MUNI HCI LAB

PV182
Human Computer Interaction

Lecture 7

Psychopathology and Psychology

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HCI LAB

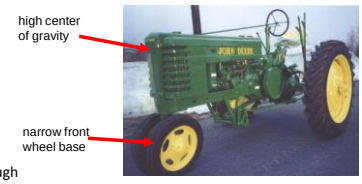
Psychopathology

Pathological Designs

- Many human errors result from design errors bad conceptual model

Tractors

- Early design

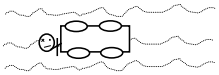


- Terrain
- unsurfaced and rough
- hilly

- Farmer
- works long hours
- works quickly

Tractors .

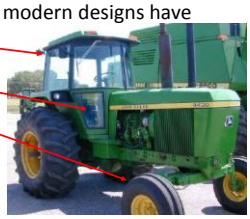
- Result



- Quotes from National AG Safety Database
  - Older tractors have narrow front ends that are easily upset
  - Tractor upsets cause more fatalities than other farm accidents
  - Injuries often include a broken or crushed pelvis

Tractors ..

- Used to be called driver's error
- But
  - Accidents less frequent as modern designs have
    - Roll cage
    - Low center of gravity
    - Wider wheel bases



Lessons

- Lesson 1
  - Many failures of human-machine system result from designs that don't recognize peoples' capabilities and fallibilities
  - This leads to apparent machine misuse and human error
- Lesson 2
  - Good design always accounts for human capabilities
- How you can train yourself
  - Look for examples of 'human error'
  - Critique them for possible 'design error'
  - Propose designs that limit / remove these errors

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
  - Cell phones?

Remote Controls

- The phone rings…
  - Hit pause

Pioneer DVD Remote

Remote Controls .

- The phone rings…
  - Hit pause
- Why is it easier?
  - Big button easier to hit (Fitt's Law)
  - Visually distinctive (color)
  - Reasonably different from other buttons
  - Shape and central position means its easy to find by feel in zero light conditions
- TiVo designed for usability
  - Part of early product development

TiVo DVR Remote

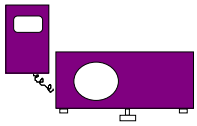
Remote Controls ..

- But of course I'll just learn it quickly…

cable box digital video recorder DVD television audio amplifier VCR
six remote controls required to operate a modest home theater

Other Pathological Examples

- Remote control from Leitz slide projector
  - How do you forward/reverse?



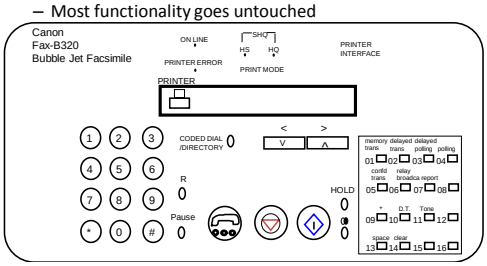
- Instruction manual:
  - Short press: slide change forward
  - Long press: slide change backward

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?

More Pathological Examples .

- VCR's, camcorders, fax machines, …
  - Most people learn only basic functions
  - Most functionality goes untouched

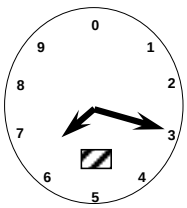


Getting Serious About Design

- World War II
  - Complex machines (airplanes, submarines…)
    - Taxed people's sensorimotor abilities to control them
    - Frequent (often fatal) errors occurred even after high training
  - Example airplane errors:
    - If booster pump fails, turn on fuel valve within 3 seconds
    - Test shows it took ~five seconds to actually do
  - Spitfire: narrow wheel base
    - Easy to do violent ground loops which breaks undercarriage
  - Altimeter gauges difficult to read
    - Caused crashes when pilots believe they are at a certain altitude
- Result
  - Human factors became critically important

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

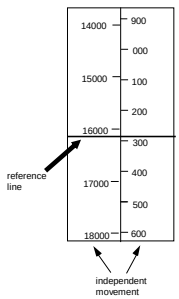


< 10,000'

> 10,000'

Tape Altimeter

- Human factors test showed:
  - Eliminated reading errors
  - Was faster to read
- But not in standard use! Why?

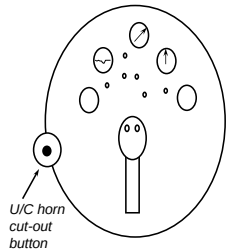


Harvard Airplane (World War II)

- 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"

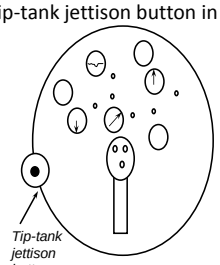
The Harvard Control Panel

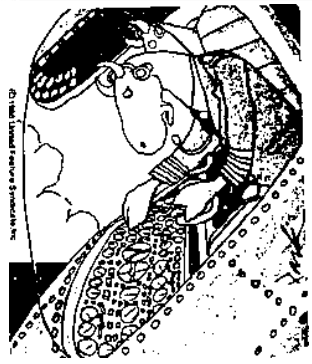
- Problem #1: Conditioned response
  - stall -> push button; therefore stimulus nullified



The T-33 Control Panel

- 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 1976
  - Motorway communication system operated 40% of it's highways
  - Police controlled it in real time to change lane signs, direction signs, speed limits, etc
- On December 10th, police failed to change the speed limit signs when fog descended
  - 34 vehicles crashed
  - 3 people killed
  - 11 people injured and trapped in their vehicles
  - Motorway closed for 6.5 hours

Some Quotes

- Police (at inquest)
  - "The system did not accept the instruction"
- Dept of Transport (after examining computer logs)
  - "There is no evidence of technical failure"
- System designers
  - After emphasizing that they have no responsibility for the system
  - "We supplied it over 5 years ago and have never been called to look at that problem"
- The Coroner's court
  - Judged it as "operator error"
  - The police operator: "failed to follow written instructions for entering the relevant data"
- Where have we heard this before?

Example Problems

- Cryptic input codes
  - XR300/1: change (X) sign 300 on highway M5 (R) to code 1
  - i.e. change particular sign to indicate fog condition
- No feedback
  - Operator entered command, no visible effect of system response
- Cryptic error messages
  - "Error code 7"
- Teletype machine was old, text illegible
  - People could not see what they typed or system's reply
- Operator overloaded with other chores
  - Also handled radio and telephone traffic

Psychopathology of the Single Key Press

- From InfoWorld, Dec '86
  - "London—

    An inexperienced computer operator pressed the wrong key on a terminal in early December, causing chaos at the London Stock Exchange. The error at [the stockbrokers office] led to systems staff working through the night in an attempt to cure the problem"

Psychopathology of the Single Key Press .

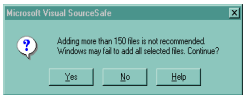
- From Science magazine
  - In 1988, the Soviet Union's Phobos 1 satellite was lost on its way to Mars, when it went into a tumble from which it never recovered.

    "not long after the launch, a ground controller omitted a single letter in a series of digital commands sent to the spacecraft. And by malignant bad luck, that omission caused the code to be mistranslated in such a way as to trigger the [ROM] test sequence [that was intended to be used only during checkout of the spacecraft on the ground]"

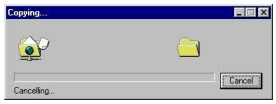
The PC Cup Holder

- 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 call, 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



Umm, thanks for the warning, but what should I do?



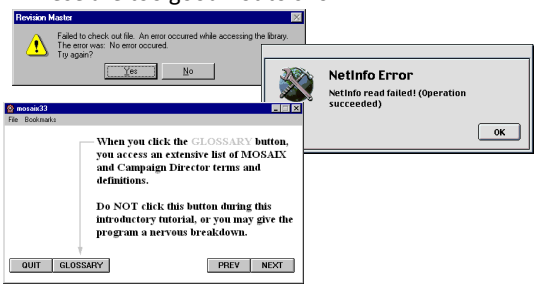
What happens when you cancel a cancelled operation?

Do I have any choice in this?

Uhhh… I give up on this one

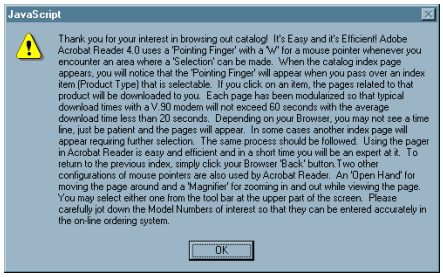
Inane Dialog Boxes .

- These are too good not to show

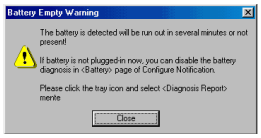


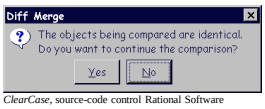
Inane Dialog Boxes ..

- Midwest Microwave's online catalog

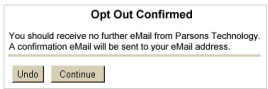


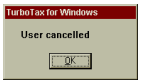
Inane Dialog Boxes …

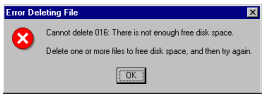




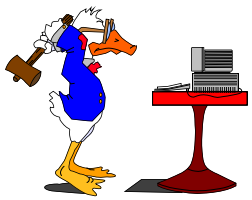
ClearCase, source-code control Rational Software







Hit Any Key To Continue



Psychology

Design of Everyday Things

- Pathological designs
- Many human errors result from design errors
- Designers help through a good conceptual model

Why Should You Care?

- Today: Usability sells
  - Product reviews emphasize usability (e.g., Consumer Reports)
  - Customers have used related products, and can often download trial versions (including competitors)
  - Today's users are impatient and intolerant of bad design
- Consequences of bad design now large
  - Costly errors in serious systems (e.g., financial institutes)
  - Widespread effects (e.g., incorrect billing, failures)
  - Life-critical systems (medical, air traffic control)
  - Safety (in-car navigation systems)

Why Should You Care? .

- Professionalism
  - Software engineers are designers
  - We are ultimately responsible for the products we build
  - A history of 'hack' designs does not excuse our responsibilities
- Compared to civil engineers
  - What would happen to an engineer who built a bridge where people fell off of it into the river (because the guard rails were too low), and where accidents were high (because the bridge was too narrow)?
  - We would call this incompetence
  - The same standard should apply to software engineers

Design of Everyday Things

- Important concepts for designing everyday things
  - Perceived affordances
  - Causality
  - Visible constraints
  - Mapping
  - Transfer effects
  - Idioms & population stereotypes
  - Conceptual models
  - Individual differences
  - Why design is hard

Perceived Affordances

- The perceived properties of the object that suggest how one could use it


chairs are for sitting table for placing things on


knobs are for turning


slots are for inserting handles are for turning


buttons are for pressing


switch for toggling


computer for..

Perceived Affordances .

- Product design
  - Perceived affordances:
    - Design invites people to take possible actions
  - Actual affordances:
    - The actual actionable properties of the product
- Problems occur when
  - These are not the same
  - People's perceptions are not what the designer expects

Perceived Affordances ..

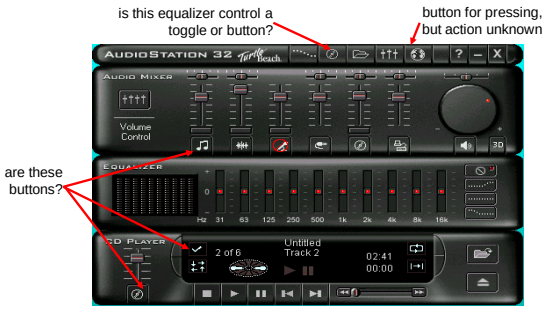
Perceived Affordance Problems

More Perceived Affordances

- GUI design
  - Perception only through visuals
  - Designer creates appropriate visual affordances via
    - Familiar idioms
    - Metaphors

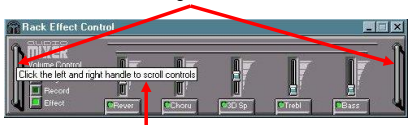
More Perceived Affordances .

More Perceived Affordance Problems



More Perceived Affordance Problems .

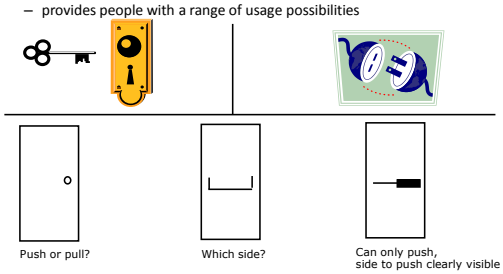
- Handles are for lifting, but these are for scrolling!



- Complex things may need explaining but simple things should not
  - when simple things need labels & instructions, then design has failed

Visible Constraints

- Limitations of the actions possible perceived from object's appearance
  - provides people with a range of usage possibilities



Which Side Do You Use for Cutting?

- Knife example

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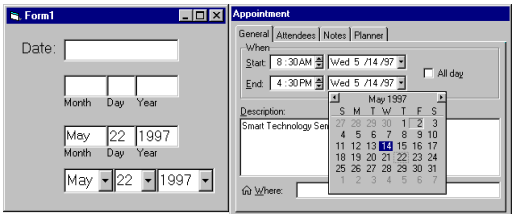
Visible constraints: Entering a Date

- The more constraints, the less opportunity for error



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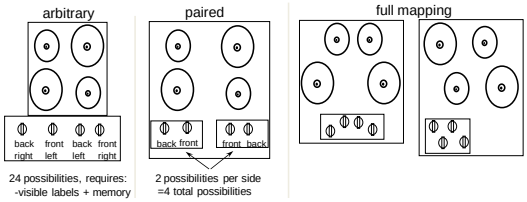
Mapping

- The set of possible relations between objects
- Control-display compatibility
  - the natural relationship between controls and displays
  - e.g., visual mapping of stove controls to elements



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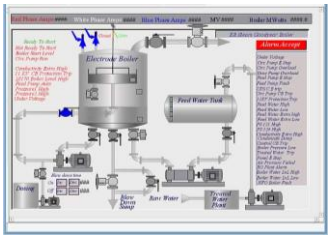
Mapping

- Control-display compatibility
  - Mimic diagrams for feedback / control imitates physical layout



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Mapping .

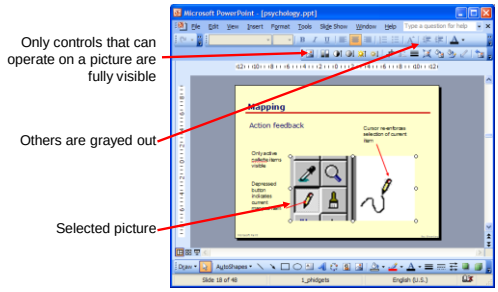
- Control-display compatibility
  - Cause and effect

steering wheel-
turn left, car turns left

scroll bar – scroll down
viewport goes down

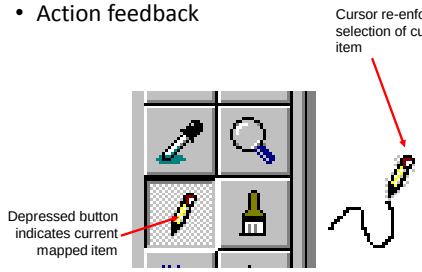
Mapping

- Palette controls and active objects



Mapping

- Action feedback

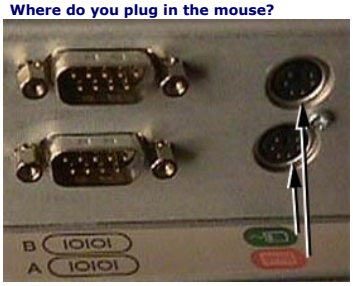


Mapping Problems

Quick, open the top drawer

Mapping Problems

Where do you plug in the mouse?



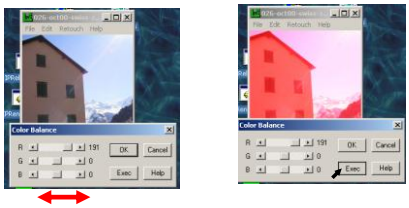
Mapping ambiguous

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
      - Invoking unfamiliar function just as computer hangs
      - Causes "superstitious" behaviors
    - Invisible effect
      - Command with no apparent result often re-entered repeatedly
      - e.g., mouse click to raise menu on unresponsive system

Causality Problems

- Effects visible only after Exec button is pressed
  - Ok does nothing!
  - awkward to find appropriate color level



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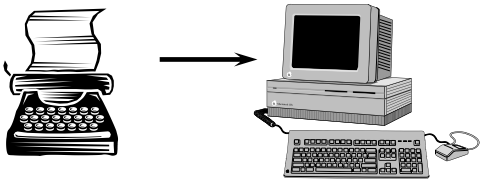
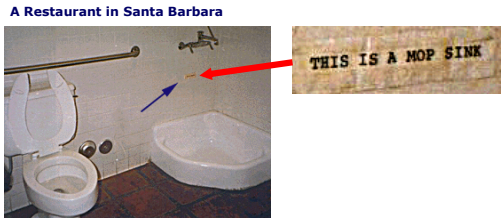
Transfer Effects

- 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



Transfer Effect Problems



Photograph courtesy of www.baddesigns.com

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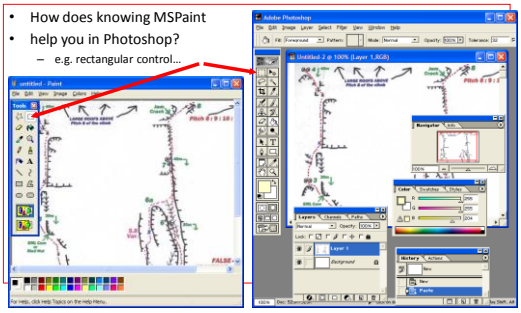
Transfer Effect Problems

- How does knowing MSPaint
- help you in Photoshop?
  - e.g. rectangular control…



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Idioms and Population Stereotypes

- Interface idioms:
  - 'standard' interface features we learnt, use and remember
- Idioms may define arbitrary behaviours
  - red means danger
  - green means safe

- Population stereotypes: Idioms vary in different cultures
  - Light switches
    - America: down is off
    - Britain: down is on
  - Faucets
    - America: anti-clockwise on
    - Britain: anti-clockwise off

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Idioms and Population Stereotypes

- Ignoring/changing idioms?
  - home handyman
    - light switches installed upside down
  - calculators vs. phone number pads
    - which did computer keypads follow and why?
- Difficulty of changing stereotypes
  - Qwerty keyboard: designed to prevent jamming of keyboard
  - Dvorak keyboard ('30s): provably faster to use

Images from www.asdvmsystems.com/Shirts/dvorakkeyboard.html

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Cultural Associations

- Because a trashcan in Thailand may look like this:

a Thai 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

Conceptual model

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

Good example: Scissors

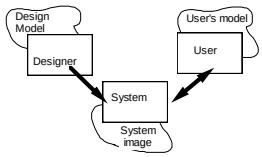
- Affordances:
  - holes for something to be inserted
- Constraints:
  - big hole for several fingers, small hole for thumb
- Mapping:
  - between holes and fingers suggested and constrained by appearance
- Positive transfer and cultural idioms
  - learnt when young
  - constant mechanism
- Conceptual model:
  - implications clear of how the operating parts work

Bad example: 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 learnt

Designing a good conceptual model

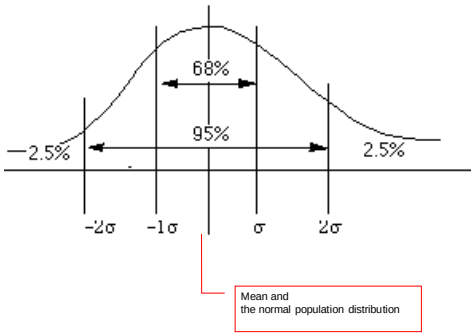
- communicate model through visual image
  - visible affordances, mappings, and constraints
  - visible causality of interactions
  - cultural idioms, transfer
  - instructions augments visuals
- all work together to remind a person of what can be done and how to do it



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
    - ceiling height: 8'
    - but tallest man: 8' 11"!
- Rule of thumb:
  - cater to 95% of audience (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?



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?

- novices — *walk up and use systems*; *interface affords restricted set of tasks*; *introductory tutorials to more complex uses* — most kiosk + internet systems
- casual — *standard idioms*; *recognition (visual affordances) over recall*; *reference guides*; *interface affords basic task structure* — most shrink-wrapped systems
- intermediate — *advanced idioms*; *complex controls*; *reminders and tips*; *interface affords advanced tasks*
- expert — *shortcuts for power use*; *interface affords full task + task customization* — 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

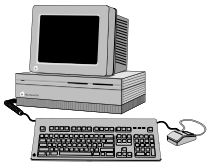
- Marketplace pressures
  - adding functionality (complexity) now easy and cheap
    - computers
  - adding controls/feedback expensive
    - physical buttons on calculator, microwave oven
    - widgets consume screen real estate
  - design usually requires several iterations before success
    - product pulled if not immediately successful

Why design is hard

- People consider cost and appearance over 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)

Human factors in computing systems

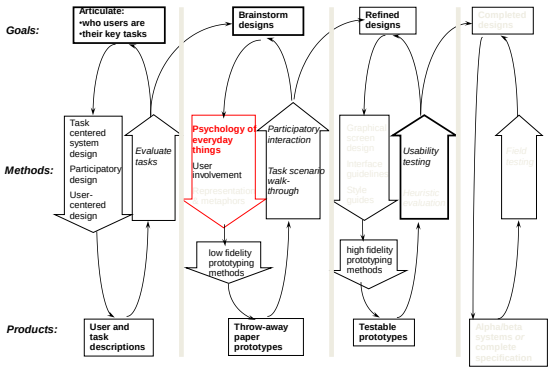
- What does this do?

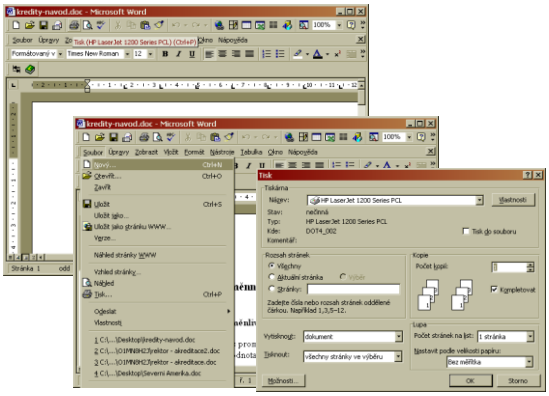


  - computers far more complex to control than everyday devices
  - general purpose computer contains no natural conceptual model
  - completely up to the designer to craft a conceptual model

What you now know

- Many human errors are actually errors in design
  - don't blame the user!
- Designers help by providing a good conceptual model
  - affordances
  - causality
  - constraints
  - mapping
  - positive transfer
  - population stereotypes and idioms
- Design to accommodate individual differences
  - decide on the range of users
- Design is difficult for reasons that go beyond design





Questions

Acknowledgements

- Prof. Ing. Jiří Sochor