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Administrivia

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Administrivia (cont’d)

- Formal Auditing not allowed, but welcome to attend lectures
- Registration status:
  - Have not registered?
  - Intend to register?
  - Thinking about registering?
- HCI background:
  - Have taken an HCI course before?
  - Which course, where?

Interface Design and Usability Engineering

Goals:
- Articulate: *Who users are*
  - Their key tasks
- Brainstorm designs
  - Psychology of everyday things
  - User involvement
  - Representation & metaphors
- Participatory interaction
  - Task scenario walkthrough
  - Low fidelity prototyping methods
- Evaluate

Methods:
- Task centered system design
  - Participatory design
  - User-centered design
- Participatory design
- User involvement
- Representation & metaphors

Products:
- User and task descriptions
- Throw-away paper prototypes
- Completed designs

Products:
- Graphical screen design
  - Interface guidelines
  - Style guides
- Usability testing
  - Heuristic evaluation
- Testable prototypes
- High fidelity prototyping methods
- Completed designs
  - Alpha/beta systems or complete specification

Products:
- Interface Design and Usability Engineering
Early tractors

Original design
Terrain
un-surfaced
rough
hilly

high center
of gravity
narrow
wheel base

Result

Used to be called “Driver’s Error” but
accidents now infrequent as designs now have
low center of gravity, wider wheel bases

Psychology of Everyday Things

- Lesson 1
  - Most failures of human-machine system are due to poor
designs that don’t recognize peoples’ capabilities and
fallibility’s
  - This leads to apparent machine misuse and “human error”

- Lesson 2
  - Good design always accounts for human capabilities.
Psychopathology of everyday things

- Typical frustrations
  - The engineer who founded DEC confessed at the annual meeting that he can’t figure out how to heat a cup of coffee in the company’s microwave oven
  
  - How many of you can program or use all aspects of your
    - digital watch?
    - VCR?
    - sewing machine?
    - washer and dryer?
    - stereo system (especially car ones)
    - unfamiliar water faucets
Other pathological examples:

Remote control from Leitz slide projector
- How do you forward/reverse?
- Instruction manual:
  - short press: slide change forward
  - long press: slide change backward

Still more pathological examples

- Modern telephone systems
  - standard number pad
  - two additional buttons * and #

- Problem
  - many hidden functions
  - operations and outcome completely invisible
    - *72+number = call forward
      - can I remember that combination?
      - if I enter it, how do I know it caught?
      - how can I remember if my phone is still forwarded?

- Ok, I’ll read the manual
  - but what does “call park” mean? what’s a link?
  - where is that manual anyway?
Getting serious about design

- **World War II**
  - invention of machines (airplanes, submarines...) that taxed people's sensorimotor abilities to control them
  - even after high degree of training, frequent errors (often fatal) occurred

- **Example airplane errors:**
  - if booster pump fails, turn on fuel valve within 3 seconds
    - test shows it took at least five seconds to actually do it!
  - Spitfire: narrow wheel base
    - easy to do violent uncontrolled ground loops which break undercarriage!
  - Altimeter gauges difficult to read
    - caused crashes when pilots believe they are at a certain altitude

- **Result**
  - human factors became critically important

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What's the altitude?

- **Early days (< 1000’):**
  - only one needle needed
- **As ceilings increased over 1000’**
  - small needle added
- **As they increased beyond 10,000’**
  - box indicated 10,000’ increment through color change

- < 10,000’
- > 10,000’
A kind of tape altimeter

- Human factors test showed that this altimeter:
  - eliminated reading errors
  - was faster to read

- But not in standard use! Why?

Harvard Airplane (World War II)

- Undercarriage crashes
  - pilots landed without dropping undercarriage!
  - undercarriage warning horn
    * sounds if wheels up and power low (landing condition)

- Stalls
  - plane airspeed drops too low to maintain lift
  - if occurs just before landing, will crash

- Training
  - deliberately stall and recover
  - but sometimes similar to landing with undercarriage up:
    * horn sounds, annoyance
  - installed "undercarriage horn cut-out button"

Oops! Now why did I do that?
Problem #1: Conditioned response
stall -> push button; therefore stimulus nullified

Problem #2: Negative transfer
T-33’s: tip-tank jettison button in same location
Darn these hooves! I hit the wrong switch again! Who designs these instrument panels, raccoons?

The Psychopathology of computers

- Britain has (had) a Motorway Communications System operating 40% of its highways
  - The system receives control information from Police
    - changes lane signs, direction signs, speed limits, etc
    - occurs on the motorway itself in real time
  - On December 10th 1976, police, using the system, failed to change the speed limit signs when fog descended
    - 34 vehicles crashed
    - 3 people were killed
    - 11 people were injured and trapped in their vehicles for several hours
    - motorway closed for 6.5 hours

40 km
Slow Down!
Fog Ahead
Some quotes

- Police (at inquest)
  - “The system did not accept the instruction”

- Dept of Transport (after examining computer activity logs)
  - “There is no evidence of technical failure”

- Designers of system
  - after emphasizing that they have no responsibility for the system:
    - “We supplied it over 5 years ago and we have never been called to look at that problem”

- The Coroner’s Court
  - after examining the evidence, claimed it was “operator error”
    - the police operator:
      “failed to follow written instructions for entering the relevant data”

Where have we heard this before?

The PC Cup Holder

A True (?) Story from a Novell NetWire SysOp

Caller: "Hello, is this Tech Support?"
Tech Rep: "Yes, it is. How may I help you?"
Caller: "The cup holder on my PC is broken and I am within my warranty period. How do I go about getting that fixed?"
Tech Rep: "I'm sorry, but did you say a cup holder?"
Caller: "Yes, it's attached to the front of my computer."
Tech Rep: "Please excuse me if I seem a bit stumped, it's because I am. Did you receive this as part of a promotional, at a trade show? How did you get this cup holder? Does it have any trademark on it?"
Caller: "It came with my computer, I don't know anything about a promotional. It just has '4X' on it."

At this point the Tech Rep had to mute the caller, because he couldn't stand it. The caller had been using the load drawer of the CD-ROM drive as a cup holder, and snapped it off the drive.
Inane dialog boxes

\[\text{Battery Empty Warning} \]

The battery is detected will be run out in several minutes or not present.

If battery is not charged in now, you can disable the battery diagnosis in [Settings] page of Configure Notification.

Please click the tray icon and select [Diagnosis Report] menu.

\[\text{Close} \]

Inane dialog boxes

\[\text{Diff Merge} \]

The objects being compared are identical. Do you want to continue the comparison?

\[\text{Yes} \quad \text{No} \]

ClearCase, a source-code control system
from Rational Software
Inane dialog boxes

Opt Out Confirmed
You should receive no further email from Parsons Technology. A confirmation email will be sent to your email address.

Undo  Continue

Inane dialog boxes

Error Deleting File

Cannot delete 016: There is not enough free disk space.
Delete one or more files to free disk space, and then try again.

OK
Inane dialog boxes

Psychology of Everyday Things

- Many so-called human errors and “machine misuse” are actually errors in design
- Designers help things work by providing a good conceptual model
- Designers decide on a range of users as the design audience
- But design is difficult for a variety of reasons that go beyond design
Psychopathology

Usable vs. Usefulness

From our friends in Japan and other places...
Usable vs. Useful

- Usability: ability to actually use the system
  - Ease of learning, recall, productivity, minimal error rates, high user satisfaction
- Useful: the system actually does what you need it to do
- Not entirely disjoint concepts
  - E.g., system not useful because it is so difficult to interact with it
Psychology of everyday things
Design Concepts

- affordances
- causality
- visible constraints
- mapping
- transfer effects
- population stereotypes
- conceptual models
- individual differences
- why design is hard

Making things work: Visual Structure

- Visual Affordances
  - the perceived and actual fundamental properties of the object that determine how it could possibly be used
  - appearance indicates how the object should be used
    - chair for sitting
    - table for placing things on
    - knobs for turning
    - slots for inserting things into
    - buttons for pushing
    - computers for ???
  - complex things may need explaining, but simple things should not
    - when simple things need pictures, labels, instructions, then design has failed
Low level affordances:
needs familiar idiom and metaphor to work

Xerox Star: Desktop metaphor

Fig 1, pg 55, BGBG
Some non-obvious visual affordances

Is this a graphic or a control?

A button is for pressing, but what does it do?

Visual affordances for window controls are missing!

Text looks like it is for editing, but it doesn't do it.

A non-obvious visual affordance
More non-obvious visual affordances

Windows media player

A bad affordance
Handles are for lifting, but these are for scrolling

from AudioRack 32, a multimedia application
Making things work: Visual Structure (continued)

Visible Constraints
- limitations of the actions possible perceived from object’s appearance
- provides people with a range of usage possibilities

Push or pull?
Which side?
Can only push, side to push clearly visible

A Progression of Visible Constraints to Enter a Date

[Diagram of a form with date fields and a calendar]

Date: ______ / ______ / ______
Month: May
Day: 22
Year: 1997

Description:
Smart Technology Seminar

Where: ______
Xerox Star: Constraints

The peace sign is a stylized rendition of the footprint of a dove, the international bird of peace.
Making things work: Visual Structure (continued)

- Mappings
  - the set of possible relations between objects
  - the natural relationship between two things
    - eg control-display compatibility
      - visible mapping and mimic diagrams: stove and controls
      - cause and effect: steering wheel-turn right, car turns right

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### Mapping

Only active pallette items visible

Depressed button indicates current mapped item

Cursor re-enforces selection of current item
Making things work: Understandable action

- Causality
  - the thing that happens right after an action is assumed by people to be caused by that action
  - interpretation of “feedback”

- false causality
  - incorrect effect
    - starting up an unfamiliar application just as computer crashes
    - causes “superstitious” behaviors

  - invisible effect
    - command with no apparent result often re-entered repeatedly
    - e.g., hitting esc, or alt-ctrl-del, on unresponsive system

Making things work: Understandable action

Effects visible only after Exec button is pressed
- OK does nothing!
- awkward to find appropriate color level
Making things work: Understandable action

- Transfer effects
  - people transfer their learning/expectations of similar objects to the current objects
  - positive transfer: previous learning's also apply to new situation
  - negative transfer: previous learning's conflict with the new situation
Population stereotypes

- Populations learn idioms that work in a certain way
  - red means danger
  - green means safe
- But idioms vary in different cultures!
  - Light switches
    - America: down is off
    - Britain: down is on
  - Faucets
    - America: anti-clockwise on
    - Britain: anti-clockwise off
- Ignoring/changing stereotypes?
  - home handyman: light switches installed upside down
  - calculators vs. phone number pads: which should computer keypads follow?
- Difficulty of changing stereotypes
  - Qwerty keyboard: designed to prevent jamming of keyboard
  - Dvorak keyboard ('30s): provably faster to use
Cultural associations

- Because a trashcan in Malaysia may look like this:

  a Malaysian user is likely to be confused by this image popular in Apple interfaces:

- Sun found their email icon problematic for some American urban dwellers who are unfamiliar with rural mail boxes.

Cultural associations

A Mac user finds a Windows system only somewhat familiar
Conceptual model

- People have "mental models" of how things work
- Conceptual models built from:
  - affordances
  - causality
  - constraints
  - mapping
  - positive transfer
  - population stereotypes/cultural standards
  - instructions
  - interactions
  - familiarity with similar devices (positive transfer)
- Models may be wrong, particularly if above attributes are misleading
- Models allow people to mentally simulate operation of device
Example

Good: Scissors

affordances:
- holes for something to be inserted

constraints:
- big hole for several fingers, small hole for thumb

mapping:
- between holes and fingers suggested and constrained by appearance

positive transfer and cultural idioms:
- learnt when young
- constant mechanism

conceptual model:
- implications clear of how the operating parts work
Example

Bad: Digital watch

affordances:
- four push buttons to push, but not clear what they will do

constraints and mapping unknown
- no visible relation between buttons, possible actions and end result

transfer of training
- little relation to analog watches

cultural idiom
- somewhat standardized core controls and functions but still highly variable

conceptual model:
- must be taught

Two guidelines for design

1. Provide a good conceptual model
   - allows user to predict the effects of their actions
   - problem:
     - designer’s conceptual model communicated to user through system image:
       - appearance, written instructions, system behaviour through interaction,
       - transfer, idioms and stereotypes

       - if system image does not make model clear and consistent, user will develop wrong conceptual model
Two guidelines for design

2. Make things visible
   - relations between user’s intentions, required actions, and results are
     • sensible
     • non arbitrary
     • meaningful
   - visible affordances, mappings, and constraints
   - use visible cultural idioms
   - reminds person of what can be done and how to do it

Who do you design for?
Who do you design for?

- People are different

- It is rarely possible to accommodate all people perfectly
  - design often a compromise
    - eg ceiling height: 8’
      - but tallest man: 8’ 11”!

- Rule of thumb:
  - design should cater to 95% of audience (i.e., for 5th or 95th percentile)
    - but means 5% of population may be (seriously!) compromised
  - Designing for the average a mistake
    - may exclude half the audience

- Examples:
  - cars and height: headroom, seat size
  - computers and visibility:
    - font size, line thickness, color for color blind people?
Xerox Star: Progressive Disclosure
Proverbs on individual differences

- You do NOT necessarily represent a good average user of equipment or systems you design
- Do not expect others to think and behave as you do, or as you might like them to.
- People vary in thought and behaviour just as they do physically

Who do you design for?

Computer users:

- **novices**
  - walk up and use systems
  - interface affords restricted set of tasks
  - introductory tutorials to more complex uses

- **casual**
  - standard idioms
  - recognition (visual affordances) over recall
  - reference guides
  - interface affords basic task structure

- **intermediate**
  - advanced idioms
  - complex controls
  - reminders and tips
  - interface affords advanced tasks

- **expert**
  - shortcuts for power use
  - interface affords full task + task customization

most shrink-wrapped systems
most kiosk + internet systems
custom software
Why design is hard

Over the last century

- the number of things to control has increased dramatically
  - car radio: AM, FM1, FM2, 5 pre-sets, station selection, balance, fader, bass, treble, distance, mono/stereo, dolby, tape eject, fast forward and reverse, etc (while driving at night!)

- display is increasingly artificial
  - red lights in car indicate problems vs flames for fire

- feedback more complex, subtle, and less natural
  - is your digital watch alarm on and set correctly?

- errors increasing serious and/or costly
  - airplane crashes, losing days of work...

Why design is hard

Marketplace pressures

- adding functionality (complexity) now easy and cheap
  - computers

- adding controls/feedback expensive
  - physical buttons on calculator, microwave oven
  - widgets consume screen real estate

- design usually requires several iterations before success
  - product pulled if not immediately successful
Why design is hard

People often consider cost and appearance over human factors design

- bad design not always visible
- people tend to blame themselves when errors occur
  - “I was never very good with machines”
  - “I knew I should have read the manual!”
  - “Look at what I did! Do I feel stupid!”
- eg the new wave of cheap telephones:
  - accidentally hangs up when button hit with chin
  - bad audio feedback
  - cheap pushbuttons—mis-dials common
  - trendy designs that are uncomfortable to hold
  - hangs up when dropped
  - functionality that can’t be accessed (redial, mute, hold)

Aesthetics too please!
Attractive things work better

- No information advantage to colour displays, but would you trade yours in for black and white?
- Affective system is judgmental – assigns positive and negative valence to the environment
  - Negative – focuses mind – depth first
  - Positive – broadens thought – breadth first
- Aesthetics and usability must be in harmony
Summary

- Human factors comes of age in WWII
  - human control of complex machinery could not be maintained even after high degree of training
- Many so-called human errors are actually errors in design
  - don’t blame the user!
- Designers help things work by providing a good conceptual model
  - affordances
  - causality
  - constraints
  - mapping
  - positive transfer
  - population stereotypes
- Design to accommodate individual differences
  - decide on the range of users
- Design is difficult for a variety of reasons that go beyond design

Readings