Vorlesung
Mensch-Maschine-Interaktion

Output devices & technologies

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WS2003/2004
http://www.medien.informatik.uni-muenchen.de/

Table of Content

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)

Paper interface for photo printing

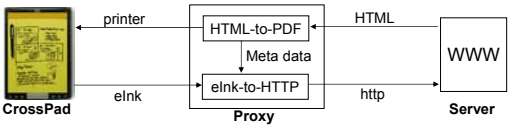
- E.g. HP PSC 2210 all-in-one
- Steps
  - Insert memory card
  - print proof sheet (index)
  - Select on paper
  - Scan selection
  - Get your selection printed

Paper as input medium

(University of Karlsruhe & SAP cooperate research, 2000)

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)**

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)

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
```

Further 2D Printer

- Plotter
- Not just paper, e.g.
  - Laser cutter
  - Sewing machine

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

Stereo-litho-graphy

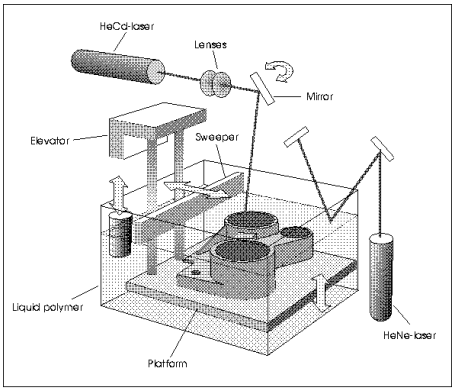
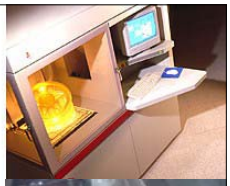


FIGURE 1. A schematic drawing of an SLA.

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

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

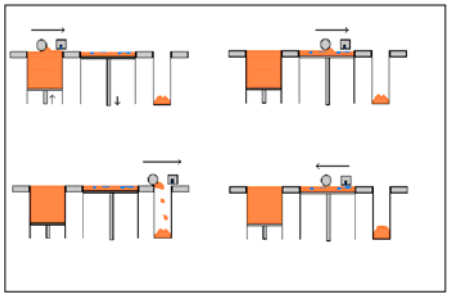
3D Printer

- *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

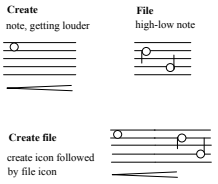


http://www.fmf.uni-freiburg.de/service/sg_surface/pfister-project.pdf

3D Printer (example printout)

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

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

- 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

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

- 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

- 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

Alternative Lo-Fidelity
Output Devises

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

Further UIs…

- Biometric UIs
  - Persons IDs
  - Stress level
  - Excitement
  - Tiredness
- Smell output
  - "storing virtually any fragrance and controlling the dispensing of these scents within a fraction of a second" http://www.aerome.com/
  - Fixed fragrances and mixing

Limitations on Interactive System

especially relevant for systems beyond the desktop

- Computation bound
  - Time to complete a computation, systems keeps the user waiting
- Storage bound
  - Limitations to the amount of data that can be stored
- Storage channel bound
  - transferring data between different types of memory (RAM – harddrive)
- Graphics bound
  - Limitations to displaying information
- Media capture bound
  - Limitations to for acquiring information / capturing
- Network bound
  - Access to networked resources

Computation

- Unlimited processing for applications?
  - Standard office task on a PC (e.g. writing email) – processor is often idle
- Not really…
  - Media intensive applications (e.g. video editing)
  - Scientific computing (e.g. simulations)
  - Mobile devices (e.g. mobile phone)
  - Embedded systems (e.g. heating controller)
- Strategies for interactive applications
  - Give interactive tasks high priority
  - Do calculations/processing before the user asks for them (while the system is idle) – this is difficult as it is often hard to predict what the user wants…
  - If computational results are not provided immediately indicate the duration and an option to pause or stop
  - Don't block the systems while doing computations (e.g. allow the user to interact while long term computations are done)

Storage

- Storage bound
  - Nearly unlimited storage for stationary systems available
  - More difficult for mobile systems, especially for media capture (e.g. a digital video camera)
- Storage channel bound
  - Transfer speed differs, RAM, Harddrive, DVD, DVD-RW, network, …
- Strategies for interactive systems
  - Make use of the storage available
    - Speed up interaction (e.g. store multiple index to a database, store search queries)
    - To allow reversing user action (even over multiple sessions)
    - Free users short term and long term memory (store what the user told the software once – only ask again if there is reason)
  - Minimize transfer between different storage types
  - Don't cache data that is written to a device that can be removed at any time (e.g. USB memory)

Use of storage – Example

- Basic concept
  - Ticket machine for public transport
  - User pays by cash-card / credit card
  - System provides short cuts to last travels done
- Storage
  - Data can be stored locally in the ticket machine – as the last travel is particular meaningful in this context
  - Minimal amount of data – id (computed from the card) and a list of travels (start-point, end-point, type of ticket)

Use of storage – future speculation

- Digital VCR
- Much effort goes by now into how the user selects what should be stored!
- User is probably more interested what to watch…
- As more storage becomes available (and multiple receiver are cheap enough) the system can record everything and the interface is only concerned with selecting what to watch?

- 24h x 50 channels x 7 days = 8400 hours of Video
- How long will it take? … 10 years?
- Will TV change before that?

Graphics Bound

- No problem for office applications
- Even multiple screens are no problem

- Gaming and Entertainment
  - Graphics and rendering are a limiting factor
  - High resolution video (digital cinema)

- CAD
  - Resolution and screen size a limiting factors

- Mobile devices
  - Inherent trade-off between device size and screen area
  - Rendering performance a limiting factor (e.g. mobile phone)

- Strategies
  - Use the maximal display size available in the context
  - Use graphics hardware to

Network Bound

- Different types of networks
  - Local wired networks (e.g. 1GBit/s)
  - Local wireless networks (e.g. WiFi 54MBit/s, Bluetooth < 1MBit/s)
  - Global wired network (Internet)
  - “global” wireless networks (small bandwidth, e.g. GSM, UMTS)

- Issues for interactive applications
  - Bandwidth, throughput
  - Jitter
  - Delay
  - Reliability

- Strategies
  - Design the system and interaction to fit the underlying network, e.g.
    - Unreliable network → allow offline use
    - Low bandwidth network → minimize data that is transferred (compression)
    - Network with long delay → keep interaction local
  - some network short comings can be compensated by storage use

Workshop: Benutzerschnittstellen und Bedienkonzepte für Leseschwache

- Gemeinsam mit Sonderpädagogik
- 12. Januar 2004, 18 Uhr c.t.
- Amalienstr. 17, 506
- Prototyping
- Beispiel E-Mailanwendung

References

- Alan Dix, Janet Finlay, Gregory Abowd and Russell Beale. (1998) Human Computer, Interaction (second edition), Prentice Hall, ISBN 0132398648 (new Edition announced for October 2003)

- 3D Displays
  - http://www.actuality-systems.com/admin/publications/Actuality_Whitepapsr_AeroSense_2002.pdf
  - http://www.stereographics.com/support/hp-paper.htm
  - http://www.seereal.com/_docs/SeeReal_Stereo_Implementation.zip

- Postscript
  - http://www.cs.indiana.edu/docproject/programming/postscript/postscript.html

- 3D Printing
  - http://www.what-is-injection-molding.com/stereolithography.aspx
  - http://www.cs.hut.fi/~ado/rp/subsection3_6_1.html
  - http://www.3dsystems.com/products/sla/tour/movtest.asp
  - http://computer.howstuffworks.com/stereolith3.htm
  - http://www.zcorp.com/products/printersdetail.asp?ID=2
  - http://www.fmf.uni-freiburg.de/service/sg_surface/pfister-project.pdf

- Guidelines for the Creation of Earcons
  - http://www.dcs.gla.ac.uk/~stephen/earcon_guidelines.shtml

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

- Video Capture
  - 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