

CPEN441: user interface design

the psychology of bad and good design
&
design concepts

when we're done this set...

•you should be able to speak intelligently
on:

- why and how interfaces fail:
the psychopathology of everyday things
- why designers make such a mess of it
- design concepts

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why and how interfaces fail

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Making coffee...

www.baddesigns.com

- coffee maker video



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psychology of everyday things

•lesson 1: the myth of human error

- most **failures** of human-machine systems are due to **poor 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 limitations**.

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psychopathology of everyday things

• typical frustrations

the engineer who founded DEC 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/smart watch?
- PVR?
- sewing machine?
- washer and dryer?
- microwave?
- unfamiliar water faucets



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telephone systems

•modern telephone systems

- standard number pad
- two additional buttons * and #



•problems

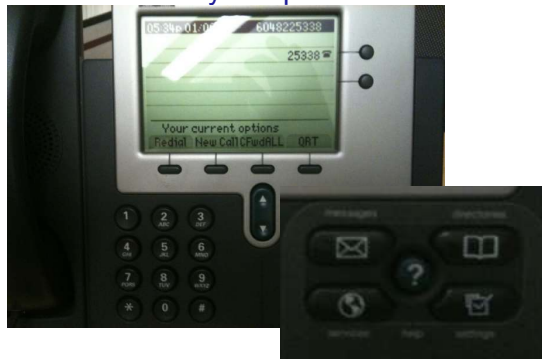
- many hidden functions
- operations and outcome completely invisible – e.g.:
 - *72+number = call forward
 - can I remember that combination?
 - if I enter it, how do I know it caught?
 - how can I remember that I left my phone forwarded?

Ok, I'll read the manual

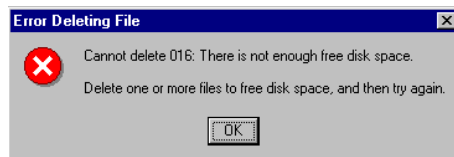
- but what does "call park" mean? what's a link?
- where is that manual anyway?

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My Telephone



inane dialog boxes (1 of 2)



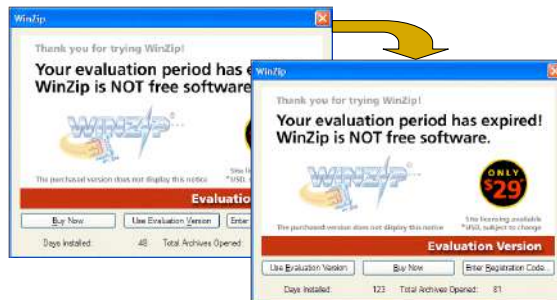
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inane dialog boxes (2 of 2)



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bad design as good/manipulative design?

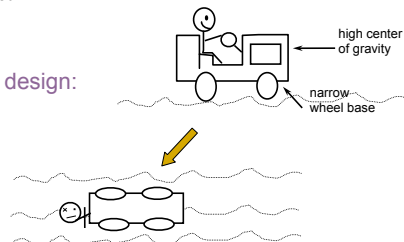


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typical terrain:
un-surfaced
rough
hilly

early tractors

original design:



used to be called "Driver's Error" ...

but, accidents became infrequent when designs changed to low center of gravity & wider wheel bases

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getting serious about design: World War II = turning point

- control of new airplanes, submarines taxed sensorimotor abilities
- frequent errors (often fatal) even after high degree of training

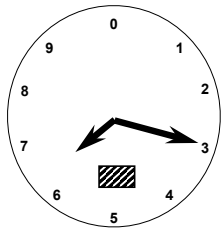


• example airplane errors:

- if booster pump fails, turn on fuel valve within 3 sec
 - test shows it physically required at least five seconds to do!
- Spitfire: narrow wheel base
 - easy to enter violent uncontrollable loops → break undercarriage!
- altimeter gauges difficult to read
 - pilots misunderstood altitude and crashed

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what's the altitude?



•early days (< 1000'):

- only one needle needed

•as ceilings increased over 1000':

- small needle added

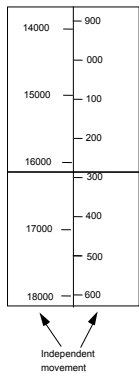
•as they increased > 10,000':

- box indicated 10,000' increment through color change



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a kind of tape altimeter



- human factors test showed that this altimeter

- eliminated reading errors
- was faster to read

- but it was not put into standard use!

why?

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psychology of everyday things

- many so-called **human errors** and “machine misuse” are **actually errors in design**
- good design **accounts for human limitations**
- 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

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how do interfaces fail?

- **functionality / mental model problem**
what are the functions this object can perform? will it do what I want?
- **state problem**
what mode is this object in?
- **control problem**
which control or sequence of controls do I use to get what I want?
- **feedback problem**
how do I know I got what I wanted?
what's wrong?

come back to this in a while...

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the myth of human error

- **humans are imperfect and unpredictable.**
 - we have lousy memories
 - we don't see what's really there
 - we don't say what we really mean
 - we get confused when too much is going on
 - we get tired or bored and don't pay attention
 - we are easily distracted

- it's your job to take that into account:

many so-called human errors and “machine misuses” are actually errors in design

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where exactly do designers go wrong?

- designers fail to understand the range of users and their physiological limitations
- designers fail to communicate functionality
- designers fail to provide a good model of how something works
- designers fail to provide feedback
- designers fail to foresee possible contexts of use

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why do interface designers make such a mess of it?

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because non-user-oriented attitudes towards design are natural

•attitude of technology-centred design

- progress made by technological advances
- goal is to show off gadgets and inventions

•attitude of designer-centred design

- progress made by considering designers' intuition
- imagining what the user will do and feel

•attitude of user-centred design

- progress made by incorporating the users into the process
- empirical studies integrated early into the design + users as part of the development team

user

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because the design task is intrinsically complex and poorly defined

- system

- human ↔ machine (*what's a human? what's a machine?*)

- interaction

- cooperative (*that means coordinated → complicated*)
 - users are failure-prone & change their minds

- task oriented

- distribution of tasks between human & machine (*division of labor is a moving target*)
 - goal-directed (*but the machine doesn't always know the goal*)

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Lack of tool support

poor SW support

- traditional programming languages

- designed for batch I/O, level of control not event-driven

laborious prototyping: must test empirically

- even with specialized UI support,

- UI widget libraries and interface builders available
 - buttons, sliders, list boxes, dialog boxes, menus, etc. (see wiki pages for typical ones or your s/w IDE documentation)
 - UI code is 50-80% of effort in interactive program

- lack of standardized interfaces

- still evolving
 - vendor competition

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usable vs. useful

- Thomas Landauer, *The Trouble with Computers: Usefulness, Usability, and Productivity*, 1995
 - see also the Technology Acceptance Model (TAM) [Davis, 1989]

- 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

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psychology of everyday things: design concepts

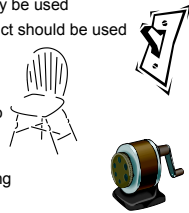
- affordances
- causality
- visible constraints
- mapping
- understandable action
- transfer effects
- cultural associations
- conceptual models
- individual differences

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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
- simple things should not
 - when simple things need pictures, labels, instructions → design has failed



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physical affordance



photo from Don Norman's good design gallery²⁷

a bad affordance

handles are for lifting, but these are for scrolling



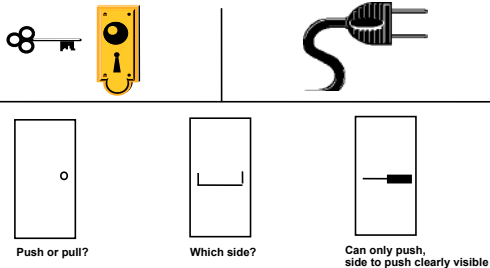
from AudioRack 32, a multimedia application

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visual structure (cont)

• visible constraints

- object's appearance indicates *limitations* of possible actions



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a progression of visible constraints to enter a date

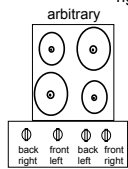
Two screenshots showing the progression of visible constraints for entering a date. The first screenshot shows a simple 'Form1' with a 'Date:' label and a text input field. The second screenshot shows an 'Appointment' form with a 'When:' section containing 'Start' and 'End' time and date fields, and a calendar view for May 1997.

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mappings

- the set of possible / natural relations between objects
- e.g. **control-display compatibility**:
- visible mapping and mimic diagrams: stove and controls
 - cause and effect: steering wheel-turn right, car turns right



Exercise

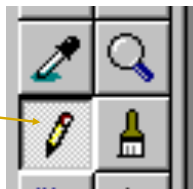
24 possibilities, requires:
-visible labels
-memory

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mappings

Only active
palette items
visible

Depressed
button
indicates
current
mapped item



Cursor re-enforces
selection of current
item



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understandable action

- **causality**: *A caused B to happen*
- **true causality** != perceived causality
 - we usually assume that the thing that happens right after an action was caused by that action
 - interpretation of "feedback"
 - false causality
 - incorrect effect:
 - starting up an unfamiliar application just as computer crashes
 - causes "superstitious" behaviours
 - invisible effect:
 - command with no apparent result often re-entered repeatedly
 - e.g., hitting esc, or alt-ctrl-del, on unresponsive system

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understandable action

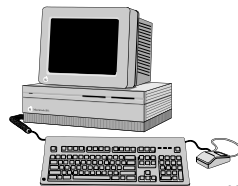
- How to set colour in **Powerpoint**?
 - Can't see effect until after 'OK'



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transfer effects

- **transfer effects**
 - people transfer their learning/expectations of similar objects to the current objects
- **positive transfer**: previous learning apply to new situation
- **negative transfer**: " " conflict with the new situation



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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: up is (N America) on (Britain) off
 - faucets: clockwise is (N America) off (Britain) on
- 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

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cultural associations

- Because a trashcan in Malaysia may look like this:



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



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



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Conceptual and mental models

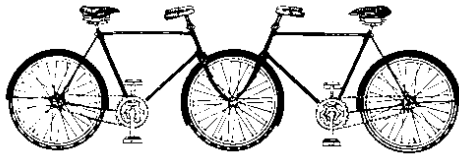
- Designers create conceptual models of system
 - Not necessarily the same as the system model
- people have “mental models” of how things work
- mental models derived from:
 - Design
 - affordances
 - causality
 - constraints
 - mapping
 - positive transfer
 - population stereotypes/cultural standards
 - instructions
 - interactions (with computer and people)
 - familiarity with similar devices (positive transfer)
- Mental models may be wrong, esp. if attributes are misleading
- Mental models allow us to mentally simulate device operation

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Jacques Carelman: Catalog of unfindable objects

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Jacques Carelman: Catalog of unfindable objects

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a good conceptual model: scissors

- visual affordances:
 - holes for something to be inserted
- constraints:
 - big hole for several fingers, small hole for thumb
- mapping:
 - connection between holes and fingers suggested and constrained by appearance
- positive transfer and cultural idioms:
 - learnt when young
 - constant mechanism
- Object provides conceptual model:
 - implications clear of how the operating parts work
- Mental model develops easily and consistently



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a poor conceptual model and system image:

- affordances:
 - four 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 not provided by activity or object:
 - must be taught



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Creating a Conceptual Model

1. Based on activities
 - Instructing
 - Conversing
 - Manipulating and navigating
 - Exploring and browsing
2. Objects
3. Interface metaphor
4. Interaction paradigms

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Communicating design/conceptual models: guideline #1

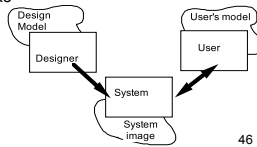
•construct a good conceptual model

- allows user to predict the effects of their actions

•problem:

- designer's conceptual model communicated via 'system image': appearance, instructions, system behaviour through interaction transfer, idioms and stereotypes
- if system image does not make model clear and consistent:

→ user will develop wrong mental model



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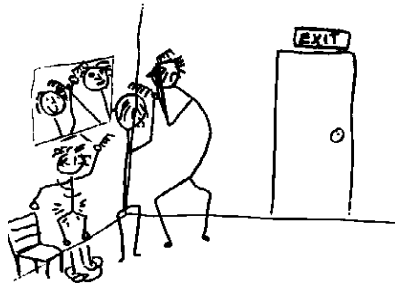
Communicating design model: guideline #2

• make things visible

- relations between user's intentions, required actions, and results are **sensible** and **meaningful**
- employ visible affordances, mappings, and constraints
- use visible cultural idioms
- remind person of what can be done and how to do it

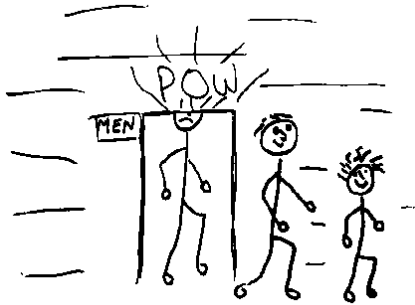
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individual differences



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individual differences



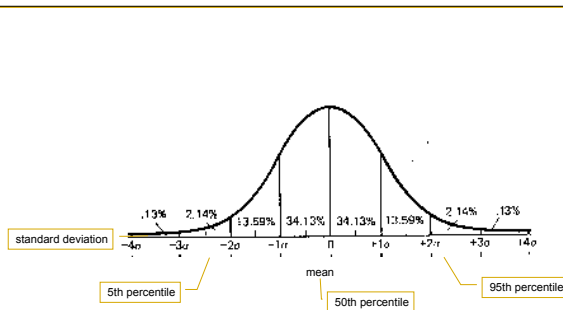
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individual differences: physical

• people are different

- it is rarely possible to accommodate all people perfectly
 - design often a compromise:
ceiling height: 8' ... but tallest man: 8' 11"!
- general guideline:
 - design should cater to 95% of audience (5th or 95th percentile)
 - 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, colour for colour-blind people?

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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

UX Panel in 2016:

- one of the biggest design mistakes is to design for yourself
- programming done by design team
- not enough testing (Samsung leader)

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individual differences: expertise

computer users:

novices	walk up & 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

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why design is getting harder

•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 increasingly serious and/or costly
 - airplane crashes, losing days-worth of work...

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why design is getting harder

• marketplace pressures

- adding functionality (complexity) now easy & cheap
 - mobile, sensing, 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

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why design is getting harder

• consumers often value cost / looks over usability

- trendy appearance is visible
 - looks great in the store!
- bad design often isn't visible
 - notice after you take it home, then live with it
- then blame yourself 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!"

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but it is important...

1. Safety
2. Profit



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Something to think about

- 2013 vision of the iWatch in 2019
- https://www.youtube.com/watch?v=u5OV_BJreTA



summary

- what "HCI" means
- why and how interfaces fail:
the psychopathology of everyday things
- why designers make such a mess of it
- design concepts