Course Overview

- Introduction
- Understanding Users and Their Tasks
- **Principles and Guidelines**
- Interacting with Devices
- Interaction Styles
- UI Design Elements
- Visual Design Guidelines
- UI Development Tools
- Iterative Design and Usability Testing
- Project Presentations & Selected Topics
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Chapter Overview: Principles and Guidelines for Good User Interfaces

- Motivation
- Objectives
- UI Design
  - Principles
  - Guidelines
  - Rules
  - Standards
- Conceptual and Mental Models
- Metaphors
  - Guidelines for Choosing Metaphors
- Important Concepts and Terms
- Chapter Summary

Motivation

- Experiences from approaches that work or don't work should be utilized for the design of new systems
- Frequently design principles or guidelines can be extracted from previous approaches
- Once principles and guidelines have been confirmed, they may be expressed as rules or standards
- Conceptual models and metaphors often help users understand the system better

Objectives

- to become aware of some general user interface design principles and guidelines
- to be able to apply relevant principles and guidelines to design examples
- to identify and use appropriate rules and standards
- to utilize and formulate conceptual models and metaphors for a better understanding of the system interface by the user

Good User Interfaces

- What makes a good user interface (UI)?
- How does one tell the difference between a good UI and a bad one?
- Where does knowledge about designing good UIs come from?
- Where does accumulated knowledge and wisdom about UI design go?

HCI principles, guidelines, rules, and standards drive good user interface design

Principles

- Very broad statements that provide advice on UI design issues and problems.
- Usually based on research about how people learn and work.
- Examples:
  - ***Be consistent.***
  - ***Keep users informed***
- Meta-principle:

There is no easy "cookbook" solution to designing UIs

Principles (cont.)

- **Benefits**
  - Easy to understand and remember
  - Provide a framework for development
- **Drawbacks**
  - State a goal; they do not tell you how to achieve the goal
  - "Motherhood" statements
  - Cannot be treated as simple checklists
  - Hard to apply in specific situations
  - Often open to interpretation
  - Must be interpreted in context of use
  - Best applied by experienced designers who understand the application

Guidelines

- Lower-level, more specific than principles.
- Derived from basic psychological and human factors studies, "common sense."
- Take advantage of practical experience, incorporate applicable experimental findings, and promote consistency among designers responsible for different parts of the system's user interface.
- Examples:
  - ***Be consistent in the way that you have users leave every menu.***
  - ***Tell the user what is going on by providing feedback***
  - Guidebooks issued by OS companies (e.g. Apple Guides)

Guidelines (cont.)

- **Benefit**
  - Provide quick answers
- **Drawbacks**
  - Can be misinterpreted or misapplied.
  - Too many guidelines (e.g., 199 guidelines for data entry, 298 guidelines for data display - Smith & Mosier)
    - Difficult to know them all
    - Easy to miss one
    - Tend to apply the first one that fits
  - Many tied to obsolete technologies

Roles of Principles and Guidelines

- Promote Awareness of Concepts
  - Example: Cascading menus
    - "A cascading or hierarchical menu is a sub-menu attached to the right side of a menu item ..."
- Assist in Design Choices
  - Example: Locating a command line for type in
    - "Place the command line near the bottom of the screen unless it is clear that the user's gaze will be elsewhere ..."

Roles (cont.)

- Offer Strategies for Problem Solving
  - Example: Scrolling through large amounts of data
    - "When your application organizes data logically into pages, provide page-oriented scroll bars..."
- Support Evaluation
  - Example: Evaluating a menu design in terms of a guideline
    - *Heuristic evaluation* (more on this technique in a later lecture)
      - Small team of usability experts examines a design/prototype, and judges its compliance with a recognized set of usability principles/guidelines.
    - "Facilitate backward navigation ..."

Rules

- Specific guidelines that tell designers *how* a particular principle or guideline should be *implemented* in the system being designed. Also known as *Conventions*.
  - e.g. Consistency Principle
    - Provide an "Escape" option in the dialog in which users may want to leave the dialog box without making any changes or selecting any options.
      -> "Cancel" button

Rules (cont.)

- Can be global or local.
  - *Local* rules force everyone who works on an application or product to be consistent in the way users enter and exit, how they navigate within the application, how the documentation is designed, etc.
  - e.g. Press the "Done" key to leave menus.
    - Every confirmation message will take the form: "..."
    - Make the headings stand out from the text.
    - Use **boldface**, 24-point, **Helvetica**, with a 2-point line underneath.
- Can also be used to produce product family resemblances (e.g., color of terminals, size of windows, location of error messages, etc.)

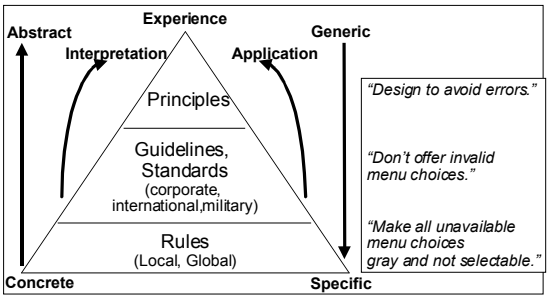
Standards

- Principles, guidelines, or rules that must be followed because of *mandated* or *industry* pressures
  - e.g., MIL STD-1472C, ANSI/HFS-100, ISO 9241
  - e.g., de facto standards such as the Macintosh toolbox, Microsoft Windows, etc.
- Set by national and international bodies.
- Frequently evolve from guidelines or rules.

UI Standards

- Specify how the UI should appear to the user.
- International standards for UI design are slowly emerging.
- ISO 9241 is an HCI standard. Now up to 17 parts.
  - ISO 9241- 2 deals with the design of tasks and jobs involving work with visual display units
  - ISO 9241-10-17 deal with usability, human-computer dialog, software aspects of display design, keyboard requirements, and user guidance.

Principles, Guidelines, Standards, & Rules



UI Design Principles

- Many by many people
- Similar intentions, but different emphasis depending on domains of expertise
- Principles, guidelines, and rules tend to be used somewhat interchangeably
- Examples:
  - Ben Shneiderman's 8 golden rules for dialog design (see handout)
  - IBM's 11 design principles (see handout)
  - Microsoft's Tandy Trower (see video)
  - Jacob Nielsen's 10 UI design principles (next set of slides)

Nielsen and Norman's UI Design Principles 1

- Use Simple and Natural Dialog
  - ***Match the user's task in as natural a way as possible***
    - Minimize mappings between computer syntax/semantics and task semantics
  - ***Present exactly the information the user needs***
    - "Less is more"
      - less to learn, get wrong, distract ...
  - ***Information should appear in a natural and logical order***
    - Related information is close together and graphically clustered
    - Order of accessing information matches (or is controlled) by user's expectations
  - ***Remove or hide irrelevant or rarely needed information***
    - Competes with important information

N&N's UI Design Principles 2

- Speak the Users' Language
  - *Use words and concepts from the users' world. Avoid the use of system-oriented terms.*
    - Example: withdrawing money from a bank machine
      - "Maximum withdrawal of $50 at this time" vs. "X.25 connection down due to network congestion. Local limits now in effect."
  - *View interactions from the user's perspective*
    - Example: security transaction
      - "You have purchased 100 shares of Intel common stock" vs. "We have sold you 100 shares of Intel common stock."
  - *Use meaningful icons, abbreviations, and metaphors*
    - A meaningful symbol or abbreviation is easily remembered
    - Metaphors help map between a computer system and users' mental model of the world (e.g., desktop metaphor)

N&N's UI Design Principles 3

- Minimize the Users' Memory Load
  - *Computers are good at remembering; humans are not.*
  - *Promote recognition over recall*
    - Menus, icons, choice dialog boxes, etc. vs. command lines, field formats, ...
    - Rely on visibility of objects to the user (but - less is more!)
  - *Describe required input format and example, and default*
    - "Enter date _ _ - _ _ _ - _ _ (DD-Mmm-YY, e.g., 25-Sep-99)"
  - *Apply a small number of rules universally*
    - Generic commands (the same command can be applied to all or most interface objects)
      - copy, cut, paste, drag and drop, ... Work the same for characters, words, paragraphs, circles, files, ...

N&N's UI Design Principles 4

- Be Consistent
  - *Consistency of effects*
    - same word, commands, and actions will always have the same effect in equivalent situations
      - Example: a pop-up window should always appear in the same place relative to the cursor
        --> ***predictability*** *(Rule of Least Astonishment)*
        --> ***control***
  - *Consistency of input*
    - Consistency of syntax across the complete system

N&N's UI Design Principles 4 (cont.)

- *Consistency of language and graphics*
  - same information/controls should be in the same location on all screens/dialog boxes
    - OK and Cancel buttons
    - function keys have the same meaning/location on different screens
    - forms follow a template
  - same visual appearance across the system (e.g., widgets)
    - e.g., different scroll bars in a single window system
- *Consistency of metaphor*
  - Example of a consistency problem: Macintosh floppy eject

Macintosh Floppy Ejection

- Macintoshes use a motorized floppy disk drive
  - no button to manually eject floppy
    - less error prone
  - Problem 1: What is a good desk-top metaphor for ejecting the floppy disk?
    - Solution: Drag floppy disk icon to the trash!
      - Novice users frequently are afraid to "throw away" the floppy.
  - Problem 2: "Disk Shuffle"
    The command "Eject Disk" physically ejects the disk, but leaves it logically "mounted"; the user is hounded endlessly to insert the disk.
    - Cause: Copying between disks on machines with only one floppy disk drive and no hard drive

N&N's UI Design Principles 5

- **Provide Feedback**
  - *Continuously inform the user about*
    - where they are, where they have been, and where they can go
    - what the system or application is doing
    - how the system is interpreting the user's input
  - *Should be as specific as possible, based on the user's input*
    - e.g., "Saving the file 'Lecture 3' into the folder 'LECTURES'..." vs. "Saving..."

Dealing with ...

- Delays
  - how users perceive delays
    - **0.1 sec** max: perceived as "instantaneous"
    - **1 sec** max: user's flow of thought stays uninterrupted, but they notice delay
    - **10 sec** max: limit for keeping user's attention focused on the dialog
    - **> 10 sec** max: user will want to perform other tasks while waiting

Dealing with ...

- Long Delays
  - *Cursors*
    - For short transactions (e.g., hourglass, clock)
  - *% done indicators*
    - For longer transactions
      - how much is left
      - estimated time
      - what is going on
  - *Random*
    - For unknown lengths of time
      - e.g., connecting to a network, Internet, ...

Dealing with ...

- System Error
  - *Provide informative feedback quickly*
    - The worst thing that one can do is not to provide any feedback whatsoever.
      - Example: On February 13, 1993, all 1,200 ATMs belonging to a major bank in New York City went down for 4 hours due to a software bug. The system provided no feedback.
  - *Design for graceful degradation*
    - "The system is experiencing technical problems. Please hang up and try again later. Thank you. Good-bye."

N&N's UI Design Principles 6

- **Provide Clearly Marked Exits**
  - *Users don't like to feel trapped by the computer*
    - You should always offer an easy way out of as many situations as possible
  - *Strategies:*
    - Cancel button (for dialogs waiting for user input)
    - Universal Undo (can get back to previous state)
    - Interrupt (especially for lengthy operations)
      -> barge-in in speech apps
    - Quit (for leaving an application or system at any time)
    - Defaults or Resets (for restoring to initial system settings)

N&N's UI Design Principles 7

- Provide Shortcuts
  - ***Experienced users should be able to perform frequently used operations quickly***
  - *Strategies:*
    - Keyboard and mouse accelerators
      - abbreviations
      - menu shortcuts
      - function keys
      - double clicking vs. menu selection
      - gestures (in pen-based computers and PDAs)
    - Type-ahead, click-ahead
      - entering input before the system is ready for it
    - Navigation jumps
      - going to window/location, and avoiding intermediate nodes

N&N's UI Design Principles 8

- Deal with errors in a positive and helpful manner
- *Everyone makes errors*
  - *Provide meaningful error messages*
    - Error messages should be phrased in the user's language
    - Error messages should be precise
      -> let the user know what the problem is and how to correct it
    - Error messages should not make users feel stupid
      - *awful*: "Try again, you idiot!"
      - *bad*: "Error -151."
      - *better*: "Cannot open this document."
      - *even better*: "Cannot open 'Chapter 5' because the application 'Microsoft Word' is not on your system."
      - *best*: "Cannot open 'Chapter 5' because the application 'Microsoft Word' is not on your system. Open it with 'SimpleText' instead?"

N&N's UI Design Principles 9

- Prevent Errors
  - Try to make errors impossible
    - menus: only "legal commands" can be selected
    - command lines: (UNIX) "command not found"
      - typos can invoke existing, different commands
  - Provide reasonableness checks on input data
    - e.g., (on entering an order for office supplies)
      "5000 pencils is an unusually large order.
      Do you really want to order that many?"

N&N's UI Design Principles 10

- Provide Help and Documentation
  - *Manuals are not a replacement for bad design!*
    - Avoid statements like "It's all explained in the manual."
  - *Most users never read manuals.*
  - *If they do read the manual, it's because they are probably in some kind of a panic, and need immediate help.*
  - *Manuals and documentation should be simple to read and follow.*
    - Provide only essential information for users to get started
    - Provide only information that users need
  - *Provide context-sensitive help whenever possible*

Conceptual and Mental Models

- Good user interface design also depends on the selection of appropriate conceptual models.
- Conceptual models facilitate the development of effective mental models for the user.
- **Models**
  - *Internal representations of how things work.*
    Can be physical, psychological, philosophical,or spiritual.

Conceptual Model

- *General conceptual framework through which the functionality of a user interface is presented to users.*
  - What is the interface trying to convey?
  - Also referred to as the *"design model."*
- Designer's attempt to create a useful and accurate mental model of the system for the user.
  - The user interface is very influential for the construction of a mental model.

Mental model

- *Internal representation of a user's current conceptualization and understanding of a system.*
  - Also sometimes referred to as the *"user model."*
- A user's mental model may evolve to become more accurate and complete as new information is acquired
  - (e.g., novice vs. expert users, children vs. adults).

Users' Mental Models

- ***Previous experience**, interactions with a user interface, and its behavior*
- ***Affordances***
  - clues that communicate how an object can be used *"natural mapping"*
  - The design of objects should suggest (i.e., afford) their functionality -> how they are to be used.
    - Examples:
      - doors are meant to be opened/closed;
      - chairs are for sitting,
      - tables are for putting things on,
      - knobs are for turning,
      - handles are for pulling,
      - buttons are to be pushed, etc.

Users' Mental Models (cont.)

- ***Causality***
  - cause-and-effect relationships
- ***Stereotypes***
  - e.g. different people learn certain behaviors, and expect things to work in a certain way
    - --> **red** means **danger**, **green** means **safe**
  - BUT, expectations may vary in different cultures
    - e.g. light switches
      --> in N.A., down is off; in U.K., down is on
      doesn't work for multiple switches
      --> in N.A., counter-clockwise is off;
      in U.K., counter-clockwise is on, ...

Why Mental Models?

- Enable users to infer future events
  - leave lights on, battery will drain
- Allow users to find causes for observed events
  - car does not start because the battery may be dead
- Allow users to determine appropriate actions to cause desired changes
  - boosting the car will start it
- Mnemonic devices for remembering relations and events
  - engine parts and symptoms - disconnected spark plug and inability to start car
- Natural means of understanding an analogous device
  - knowing one type of engine makes it easier to learn about another

Designing Conceptual Models

- The goal for UI designers is to help users develop accurate mental models of the system.
- Ideally, the users' mental model should map completely onto the designers' conceptual model of the system.
  - what the designers intended the system to do

The intended conceptual model should match the users' expectations, not reflect the designers' knowledge and mental models

How to Design Conceptual Models

- Build on familiarity
  - Take into account the mental models users bring with them to the new system.
- Make invisible parts and processes visible to the user
  - e.g. E-mail inbox that changes state and beeps when new messages arrive; drag-and-drop, etc.
- Build in consistency
  - e.g. Consistent location of certain types of information; consistent command syntax; consistent design of captions and fields on forms and displays, etc.

Design Conceptual Models (cont.)

- Provide consistent, unambiguous, concrete, informative feedback to reinforce the conceptual model
  - informative status messages - "Searching..."; "Connecting..."; "Transferring to voice mail..."
  - constructive error messages - "The system did not understand your response. Please repeat."
  - visible results of actions
    - highlighting of selected object or **item**
  - display actions in progress
    - trash being emptied, file transfer in progress
- Present functionality through a familiar metaphor

Metaphors

- Way of making an abstract concept seem more concrete, more familiar, more accessible to users.
  - e.g. Time is a very abstract concept; use money as a metaphorical expression to denote time
    - spend time, save time, waste time, give someone our time, live on borrowed time, etc.
- In UI design, a metaphor serves as a *concrete* model with which the user is familiar.
  - Allows the user to exploit existing knowledge of other domains when learning to use a system.
- The most well-known example is the *desktop metaphor.*

Metaphors as Conceptual Models

- It is important to design a user interface that enables a user to develop an appropriate mental model.
- One way is to develop an explicit metaphor that is suitable for the system or application.

Interface Metaphors

- *Ways of presenting user objects* so that they mimic real life objects in the user's everyday world.
- *Make software easier to use*
  - users can recognize and generalize the attributes and actions of the concrete object that they know in *their* everyday world.
- *Facilitate the process of learning* to use a system
  - exploit a mental model and a set of expectations that the user already has
- A major challenge is to decide which metaphor will best match a task.

Selection of Metaphors

- Task analysis
  - establish an understanding of the users and their domain
- Talk to users, observe them
  - Find out how they
    - organize their work
    - go about completing their tasks
    - sort and group things

If you choose your metaphors carefully, it will be easier for users to learn and use your software.

Metaphors are More than Icons

- Picking a metaphor does not mean choosing an icon or picture for an object.
- an overall metaphor decides on the "look-and-feel" of an entire series of screens (in the case of a GUI)
- Commonly used metaphors
  - Desktop* - GUI
  - Spreadsheet - ledger
  - Form - accounting
  - Card catalog - library
  - Index cards - hypertext
  - Pile or Stack

Recent Metaphors

- CD players (to play audio)
- film rolls (to denote movies)
- Notebook* (e.g., PenPoint)
- Places* (General Magic)
- Lifestreams (U. Maryland)
- Social User Interfaces* (e.g., Microsoft)
  - "Bob," "Clippit," "Genie," "Peedy the Parrot" (Microsoft Persona Project)

Desktop Metaphor

- First example of a desktop metaphor was the Xerox Star user interface (late 1970s).
  - Precursor to today's GUI.
- Most prevalent computing metaphor for GUIs.
- Draws on the familiar analogy of office filing systems, and the familiar operations of opening files and moving objects from file to file.

Desktop Metaphor (cont.)

- Screen looks like an office or desktop
  - familiar objects such as folders, documents, an inbox and outbox for mail, a trash can, a clock, an appointment book, ...
- The folder is a particularly useful and successful metaphor.
  - Purpose immediately apparent.
- Use of mouse as a *direct manipulation* device.
  - sometimes difficult to grasp for novices
  - no immediate counterpart
  - name refers to its shape, not its function

Notebook Metaphor

- Popularized in pen-based interfaces in the early 1990s
  - Go Corp.'s PenPoint
  - Apple Newton
- Provides the user with a simple, on-screen notebook
- Information organized as a collection of *pages* and *sections*
  - *Tabs* at the right-hand side
  - *Table of Contents* at the front

Notebook Metaphor (cont.)

- Notations and functions derived from the paper counterpart
  - turn a page with a tap or a flick of the pen tip on or near the page number
  - Bookshelf
    - repository of system-wide objects and resources such as:
      - Inbox and outbox
      - On-line help
      - Tools palette
      - Disk manager
      - Software keyboard, ...

Other UI Metaphors

- "Places" - General Magic
  - Things done on users' behalf by having software agents "go" to "places" (Downtown, Hallway, Office) and find what users need or request.
  - More on software agents in a later lecture.

Social UI Metaphors

- People interact with computers in fundamentally social ways.
  - "People interact with computers in the same way that they interact with other people." (Byron Reeves & Clifford Nass, Stanford University)
    - Are polite to computers.
    - Form perceptions and beliefs about the personality of the computer.
- Social UIs incorporate anthropomorphic characters
  - to interact with users by means of natural spoken dialog.
    - Conversational, engaging, visual presence
- **Animated, "life-like" characters**
  - provide assistance to users.

Microsoft "Bob"

- Animated personal guide in that communicates with the user through speech balloons.
- Life-like (or claims to be)
- Single source of relevant information at any given point in the interaction.
- Provides tips and suggestions
  - system capabilities
  - more efficient ways of completing a task

"Clippit" and Friends

- Office 97 Assistant
  - animated character that is the intelligent center of the user assistance system in Office 97.
- Serves analogous role to the departmental guru.
- Provides quick and easy answers to user questions
- Supposed to be *fun*.
- Friends include: The Dot, The Genius, Will, Power Pup, ...

Genie and Friends

- MS ActiveX™ Project
- Interactive personalities
  - provide enhanced capabilities to the existing interactive modalities of the Windows interface.
- Users can select the personality they want
  - Genie, Merlin, or Robby the Robot.

Peedy the Parrot

- MS Persona Project
- Expressive visual presence.
- Conversational assistant that accepts user requests for audio CDs, and then plays them.
- Integrates spoken language input, a conversational dialog manager, reactive 3D animation, speech output and sound effects.

Choosing Metaphors

- Match the most important user objects
  - The objects in your interface that users have to manipulate in order to get their work done.
  - Look at your major user objects and the actions users will need to perform with them.
  - Then, decide what kind of metaphor would work best for those objects and actions.
- **Simple is better**
  - The simplest metaphors are often the most powerful.

Choosing Metaphors

- Your metaphor does not need to be unique
  - A metaphor works best if it is common. If someone else has already used a notebook idea, then it is OK for you to also use it.
- Look at the users' real world for metaphor ideas
- Be flexible
  - Try out your metaphors and get feedback before you make any final design decisions.
- If a metaphor works naturally, use it.
  If it doesn't, be careful.

Pitfalls of Metaphors

- Metaphors can hinder as well as help
  - e.g. Use of metaphors as icons. Consider the Microsoft Word 6.0 toolbar. Some icons are readily identifiable; others are not. Contrast this with the Netscape toolbar.
- Metaphors may not translate across global cultural norms.
  - What does a desktop mean to a person who has never seen as desk?
- We don't know enough about the impact of social user interface metaphors.

"Global" Metaphor

- Metaphor intended to encompass entire application
  - desktop concept is a good example.
- Problem arises when the reality begins to diverge from the metaphor.
  - trash can is a great metaphor for the deletion function, but a bad one for ejecting a disk
    - "trashing" a disk
- Also, the fact that desktop metaphor has to be explained to first-time users is an *indication* that it may not be terribly intuitive.

Important Concepts and Terms

- conceptual model
- design principles
- design guidelines
- design rules
- design standards
- desktop metaphor
- graphical user interface (GUI)
- interaction
- interaction styles
- interface metaphor mental model
- metaphor
- mouse
- notebook metaphor
- task analysis
- user interface design
- user model
- WIMP
- window

Chapter Summary

- User interface design is hard work
  - Adhere to proven HCI principles and guidelines
- There are no magic formulas - no immutable rules
  - Every application is different
    Know your users and understand their tasks
- UI design is an adaptive process
  - Conceptual models change
  - Paradigms shift
  - New metaphors emerge
  - Users' mental models evolve