CIS 443/543
User Interfaces

Lecture 1: Motivations and Contexts

Topics for Today's Lecture

- Part 1: Why study user interfaces?
- Part 2: What can we learn about design from simple everyday things?
- Part 3: Contexts for Human-Computer Interaction

Part 1: Why study user interfaces?

- Because it's one of the most exciting areas in future computing
- Because there does seem to be a problem
- Because the problem is
  - Extensive and getting bigger
  - Expensive
  - Dangerous

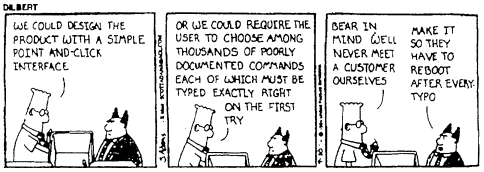
Computing = User Interfaces!

- Computing + Communication
- New Technology
  - chat rooms, digital libraries, touchable interfaces, intelligent agents, video conferencing, mobile and wearable computing, PDAs,VR, multimedia, speech recognition
- Social & ethical issues
  - Privacy, copyright, safety-critical systems

But is it all good?

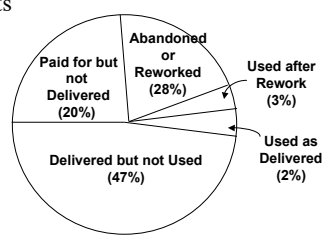
Recent Book:

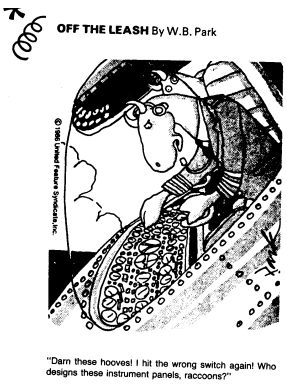
The Inmates Are Running the Asylum : Why High Tech Products Drive Us Crazy and How To Restore The Sanity by Alan Cooper, Paul Saffo



How Bad is it?

- Software Costs vs. Results (US Federal Software Projects)





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

What is the problem here?

- Actually it is an old problem:

The designer fails to communicate the design!

- How does the user know what to do next?
- What do those knobs and dials mean?
- How can the task be designed so that it is easy to learn and do with minimal failure?

First part of the old problem

- How do I know what to do next?
- What do those knobs and dials mean?

Solution late 1940's

- New science: Applied psychology and human factors
  - Group and sub-group things by function to reduce complexity & improve performance
  - Make things suggest their function
  - Create unique shapes for different functions
  - Make dials readable; make controls fit human body and behavior
  - Make it hard to do risky things
- Test ideas with experiments, engineer based on those findings

The other old problem is…….

- How can we design a task so that it is easy to learn and do with minimal failure?

Solution early 1900's

- An "easy" task is one which takes less time to perform, has fewer problems, and maintains quality.
- A easy task is created by
  - Breaking the overall task down into steps which are fast to perform
  - Repeating these over and over so that the person improves performance by practice
- Tasks and work can be *designed* and *analyzed*

1911-1920's

Frederick Taylor

Henry Ford

Frank Gilbreth

Lillian Gilbreth

Henry Ford

- Designed his own assembly line in 1913
- Wrote that the assembly line should be based on three basic principles:

1. the planned, orderly, and continuous progression of the commodity through the shop;
2. the delivery of work instead of leaving it to the workman's initiative to find it;
3. an analysis of operations into their constituent parts.

Ford's Efficiency

- This assembly line could reduce the time for creating a new magneto from 20 to 5 minutes. On April 1, 1913, Ford began to experiment with his assembly line. First, he had one workman assemble a new magneto using the usual method. He accomplished his task in approximately 20 minutes.
- This job was then split into 29 individual jobs. This cut down the assembly time to 13 minutes, 10 seconds. In 1914 the height of the assembly line in Ford's factory was raised 8 inches, lowering the amount of time it took to build a magneto to 7 minutes. With further experimentation, the time was cut to 5 minutes.

Frank and Lillian Gilbreth

- The Gilbreth's were concerned with the operational aspects of individual worker efficiency, using photography to study the various motions as workers completed tasks to achieve the greatest economy of effort. Their studies, for example, helped reduce the number of motions in the bricklaying process from 18 – 1⁄2 to 4, significantly improving output.
- Also interested in reducing worker fatigue/stress
- Created task analysis and time-motion study

Human Factors Summary

- Assembly lines (circa 1911-20)
  - Time and errors are important to business
  - Repetitive operations are faster overall (learning curve)
  - Task analysis
    - Tasks are composed of sub-tasks with elementary human physical movements such as "reach"
    - Motion studies to reduce overall task time (labor time = $$$)
- Airplane cockpits (circa 1943-1948)
  - Indirect complex operation: flying a plane occurs through indirect physical motions (controls) and decision-making based on information (instruments)
  - Knobs and dials problem: input and control complexity
  - New science of human factors (applied psychology)
  - Task analysis includes safety, human decision-making

Goals of this Course

- Learn how to design useful, usable and safe interactive software
  - Human-centered software design & development using a scenario-based approach
  - Evaluation of usability
- Understand why systems and people fail to work and play together
  - Basic issues of human psychology & sociology
  - Common design flaws and how to avoid them

Part 2:
What can we learn about design from simple everyday things?

Examples of Everyday Objects and their usability

- These are 35 mm slides which show
  - different types of doors and door handles
    - ordinary interior house door
    - refrigerator door
    - exterior and interior doors of public buildings
  - different types of scissors
    - ordinary paper scissors
    - sewing scissors
    - kitchen meat scissors
    - folding scissors
  - diskette
  - automobile driver's console
  - answering machine

Lessons Learned

- Form follows function (use)
- Form follows human physical anatomy and behavior
- Form follows average or stereotyped person
- Form follows custom (culture)
- "Intuitive" interface just means the designer matched the design with what people expect!

Causes of Problems with Usability

- FUNCTIONALITY PROBLEM
  - What are the functions this object can perform? Will it do what I want?
- 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?

Basic Concepts of Design

1. AFFORDANCES
2. VISIBLE CONSTRAINTS
3. TRANSFER EFFECTS
4. CONCEPTUAL MODEL
5. CAUSALITY (FEEDBACK)
6. "NATURAL" MAPPING
7. POPULATION STEREOTYPES
8. INDIVIDUAL DIFFERENCES

Basic Concepts of Design #1

- AFFORDANCES (from Gibson)
  - The perceived and actual fundamental properties of the object that determine how it could possibly be used
  - Shows relationship between what you want to do and what is possible (Functionality)
  - Must be visible!
  - Appearance indicates WHAT object it is
- Example
  - "This is a pocket knife. I must be able to cut with it."
  - Unknown device

Basic Concepts of Design #2

- VISIBLE CONSTRAINTS
  - Limitations of the actions possible perceived from the object's appearance
  - Shows what parts operate and how
  - Provides range of possible uses
- Example
  - "This is a switch therefore it has two states. Maybe I can use it to turn on the computer?"
  - "This doesn't have a blade. I don't see how it could be a pair of scissors.
  - "This is a nice flat table. Maybe I can sit on it."

Basic Concepts of Design #3

- TRANSFER EFFECTS
  - Prior experience gives cues for functionality and how to operate
  - Learning, analogy, metaphor
    - positive transfer: previous learning transfers
    - negative transfer: previous learning conflicts
- Example
  - "This is a pair of scissors therefore you put your fingers in the holes."
  - "This keyboard looks like a phone pad. Maybe I can use it to key in the phone number."

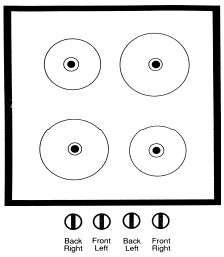
Basic Concepts of Design #4

- CONCEPTUAL MODEL
  - Mental model
    - Parts
    - Actions and Effects
  - Mental simulation of how things work
    - Simplified
- Example
  - "These look like scissors, and these are the blades, therefore they must move to cut."

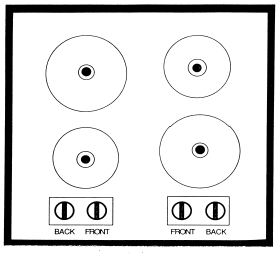
Basic Concepts of Design #6

- "NATURAL" MAPPING
  - The set of possible relations between objects
  - Physical mapping
    - displays and controls
  - Cultural mapping
    - functionality and appearance
- Example
  - Spatial layout between placement of burners and controls on stove
  - Steering wheel turns right, car turns right
  - Icon of a trashcan means you delete files with it

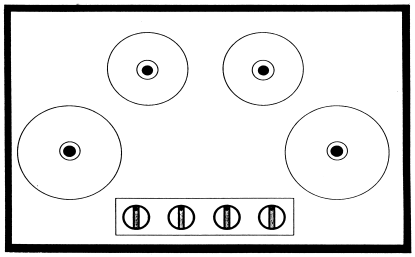
Arbitrary Mapping



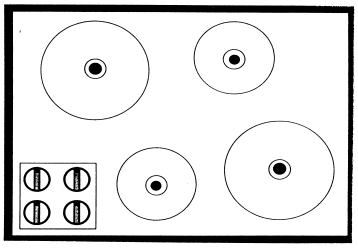
Partial Mapping



Natural Mapping



Natural Mapping



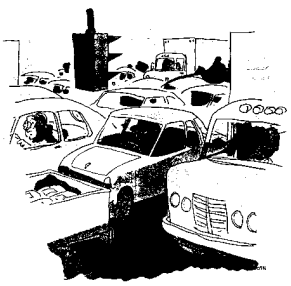
Basic Concepts of Design #7

- POPULATION STEREOTYPES
  - What the designer assumes about people
  - Can be
    - Cultural
    - Physical
    - Mental
- Example
  - In US light switch down is “off”; in UK down is “on”
  - People understand the concept of “restart”
  - All keyboards have function keys
  - Aviators have fingers

Basic Concepts of Design #8

- INDIVIDUAL DIFFERENCES
  - Individuals within a group differ by experience, interests, ability
- Example
  - Some people are right-handed, some left, and some ambidextrous
  - “I usually remember how to program my VCR, but I see to have forgotten.”

Part 3: Contexts for Human-Computer Interaction

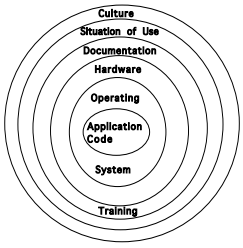


"Your engine has stalled. Your engine has stalled. Carefully, now coast completely off the highway and stop. Release the hood and get out of your car. Look at your engine. Look at your engine. There are six metal-and-ceramic objects with wires attached to your engine. These are your spark plugs. These are your spark plugs. Your spark plugs are dirty, dirty, dirty. You did not release the hood. Release the hood and get out of your car. Look at your engine. Look at your engine. There are six metal-and-ceramic objects with wires attached to your engine. These are your spark plugs. These are your spark plugs. Your spark plugs are dirty, dirty, dirty."

The User "Interface" as Human-Computer Interaction

Definition

- Any part of the computer system that the user comes in contact with either physically, perceptually, or conceptually



Many Contexts for HCI

- Traditional user interfaces for applications and OS
  - Command languages
  - GUI applications & desktops
- Embedded systems
  - Heating controls for house
  - Phone answering maching
- Information retrieval
  - Web pages: from hypermedia to GUI's to integrated databases
- Computer mediated social interaction and communication
  - email
  - Chat rooms
- Virtual reality

Types of Interaction Models & Interfaces

- Interaction models
  - Tools vs. language
- Styles of interfaces
  - Command languages
  - Forms
  - Graphical User Interfaces (WIMP)
  - Hypertext & Hypermedia
  - Natural language (including speech recognition)
  - Perceptual interfaces
  - Immersive environments
  - Groupware

Command Language

> ls -l *.*
foo.dat slides.prt exer.prt
> rm foo.dat
> ls -l *.*
slides.prt exer.prt

Forms

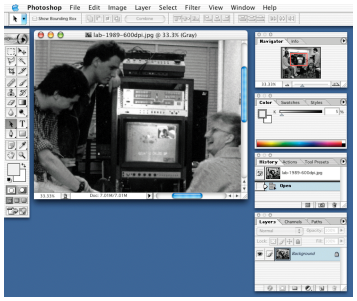
Billing Information

First Name*	Sarah
Last Name*	Douglas
Address Line 1*	
Address Line 2	
City*	
State/Province* (required for U.S. and Canada)	
Postal Code	
Country*	United States

Graphical User Interface (GUI)

- Continuous representation of the object(s) of interest
- Pointing actions instead of complex typing
- Rapid, incremental reversible operations whose impact on the object(s) of interest is immediately visible
- WIMP, WYSIWYG

GUI Example



Hypertext & Hypermedia

- Information presented as networks of nodes (articles, documents, files, pages, etc.) containing text, graphics, video, sound.
- Navigated by selecting links (pointers, cross-references, citations, etc.)
- Browsing versus retrieving model
- Example: HTML on the WWW

Natural Language

- Components
  - Speech recognition (input)
  - Speech synthesis (output)
  - Natural language processing(understanding)
    - words
    - grammar
    - semantics
    - discourse
- A dream as yet!

Perceptual Interfaces

- Captures user actions and makes inferences about intentions
  - Example: Eye tracker observes where user is looking and makes inferences about objects on the desktop to select
  - Example: Sensor observes that you are in your office with the door closed and makes inference that you don't want to be disturbed by a video cam chat session.

Immersive Environments

- Simulates real world perceptions, ego-centric point-of-view
- 3-D visuals, stereo sound, motion, touch simulation
  - Example: Virtual reality

Groupware

- Software that mediates group interaction or communication
  - Distributed asynchronous (different place, different time)
    - Examples: email, newsgroups, bulletin-boards
  - Distributed synchronous (different place, same time)
    - Examples: Multi-user online game, Chat room

Causes of Problems with Software Usability

- Same as Everyday Objects
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Basic Concepts of Design apply to User Interfaces

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Summary of Today's Lecture

- Part 1: Why study user interfaces?
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- Part 3: Contexts for Human-Computer Interaction

Next Lecture

- Explanations of Users' behavior using some Psychological and Social Fundamentals