

Course: Human Computer Interface (HCI)

Week 4: Theories and Principles of Human Computer Interfaces

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Lecture Learning Outcomes

At the end of this lecture, the learner will be able to:

- (i) Describe the theories and design principles of Human Computer Interfaces
- (ii) Describe display design principles of HCI
- (iii) Describe the golden rules of interface design

Theories and Principles of Human Computer Interfaces

Introduction:

Design principles

When evaluating existing user interfaces or designing new user interfaces, it is important to keep in mind the following experimental design principles which are related to human activity and system design: -

- (i) **Early focus on users and tasks** - determine the following: -
 - ✓ how many users are needed to perform the task(s)?

- ✓ who are the appropriate users? Are they first time users, intermittent users, expert users or unlikely users who have never used the interface, and will not use the interface in the future?¹
 - ✓ which task(s) will the users be performing and
 - ✓ how often will the task(s) be performed?
- (ii) **Empirical measurement:** This entails testing the interface early on with real users who come in contact with the interface on an everyday basis. Results may be altered if the performance level of the user is not an accurate depiction of the real human-computer interaction. Establish quantitative usability specifics such as the number of users performing the task(s), time to complete the task(s) and number of errors made when performing the task(s).
- (iii) **Iterative design:** After determining the users, tasks, and empirical measurements to include, perform the following iterative design steps:
- ✓ Design the user interface
 - ✓ Test the interface
 - ✓ Analyze results
 - ✓ Repeat the design process until a sensible, user-friendly interface is created.

Display Designs

Displays are human-made artifacts designed to support the perception of relevant system variables and to facilitate further processing of that information². Before designing a display, first define the task to be supported by that display e.g., navigating, controlling, decision making, learning, entertaining, etc. Users need to be able to process whatever information is generated and displayed by the system therefore, this information should

¹ Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg. 66-68

² Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg 508

be displayed according to principles in a manner that will support *perception, situation awareness, and understanding*.³

Principles of display design

Certain principles of human perception and information processing can be utilized to create an effective display design and realize several benefits. These include a reduction in errors and required training time; and, an increase in efficiency and user satisfaction.

A. Perceptual principles

- a) *Readable displays* - A display's legibility is critical and necessary for designing a usable display. If the characters or objects being displayed are not noticeable, then the operator cannot effectively make use of them⁴.
- b) *Avoid absolute judgment limits* - User response should not be limited to single sensory variables since they contain many possible levels. Example, do not ask users to determine the level of a variable like color, size, loudness.
- c) *Top-down processing*. Signals are likely perceived and interpreted in accordance with what is expected based on a user's past experience. If a signal is presented contrary to the user's expectation, more physical evidence of that signal may need to be presented to ensure correct comprehension of the same.
- d) *Redundancy is good*. A signal presented more than once is likely to be understood correctly. This can be done by presenting the signal in alternative physical forms (e.g., color and shape, voice and print, etc.), as redundancy does not imply repetition. A traffic light is a good example of redundancy, as color and position are redundant.
- e) *Similarity causes confusion* - Signals that appear to be similar will likely be confused. Unnecessary similar features should be removed and dissimilar features should be highlighted.⁵

³ Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg 508

⁴ Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg 515

⁵ Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg. 491

B. Mental Model Principles

- a) *Principle of picture reality* - Displays should resemble the variables they represent e.g., as temperatures rise, the thermometer should show a high vertical level.
- b) *Principle of the moving elements*- Moving parts should change in a pattern and direction compatible with the users' mental model of how they actually move in the system, e.g., as altitude increases, the altimeter moving element should move upward.

C. Principles Based on Attention

- a) *Minimizing information access cost.* – Diverting users' attention from one location to another to access necessary information has added cost in time or effort and display designs should minimize this cost by facilitating easy access to frequently accessed resources. However, adequate readability should not be sacrificed to reduce this cost - *proximity compatibility principle* and close display proximity can be harmful by causing too much clutter⁶. Divided attention between two information sources may be necessary for the completion of one task and these sources must be mentally integrated and defined to have close mental proximity. Source linkage can be achieved via common colors, patterns, shapes, etc.
- b) *Principle of multiple resources.* Users can process information across different resources e.g., visual and auditory sources can be presented simultaneously rather than independently.

D. Memory Principles

- a) *Replace memory retention with visual information* - Users need not need retain important information solely in working memory or to retrieve it from long-term memory. Menus, checklists or other visual displays can aid users minimize memory use. E.g., expert computer users prefer using direct commands from memory other

⁶ Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg. 501

than referring to manuals. A balance between the use of knowledge in memory and knowledge in the world is needed to achieve effective designs⁷.

- b) *Principle of predictive aiding* - Proactive actions are more effective than reactive actions and displays need not have resource-demanding cognitive tasks but simple perceptual tasks that reduce the need for user's mental resources. This allows users to focus on current conditions as they imagine possible future conditions e.g., road signs displaying the distance from a certain destination.
- c) *Principle of consistency*. Previously seen displays will easily transfer to support processing of new displays if they are designed in a consistent manner. User long-term memory will trigger actions that are expected to be appropriate and designs must accept this fact and utilize consistency among different displays.

Shneiderman's "Eight Golden Rules of Human – Computer Interface Design"

The author Shneiderman proposed a collection of principles derived heuristically from experience and applicable in most interactive systems after proper refinement, extension and interpretation⁸.

Recognize Diversity

- ✓ Designers must consider the type of user frequenting the system. Are they novice users, knowledgeable but intermittent users or are they expert frequent users?
- ✓ Users expect the screen layout to accommodate their desires; novices need extensive help while experts want fast results
- ✓ To accommodate all users, include both menu or icon choices and commands or provide an option for both full descriptive menus and single letter commands.

A well-designed interface is critical in improving the usability of an application and *Shneiderman's* "Eight Golden Rules of Interface Design" are a guide to good interaction design⁹.

⁷ Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg. 501

⁸ Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg 92

1. **Strive for consistency** – for similar situations, there should be consistent sequence of actions such as identical terminology for prompts, menus, and help screens and use of consistent color, layout, capitalization and fonts.
2. **Enable frequent users to use shortcuts**, abbreviations, special keys, hidden commands, and macros. This increases the pace of interaction.
3. **Offer informative feedback** - for every user action, the system should respond in some way e.g., a button will make a clicking sound or change color when clicked to show there is a response.
4. **Design dialogs to yield closure** -Sequences of actions should be organized into groups with a beginning, middle, and end section. Informative feedback at the completion of a group of actions shows the user their activity has completed successfully¹⁰
5. **Error prevention and simple error handling strategies** such as form fills that do not allow alphabetic characters in numeric entry fields to reduce serious errors. Menu selection is better than form-fills and whenever users make an error, instructions should be written to detect the error and offer simple, constructive, and specific instructions for recovery. Long forms should be segmented and sections sent separately so that users are not penalized by having to fill the form in again. Inform the user that multiple sections are coming up¹¹
6. **Permit easy reversal of actions**
7. **Support internal control locus** - Experienced users want to be in charge and having unusual system actions, tedious data entry sequences, complex information access and inability to produce desired output all builds anxiety and dissatisfaction¹²

⁹ Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg 92-93

¹⁰ Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg 92-93

¹¹ Human-computer interaction (3rd ed.), Dix, A., Finlay, J., Abowd, G., & Russell, B. New Jersey: Prentice Hall. ISBN-10: 0130461091, ISBN-13: 978-0130461094, (2004). Pg. 30 Pg 313

¹² Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg 92-93

8. **Reduce short-term memory load** - humans can only store limited information in their short-term memory and designers should reduce short term memory load by designing screens with clear visible options or use of pull-down menus and icons¹³

Content Covered in Week 4: Theories and Principles of HCI

Week 4: Theories and Principles of HCI

- (i) We have described the theories and design principles of Human Computer Interfaces
- (ii) We have described various display design principles of HCI
- (iii) We have described the golden rules of interface design

References

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2. Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005).
3. The design of everyday things, Norman, D. A. New York: Basic Books. ISBN-10: 0465067107, ISBN-13: 978-046506710, (2002).
4. Designing the user interface: Strategies for effective human-computer interaction (5th ed.), Shneiderman, B., Plaisant, C., Cohen, M., & Jacobs, S. New Jersey: Prentice Hall. ISBN-10: 0321537351, ISBN-13: 978-0321537355, (2009).

¹³ Designing for Effective Human/Computer Interaction (4th ed.), Schneiderman, B., Plaisant, C.: Pearson Education, Inc.: ISBN 0-321-19786-0, (2005). Pg 94