Design of Everyday Things

Pathological designs

Many human errors result from design errors

Designers help through a good conceptual model

41 BC: Emperor tired of loosing to the Gauls

Slide idea from David Hill

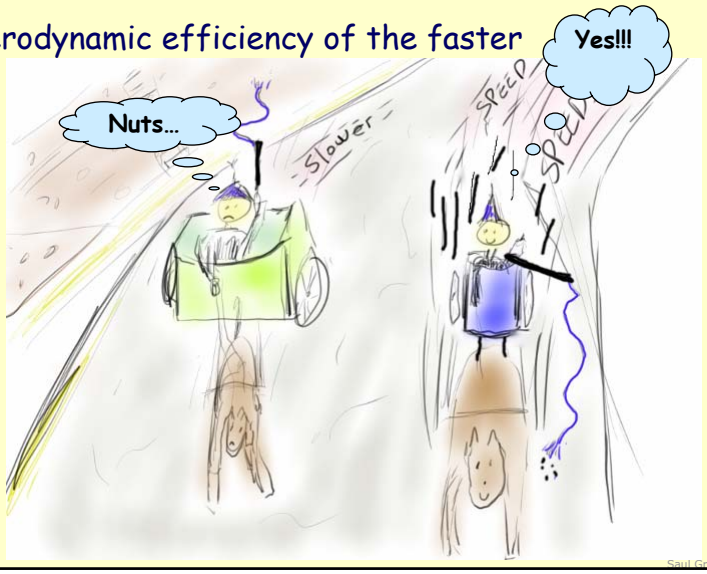
Advisor intuitively finds a solution...

Slide idea from David Hill

Saul Greenberg

The Chariot Race

Notice aerodynamic efficiency of the faster chariot



Slide idea from David Hill

Saul Greenberg

The Chariot Race

But, in maneuvering for position on the turn, the DRIVER makes an error!!!

Or was it the DESIGNER???

Slide idea from David Hill

Human factors engineered

- Boadiceaised as well

Slide idea from David Hill

Tractors

Early design

high center of gravity

narrow front wheel base

Terrain
- unsurfaced and rough
- hilly

Farmer
- works long hours
- works quickly

Images from www.co.lawrence.tn.us and www.uni-magdeburg.de

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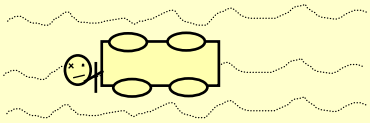
Tractors

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.

Accident image from //www.osh.dol.govt.nz/

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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

Tractor from www.historylink101.com

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So what does this teach us?

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

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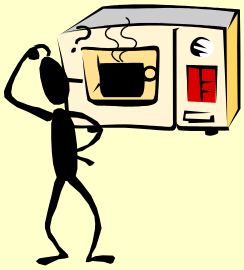
Psychopathology of everyday things

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?

Slide idea from Donald Norman

Saul Greenberg

Remote Controls

The phone rings…
- hit pause

Pioneer DVD Remote

Slide idea from Jacob Nielsen Alertbox March 15, 2004

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

Slide idea from Jacob Nielsen Alertbox March 15, 2004

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

Photo + caption from Jacob Nielsen's Alertbox June 7, 2004

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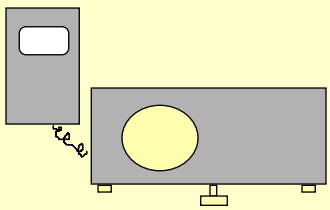
Other pathological examples:

Remote control from Leitz slide projector

- How do you forward/reverse?



Instruction manual:

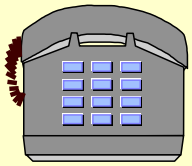
- *short press*: slide change forward
- *long press:* slide change backward

Slide idea from Donald Norman

Saul Greenberg

Still more pathological examples

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



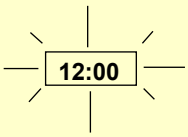
Problem
- many hidden functions
- operations and outcome completely invisible
  - *72+number = call forward
    - can I remember that combination?
    - if I enter it, how do I know it caught?
    - how can I remember if my phone is still forwarded?
  - Ok, I'll read the manual
    - but what does *call park* mean? what's a link?
    - where is that manual anyway?

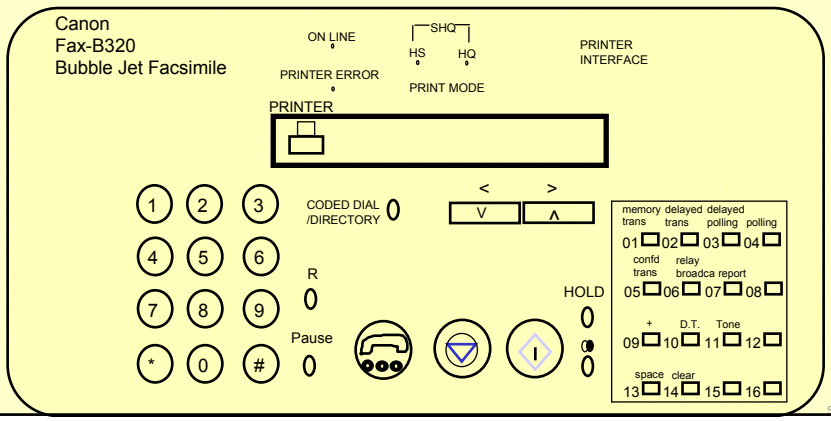
Phone operation for the University of Calgary phone system

Saul Greenberg

Still more pathological examples

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





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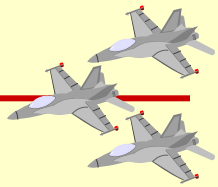
Getting serious about design



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

Slide ideas from David Hill

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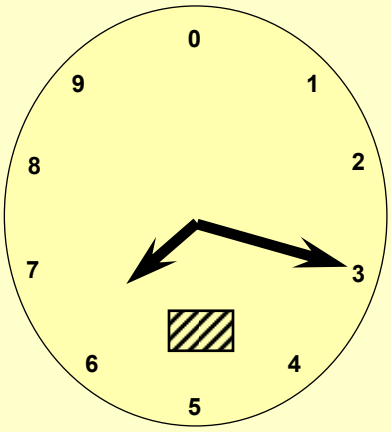
What's the altitude?



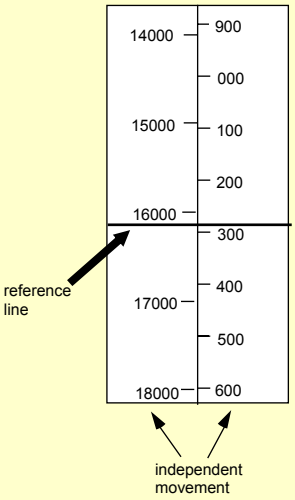
- Early days (< 1000'):
  - only one needle needed
- As ceilings increased over 1000'
  - small needle added
- As they increased beyond 10,000'
  - box indicated 10,000' increment through color change

< 10,000'

> 10,000'

Slide ideas from David Hill

Tape altimeter



Human factors test showed:

- eliminated reading errors
- was faster to read

But not in standard use! Why?

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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"

Slide ideas from David Hill

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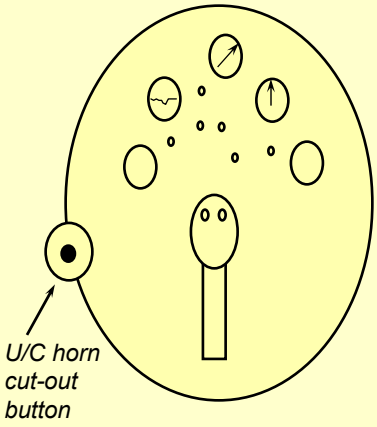
The Harvard Control Panel



Problem #1: Conditioned response

stall -> push button; therefore stimulus nullified

Slide ideas from David Hill

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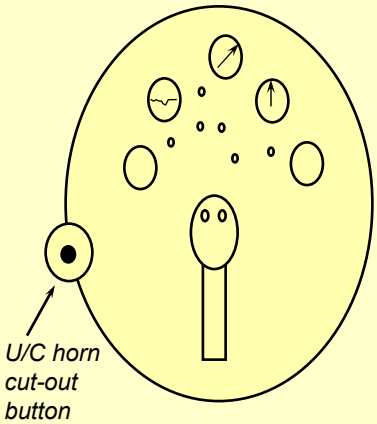
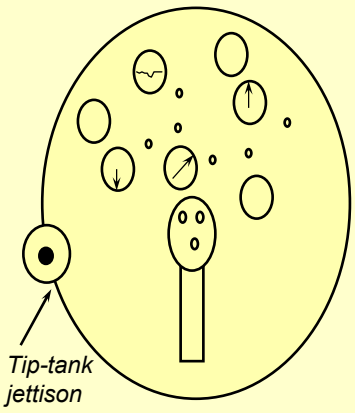
The Harvard Control Panel | **The T-33 Control Panel**





Problem #2: Negative transfer

T-33's: tip-tank jettison button in same location

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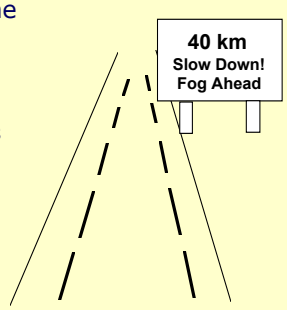
Darn these hooves! I hit the wrong switch again!
Who designs these instrument panels, raccoons?

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



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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

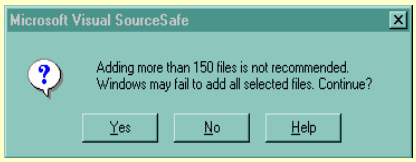
A true (?) story from a Novell NetWire SysOp

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.

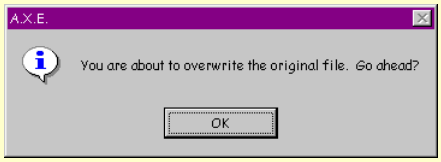
The caller had been using the load drawer of the CD-ROMdrive as a cup holder, and snapped it off the drive.

Inane Dialog Boxes



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

What happens when you cancel a cancelled operation?



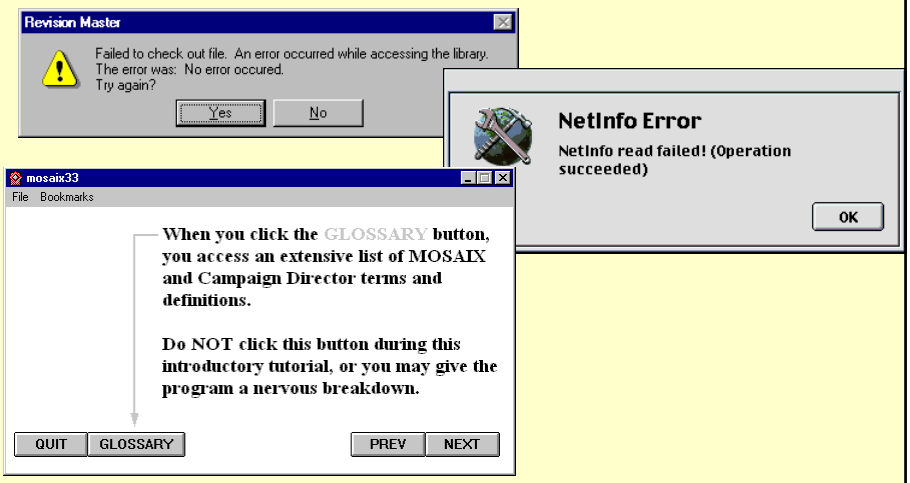
Do I have any choice in this?

Uhhh… I give up on this one

Some of these interfaces were posted on Interface Hall of Shame

Inane Dialog Boxes

These are too good not to show



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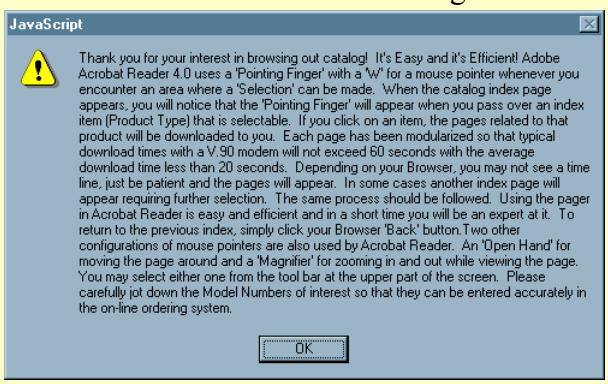
Inane Dialog Boxes

Midwest Microwave's online catalog



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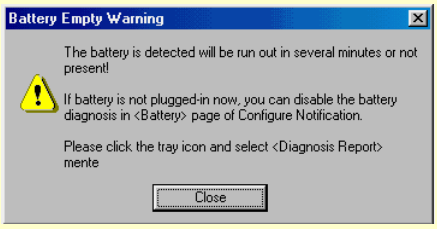
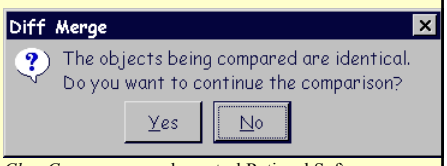
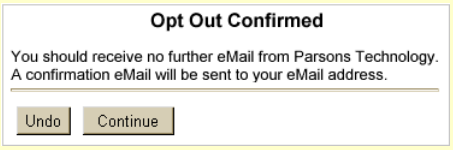
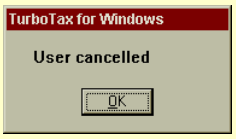
Inane Dialog Boxes

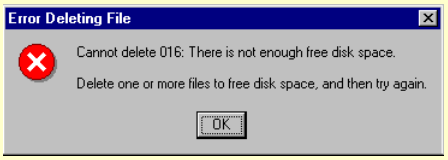




ClearCase, source-code control Rational Software







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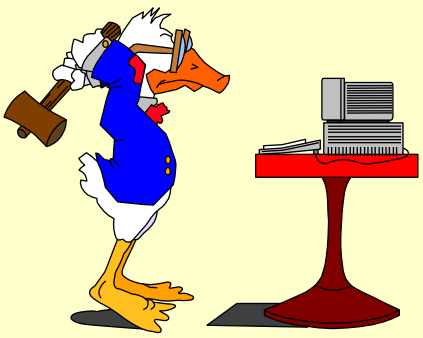

“HIT ANY KEY TO CONTINUE”

Why should you care?

Past

- manufacturers had little incentive to emphasize usability
- customers have no experience until after they buy the product
- early technology adaptors were 'resilient'
  - willing to put up with annoyances
- consequences of bad design typically small (annoyances)

Slide idea from Jacob Nielsen Alertbox March 15, 2004

Saul Greenberg

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)

Saul Greenberg

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.