CHAPTER 9: HUMAN-COMPUTER INTERFACE DESIGN

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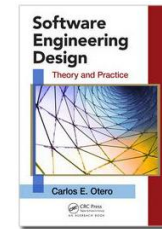
SESSION I: OVERVIEW OF HUMAN-COMPUTER INTERFACE DESIGN

Software Engineering Design: Theory and Practice
by Carlos E. Otero

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SESSION'S AGENDA

➢ What is Human-Computer interface design and why it?

➢ General HCI design principles
  ✓ 10 general design principles for HCI design

➢ HCI design methods
  ✓ Fidelity in Prototypes
  ✓ Metaphors
  ✓ Gestalt Principles
  ✓ Reusing Earlier Designs

➢ Evaluation of HCI quality
  ✓ Usability Testing
  ✓ Analytic Testing
  ✓ Empirical Testing

➢ What's next…

WHAT IS HUMAN COMPUTER INTERFACE DESIGN?

➢ As part of the Software Design process, Human-Computer Interaction (HCI) design must account for the user of the software.

➢ While designing the architecture and detailed design of software systems is essential for meeting most quality attributes, designing an efficient user interface that is understandable by the end user is paramount to the usability quality of all successful software systems.
  ✓ The most elegant, efficient, and high-quality architectural and detailed designs can be felled by a poor interface.

➢ In the context of HCI, interface design refers to the creation of the user interface. The IEEE defines the user interface as follows [1]:
  ✓ *An interface that enables information to be passed between a human user and hardware or software components of a computer systems.*

➢ HCI entails selecting appropriate information layouts, correct language, appropriate interface controls (e.g. radio buttons versus check boxes) and tying the detailed design to the various input mechanisms provided in the interface.

WHAT IS HUMAN COMPUTER INTERFACE DESIGN?

➢ An essential task of the HCI design activity involves making sure that the interface provides appropriate means for using the system in efficient manner.

➢ The best way to ensure an interface is sufficiently good is to iteratively improve the design through user testing.

➢ The implication is that there will be multiple iterations of a process that includes the following HCI design tasks:
   1. Creating a prototype of the system
   2. Having end-users use that prototype in realistic ways
   3. Gathering data from these tests
   4. Re-designing the interface to address discovered problems.

WHY STUDY HUMAN COMPUTER INTERFACE DESIGN?

➢ Visual designs have a major role on the success or failure of software systems.

  ✓ Systems that meet functional requirements but are not usable, cannot succeed.

➢ Studying HCI designs because it helps you evaluate modes, navigation, visual designs, response time and feedback, and design modalities, such as forms, menu-driven, etc.

  ✓ HCI designs directly influence the quality of any system and are essential to understanding and addressing the factors that affect the overall usability of the system.

  ✓ Many design principles and evaluation techniques exists to successfully design user interfaces.

➢ Therefore, understanding the techniques and tools for designing interfaces allows designers to become proficient in creating efficient interfaces.

WHY STUDY HUMAN COMPUTER INTERFACE DESIGN?

➢ Providing an interface that allow users to accomplish their goals with the software, *without unnecessary effort*, is the ultimate goal of the user interface designer.

    ✓ The "*without unnecessary effort*" clause is important. Consider a system that requires a date from the user, as presented below.

GENERAL HCI DESIGN PRINCIPLES

➢ Ten major heuristics to follow when creating a user interface [2]:

1. *Visibility of system status:* The interface should have some mechanism for showing where the user is in his/her task.

2. *Match between system and the real world*: The interface should provide interaction techniques that mimic or model what is expected in the real world.

3. *User control and freedom:* The interface should support user exploration without fear of breaking anything. Undo and redo should be supported.

4. *Consistency and standards:* The interface should use language, wording, etc that is consistent with the users' expectations. Follow style guides and platform standards.

5. *Error prevention:* The interface should help the user avoid mistakes. Always ask the user when they initiate a destructive command.

GENERAL HCI DESIGN PRINCIPLES

➢ Ten major heuristics to follow when creating a user interface (cont.) [2]:

    5. *Recognition rather than recall:* The interface should support rapid and easy learning of the system and support recognizing features and their associated actions, rather than relying on memorization of unique interface widgets.

    6. *Flexibility and efficiency of use:* The interface should provide the user with shortcuts or other accelerators. This helps the interface get out of the way of expert users while allowing novice users the opportunity to become more efficient.

    7. *Aesthetic and minimalist design:* The interface should only present the necessary information, and no more. Extra visual elements can distract from the important information.

    8. *Help users recognize, diagnose, and recover from errors:* Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

    9. *Help and documentation:* Make sure the help and documentation is clearly available in the interface.

GENERAL HCI DESIGN PRINCIPLES

➢ These ten guidelines or heuristics are generic and open.
  ✓ This is intentional so that they can be applied across a large cross-section of software systems.
  ✓ Applying these rules in a specific application can help create an interface that users will find both useful and usable. Consider the following popular on-line calendar application as an example.
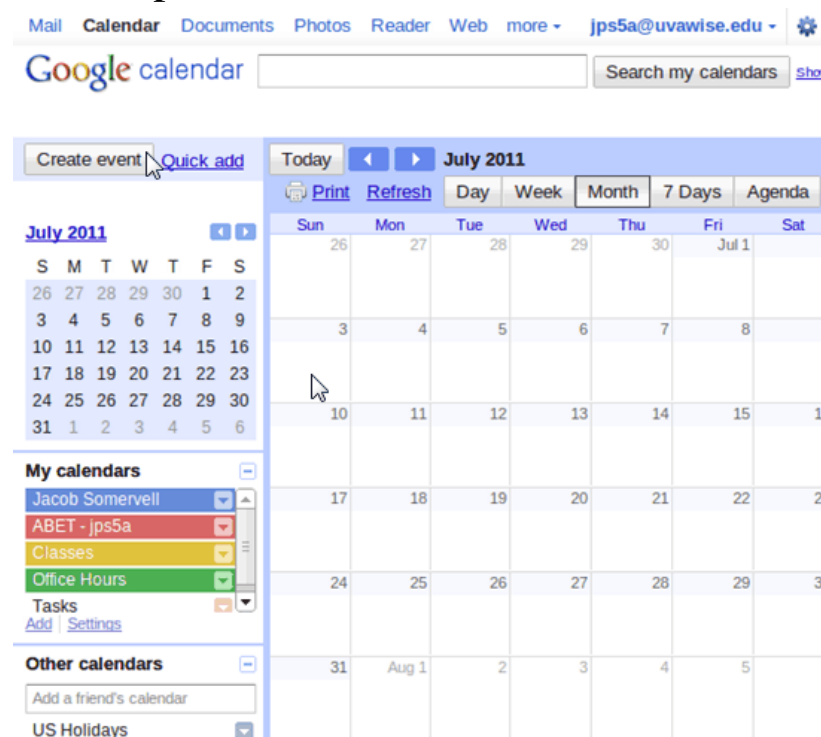
HUMAN-COMPUTER INTERFACE DESIGN METHODS
- GETTING STARTED -

➢ Almost all design activities, regardless of discipline, start with some form of brainstorming activity.
- ✓ There is no specific structure required or followed; the designer simply starts thinking about ways to solve a problem and then drawing or writing out descriptions of that solution.
- ✓ Often at this stage in design, the only technologies needed are kindergarten tools: pencils, paper, crayons, markers, scissors, tape, etc.
- ✓ Some people prefer to work on a chalk- or white-board and take pictures of the drawings for record keeping.

➢ When brainstorming, understanding of the human element can help the interface designer create effective and usable interfaces.
- ✓ It is interesting (but not surprising) to note that the majority of interfaces (electronic) are rectangular.
- ✓ We use rectangular paper, rectangular calendars, rectangular screens, and rectangular books. Humans like rectangles.
  - ▪ Most of the interfaces you will design will be contained in rectangles. This fact can be leveraged when creating an interface.
- ✓ Furthermore, at least in North America, people read from left to right and from top to bottom.

➢ Take a moment to examine your favorite program.
- ✓ Check out the interface and identify the type of information placed in the upper left quadrant.
- ✓ Most programs will have some important functionality located in that area of the interface.
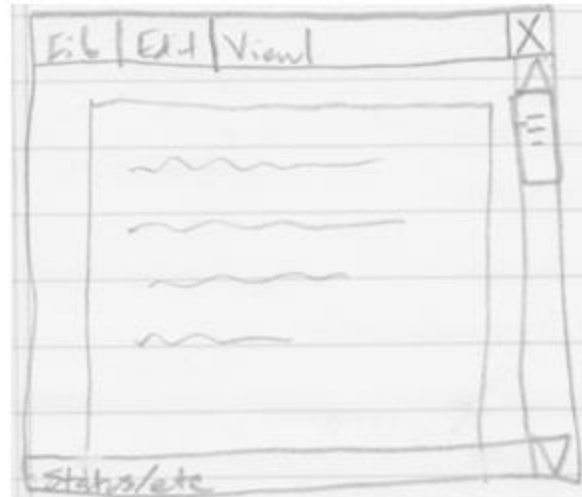
HUMAN-COMPUTER INTERFACE DESIGN METHODS
- FIDELITY IN PROTOTYPES -

➢ Early design efforts generate low fidelity prototypes of the system interface.

- ✓ Fidelity in this sense means the level of sophistication or realism in the interface.
- ✓ The idea is that there is a spectrum of fidelity when it comes to designing prototypes. For example,
  - ▪ Low-, medium-, and high-fidelity

➢ Each level of fidelity is useful to the designer and will likely be utilized during the interface creation process.

- ✓ Low-fidelity prototypes are useful in early design for communicating and eliciting requirements from the client and end users.
- ✓ Medium-fidelity prototypes are useful for illustrating interaction sequences and specific design choices.
- ✓ High-fidelity prototypes are required for effective end-user testing.

HUMAN-COMPUTER INTERFACE DESIGN METHODS
- FIDELITY IN PROTOTYPES -

➢ Low-fidelity prototypes are useful to the designer in the early stages for several reasons.

- ✓ Low cost. Pencil and paper and other similar materials are cheap.
- ✓ The time and energy required to create a simple sketch of an interface is also negligible.
- ✓ Low-fidelity prototypes can also be "thrown away" easily.
    - ▪ Often designers simply crumple up a piece of paper and "start over" with the design.

➢ Consider a low-fidelity prototype of a fictional document editor, in which the major interface components are illustrated without any real details.

HUMAN-COMPUTER INTERFACE DESIGN METHODS
- METAPHORS -

➢ One highly used technique for helping the end user learn and use a new interface is the incorporation of metaphors in the design.

  ✓ A metaphor is the application of a known, often real-world, object and its characteristics to an electronic interface.

➢ A classic example is the desktop metaphor used in all major operating system graphical shells (GUIs).

  ✓ Before computers became ubiquitous in the workplace, people sat at desks where all of the tools needed in their work were available within arms reach.

  ✓ This work environment and management style was "copied" in the creation of the virtual desktop.

  ✓ People now rely on their graphical user interface to access all of the tools they need to get their work done.

  ✓ Learning this environment is straightforward and relatively simple for those familiar with a physical desk.

HUMAN-COMPUTER INTERFACE DESIGN METHODS
- METAPHORS -

➤ While the use of metaphors provides for ease of learning and ease of use, one must be mindful of overusing metaphors.
  ✓ Over-application or too literal application of a metaphor can limit the designer and prevent improvements. For example, consider the GUI design of the classic calculator, as seen below.
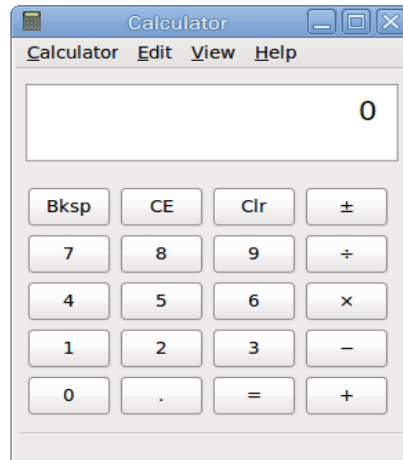

➤ Notice that the software version looks much like a hand-held calculator.
  ✓ The interface is a literal copy of the real-world interface and as such does not provide any extra features that might be expected in software: selectable history, multiple storage areas (variables), visualizations (like graphing or showing the equation that yielded the answer), etc.

➤ In this case, it could be said that the designers took the metaphor too far and restricted the utility of the program.

HUMAN-COMPUTER INTERFACE DESIGN METHODS
- GESTALT PRINCIPLES -

➢ Another set of useful design guidance comes from perceptual psychology.
- ✓ Knowing how the human brain processes information should be high on the list of things with which an interface designer should be familiar.

➢ German psychologists described several principles of perception in the 1920's.
- ✓ They used the term Gestalt, which means "whole", to illustrate how the human brain recognizes and organizes information.

Take a moment to examine the following figure. What do you see?

I see a plus sign!
2 + 2 = 4

I see two symmetric right angles sharing a common point
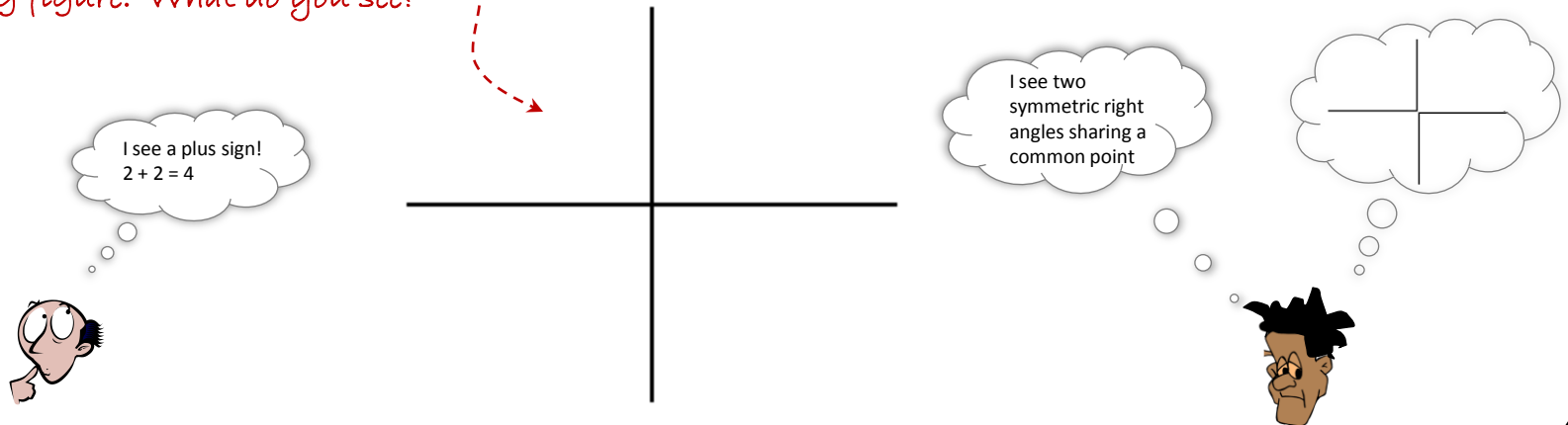
HUMAN-COMPUTER INTERFACE DESIGN METHODS
- GESTALT PRINCIPLES -

➢ There are six major Gestalt Principles [3]:
- ✓ Proximity
  - ▪ Relies on the fact that objects arranged close together are considered grouped together.
- ✓ Similarity
  - ▪ Objects that share visual characteristics (color, shape, etc) will be considered as a group or as similar in functionality.
- ✓ Closure
  - ▪ The idea that humans try to organize things into closed figures
- ✓ Area
  - ▪ Similar to closure but with the extra emphasis on the fact that humans try to create the figure with the smallest area.
- ✓ Symmetry
  - ▪ Refers to the fact that humans often treat symmetric elements as part of the same figure or group.
- ✓ Continuity
  - ▪ Refers to the human predisposition to see continuous contours or patterns.

HUMAN-COMPUTER INTERFACE DESIGN METHODS
- DESIGN REUSE -

➤ Another set of useful design guidance comes from reusing designs.

   ✓ Sometimes interface designers do not need to start from scratch.

   ✓ Instead, they have access to similar products or have rough designs given to them.

   ✓ In these types of situations, interface designers are likely to work with designs that do not need heavy modification to meet the unique needs of the new system.

➤ In such situations, designers need to rely on field studies and other empirical testing to identify areas for improvement.

   ✓ In other words, reusing an existing interface can sometimes reduce the design effort, but will usually increase the testing effort.

EVALUATION OF HCI QUALITY

➢ Before systems are deployed, significant efforts must be made to ensure that user interfaces are:
   ✓ Sufficiently complete
   ✓ Understandable
   ✓ Efficient for providing users with systems that exhibit high quality in terms of usability.

➢ Usability Testing
   ✓ At this point during the interface design process there should be some usable prototype of the interface that can be used for testing purposes
   ✓ It is beneficial to understand testing and how to go about doing it. First, it should be noted that there are two classes of evaluation (Scriven 1967):
      ▪ Formative
      ▪ Summative

EVALUATION OF HCI QUALITY

➤ Formative evaluation occurs within the design process and focuses on alternatives and clarification.
   ✓ Should be heavily utilized throughout the interface design process, iteratively improving the design.

➤ Summative evaluation occurs "after" the design process and focuses on assessing the result.
   ✓ Should be utilized when a solid version of the interface is completed.

➤ An easy way to distinguish between formative and summative evaluation:
   ✓ Formative evaluation is like the cook tasting the soup, summative evaluation is like the customer tasting the soup.

➤ Two methods of user interface design testing for both formative and summative evaluations are:
   ✓ Analytic Testing
   ✓ Empirical Testing

EVALUATION OF HCI QUALITY
- ANALYTIC TESTING -

➤ Analytic testing is often used earlier in the development process than empirical testing.
  - ✓ Early in the interface design process, there is usually no working system with which to test end users. Instead there are low- or high-fidelity prototypes.
  - ✓ These prototypes can be examined by knowledgeable experts for compliance with design guidelines, style guides, compatibility guides, etc.

➤ There are multiple specific tests that fall under the analytic umbrella:
  - ✓ Usability Inspection
    - ▪ Entails experts using the prototype in intended ways while ensuring usability guidelines are followed.
  - ✓ Heuristic evaluations
    - ▪ Similar to usability inspection whereas it involves multiple experts reviewing an interface with respect to a list of heuristics , but the difference is that the evaluator may be a representative stakeholder (developer, end user, etc).
  - ✓ Cognitive walkthroughs
    - ▪ An example of a usability inspection. Experts are given a script to work through in an interface while looking for violations of usability guidelines and standards while assessing the interface for visual cues [4].

EVALUATION OF HCI QUALITY
- EMPIRICAL TESTING -

➢ The opposite of subjective data is objective data, or empirical data.
  ✓ This type of data is highly respected because it is hard to argue about – it is factual data about the system of interest.

➢ Empirical testing provides this type of data to the designers. Unfortunately, empirical testing is difficult and expensive.
  ✓ It costs time and money to setup and execute a good empirical study.

➢ There are many types of empirical testing that can be used for interface evaluation:
  ✓ Field studies
  ✓ Lab-based experiments
  ✓ User surveys

WHAT'S NEXT…

➤ In this session, we introduced the concept of human-computer interface design., including:

  ✓ General HCI design principles

  ✓ HCI design methods

  ✓ Evaluation of HCI quality

➤ This concludes the presentation of human-computer interface design. In the next module, we will finalize our study of software engineering design by discussing management, ethical, and professional topics essential for designers of large-scale software systems.

REFERENCES

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➢ [4] Lewis, C., P. Polson, C. Wharton, and J. Rieman. "Testing a Walkthrough Methodology for Theory-Based Design of Walk-Up-and-Use Interfaces." *Chi '90 Proceedings*. 1990. 235–242.