PV182
Human Computer Interaction

Lecture 7

Psychopathology and Psychology

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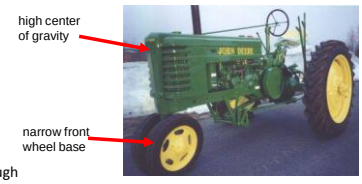
Psychopathology

Pathological Designs

- Many human errors result from design errors bad conceptual model

Tractors

- Early design

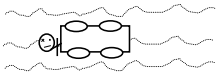


- Terrain
- unsurfaced and rough
- hilly

- Farmer
- works long hours
- works quickly

Tractors .

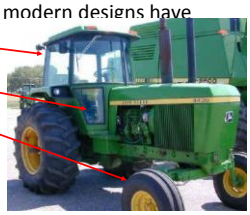
- Result



- 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

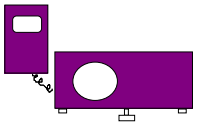
Remote Controls ..

- 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?



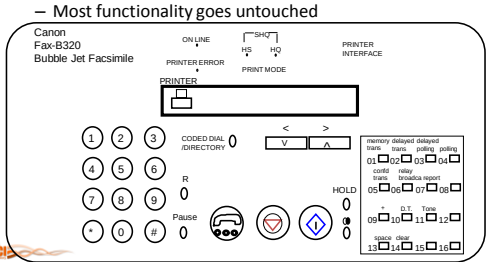
- Instruction manual:
  - Short press: slide change forward
  - Long press: slide change backward

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

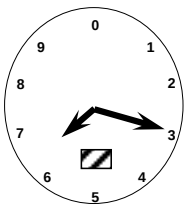


Getting Serious About Design

- 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

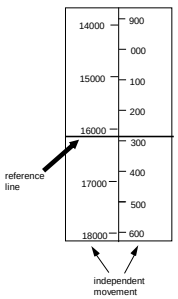


< 10,000'

> 10,000'

Tape Altimeter

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

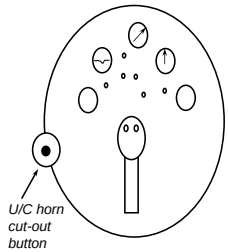


Harvard Airplane (World War II)

- 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"

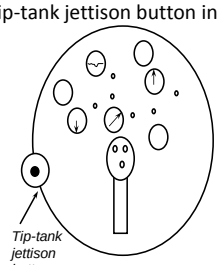
The Harvard Control Panel

- 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 .

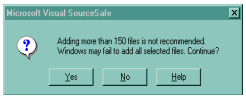
- From Science magazine
  - In 1988, the Soviet Union's Phobos 1 satellite was lost on its way to Mars, when it went into a tumble from which it never recovered.

    "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]"

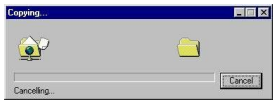
The PC Cup Holder

- 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?



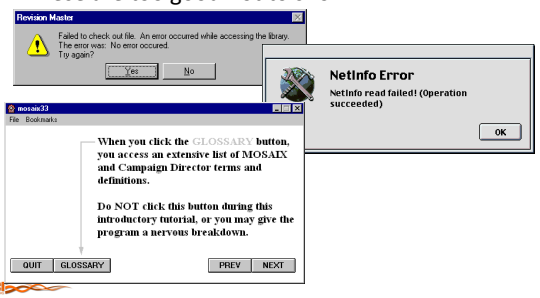
What happens when you cancel a cancelled operation?

Do I have any choice in this?

Uhhh... I give up on this one

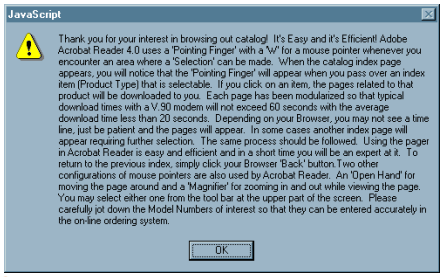
Inane Dialog Boxes .

- These are too good not to show

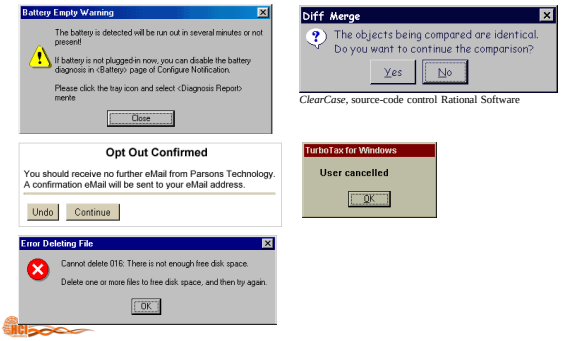


Inane Dialog Boxes ..

- Midwest Microwave's online catalog

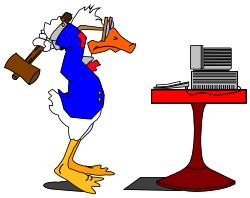


Inane Dialog Boxes …



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

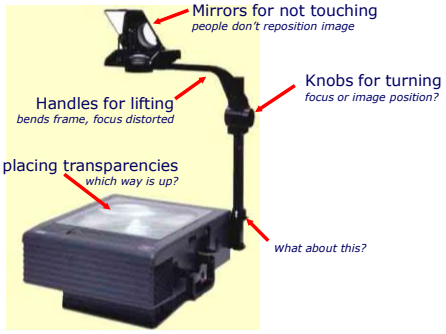

computer for..

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

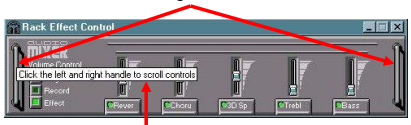
- GUI design
  - Perception only through visuals
  - Designer creates appropriate visual affordances via
    - Familiar idioms
    - Metaphors

More Perceived Affordances .

More Perceived Affordance Problems

More Perceived Affordance Problems .

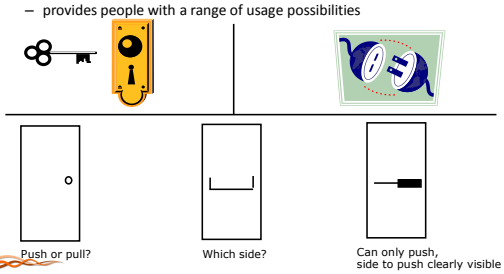
- Handles are for lifting, but these are for scrolling!



- 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

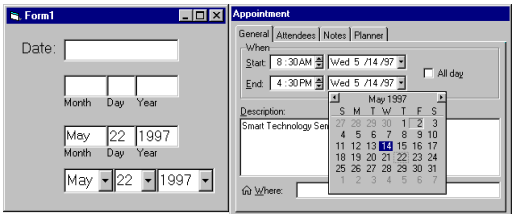


Which Side Do You Use for Cutting?

- Knife example

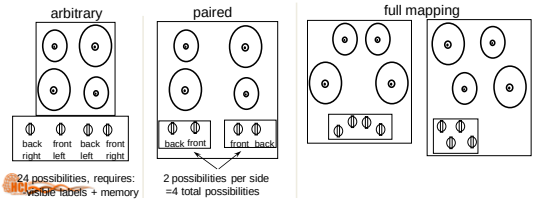
Visible constraints: Entering a Date

- The more constraints, the less opportunity for error



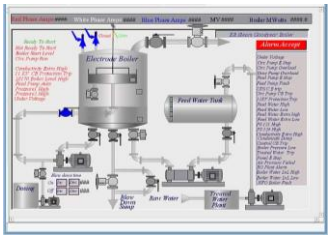
Mapping

- 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



Mapping

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



Mapping .

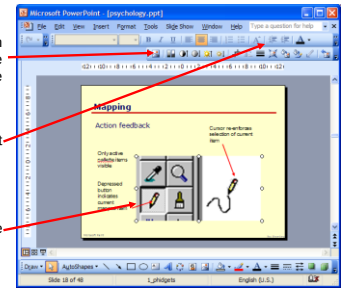
- Control-display compatibility
  - Cause and effect

steering wheel- turn left, car turns left

scroll bar – scroll down viewport goes down

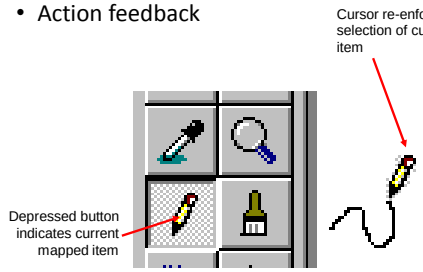
Mapping

- Palette controls and active objects



Mapping

- Action feedback

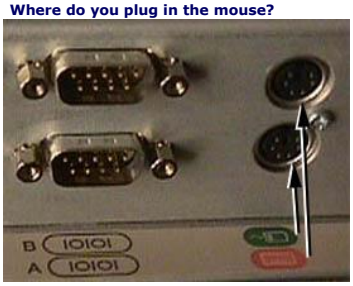


Mapping Problems

Quick, open the top drawer

Mapping Problems

Where do you plug in the mouse?



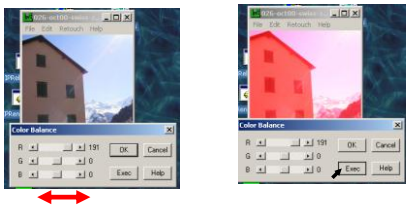
Mapping ambiguous

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

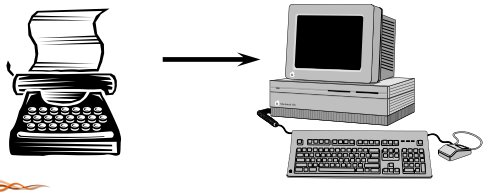
Causality Problems

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

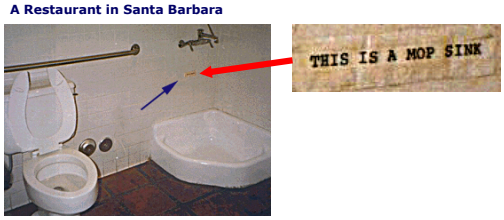


Transfer Effects

- 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

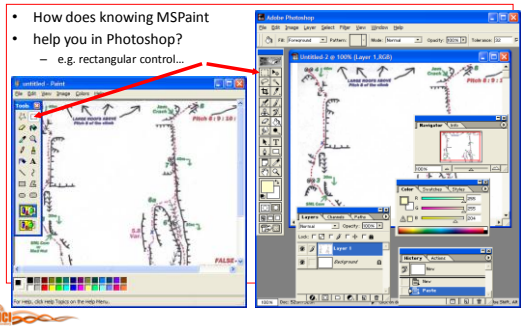


Transfer Effect Problems



Transfer Effect Problems

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



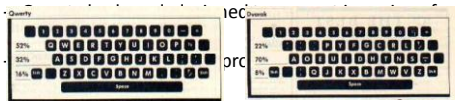
Idioms and Population Stereotypes

- 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

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



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

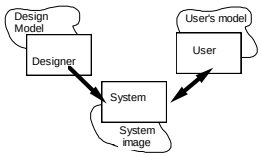
- affordances:
  - holes for something to be inserted
- constraints:
  - big hole for several fingers, small hole for thumb
- mapping:
  - between holes and fingers suggested and constrained by appearance
- positive transfer and cultural idioms
  - learnt when young
  - constant mechanism
- conceptual 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

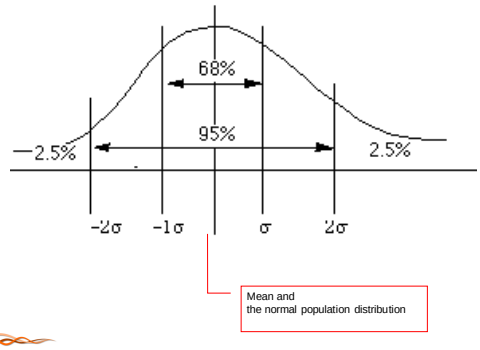
- communicate model through visual image
  - visible affordances, mappings, and constraints
  - visible causality of interactions
  - cultural idioms, transfer
  - instructions augments visuals
- all work together to remind a person of what can be done and how to do it



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
- 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 kiosk + internet systems

most shrink-wrapped 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

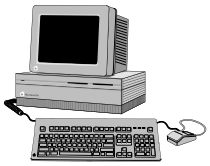
- Marketplace pressures
  - adding functionality (complexity) now easy and cheap
    - computers
  - adding controls/feedback expensive
    - physical buttons on calculator, microwave oven
    - widgets consume screen real estate
  - design usually requires several iterations before success
    - product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

Why design is hard

- People 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

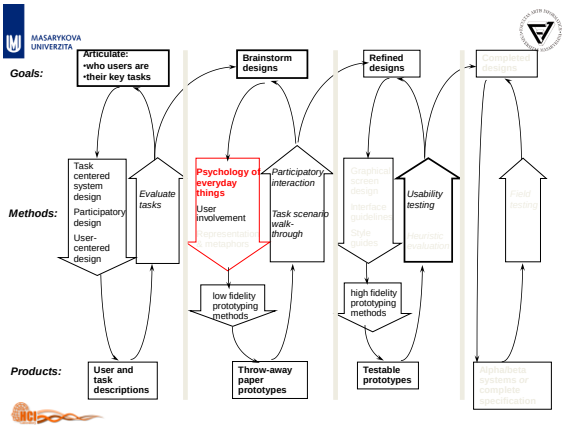
- What does this do?

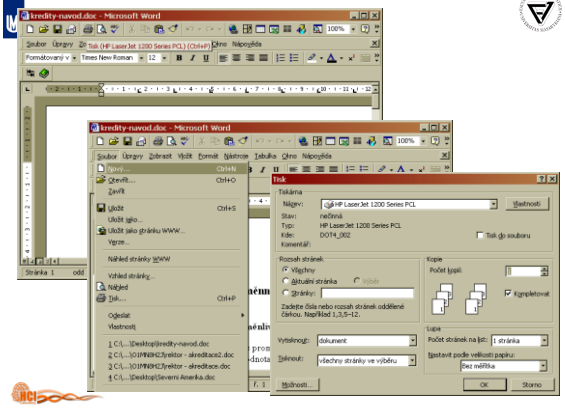


  - computers far more complex to control than everyday devices
  - general purpose computer contains no natural conceptual model
  - completely up to the designer to craft a conceptual model

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

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- Prof. Ing. Jiří Sochor