Connecting with Computer Science, 2e

Chapter 11
The Human-Computer Interface
Objectives

• In this chapter you will:
  – Learn the origins of human-computer interface development
  – Learn about human interaction technologies
  – Learn the foundations of human interface design
  – Understand how to build an effective user interface
  – Discover how contemporary design experts create cutting-edge technologies
  – Find out what human emotion has to do with good design
Why You Need to Know About...The Human-Computer Interface

• Putting off user interface design
  – System and engineering needs drive development
  – Easy to blame the user for problems
    • RTFM: Read the Fabulous Manual
• Cannot expect excellent results from poorly designed technology
The Evolving Interface

• Technology not performing as intended
  – Bank glass exit doors
  – Burners on a stove
• Users and interface design: second-level status
• Reasons for not focusing on users
  – System-first development approach
  – No team member with user interface design skills
  – Established development processes
  – Developers protecting their turf
  – Believe extra steps result in increased costs
The Evolving Interface (cont’d.)

• Consumer involvement in software development
  – Example: beta releases
  – No correlation with addressing user needs

• Obtaining skills required to address spoken and unspoken user needs
  – Team approach

• User interface
  – Handles interaction between technology and user
  – Consists of what user’s senses perceive
    • What the user can manipulate to operate technology
User Interface Technologies

• Human-computer interface technologies
  – Mouse, keyboard, screen, and GUI
  – Computer input
    • Voice, leg movements, biochemical changes, pulse and respiration rates, and eye movements
  – Computer feedback
    • Visual display, sound, movement, and heat
• “Multimodal” interfaces have many interaction modes
User Interface Technologies (cont’d.)

- Gaze system: users’ eye movements as input
- Voice-recognition technology: recognizes human speech and processes instructions
  - Systems designed to interact with many users
    - Must accommodate many different voices
    - Limit number of phrases understood: grammar
  - Natural-language processing
    - Being able to recognize “normal” conversation
User Interface Technologies (cont’d.)

Figure 11-2, Gaze systems in action
Courtesy of Päivi Majaranta and Harri Rantala from the Tampere Unit for Computer-Human Interaction at the University of Tampere, Finland
User Interface Technologies (cont’d.)

• Haptics technologies: users feel response
  – Examples: Wii and aviation
  – Allow direct neural connection to the body
    • Advanced prosthetic limbs
  – Remote operations (“haptic teleoperation”): flying remote drones, operating on a patient in another location, controlling an underwater robot
  – Virtual reality technologies: training people

• User interfaces for sensing input
  – Tracking eye, head, body movements; sensing neural output; measuring brain activity; and others
User Interface Technologies (cont’d.)

Figure 11-3, An example of haptics technology
Courtesy of Arto Hippula (left) from the Tampere Unit for Computer-Human Interaction at the University of Tampere, Finland, and author David Ferro (right)
Foundations of User Interface Design

• Perfect user interface will never exist
  – Designers bring personal factors into their work
  – Designers tend to design for physical capabilities

• Models, metaphors, and analogies
  – Distinguished from one another
  – All describe the technology mental view
Foundations of User Interface Design (cont’d.)

• Models allow users to:
  – Predict what will happen given certain input
  – Find causes for the system’s behavior
  – Determine what actions cause changes they want
  – Serve as a device for recalling relationships between actions and events

• Mapping a model to another similar device
  – Get similar results

• Everyone involved in the development process has his or her own model
Foundations of User Interface Design (cont’d.)

• Superstitious behavior
  – Users with incomplete information on how to use a technology create an incorrect model of the way a technology works
    • Created by not bringing mental models into some accord or not incorporating everyone’s expectations
    • Consistency in the user interface is important
Human Psychology in Human-Computer Interaction

- **Sensory storage**
  - Where sensory information is first processed by the human brain before passing it to short-term memory
    - Handles a lot of information simultaneously
    - Cannot store it for long
    - Information paid attention to is moved into higher memory functions
  - Buffer storing all sensory information coming in
  - Examples:
    - Processing movies
    - Party: keeping an eye on surroundings
Human Psychology in Human-Computer Interaction (cont’d.)

• Short-term memory
  – Stores information after sensory system receives it
    • Limited to five to nine items temporarily
    • Information held up to 30 seconds
  – Tactics to retain: repetition and chunking
    • Example: phone numbers

• Be aware of short-term memory in design
  – Avoid moving users to another page requiring information from previous page
  – Avoid placing pop-up windows over information users need
Human Psychology in Human-Computer Interaction (cont’d.)

• Long-term memory
  – Stores information on a semipermanent basis
    • Potentially limitless amount
    • Retrieving information is difficult
  – Tactics to retain: mnemonics and chunking
    • Examples:
      – Storytellers
      – Word-processing program prompting user with a list of recently opened documents
Ignoring Human Psychology?

- Question: design only for accessing long-term memory through recognition?
- GUI menu system
  - Not the answer for all users
    - Example: after users become familiar with application
      - Keyboard shortcuts or command-line input used
Ignoring Human Psychology? (cont’d.)

• Menu interface advantages
  – No commands to memorize
  – Functions easy to recognize and access
  – Keyboard entry errors reduced
  – Nonexperts learn the application quickly
  – Menu selections
    • Flexibility provided by shortcut keys
Ignoring Human Psychology? (cont’d.)

- Menu interfaces drawbacks
  - Users might get lost in broad or deep menu structure
  - Menu terms not recognizable or meaningful for users
  - Menu graphics require computing power to work quickly
  - Menus use more screen space
  - Combining commands with a menu is not as easy as with a command-line interface
Design Criteria for a Quality User Interface

• Design criteria
  – Factors to consider in creating a good design
    • Including users’ needs and experiences and what is appropriate given design’s constraints

• Design criteria factors
  – Quality of the experience
    • How does the design give people a satisfying experience?
    • What need does the product satisfy?
Design Criteria for a Quality User Interface (cont’d.)

• Design criteria factors (cont’d.)
  – An understanding of users
    • How well did the design team understand the needs, tasks, and environments of users?
    • How well was this understanding reflected in the product?
  – An effective design process
    • Is the product a result of a well-thought-out and well-executed design process?
  – Learnability
    • Is the product easy to learn and easy to remember how to use?
Design Criteria for a Quality User Interface (cont’d.)

• Design criteria factors (cont’d.)
  – An aesthetic experience
    • Is using the product aesthetically pleasing or satisfying?
    • Does it show consistency of style and operation?
    • Does the design perform well within technological constraints?
Design Criteria for a Quality User Interface (cont’d.)

• Design criteria factors (cont’d.)
  – Changeability
    • Have the designers considered whether the product’s changeability is appropriate?
    • How well can the product be adapted to suit users’ needs and preferences?
    • Does the design allow the product to evolve for new, perhaps unforeseen, uses?
  – Manageability
    • Does the product account for and help users manage needs such as installation, training, and maintenance?
Guidelines for User Control

- Use modes judiciously
  - Strive to make application as modeless as possible
- Give users flexibility in using different input interfaces
- Allow users to change focus
- Display helpful and not distracting descriptive messages
- Provide immediate feedback and reversible actions
Guidelines for User Control (cont’d.)

• Provide meaningful, helpful navigation paths and exits
• Accommodate users with different capabilities
• Make the user interface “transparent”
• Allow users to customize the interface
• Allow users to manipulate interface objects directly, as in moving files on the desktop
• Encourage exploration
Guidelines for Users’ Memory Load

• Reduce the need to rely on short-term memory
  – Ensure information needed for program operation is readily available

• Rely on recognition more than recall
  – Include cues for available actions
    • Visual, audio, etc.

• Provide visual cues
  – Indicate location in document
  – Use status bar displaying font size
Guidelines for Users’ Memory Load (cont’d.)

- Provide defaults and undo and redo actions
- Provide interface shortcuts
- Promote an object-action syntax
- Use real-world metaphors
- Reveal information progressively
- Promote visual clarity
Guidelines for Consistency of the Interface

• Sustain the context of users’ tasks
• Maintain consistency within and across products
• Keep interaction results the same to avoid creating superstitious behavior in users
• Strive for aesthetic appeal
Designing for the Web

- Explosion of Web pages since the mid-1990s
  - External Web pages for users
  - Intranet Web pages for internal company information
  - Web design, a special user interface design category
What Do Designers Know About Their Users?

• Many different end users’ Web technologies
  – Browser, platform, preference settings, window size, monitor size or screen resolution, connection speed, color settings, font, etc.

• Disadvantages exists
  – Force the display to developer’s way of thinking using graphics and Flash programs instead of text
  – Better to reflect users’ needs and wants

• Be aware of programming elements
  – Fonts, images, and usable screen space
Deconstructing Web Pages

- Communicate site’s purpose
- Communicate the organization’s information
- Write good content
- Reveal content through examples
- Make links obvious, and use clear navigation
- Make search capabilities obvious
- Use graphics, animation, and widgets wisely
- Follow good graphic design principles
- Follow other guidelines for content
Figure 11-4, The home page of the Visual Arts Department at Weber State University
The User-Centric Design Process

• Focusing on users’ needs before considering other system constraints
• Main phases
  – Gather and analyze user information
  – Design the user interface
  – Construct the user interface
  – Test the user interface
• Designers often repeat phases or delve into subphases
• Can reflect the software development life cycle
Phase 1: Gathering and Analyzing User Information

• Developing user profiles, analyzing users’ tasks, gathering user requirements, and analyzing the user environment

• User profiles: written descriptions of the users
  – Includes backgrounds, skills, and so forth

• User tasks: what users do and how they do it

• User requirements: what users want and need to do

• User environment: where users perform their tasks
Phase 2: Designing the User Interface

• Define product’s usability goals and objectives
• User scenarios: user activity example
  – Show steps users go through in using technology
• Usefulness
  – Measures how many intended tasks users can perform with the technology
• Effectiveness
  – Measures how well technology helps users perform their tasks
    • How quickly, how easily, how safely, and so forth
Phase 2: Designing the User Interface (cont’d.)

• Learnability
  – Measures how quickly users can learn to use the technology to perform tasks

• Attitude
  – Measures how much users enjoy their experience with the technology
Phase 3: Constructing the User Interface

• Prototype
  – Early and often
  – Have alternatives
  – Be prepared to throw many away
• Prototype risk
  – People consider prototype the final product
• Prototype purpose
  – Gain support for the approach
  – Help managers and eventual users realize technological solution possibilities and limitations
Phase 4: Validating the User Interface

• Phase 2 usability goals and objectives measured
• Assess effectiveness of meeting objectives
  – Create a variety of tables and measures
    • Use traditional social science methods of observing, surveying, and interviewing users or trial users
Phase 4: Validating the User Interface (cont’d.)

Figure 11-5, An example of a user interface testing lab
Courtesy of Päivi Majaranta from the Tampere Unit for Computer-Human Interaction at the University of Tampere, Finland
Human Emotion and Human-Computer Interfaces

• Aesthetically pleasing user interfaces work better
  – Users feel good
  – Users more forgiving of functional problems
  – Emotional interface commitment
    • Influences users’ opinions on interface use practicality

• Affect system
  – How emotions and potentially aesthetics play a role in decision making
Human Emotion and Human-Computer Interfaces (cont’d.)

Figure 11-6, Measuring users’ emotional responses
Courtesy of Toni Vanhala from the Tampere Unit for Computer-Human Interaction at the University of Tampere, Finland
Human Emotion and Human-Computer Interfaces (cont’d.)

• Visceral thinking
  – Immediate, instinctive thinking
    • Object’s look and feel play a role in how it is perceived
    – Snap judgment about an object

• Behavioral thinking
  – Thinking about how something works
  – Drives most human behavior
Human Emotion and Human-Computer Interfaces (cont’d.)

• Reflective thinking
  – Thinking about how something reflects on the user and his or her relationship to others
  – Not directly affected by sensory input or behavior control
  – More sophisticated
    • Susceptible to changes in fashion and culture
    • Appeals to more learned behaviors
Personalization and Customization

• Personalization
  – Increases all three user-appeal levels
  – May provide positive emotional responses
    • Examples: iPhone and mass-produced commodities

• True total customization is difficult
One Last Thought

• User interface development dependencies
  – Organization resources available
  – How much an organization values satisfying end users
  – Organizational politics
  – Strong leader with vision to focus
Summary

- User design as a secondary concern
  - Poorly designed technology results in poor usability
- Technologies for interacting with computers
  - Many available
- A perfect user interface will never exist
- Models, metaphors, analogies
  - Describe technology’s mental view
  - Everyone involved in the development process has his or her own model
Summary (cont’d.)

• Consistency in user interface important due to superstitious behavior
• Human memory: sensory storage, short-term memory, long-term memory
• Interface design must consider more than psychology
  – Many factors to consider in creating a good design
• Web design is a special user interface design category
  – Complicated due to many different end users’ Web technologies
Summary (cont’d.)

• User-centric design process
  – Starts with the end user, not system needs
• User interface design can be iterative
• Human emotional response
  – New but growing area
  – Personalization may provide positive emotional responses