Vorlesung Mensch-Maschine-Interaktion

Albrecht Schmidt
Embedded Interaction Research Group
LFE Medieninformatik
Ludwig-Maximilians-Universität München
http://www.hcilab.org/albrecht/

Chapter 4 Analyzing the Requirements and Understanding the Design Space

Media Capture Text

- Legacy content (documents, books)
- Technologies for capture
  - Scanner
  - Digital photo camera
  - Results in a bitmap of the text
- Technology for recognition / transformation into text
  - OCR (optical character recognition)
  - Recognize text and format
  - less storage required (if only textual content is of value)
  - Allow search in archived documents

Media Capture Still images, graphics

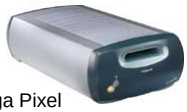
http://www.reflecta.de

- Drawing (e.g. cartoon, caricature)
  - Artistic interpretation
  - Digital input (pen, tablet, mouse?)
  - Analog creation and digitizing
- Photo capture (chemical) and digitizing
  - High resolution (e.g. photo for a 4m x 8m poster or A1 Poster with 100dpi)
- Legacy content (e.g. slides, photos, book pages)
- Technologies for still image digital capture
  - Scanner
  - Digital photo camera

Scanner, examples

- Xerox DigiPath Network Scanner
  - Up to 65 pages per minute
  - Automatic duplex
  - document handler with a 100-sheet capacity

- Polaroid SprintScan 120
  - optical resolution 4000 dpi
  - medium-format film scanner
  - E.g. theoretical 6cm x 9cm ~ 9400 pixel x 14000 pixel = 126 Mega Pixel
  - 6cm x 6cm scan about 1 minute



Media Capture Video

- Record on photographic film and subsequent digitizing
- Digital capture, examples
  - DV (e.g. Canon XL1 DV)
  - Betacam digital (Sony Betacam SX Camcorder)
  - D1 (8-bit uncompressed digital)
- Capture analog video signal
  - Digitizing legacy content

http://videoexpert.home.att.net/artic3/256atab.htm
http://www.belle-nuit.com/dv/dvddix.html
http://www.jamesarnett.com/2-1-6-4.html

Chapter 4
Analyzing the Requirements and Understanding the Design Space

- 3.1 Factors that Influence the User Interface
- 3.2 Analyzing work processes and interaction
- 3.3 Conceptual Models – How the users see it
- 3.4 Analyzing existing systems
- 3.5 Describing the results of the Analysis
- 3.6 Understanding the Solution Space
- **3.7 Design space for input/output, technologies**
  - 3.7.1 2D input
  - 3.7.2 3D input
  - 3.7.3 Force feedback
  - 3.7.4 Input device taxonomy
  - 3.7.5 Further forms of input and capture
  - **3.7.6 Visual and audio output**
  - 3.7.7 Printed (2D/3D) output
  - 3.7.8 Further output options

TFT LCD Screens

- Typical color resolution 640x480 to 1920x1200
- ~ 85 pixel/inch
- viewing angle to 170°
- pivot function (90° rotation)

- More on the basic technology
  - http://electronics.howstuffworks.com/lcd.htm
  - http://www.pctechguide.com/07panels.htm

Multiple Screens

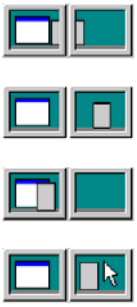
- Increased screen real estate
- Connected to one computer (one keyboard and one mouse)

- Screen arrangements with standard hard- and software
  - Dual display
  - Triple display
  - Quad display

- Application areas
  - CAD
  - Software development
  - Media production
  - Financial software
  - Comparison tasks
  - Customer info & adverts
  - Time tables

Multi-screen problems & solutions

- Dialog box appears on the boarder between the screens
  - Position in new screen
  - Position in application screen
  - Position at the cursor
- What is the meaning of maximizing a window
  - Within the current screen
  - overall
- Losing the cursor
  - Example of a solution: High density cursor
    http://www.patrickbaudisch.com/projects/highdensitycursor/

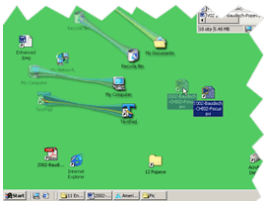


More on Multi Displays

Hutchings, D., Smith, G., Meyers, B., Czerwinski, M., & Robertson, G. (2004).
Display space usage and window management operation comparisons between single monitor and multiple monitor users.
In Proceedings of the working conference on Advanced Visual Interfaces, AVI 2004, p. 32-39.

Multi-screen problems & solutions drag and drop over screen borders

- Scenario:
  - Multiple touch screens (e.g. smart boards) are connected to become “one” display
  - Drag-and-drop does not work over borders



- Suggested solution – move possible targets to the object that is dragged
- Drag-and-Pop

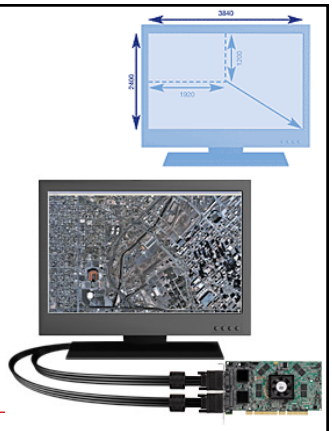
  http://www.patrickbaudisch.com/projects/dragandpop/

Hi-Resolution Grayscale Displays

- Use for medical imaging, radiology
- Image presentation according to DIN 6868-57
- Calibration software
- E.g. Eizo RadiForce G51
  - 21.3" monochrome LCD
  - 5 mega pixel
  - 2560 × 2048 pixel
  - 154 pixel/inch
  - 10-Bit simultaneous grayscale display

Hi-Resolution Color Displays

- Application examples
  - Medical imaging
  - CAD and construction
  - Digital content creation
  - Geophysical imaging
- E.g. IBM T221 Flat Panel Monitor.
  - 3840x2400 pixel
  - 9.2 million pixel
  - 22.2" TFT LCD
  - 204 pixels/inch
- Resolution close to a photo



Hi-Resolution Displays Potential Problem

- Often standard software is designed for different resolution (e.g. 90 pixel/inch)
  - controls are too small
  - fonts are hardly readable in normal size
- Approach
  - Design for the specific characteristics of the output device

Context & Focus

Baudisch et al.

- Central area is a high resolution display
- Peripheral area is low resolution and provides context

- http://www.patrickbaudisch.com/projects/focuspluscontextscreens/

Context & Focus

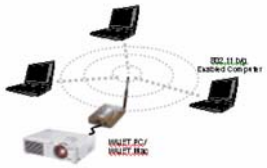
Baudisch et al.

- Central area realized as TFT screen
- Periphery is projected
- Helps with task where context does provide important information

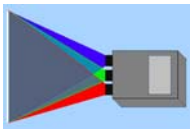
Projectors

Projectors

- Key Criteria
  - Resolution
  - Brightness
  - Weight
  - Noise
  - Lens
  - Image correction
  - Projection distance
  - Connections
  - Lamp life time
- E.g. Toshiba TLP-T720U
  - Wireless 802.11B
- E.g. WiJET
  - http://www.otcwireless.com/802/wijet.htm



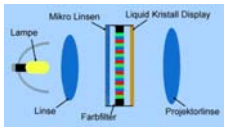
CRT projector



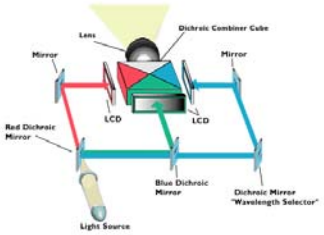
- Use R,G+B CRTs as light sources
- Good black areas
- Low brightness
- Fast
- Need to calibrate convergence!

www.projektoren-datenbank.com/rohre.htm

LCD projector

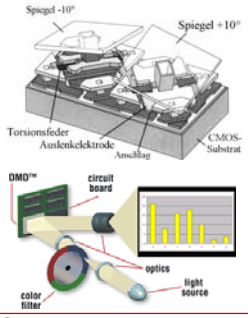


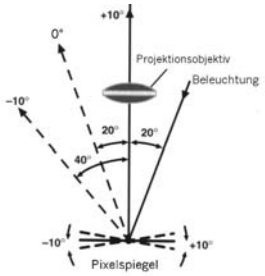
www.projektoren-datenbank.com/lcd.htm



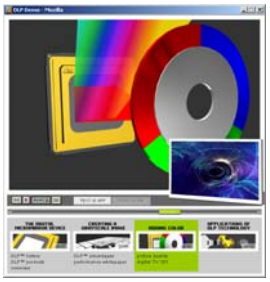
www.projectorpoint.co.uk/projectorLCDvsDLP.htm

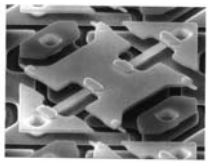
DLP projector





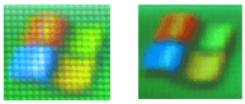
DLD projector (movie)





http://www.dlp.com/

Technological side effects



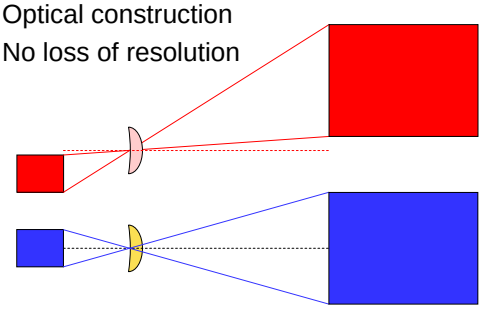
LCD DLP

(image is a magnified portion of the start up icon)

- Screen door effect
  - Caused by LCDs
  - Less prominent in DLP
- If a DLP projector is moved, color seams appear

Lens shift

- Optical construction
- No loss of resolution

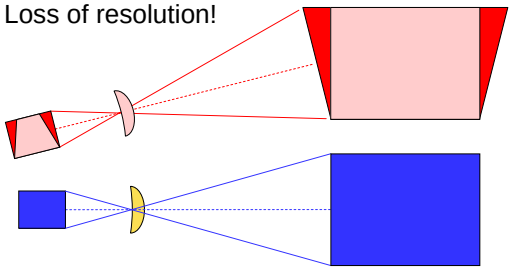


Everywhere display (cont.)

Components: a projector, a camera and a rotating mirror

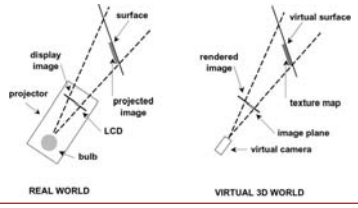
Keystone correction

- Computed correction
- Loss of resolution!

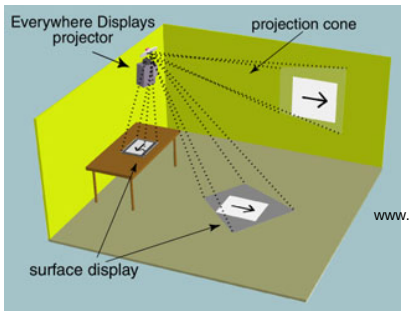


Everywhere display (cont.)

- Correct distortions
  - Use the fact that camera and projectors are geometrically the same (optically inverse)
- Use standard HW components
  - 3D-Graphics board and VRML-world



The Everywhere Display



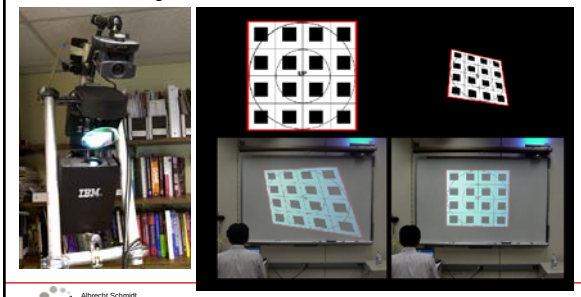
Claudio Pinhanez

www.research.ibm.com/ed/

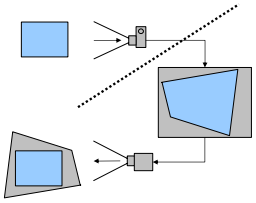
Everywhere Displays Project (IBM)

http://www.research.ibm.com/ed/

- Correct image distortion



Undistorting the projected image

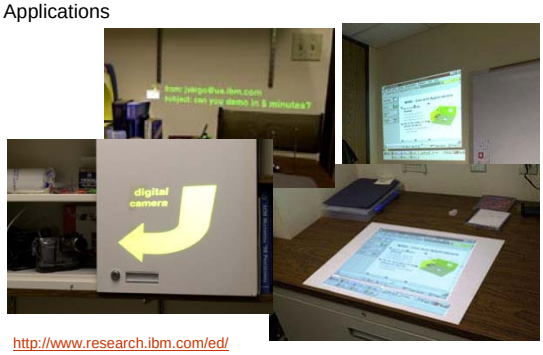


- Place original image in the 3D model
- Camera image shows it distorted
- Project the distorterd image from 3D model with the real projector

– Distortions cancel each other out IF virtual camera and physical projector are in the same location

Everywhere Displays Project (IBM)

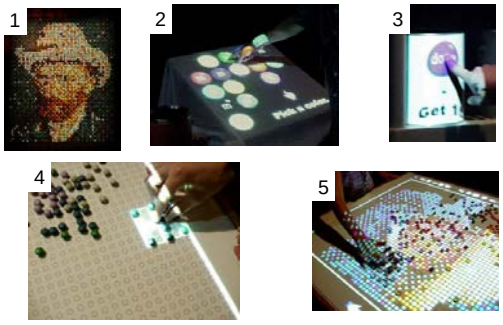
Applications



http://www.research.ibm.com/ed/

Everywhere display (cont.)

Collaborative experience at SIGGRAPH 2001



SearchLight: Basic Idea

- Build a search function for physical objects
- A tool for directing the user's attention
- No 3D model of the environment

Ideas for realization:

- Optical markers for object recognition
- Highlighting by a projected spot

Everywhere display (cont.)

BLUESPACE office scenario

Step 1: Room Scanning

- Projector/camera unit moving and taking pictures
  - Until the whole room is covered
  - Neighbouring pictures slightly overlap
- Recognized marker IDs are stored with:
  - pan/tilt values when taking the picture
  - position of the marker in the picture

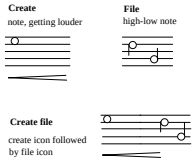
Step 2: Showing objects

- Retrieve object's marker ID
- Move unit to stored pan/tilt position
- Project a spot around the marker's position

Audio

Sound and Audio

- Variety of options
  - Beep to multi-channel spatial audio
  - Different technologies
- Output of
  - Information (e.g. click, notification)
    - Auditory icons (e.g. sound for throwing a document away)
    - Earcons – conveying complex information
  - Captured media (e.g. songs, music, films, speeches)
  - Synthesized media (music, spoken text)

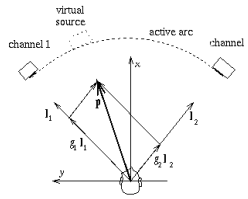


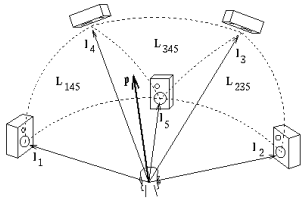
Spatial Audio with headphones

- Principle of spatial audio is simple: if the sound waves arriving at your eardrums are identical to those of a real audio source at a particular position, you will perceive that sound as coming from a source at that particular position.
- Because people only have two ears, you only need two channels of sound to create this effect, and you can present this sound over ordinary headphones. It is possible to recreate the effects of the ears and upper body on incoming sound waves by applying digital filters to an audio stream; True binaural spatial audio, when presented over headphones, appears to come from a particular point in the space outside of the listener's head. This is different from ordinary recorded stereo, which is generally restricted to a line between the ears when listened to with headphones
- Headphones are used because they fix the geometric relationship between the physical sound sources (the headphone drivers) and the ears. Headphones also eliminate crosstalk between the binaural signals. With additional signal processing, we can conceivably compensate for these effects, allowing spatial audio to be presented over free field speakers. However, to compensate for the effects of speakers, the spatial audio system must have knowledge of the listener's position and orientation with respect to the speakers

http://www.cc.gatech.edu/gvu/multimedia/spatsound/spatsound.html

Vector Based Amplitude Panning





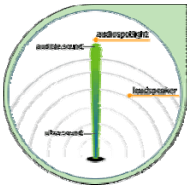
$$\underrightarrow{p} = g_1 l_1 + g_2 l_2 = Lg \qquad g = p^T L^{-1}$$

$$\underrightarrow{p} = g_1 l_1 + g_2 l_2 + g_3 l_3 = Lg \qquad g = L^{-1} p^T$$

http://www.acoustics.hut.fi/research/abstracts/vbap.html

Audio Spotlight

(BBC Video)



- Directed ultra sound is generated
- Transformed in the air in audible sound
- Generates a sound only at a predictable location

http://www.holosonics.com/

2D … 3D

Stereo photography
stereo vision is not new…

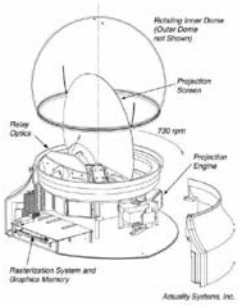
http://www.stereoblick.de/

Volumetric
3-D Display

- Creating a volume image – like an objects "Volume-filling imagery "
- Many simultaneous viewers
- Multiple viewpoints,
- Autostereoscopic
- E.g. Perspecta™ 3D
  - Swept-screen multiplanar volumetric display
  - 198 2-D slices
  - 768 x 768 pixel slice resolution
  - 100 million voxels
  - 24 Hz volume refresh
  - 10" diameter spherical image
  - 8 colors at highest resolution
  - Viewing Angle: 360º horizontal, 270º vertical

http://actuality-systems.com/

Theory of operation
high speed projection (5000 fps)



http://actuality-systems.com/index.php/actuality/products/whitepapers/100_million_voxels

Separate displays for each eye

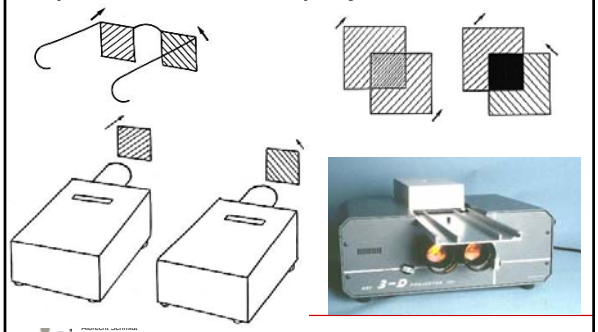
- Stereoscopic 3D computer imaging
- Separate displays
- E.g. i-glasses SVGA
  - Resolution: 800 x 600
  - Pixels: 1.44 Million per Display
  - Field of View: 26 Degrees Color Depth: 24 Bit
  - Refresh Rate: 120hz

Electro optical shutter

- E.g. CrystalEyes
  - electro-optical shutters
  - wireless active eyewear
  - infrared emitter is placed at the monitor and broadcasts synchronization information to the eyewear.
  - The system works seamlessly so the user sees stereoscopic image

http://www.stereographics.com/support/hp-paper.htm

Linear polarization filters and spectacles for 3D projection



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Dresdener 3D Display

- Auto stereoscopic display
- no special glasses
- high resolution
- Full brightness display
- tracking system that allows the user to move naturally while working but without losing the 3D effect.

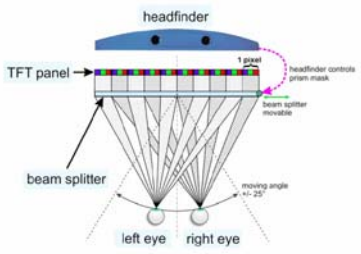
http://www.seereal.com/_docs/SeeReal_Stereo_Implementation.zip

Printing & Printers

- Printing text, graphics, and photos
- Total cost - dependent on usage/user profile
  - printer price
  - materials (e.g. paper, ink, toner, energy)
  - maintenance (e.g. changing of paper in a ticket machine)
- Hardware
  - Media size and type, e.g. paper A4, CD, card board, envelops
  - Media handling, e.g. paper container, rolls and cutting
  - Speed – e.g. pages/minute, characters per second, sq ft/h
  - Resolution – typically dpi (dots per inch)
  - Colors
  - Print technology e.g. laser, dot-matrix, ink-jet, thermo
  - Connectivity e.g. network, USB, …
  - Size, weight, noise, …
- Software
  - Printer language, e.g. PS (postscript), HPGL (Hewlett-Packard Graphics Language, plotter), PCL (printer command language), GDI (Graphical Device Interface)

Dresdener 3D Display basic Technology

- Tracking of users position
- camera or infrared (requires reflector) based
- Moveable prism provided two views
- Alternating columns for left and right eye



Some Printing Technologies

- laser (black/white and color)
  - creating standard documents
  - office use
  - high resolution
- dot-matrix
  - Point of sale
  - Ticket printers
  - Multiple copies (e.g. carbon copy slip for credit card payment)
- Thermo printer
  - Point of sale
  - Ticket printers
  - Mobile printers

Adobe Postscript

- PostScript is a programming language optimized for printing graphics and text
- device independent description
- Instructions for drawing curves, lines, text in different styles, scaling, …
- stack-based, e.g. "**`12 134 mul`**"

```
%!
% Sample of printing text

/Arial findfont     % Get the basic font
72 scalefont              % Scale the font to 20 points
setfont                   % Make it the current font

newpath                   % Start a new path
50 200 moveto             % Lower left corner at (100, 200)
(Hello World!) show       % Typeset "Hello, world!"

showpage
```


Stereo-litho-graphy

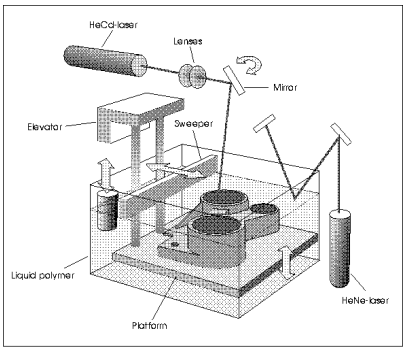


FIGURE 1. A schematic drawing of an SLA.

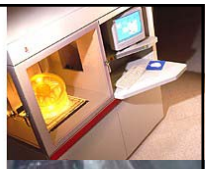
http://www.cs.hut.fi/~ado/rp/subsection3_6_1.html

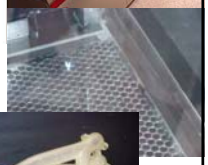
2D Printer

- Different technologies, e.g.
  - Laser (B/W and Color)
  - Ink jet
  - Plotter

- Postscript as language
- Not just paper, e.g.
  - Laser cutter
  - Sewing machine

Stereolithography Example System





- http://www.3dsystems.com/products/sla/tour/movtest.asp
- SLA 7000
  - Layer thinkness 0.025 mm – 0.127mm
  - Maximum drawing speed: 2.54 m/sec - 9.52 m/sec
  - Max part weight 68 kg (150 lb)
  - Max build envelope 508 x 508 x 584 mm
- http://computer.howstuffworks.com/stereolith3.htm

Stereolithography

- The Stereolithography process is basically performed in the following way:
  - Create a 3D model with CAD software.
  - Stereolithography software slices up model into layers; about 5-10 per millimeter.
  - 3D printer (Stereolithography machine) "paints" one of the layers by exposing the liquid polymer in the tank to the laser and hardens it.
  - The platform drops down into the tank layer by layer until the model is completedStereolithography Machine
- There are 4 main parts of the Stereolithography Machine:
  - Liquid Photopolymer Tank: holds liquid plastic sensitive to ultraviolet light
  - Perforated Platform: the platform is immersed in the tank and can be moved up and down as the process is performed.
  - Ultraviolet Laser: transforms the liquid polymer into the 3D object.
  - Computer: controls the laser and movement of the platform during the printing process.

http://www.what-is-injection-molding.com/stereolithography.aspx

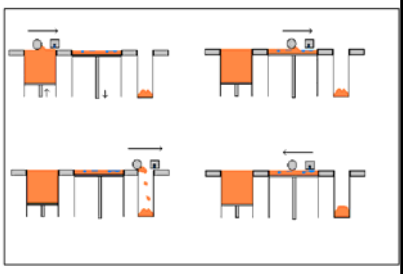
3D Printer

- *Printing in layers*
- *Different materials*
- *Different colors*
- *Build Speed:*
  - *2-6 layers per minute*
- *Build Volume:*
  - *203 x 254 x 203 mm*
- *Layer Thickness:*
  - *0.076-0.254 mm)*
- *Different formats, e.g. VRML import*

- *http://www.zcorp.com/products/printersdetail.asp?ID=2*
- *video*

3D Printer basic principle

- Powder is spread in a thin layer
- Print head spray the binder on the particles
- Repeat for each layer



http://www.fmf.uni-freiburg.de/service/sg_surface/pfister-project.pdf

Paper interface for photo printing

- E.g. HP PSC 2210 all-in-one
- Steps
  - Insert memory card
  - print proof sheet (index)
  - Select on paper
  - Scan selection
  - Get your selection printed

3D Printer (example printout)

- *3D Ribosome-Model*
- *http://www.biol.ethz.ch/dienstleistungen/digitalwerkstatt*

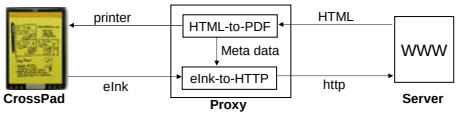
Paper as input medium

(University of Karlsruhe & SAP cooperate research, 2000)

http://www.comp.lancs.ac.uk/~albrecht/pubs/pdf/gellersen_mc2001_paper2webl.pdf

Paper-to-Web

- **Using the CrossPad as Client for paper based input**
- **Transparent proxy between CrossPad and Web Server**
  - Conversion of web forms (HTML) into print documents
  - Recognition of handwriting and marks in the paper forms and conversion



Application, Results

- **Test in different domains (interviews, inventory)**
- **Usability: unobtrusive, transparent, custom interface (additional: paper copy)**

Human Computer Interaction with Paper?

- Paperless office has not yet happened!
- Advances in technology makes it easier to use paper as interaction media
  - Printing as output mechanism
  - Scanning as input mechanism
- Paper as a temporary interface
  - Multi-step process, e.g.
    - print out a check list on paper
    - user interacts with the checklist on paper
    - scan & recognize interaction and create a database entry
  - for specific scenarios this can be a state of the art solution
- Research (e.g. Xerox) and products (e.g. HP printers)

Chapter 4 Analyzing the Requirements and Understanding the Design Space

Alternative Lo-Fidelity Output Devices

- Visual
  - analogue representations: dials, gauges, lights, etc
- Auditory
  - beeps, bongs, clonks, whistles and whirrs
  - used for error indications
  - confirmation of actions e.g. key click

Incense Clocks

- […One is a 19th-century Chinese fire clock (a slow fuse lights successive compartments, one at a time) the other an incense clock. Each new smell (another incense) marks a passage of time.] (http://www.thisislimitededition.co.uk/printversion.asp?ID=142)

http://www.nawcc.org/museum/nwcm/galleries/asian/incense.htm

Aromatic Output for HCI

- From: Joseph "Jofish" Kaye, Making scents: aromatic output for HCI, Interactions, Volume 10, Number 1 (2004), Pages 48-61
- Humans use their sense of smell
  - Is food save to eat?
  - Is there danger due to a fire?
  - Relationships
- An almost entirely unexplored medium in HCI
  - There are reasons for this: technical difficulties in emitting scent on demand,
  - chemical difficulties in creating accurate and pleasant scents

Physiology and Chemistry of Smell

- A thousand different kinds of olfactory receptors in our nose, and it is thought that each can sense a single kind of chemical bond in a molecule
- No abstract classification
  - Examples: how does mint taste? It tastes like …mint
  - Compared to colors: green vs. spinach colored
- Rapidly acclimatized
  - Less than 1 minute
- Human Olfactory Bandwidth
  - … hard to tell
  - Perfumers and florist can distinguish many different smells - potentially thousands

Technology

- Explored in movie theaters and VR… but not really successful
- Different technologies

www.scentury5d.com/

See for examples: http://www.aromajet.com/game.htm and J. Kaye, Making scents: aromatic output for HCI

Ideas in Smell Output, Open Questions

- Olfactory Icons
  - Smell a shot fired each time you press the trigger in Quake
- Ambient Notification
  - Smell of rose to notify you of a date

The question of what information should be displayed is fundamental. Olfactory display is useful for slowly-moving, medium-duration information or information for which an aggregate representation is slowly changing.

Further UIs…

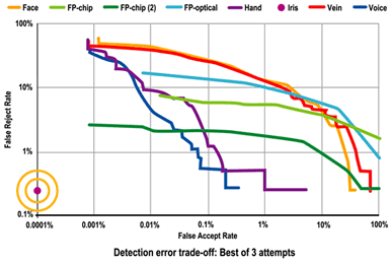
- Bio sensors for
  - Stress level
  - Excitement
  - Tiredness
- Other sensors
  - Acceleration
  - Proximity
  - Force
  - Weight
  - → see instrumented environments

User Interfaces for Authentication

- Categories
  - Password based
  - Token based – ID and Authentication in one go
  - Biometric – ID and Authentication in one go
  - Recall based, e.g. Images
- Parameters
  - False acceptance rate (FAR) – accepting user who should not be allowed in
  - False rejection rate (FRR) – rejecting user who should get in
- High FRRs reduce usability
- High FARs reduce security
- Trade-Off between FAR and FRR

Examples of Biometric Authentication

- Fingerprint
- Hand geometry
- Iris / Retina
- Voice
- Face
- Signature



Source: http://www.argus-solutions.com/iris_howitworks.htm

Selected Issues with Biometric Authentication

- How to use it
  - What to do? Instructions?
  - Feedback: Did it work? What went wrong?
- User acceptance
  - Data protection, privacy
  - Related to use (hygienic, convenience, …)
- Usability
  - Speed (total operation time), reliability
  - Finger: what finger, position, where is the sensor?
  - Iris: height adjustment, which eye, user distance
- Further issues
  - Cultural issues: e.g. Veil and face recognition?, Gloves and Finger print?
  - Injuries: e.g. burns on finger
  - Changes in appearance: contact lenses, make-up, …

Recall Based Authentication

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- Window Tap Interface
  http://www.media.mit.edu/resenv/Tapper/
- Vision-Based Face Tracking System for Large Displays
  http://naka1.hako.is.uec.ac.jp/papers/eWallUbicomp2002.pdf
- http://vered.rose.utoronto.ca/people/shumin_dir/papers/PhD_Thesis/Chapter2/Chapter23.html
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- Logitech iFeel Mouse
  http://www.dansdata.com/ifeel.htm
- Exertion Interfaces
  http://www.exertioninterfaces.com/technical_details/index.htm