Course: Human Computer Interface (HCI)

Week 4: Theories and Principles of Human Computer Interfaces

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Course Description

- The course begins with an introduction to Human Computer Interface (HCI) concepts, i.e. the human (brain, human visual system, visual perception and optical illusions), the computer and the interface perspectives.
- Theories and principles to design for attention will be covered and thereafter psychological and social interaction to address use of cognition and use of proper language and metaphors (menus).
- User-centered design and human-centered design will be covered in detail to understand how the two terminologies are similar and how they differ.
- Architectures for user interfaces mainly Graphical User Interface will lead the course coverage to user experience, universal design, design principles, heuristics and golden design rules.
- Information retrieval and utilization architectures will then be connected to designing rich interactive systems using styles that enhance usability (web and mobile) and easy navigation.
- User experience and support will be covered as we look into methods of evaluating interactive systems

Learning outcomes Week 4: Theories and Principles of HCI

At the end of the lecture, you 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

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?

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

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 during 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 information. [2]
- Before designing a display, first define the task to be supported by that display e.g., navigating, controlling, decision making, learning, entertaining, etc.
- Users should be able to process whatever information is generated and displayed by the system therefore, this information should be displayed according to principles in a manner that will support perception, situation awareness, and understanding.

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

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 such as:-
- ✓Error reduction
- ✓Reduced raining time
- ✓Increase in efficiency and user satisfaction.

A. Perceptual principles [3]

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 them[3]

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

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.
- ✓Example: traffic lights - 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[4].

4. 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 such as a thermometer showing a high vertical level to represent high temperature.

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.
- ✓Example, the moving element on an altimeter should move upward as altitude increases.

C. Principles Based on Attention[5]

a) Minimizing information access cost.

- ✓Diverting user attention from one location to another to access necessary information, brings an associated cost in **time or effort**.
- ✓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 i.e pr*oximity compatibility principle*[5].

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

Minimizing information access cost…cont…

- ✓Divided attention between two information sources may be necessary for the completion of one task.
- ✓These sources must be mentally integrated and defined to have close mental proximity.
- ✓Source linkage can be achieved via common colors, patterns, shapes, etc. However, close display proximity can be harmful by causing too much clutter[6].

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

b) Principle of multiple resources.

- ✓User can easily process information across different resources.
- ✓Example, visual and auditory information can be presented simultaneously rather than independently[7].

7. 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. 54

D. Memory Principles

a) Replace memory retention with visual information

- ✓ Users need not retain important information solely in working memory or to retrieve it from long-term memory.
- ✓ A menu, checklist, or another visual display can aid users minimize the use of their memory. E.g., expert computer users prefer using direct commands from memory than referring to manuals.
- ✓ A balance between the use of knowledge in memory and knowledge in the world is needed to achieve effective designs.

b) Principle of predictive aiding

- ✓ Proactive actions are more effective than reactive actions.
- ✓ Displays should not have resource-demanding cognitive tasks but simple perceptual tasks that reduce the need for user's mental resources.

✓An example of a predictive aid: road signs displaying the distance from a certain destination.

✓This allow users to focus on current conditions as they imagine possible future conditions.

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 being proper refinement, extension and interpretation [8].

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

Recognize Diversity

- ✓Designers must consider the type of user frequenting the system:- novice user, knowledgeable but intermittent user and expert frequent user.
- ✓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.

The Eight Golden Rules of Interface Design[9]:

- ✓To improve the usability of an application it is important to have a well-designed interface.
- ✓***Shneiderman's*** "Eight Golden Rules of Interface Design" are a guide to good interaction design.

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

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's 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 successfully

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 up [10]

6. **Permit easy reversal of actions**

10. 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

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 dissatisfaction

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 icons [11]

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

Content Covered in 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

Course Text Books

1. 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).

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).