Principles for Design

People-Oriented Computing

7.10.2019

Announcements

- Lab this Wednesday (09.10.2019)
- Exercise posted on OLAT
- Looking for note-taker for this course

GESUCHT: Note-Taker für Studentin mit einer studienerschwerenden Beeinträchtigung__NT191001

Die Fachstelle Studium und Behinderung FSB sucht eine*n Student*in, welche*r Notizen in Form einer Mitschrift der folgenden Veranstaltungen (VL und Ü) nimmt und diese zuverlässig übermittelt. Die Mitschrift soll im Word-Format übermittelt werden:

- **People Oriented Computing** (AINF 1168)

Die Fachstelle entschädigt jede Veranstaltung mit 5 CHF (z.B. Modul XY: es gibt 13 Vorlesungen und 13 Übungen also insg. 26 Mitschriften, die mit je 5.- vergütet werden)

Aufgaben:

- Ausführliche Mitschrift beim Besuch der Veranstaltung(en)
- Übermittlung der Notizen an den Studenten per E-Mail.

Interested? Full details for job posted on OLAT in General Materials folder

Learning Goals

After this lecture, you should:

- Have a fundamental understanding of the role of design
- Understand the notions of conceptual models and system images
- Be familiar with key concepts and principles of design, including
  - Affordances
  - Signifiers
  - Constraints
  - Visibility
  - Discoverability
  - Mappings
  - Feedback
- Be able to able to apply these concepts in critiquing or analyzing a design or system

DESIGN IN INTERACTION

A basic distinction

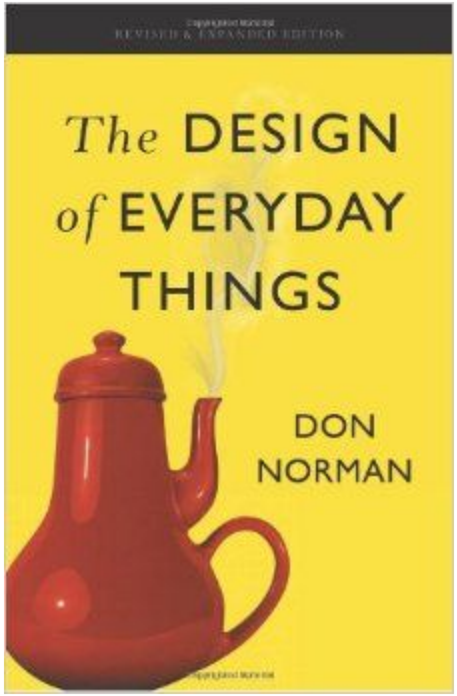
Usability versus usefulness:

- Usability – Is a system or object easy to use
- Usefulness – Does a system or object serve a function that is valuable to me?


ON/OFF
PASQUINI

The Design of Everyday Things

- Authored by Donald Norman
- Fundamental reading touches on many fields including design, human-computer interaction, cognitive science, behavioral psychology

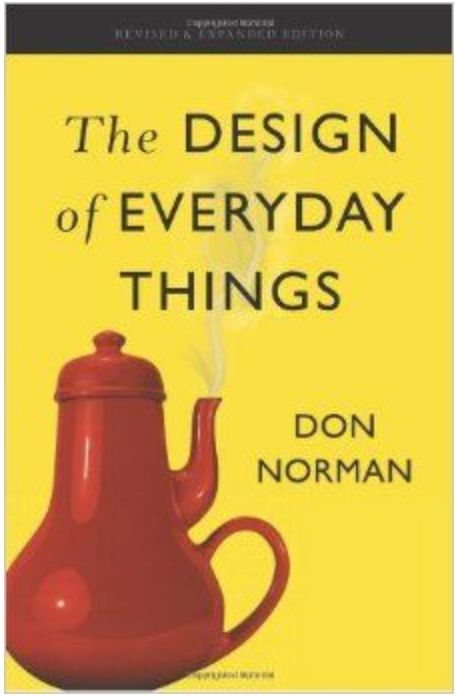


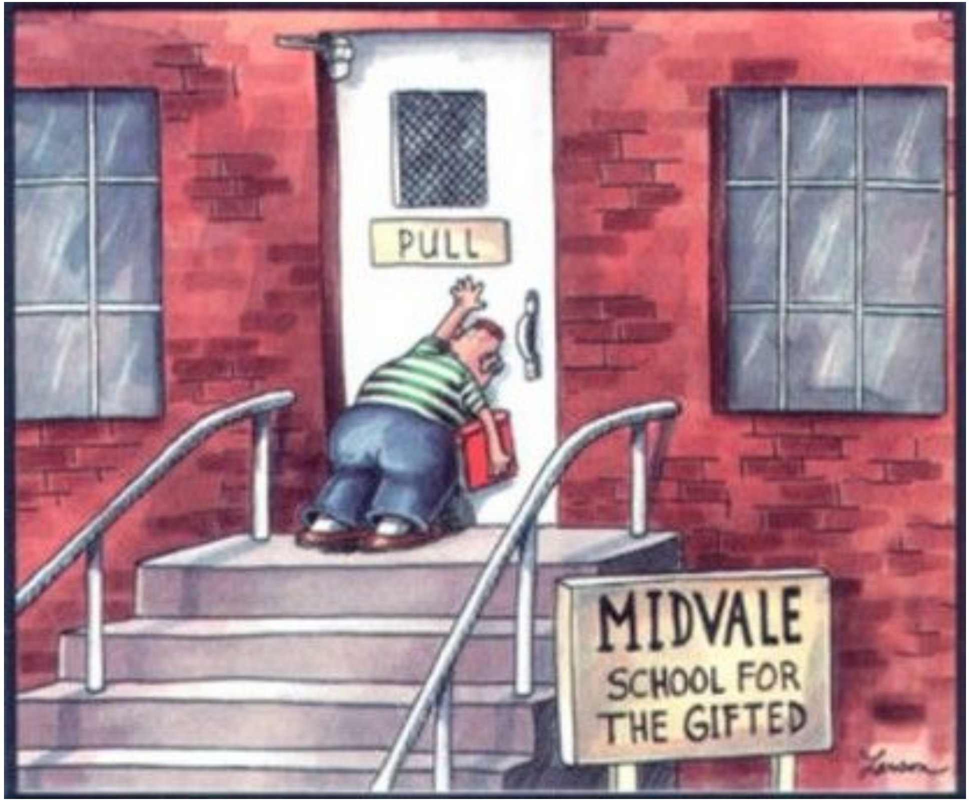
Don Norman

- Cognitive scientist and design expert
- Co-founder of Nielsen Norman Group
- Previously affiliated with Apple, Northwestern University
- University of California, San Diego

The Design of Everyday Things

- Covers many ideas in a fairly short book
- Profound effect on thinking about design
- Provides many examples of design concepts
- Emphasis on usability over usefulness
- Relatively few examples of digital systems and interfaces




PULL
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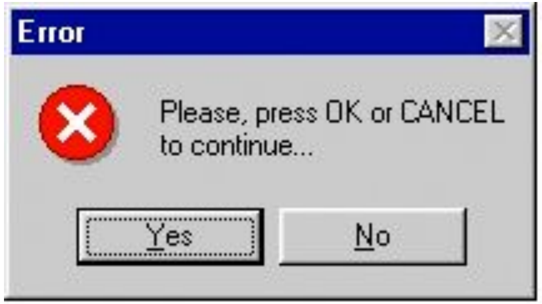
Thinking About the Digital

- How do we apply these design concepts to digital systems as well as physical objects?
- Digital examples are mostly my own, based on my interpretation of Norman's concepts

Fundamental Ideas

- Everything that is not fully created in nature has been *designed*
- Someone made decisions about how things should look or operate, how procedures and services should work, etc.
- Design may be carefully thought through or informal and haphazard



Design

- A relatively new field of study
- Considers how things work, how they are controlled, and how people interact with them

Why is Design Important?

- Affects the human experience
- Poorly designed systems and products waste money, time, resources, create frustration
- Bad design can have negative, even dangerous effects

Therac-25

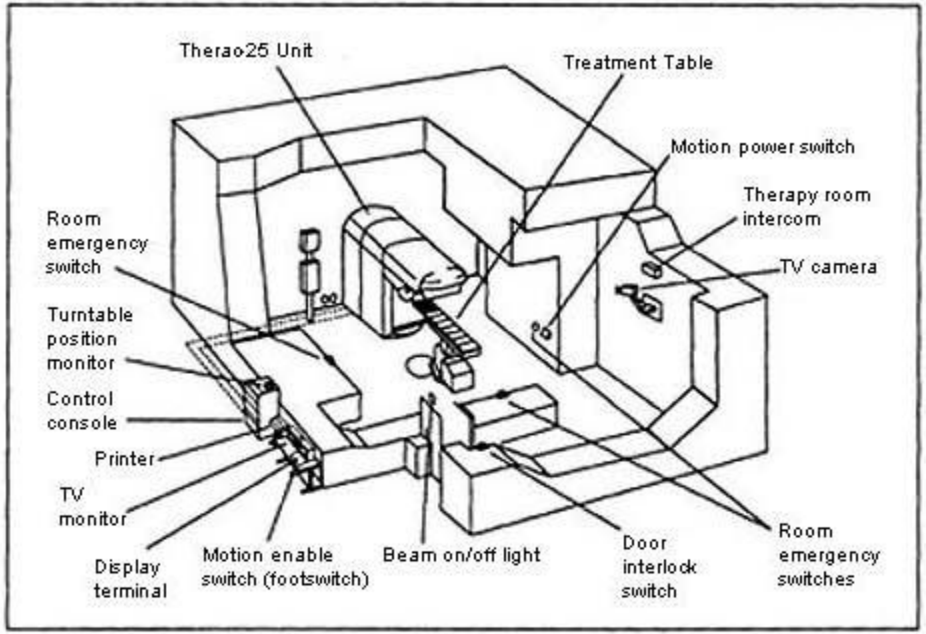


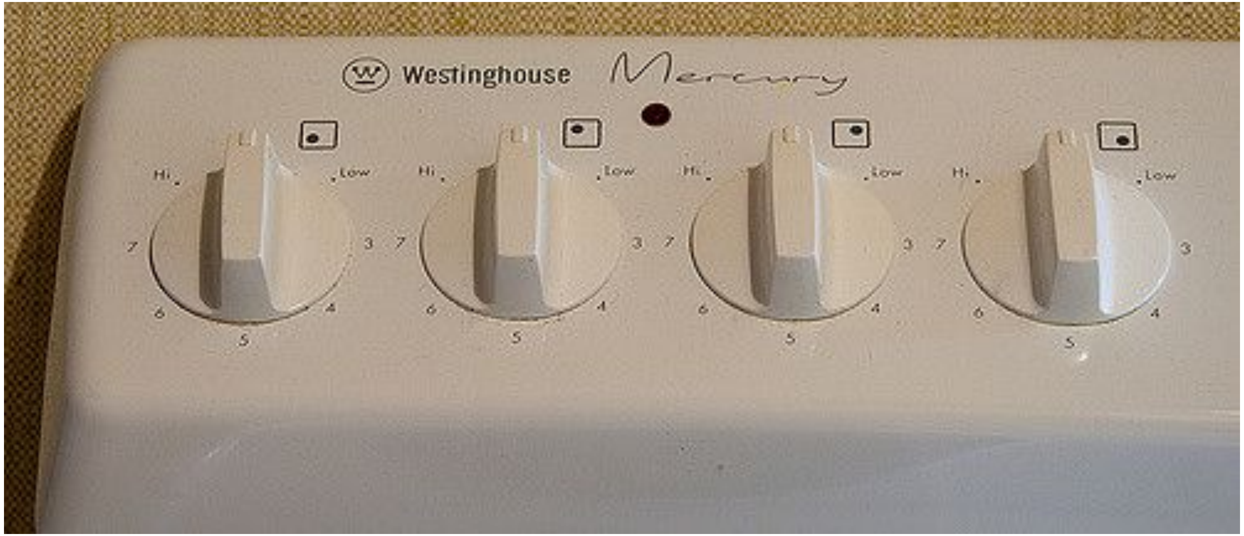
Figure 1. Typical Therac-25 facility

Source: computingcases.org

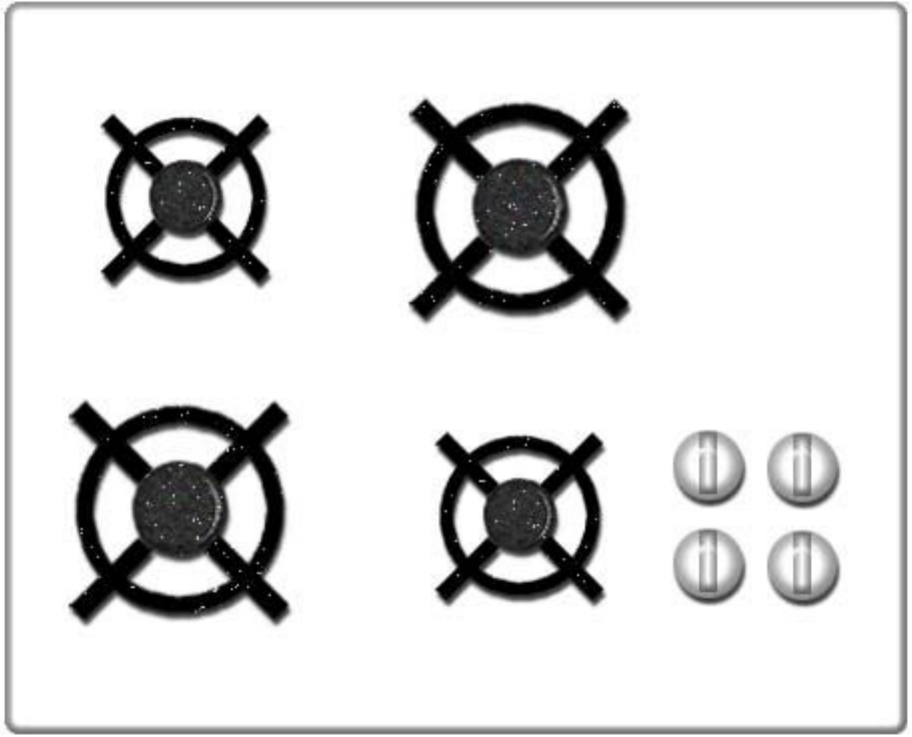
Therac-25

- Radiation therapy machine could deliver low-dose or high-dose radiation
- Software bug made it possible for operator to select low-dose radiation while machine stayed on high-dose – machine delivered 100x the intended dose
- Previous machine versions had hardware lockout and manual controls but new version only had computer control
- 6 people in the 1980s received wrong dose; 4 died and 2 were permanently injured

Stove Controls



Stove Controls



Source: wikipedia.org

Three Fields of Design

Industrial design

Focuses on function and appearance of products and systems, often physical

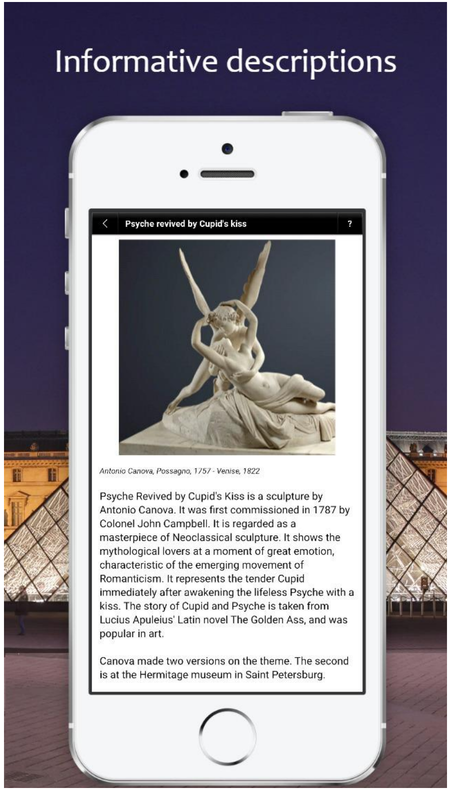
Interaction design

Focuses on how people interact with technology, in particularly understanding how to use it

Experience design

Focuses on quality and enjoyment of experience, particularly of services, environments, and events

A (Very Simplified) Example



Museum guide on a mobile phone

- Industrial design
- Interaction design
- Experience design

Human-Centered Design

- Not a *field* of design but an *approach*
- Makes human capabilities and behavior central, and designs to accommodate
- Focuses on *communication* between the person and the system
- Human-Centered Design can be applied to almost any type of design (including software design)

DESIGN PRINCIPLES AND CONCEPTS

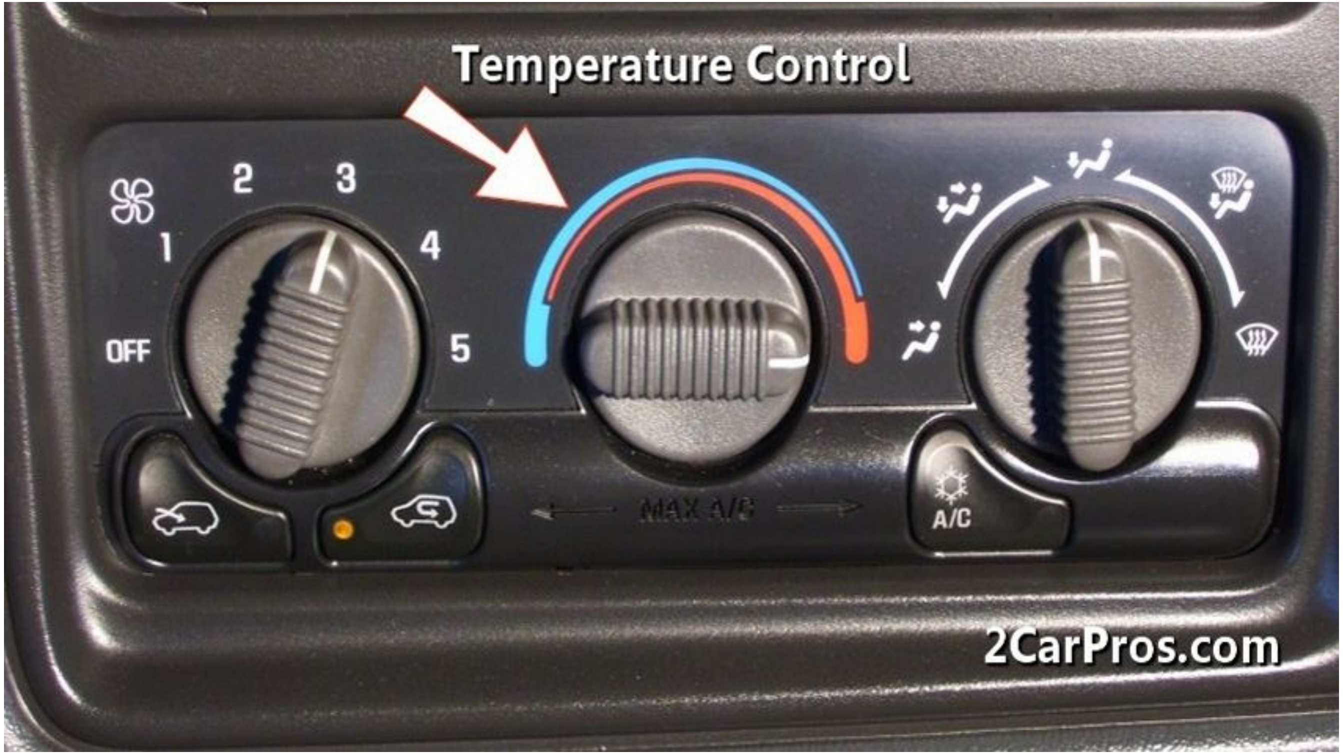
Conceptual Models and System Image

Conceptual Models

- A (usually simplified) explanation of how something works
- Is not necessarily an accurate reflection of the actual workings of the system
- Is not necessarily complete
- Conceptual models of the same system can differ from person to person

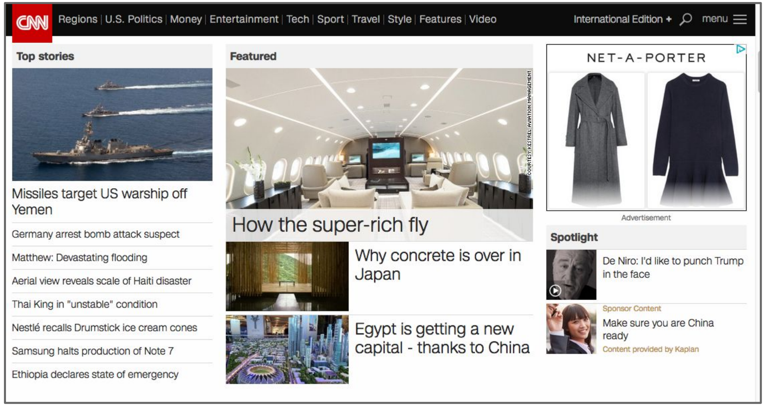
Conceptual Models: Mental Models

- Mental models are the conceptual models that people have in their minds of a system
- Mental models are often developed from experience
  - Inferred from the system itself
  - From learning from others
  - Through interaction with the system
  - From instructions or manuals


Temperature Control
2
3
1
4
OFF
5
MAX A/C
A/C
2CarPros.com

A Digital Example

“This web page is showing me an ad for the same coat I was looking at on Net-a-Porter!”



What are the possible conceptual models?

Designer’s Conceptual Model

- Represents the designer’s understanding of the system
- Usually fairly complete, detailed and accurate

Source: yellowbrickroad.com

User’s Conceptual Model

- Varies from person to person
- Varies in completeness and correctness
- Based on experience
- Influenced by system image

System Image

- The total information that is available to the user
  - Appearance of the system
  - Instructions
  - Information from salespeople and advertisements
  - Articles about products
  - Product website
  - Etc.
- Essentially, all of the information that can be communicated to the user

System Image

- Can be incomplete or contradictory
- Can foster good or poor conceptual model for user
- The only means through which the designer can communicate with the user

What Does Good Design Do?

- Good design facilitates communication of the designer’s conceptual model via the system image to the user
- Enables user to develop a good conceptual model

Fundamental Design Principles

Donald Norman's central insight about what makes for good design:

Discoverability in a system's design is what allows a user to *develop a good conceptual model* of the system

Fundamental Design Principles

Discoverability: the extent to which the design allows the user to discover what it does, how it works, and what operations are possible

Fundamental Design Principles

What concepts can be applied to yield good discoverability in a system?

- Affordances
- Signifiers
- Constraints
- Mapping
- Feedback

Affordances

- The relationship between an object and a person (or other entity)
- Determines how the object could possibly be used
- Depends on both the properties of the object and the capabilities of the person
- Affordances need to be perceivable to be effective

Affordances of Objects

Perceivability of Affordances

Affordances of Objects - Digital

Source: stadt-zuerich.ch

Signifiers

- Signifiers are any perceivable indicator that communicates an appropriate behavior to a person
  - i.e. Affordances determine what is possible, signifiers communicate what to do
- Can be deliberate in design, e.g., sign indicating how many minutes until the next tram
- Can be unintentional, e.g. presence of people waiting at a tram stop

Signifiers

- Important in design for fostering discoverability, but
- Can be misleading, poor, or superfluous
- Perceived affordances often serve as signifiers
- Not all signifiers are affordances!

Signifiers

- Simple objects or systems should be self-explanatory
  - Should not require signage or “added-on” signifiers
  - Should not require additional instruction or manuals to operate


PULL
PUSH

Signifiers

Source: stadt-zuerich.ch

Constraints

- Clues that help you discover what to do by putting limits on the set of possible actions
- Constraints especially useful for helping people determine proper course of action in new situations

Types of Constraints

- Physical
- Cultural
- Semantic
- Logical

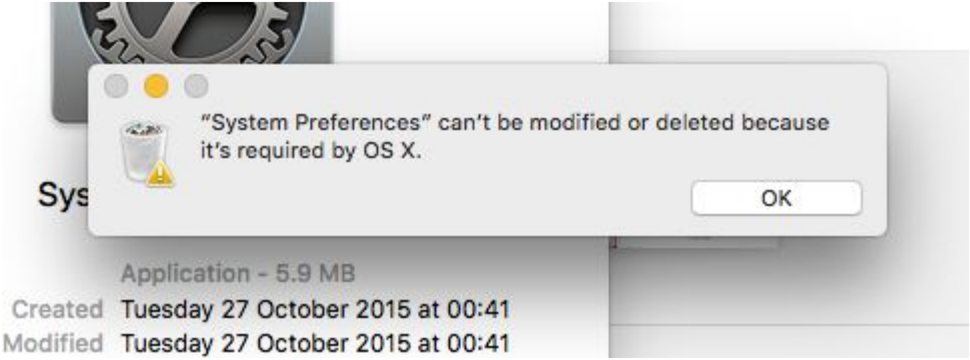
Physical Constraints

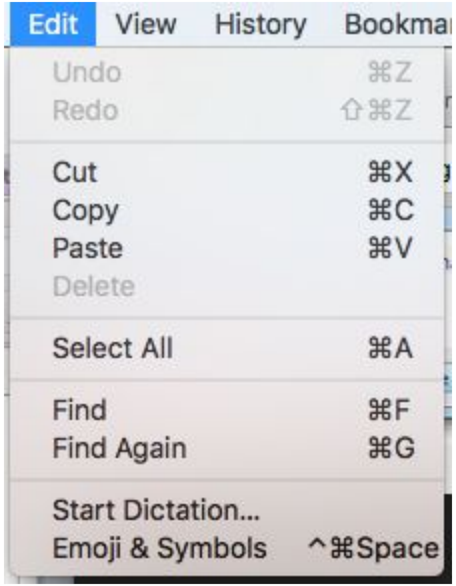
- Physical limitations to possible operations, e.g.
  - Physical keys
  - Insertion of USB drive
- More effective when they are easy to see and interpret
  - Can prevent action before it happens rather than when it is in progress

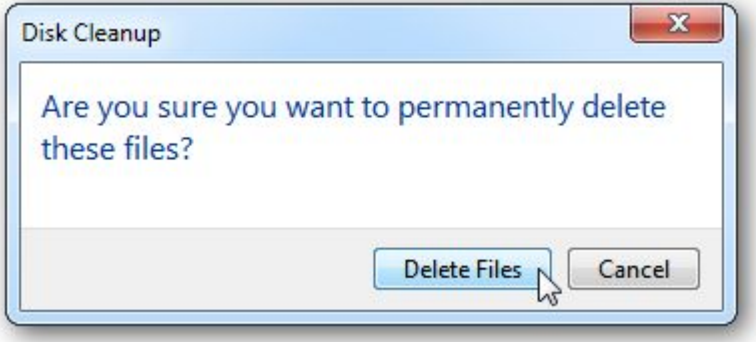
Physical Constraints

- Often lacking because of legacy systems
  - Need for backwards compatibility prevents addition of new physical constraints
- Alternative to adding physical constraints is to make devices or objects that are not orientation sensitive (e.g., some modern car keys)

Physical Constraints in a Digital System







Physical Constraints

- Forcing functions – form of physical constraint that impedes a sequence of actions
    - Failure at one stage prevents the next step
    - E.g. Needing physical key to unlock door and start ignition before driving
    - Interlock, lock in, lock out

Physical Constraints

- Interlock – forces actions to take place in a particular sequence
  - Examples: ordering processes, setup wizards, etc.

Physical Constraints

- Lock-ins – keep an operation active preventing it from being ended prematurely

Physical Constraints

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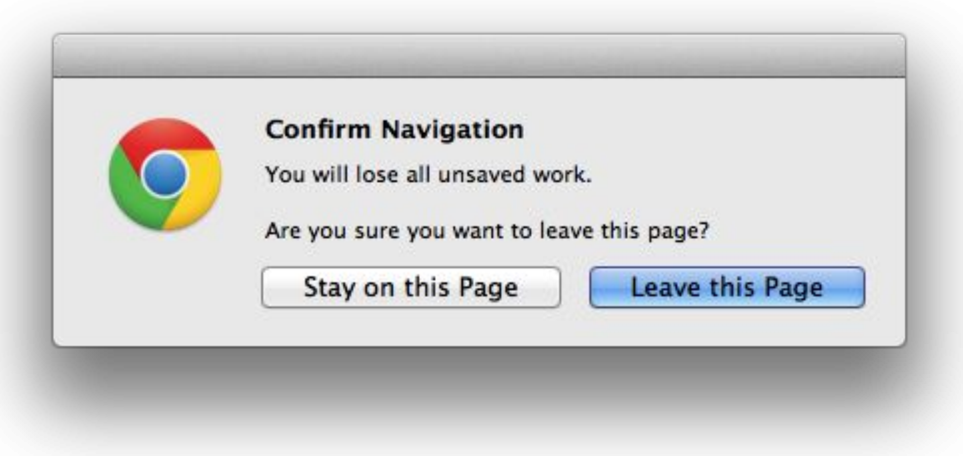

Physical Constraints

- Lock-outs – prevents an unwanted event from occurring, or prevents someone from entering a space or state that is dangerous

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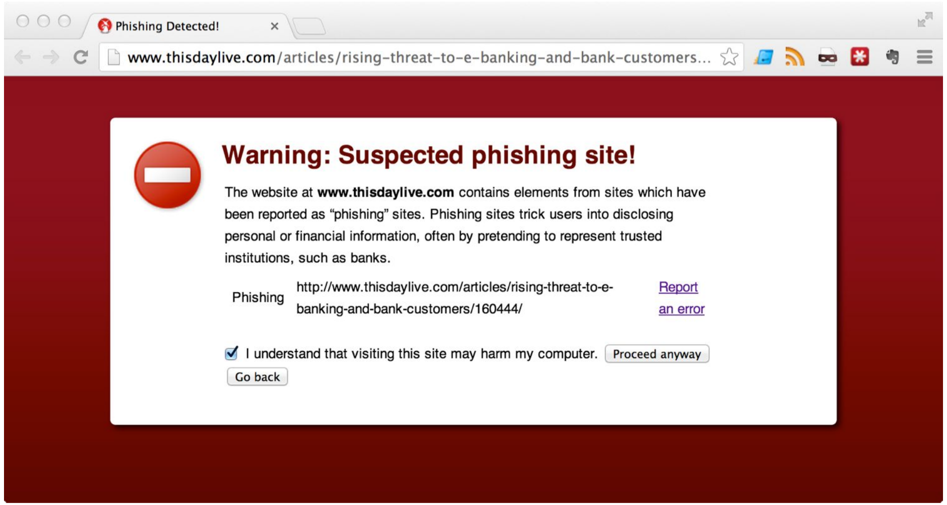
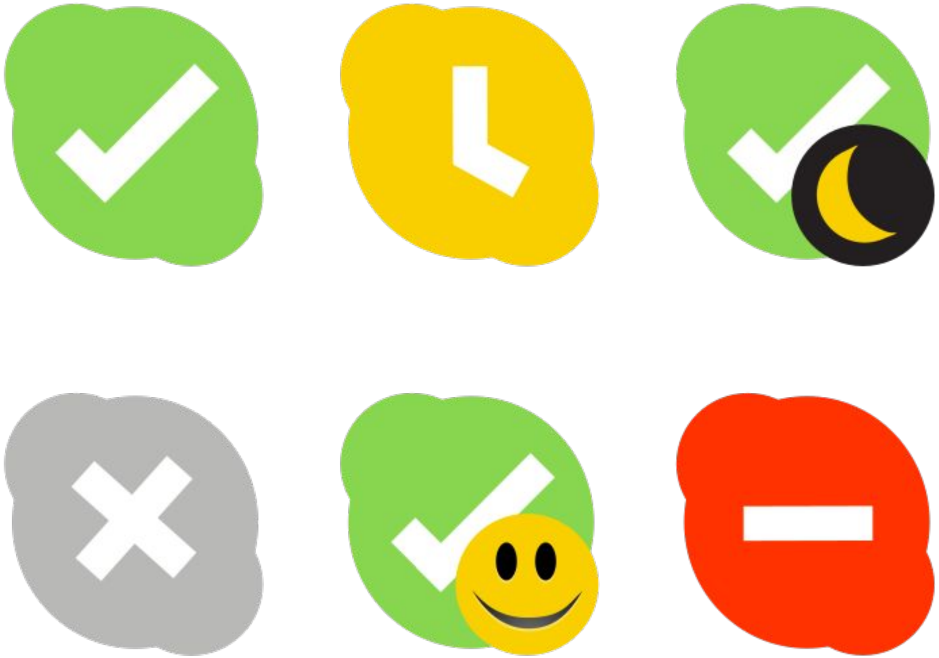


Cultural Constraints

- Cultures have embedded guidelines and cues for acceptable behavior
- Cultural constraints in design prevent incorrect action by relying on culturally understood cues and expectations
- Cultural constraints are not universally interpretable
- Likely to change over time


60

Cultural Constraint – Digital Example



Semantic Constraints

- Semantic constraints prevent incorrect actions by relying on the meaning of the situation
- “Common sense” actions
  - E.g. Dragging a file onto a printer icon rather than onto a trash can icon to print it
- Like cultural constraints, semantic constraints can change over time

Logical Constraints

- Constraints that apply because no other option exists or makes sense
- Does not rely on cultural or semantic information, or pose physical limitations
- Natural mappings employ logical constraints

Mapping

- Refers to the relationship between two sets of elements, frequently devices and their controls
- Mappings that take advantage of spatial relationships are called “natural mappings”
- Natural mappings are especially valuable for fostering discoverability and good conceptual models

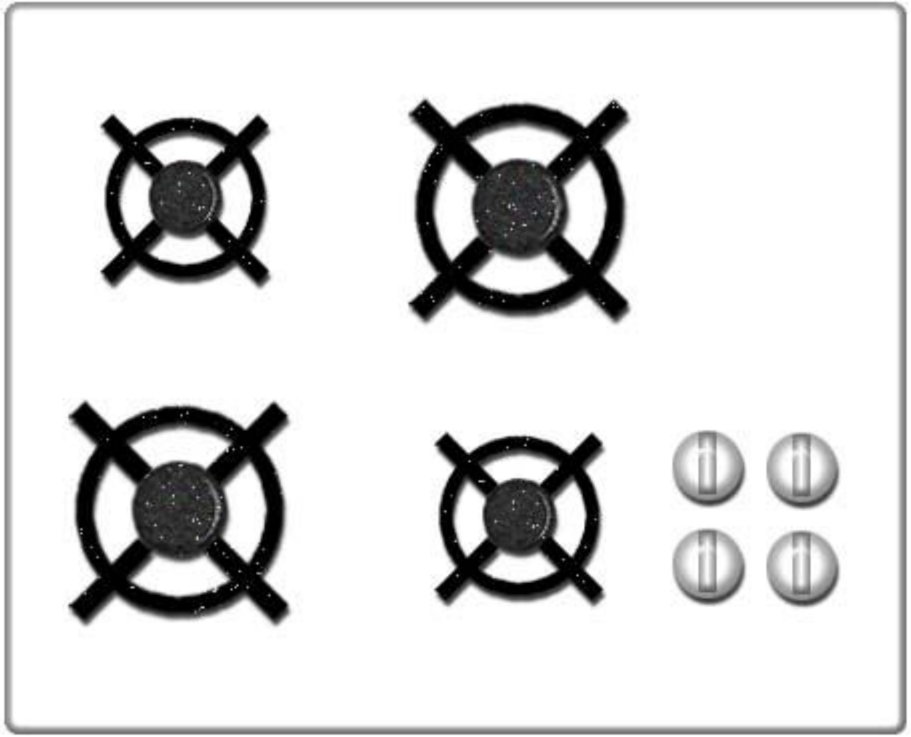

ANTI-THEFT
HI
LO
HI
LO
P
R
N
D
S


3
2
OFF
OFF

Mapping

- Good mappings lead to immediate understanding and are easy to remember
- Natural mapping can also take advantage of Gestalt principles
  - Related controls should be grouped together
  - Controls should be placed close to the item being controlled

Stove Controls



Source: wikipedia.org

Natural Mappings in Digital Systems

- Many examples of input devices
  - Touchscreens
  - Touch pads
  - Mouse
  - Joystick
  - Wii or Kinect control
- Because data doesn't have a meaningful spatial organization, natural mappings often don't apply
- Digital interfaces can offer high potential for controlling real world elements using natural mappings (e.g. tablet to control lights)

Feedback

- The communication of the outcome of an action
- Humans have numerous mechanisms for perceiving and receiving feedback, e.g. visual, auditory, and touch sensors
- Even simple tasks require feedback
    - E.g. picking up a glass – without tactile feedback you don’t know where to position your hand or how much pressure to apply
- Lack of feedback or impoverished feedback makes tasks more difficult or disconcerting
    - E.g. typing on a physical keyboard versus a soft keyboard without haptic feedback mechanisms

Feedback

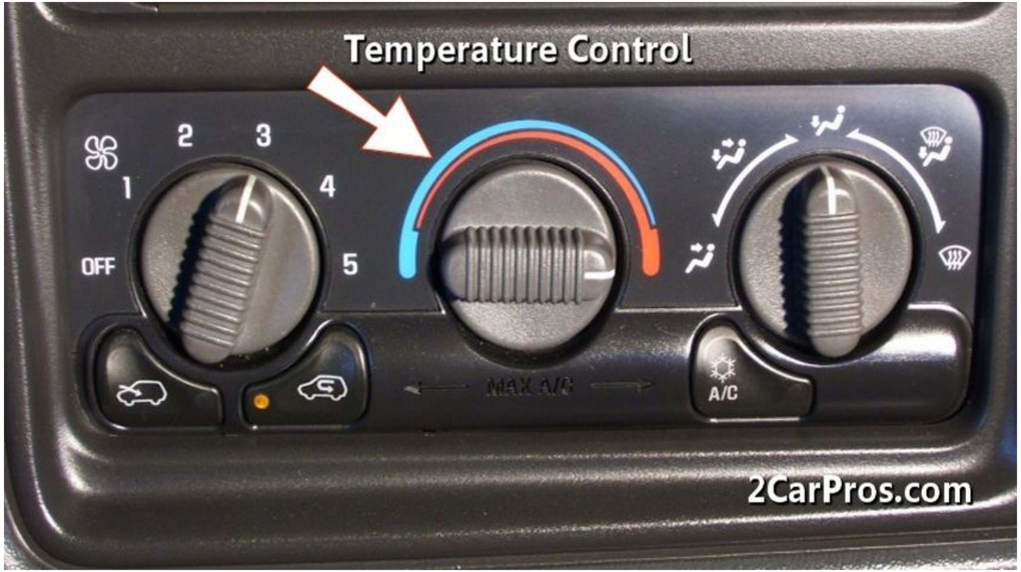
- Must be immediate – long delays are disconcerting and may cause users to abandon system
- Must be informative – impoverished feedback is confusing, frustrating, and distracting
- All actions should be confirmed in an unobtrusive manner
- Prioritized feedback should indicate importance of information

Feedback in Digital Systems

- WIMP interfaces offer continuous visible feedback
- Physical keyboards offer effective haptic feedback
- Progress bars or confirmation messages
- Progression to next step or screen

Revisiting the Car Temperature Control

- Affordances
- Signifiers
- Mappings
- Feedback



Discussing a Digital System

- What is discoverable?
- What is not?
- What principles are applied well or poorly?

Reading for Next Week (14.10.2019)

- **The Design of Everyday Things**, Chapter 2 (part), 5 (part) – Donald Norman