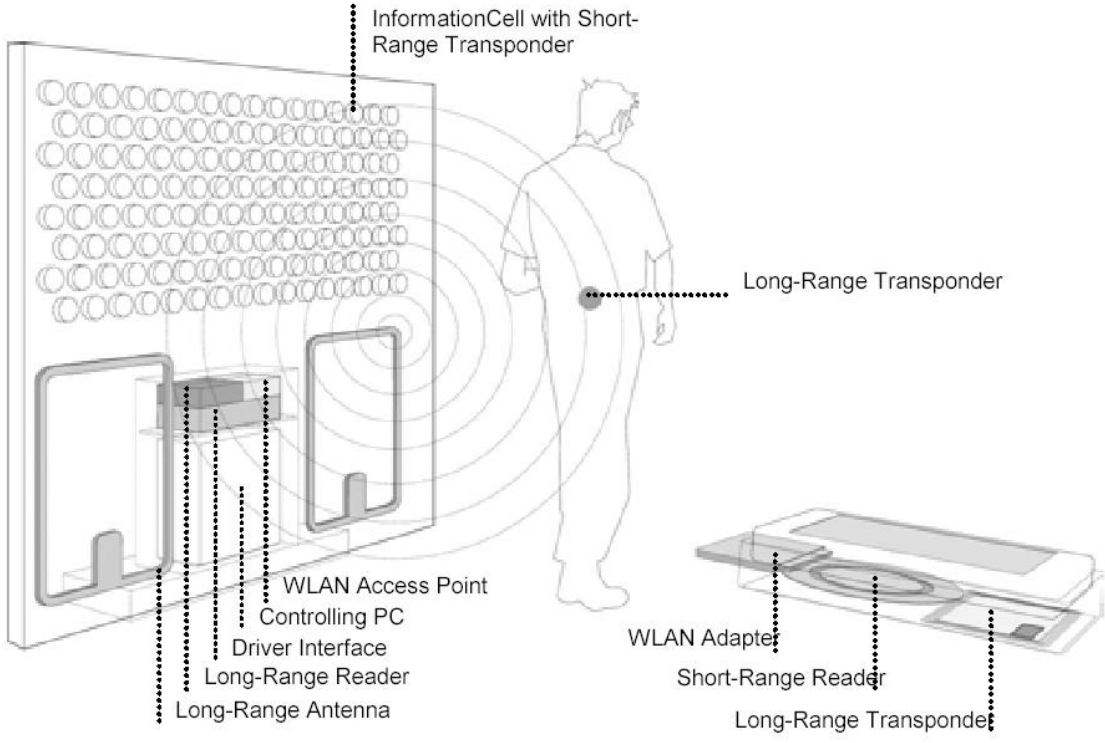


Andy Warhol's painting „200 Campbell's Soup Cans“ changes as time goes by (abstract clock)

Ambient Media and beyond

hello.wall

Video



n. Prante, C. Röcker, N. A. Streitz, R. Stenzel, C. Magerkurth, D. van Alphen, D. A. Plewe: Hello.Wall – eyond Ambient Displays. In: Peter Ljungstrand, Jason Brotherton (Eds.): Video Track and Adjunct Proceedings the 5th Intern. Conference on Ubiquitous Computing (UBICOMP'03), Seattle, Wash., USA, Oct. 12-15, 2003

Ambient Media - References

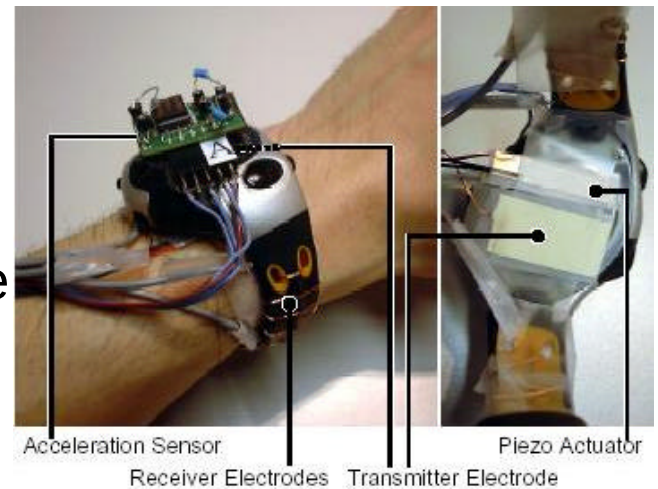
- Hans-W. Gellersen, Albrecht Schmidt and Michael Beigl: *Ambient Media for Peripheral Information Display*. Personal Technologies Volume 3(4), December 1999. pp199-208.
- http://siio.ele.eng.tamagawa.ac.jp/projects/pot/
- Holmquist, L. E. & Skog, T.: *Informative Art: Information Visualization in Everyday Environments*. In Proceedings of Graphite 2003
- Th. Prante, C. Röcker, N. A. Streitz, R. Stenzel, C. Magerkurth, D. van Alphen, D. A. Plewe: *Hello.Wall – Beyond Ambient Displays.* In: Peter Ljungstrand, Jason Brotherton (Eds.): Video Track and Adjunct Proceedings of the 5th Intern. Conference on Ubiquitous Computing (UBICOMP'03), Seattle, Wash., USA, Oct. 12-15, 2003

Gesture Interfaces

- Input by gestures, e.g. hand signs
- Convenient
- Natural
- Unobtrusive
- Personal
- Usable in difficult situations, e.g. mobile scenarios

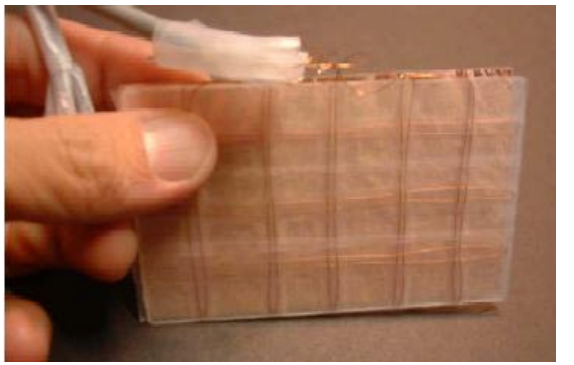
Gesture Interfaces - Examples

- Gesture Wirst and Gesture Pad (J. Rekimoto, Sony CSL)
  - Gesture Wirst
    - Wirst watch alike
    - Measure changes in wirst shape capacitivily
    - Movements are measured by accelerometers
    - Used as command input device
    - User gets a tactile feedback, when a gesture was regocnized



Gesture Interfaces - Examples

- Gesture Pad
  - Capacitive sensor pad
  - Embedded into cloths
  - Cloths as interaction surface („interactive clothing“)
  - Detect and read finger motions applied on the outside of cloths
- Combine with Gesture Wirst
  - Select-and-adjust
  - Transmit data from wirst to pad via body



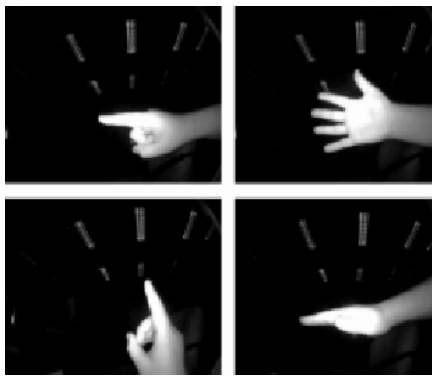
Sensor pad

Interactive clothing

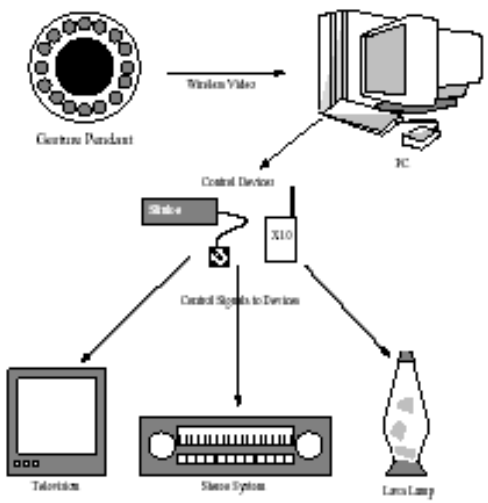
Gesture Interfaces - Examples

- Gesture Pendant (Starner et al., GaTech)
  - Small camera illuminated with IR LEDs
  - Worn as necklace or pin
- Camera captures video, gestures are recognized in backend
  - Control gestures (simple, for continuous control)
  - user-defined gestures (complex, for discrete control)
- Applications
  - Desktop and portable control
  - Control home automation devices
  - Medical monitoring (tremor)

Gesture Pendant



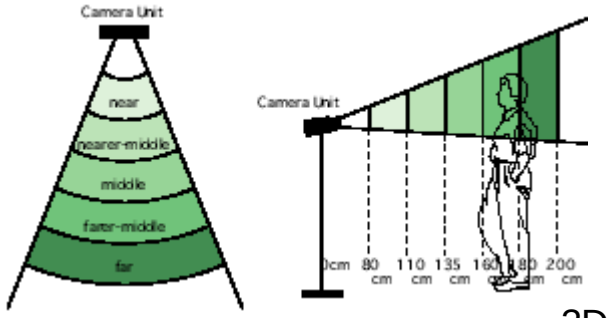
Control Gestures



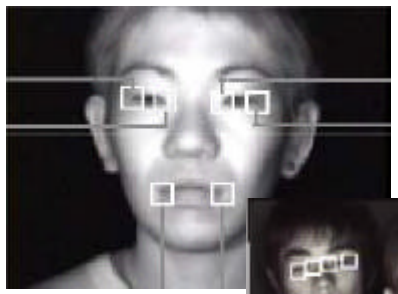
Pendant captures video tranmit it wirelessly to back-end, where gestures are recognized

Gesture Interfaces - Examples

- 3D multi person face tracking (Nakanishi et al., Uni Tokio)
- Stereo camera system tracks
  - ... 3D position of person‘s face
  - ... Orientation of person‘s face
  - ... Multiple persons
  - in real-time.
- Control display content in front of the user
  - Eyes movements as input for user interfaces
  - Advertisement/Marketing evaluations



3D position



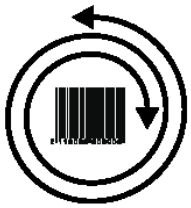
Facial detecting

Multi person tracking + orientation

Gesture Interfaces - Examples

- RWGUI - Real World GUI (Masui and Siio, Sony CSL)
- Control real-world appliances (VCR, etc.) like desktop GUIs
- Functionality of desktop GUI widgets is transfered into FieldMouse
  - ID detection device (RFID, barcode reader)
  - Motion detection device (gyro or accelerometer)
- Examples: buttons, sliders, menus, scrollers, drag-and-drop, zooming, authoring, real-world-programming
- Feedback: audio since visual is not appropriate

FieldMice



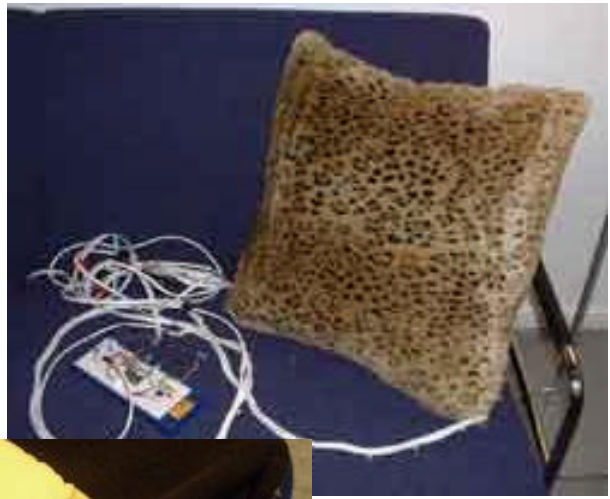
Controls

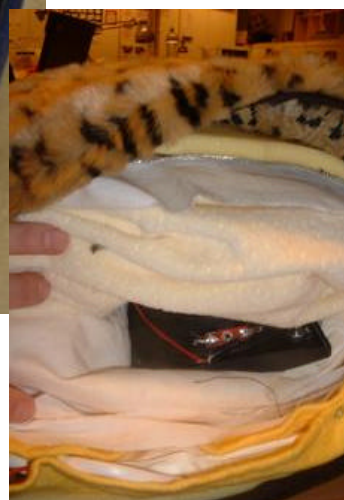
Gesture Interfaces - References

- Jun Rekimoto. *GestureWrist and GesturePad: Unobtrusive Wearable Interaction Devices.* ISWC 2001, 2001
- Thad Starner, Jake Auxier, Daniel Ashbrook, Maribeth Gandy. *The Gesture Pendant: A Self-illuminating, Wearable, Infrared Computer Vision System for Home Automation Control and Medical Monitoring.* Proceedings of IEEE International Symposium on Wearable Computing (ISWC 2000). Atlanta, GA. October 2000. pp. 87-94.
- Yasuto Nakanishi, Atsushi Nagasawa and Hideki Koike. *Enlargement of a Movement Area and Processing Multi Persons in a Vision-Based Face Tracking System.* Physical Interaction (PI03) Workshop on Real World User Interfaces (MobileHCI 2003). Udine (Italy), September 8-11 2003
- Toshiyuki Masui, Itiro Siio. *Real-World Graphical User Interfaces.* In Proceedings of the International Symposium on Handheld and Ubiquitous Computing (HUC2000), pp.72-84, September 2000.

Interactive Design

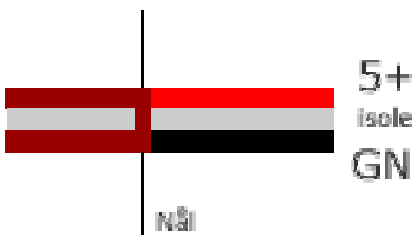
- Interaction design course at the IT University, Göteborg
- Pillow‘Mate 3000 (Dahlberg, A., Dahlén, O., Harup, A., Karner, J., Måhlin, C.)
  - Interactive pillow as replacement for a cat for lonesome people or people under stress
  - Pillow heats up
  - Touching the corner results in sound and vibration like a purring cat





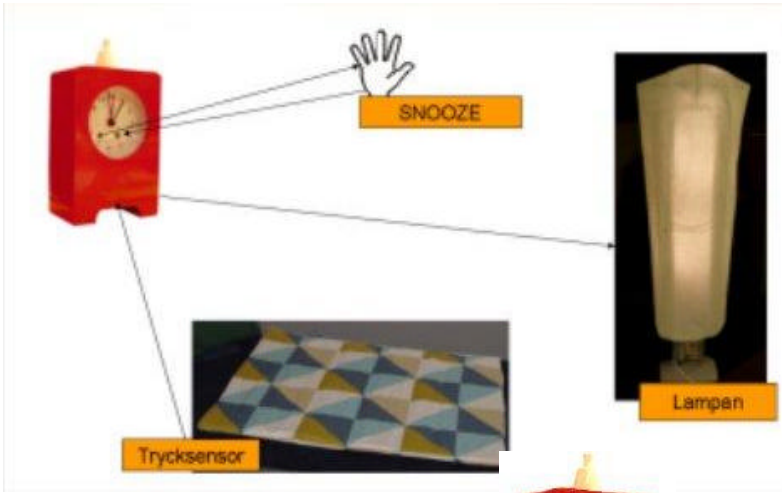
Interactive Design

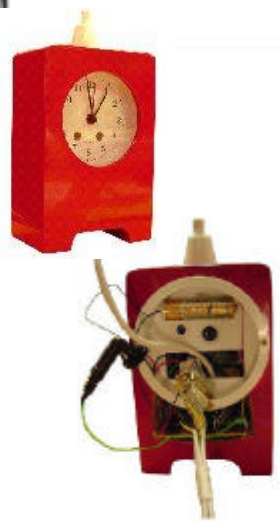
- VooDoo (Andersson J., Lundberg A., Normand E., Lundgaard, R.)
- Voodoo doll as input device
  - Needles with certain symbols have certain meaning
  - Symbols are identified via RFID transponder
  - Needles work as penetration sensors
- Application: trigger certain messages as SMS, E-mail or post them on public notice boards



Interactive Design

- Grynet (Antonsson, J., Eriksson, C., Johansson, A., Makelberge, N., Sarnold, B.)
  - Silent wake up
  - dawn simulation by building a lamp connected to an alarmclock
  - After the awakening procedure and if the user has not left the bed, the lamp will begin to blink.





Interactive Design - Reference

- http://www.cs.chalmers.se/idc/ituniv/student/2002/ubicomp/index.html

Sentient Computing

The world as seen by users.

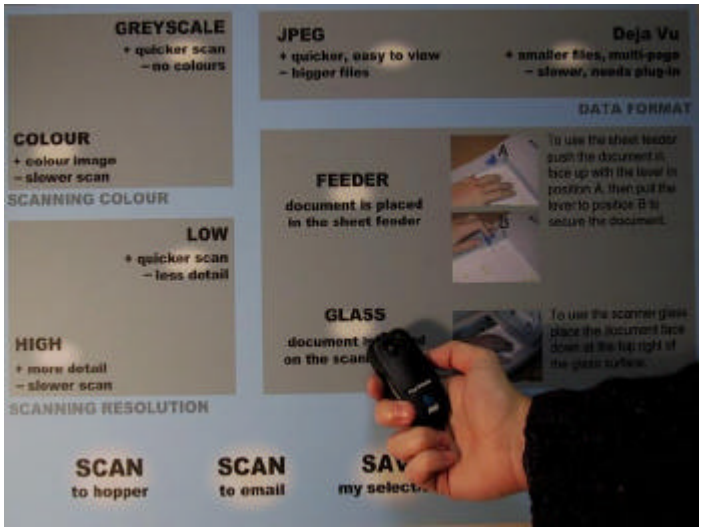
The world as seen by the sentient computing system.

http://www.uk.research.att.com/spirit/

Video (8min)

Further Videos:
http://www.uk.research.att.com/labvid.html

Papers:
http://www.uk.research.att.com/abstracts.html



Interactive Modelling (Merl)

http://www.merl.com/papers/TR2000-13/

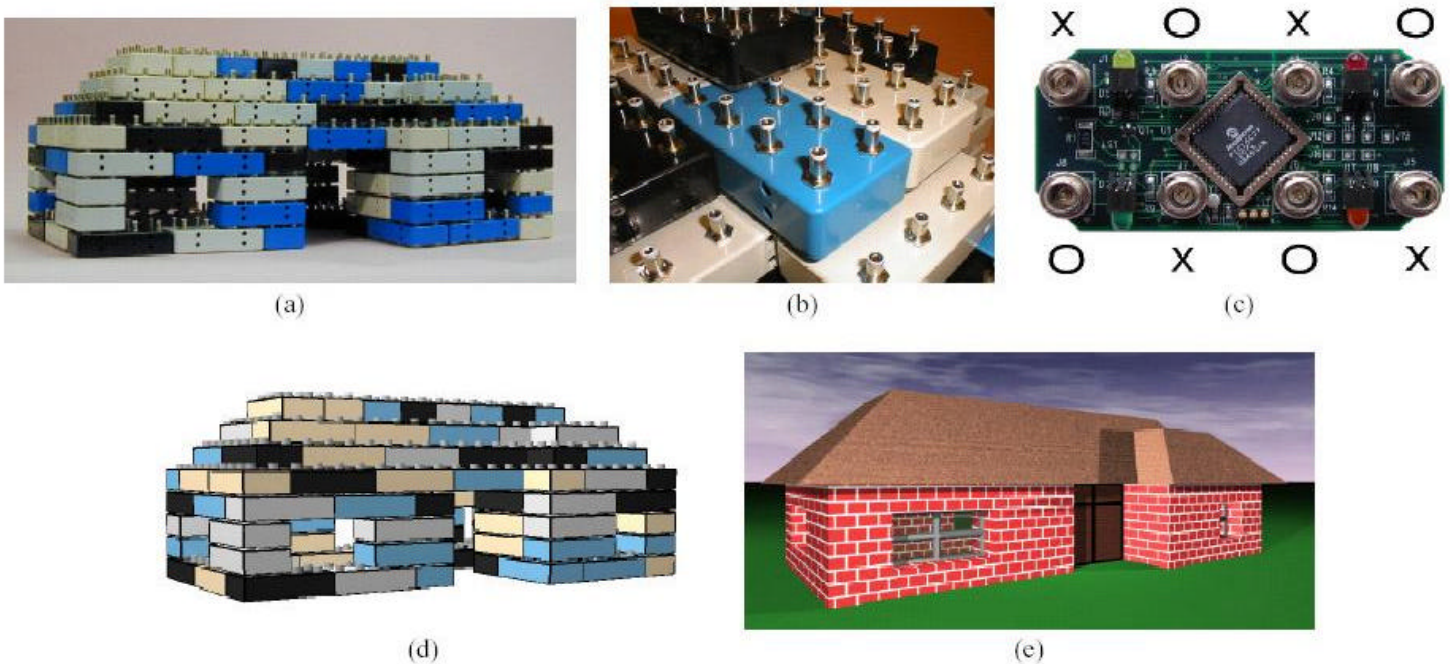


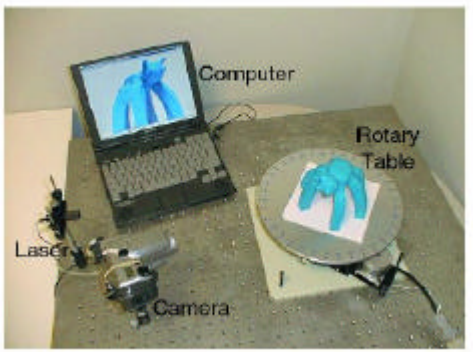
Figure 1: (a) a physical block structure comprising 98 blocks; (b) a close-up of the blocks; (c) a bottom view of the circuit board inside each block; and renderings of the virtual model recovered from the structure, one literal (d) and one interpreted (e). The literal rendering uses associated shapes and colors to render the blocks. The virtual model is augmented automatically for the interpreted rendering.

Interactive Modelling (Merl)

http://www.merl.com/papers/TR2000-13/

Figure 4: (a) a model of a castle comprising 118 blocks, and (b) an interpreted rendering of it. The automatic enhancements in this graphical interpretation include the addition of turrets, roofs, windows, archways, a portcullis, and a flagpole in appropriate locations, as well as the selection of suitable surface properties and features for all the geometry. The 560-block model in (c)—a 12-inch ruler is included to show scale—was built as a challenging virtual environment for Quake II, the data format for which is another output option in our system. Applying the same interpretive style to this larger model to get the rendering in (d) requires changing only one numerical parameter indicative of building scale: it specifies the smallest number of blocks in the structure that can constitute a distinct architectural feature.

Interactive Modelling Cont. (Merl)



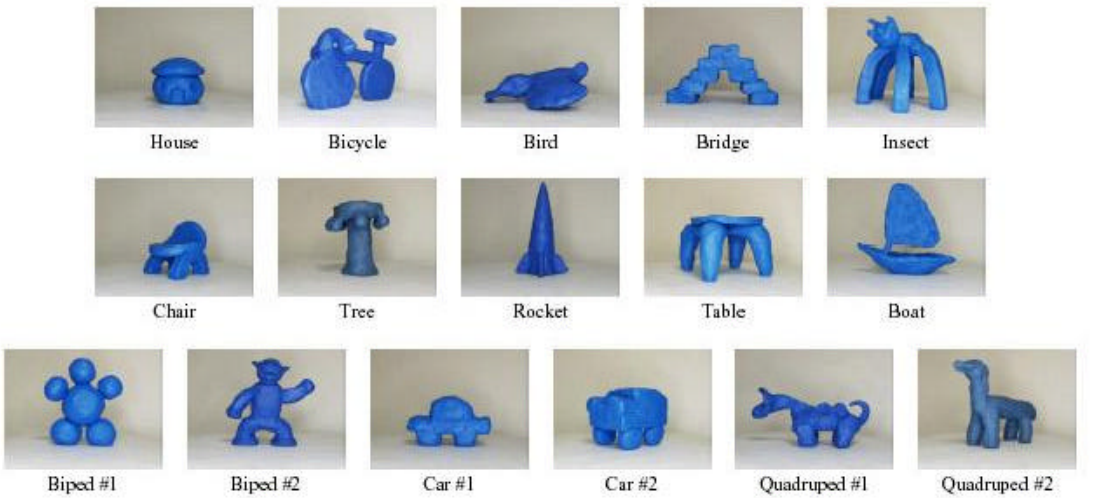
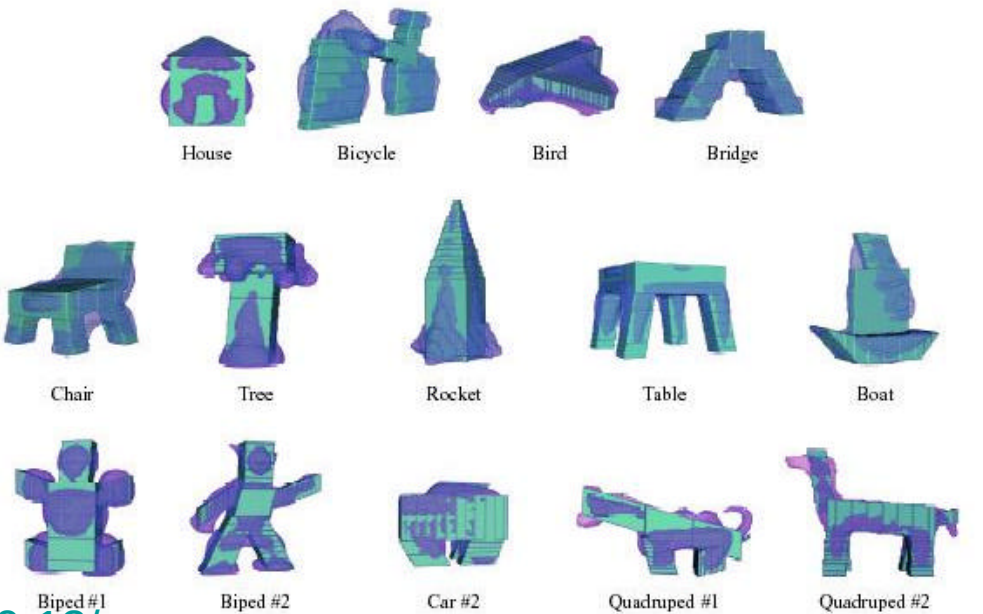


Figure 8: Examples from the image sequences for the 16 clay models captured by the camera illustrated in Figure 5.



http://www.merl.com/papers/TR2000-13/

Interactive Modelling (Merl)

- Anderson, D.; Frankel, J.L.; Marks, J.W.; Agarwala, A.; Beardsley, P.A.; Hodgins, J.K.; Leigh, D.L.; Ryall, K.; Sullivan, E.; Yedidia, J.S., "Tangible Interactions and Graphical Interpretation: A New Approach to 3D Modeling", ACM SIGGRAPH, ISBN: 1-58113-208-5, pps 393-402, July 2000

Roomware (Streitz et al., GMD/FHG)

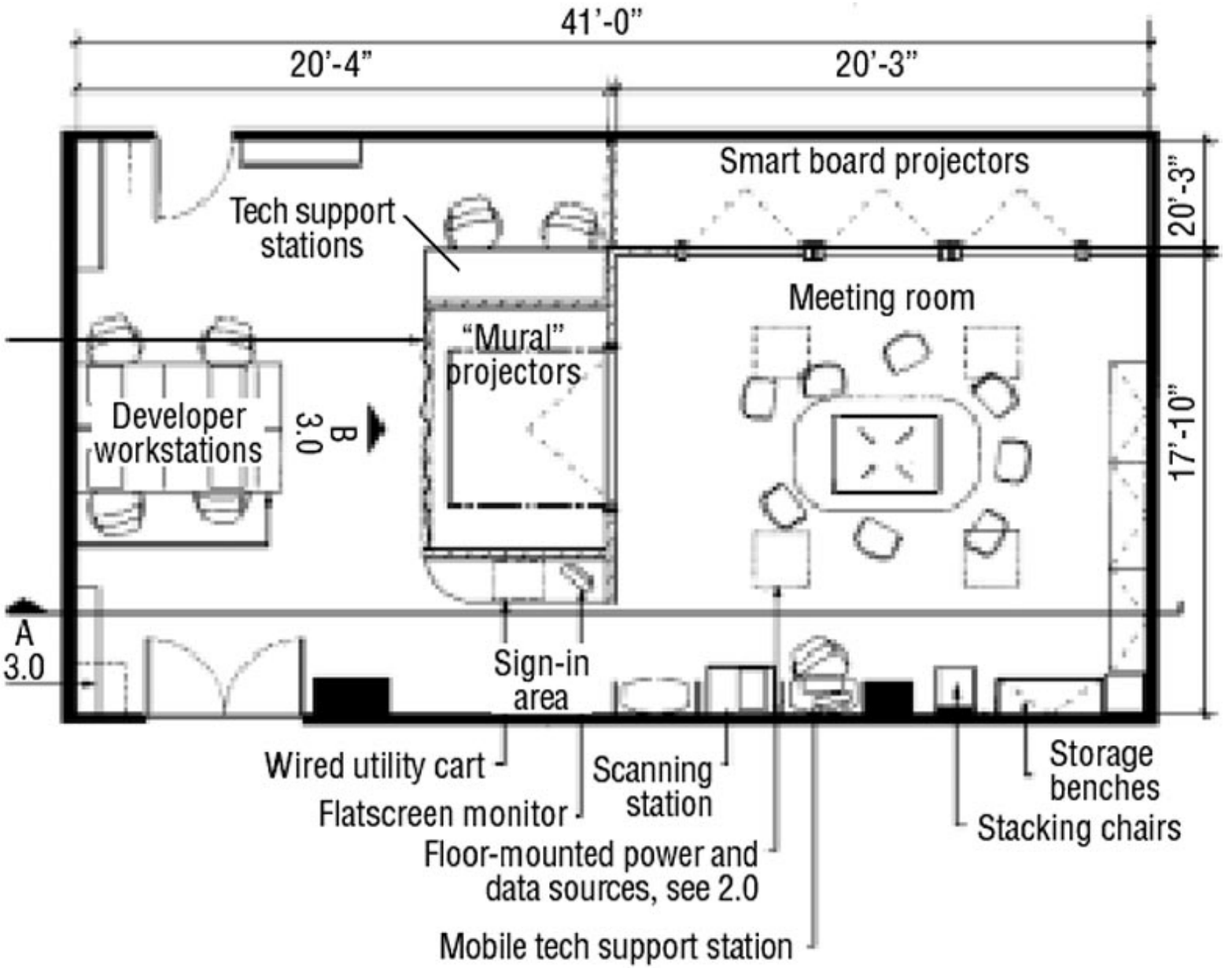
Roomware (Streitz et al., GMD/FHG)

Video

- Streitz et al. "**Roomware: Toward the Next Generation of Human-Computer Interaction Based on an Integrated Design of Real and Virtual Worlds**" In: J. Carroll (Ed.): Human-Computer Interaction in the New Millenium, Addison-Wesley, 2001. pp. 553-578.

iRoom (Stanford)

iRoom


41'-0"
20'-4"
20'-3"
Smart board projectors
Tech support stations
20'-3"
Meeting room
"Mural" projectors
Developer workstations
B 3.0
17'-10"
A 3.0
Sign-in area
Wired utility cart
Flatscreen monitor
Scanning station
Floor-mounted power and data sources, see 2.0
Mobile tech support station
Storage benches
Stacking chairs

iRoom – References

- Fox et al. "Integrating Information Appliances into an Interactive Workspace" IEEE Computer Graphics and Applications. May/June 2000 (Vol. 20, No. 3) pp. 54-65
- Johanson et al. "The Interactive Workspaces Project: Experiences with Ubiquitous Computing Rooms" IEEE Pervasive Computing, 1(2), April-June 2002

Alternative Media

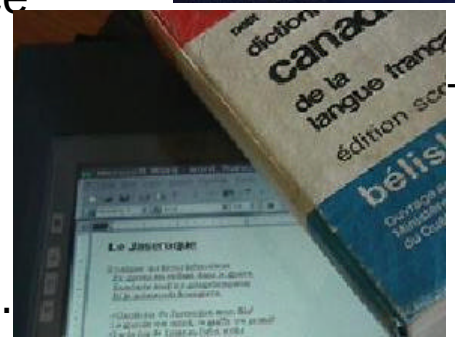
- Webstickers (Ljungstrand and Holmquist, CHI99)
  - Use objects as bookmarks
  - Transfer the Post-It into the virtual world
  - Augment objects with barcode (cheap, established, simple)
  - Use barcodes as keys in a networked database and map them on URLs (user pre-defines the mapping)
- Examples: associate a printed document with ist electronic version

Using websticker

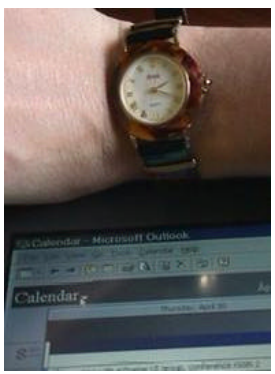
Alternative Media

- Electronic Tags (Want et al., CHI99)
- Using RFID transponder in order to identify objects
  - Robust, invisible, read-by-presence
- Tags with Context
  - ID – tagged French dictionary invokes a translation of a text
  - Location – places where tag is detected trigger a certain action, e. display documents at certain locations
  - PhotoCube – Relate documents physically
  - Wirstwatch – loads the personal calendar

Various RFI D transpoder



Translator



WirstWatch Calendar

PhotoCube

Alternative Media - References

- Ljungstrand, P. and Holmquist, L.E. *WebStickers: Using Physical Objects as WWW Bookmarks*. Extended Abstracts of ACM Computer-Human Interaction (CHI) '99, ACM Press, 1999.
- Roy Want, Kenneth P. Fishkin, Anuj Gujar, and Beverly L. Harrison. *Bridging Physical and Virtual Worlds with Electronic Tags*. Proceedings of SIGCHI '99 (Pittsburgh, PA, May 15-20) ACM, New York, 1999.

Further issues / further reading

- Wearables & Linux: http://wearables.blu.org/
- Thad Starner: http://www.cc.gatech.edu/fac/Thad.Starner
- Wearable Group@MIT: http://www.media.mit.edu/wearables
- Human Interface Technology Lab (HITLab): http://www.hitl.washington.edu

Mark Billinghurst
(http://www.hitl.washington.edu/people/grof/)

Break