UNIT 2: USER INTERFACE DESIGN PRINCIPLES AND CRITERIA/RATIONALE

Table of contents

1.0 INTRODUCTION

The human computer interface can be described as the point of communication between the human user and the computer. The flow of information between the human and the computer is defined as the loop of interaction.

Design criteria and principles are important to designing a new user interface and to evaluate a current user interface.

There are seven principles that may be considered at any time during the design of a user interface and these are: Tolerance, Simplicity, Visibility, Affordance, Consistency, Structure and Feedback. These are briefly discussed in this unit.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Carry out and evaluate simple design using some primary design principles
- Experiment design using some experimental design principles
- Explain the 1 3 principles of display design
- Learn the Norman's 7 design principles
- Know the concepts and types of design rationale

3.0 MAIN CONTENT

3.1 PRIMARY DESIGN PRINCIPLES

The following seven principles mentioned in the introduction above can be used to guide or evaluate design at any time in the process. The principles can be re-framed or re-structured to suit a particular company or project, or by professional designers.

Principle	Description	Example
Visibility	Clarity	Isthe goal obvious? Are icons used?
Feedback	Information sent back to user after their action	
Affordance	How *clear* is the use of an element to the user?	
	Is the feedback in sound? Is there a label showing success or failure?	
	Label "Push" on one side of a door; a button saying "Click Me"	
Simplicity	Utilise the principles of usability	Place an Open File option on menu, under File tag Are the elements set out in a Structure meaningful way from the perspective of the user?
	Grouping information within a dialogue box.	
Consistency	How easy is it to learn and remember the appearance, positioning and behaviour of the elements?	
	X to close a window is always on top right hand side of the window; the most important buttons are the same size with only labels indicating different goals.	
Tolerance		
	Prevents user making errors or provides easy recovery or graceful failure Ignoring of wrong or invalid keyboard input; Hiding options inappropriate in a context.	

The loop of interaction has several aspects to it including the:
Task Environment: These are the conditions and goals set upon the user.
Machine Environment: This is the environment that the computer is connected, e.g. a laptop in a college student's dormitory room.
Areas of the Interface: Non-overlapping areas involve processes of the human and computer not pertaining to their interaction. While the overlapping areas only concern themselves with the processes pertaining to their interaction.
Input Flow: This begins in the task environment as the user has some task that requires using their computer.
Output: This is the flow of information that originates in the machine environment.
Feedback: These are loops through the interface that evaluate, moderate, and confirm processes as they pass from the human through the interface to the computer and back.

3.2 EXPERIMENTAL DESIGN PRINCIPLES

Experimental design principles are also important to evaluate a current user interface or to design a new user interface and they are described below:

Early focus on user(s) and task(s):
Establish how many users are needed to perform the task(s) and determine who the appropriate users should be; someone that has never used the interface, and will not use the interface in the future, is most likely not a valid user.

In addition, define the task(s) the users will be performing and how often the task(s) need to be performed.

Empirical measurement:
Test the interface early on with real users who come in contact with the interface on an everyday basis, respectively. Keep in mind that 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), the time to complete the task(s), and the number of errors made during the task(s).

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 design
Analyze results of using the interface
Repeat the iterative design process until a sensible, user-friendly interface is created.

Design Methodologies
A number of diverse methodologies outlining techniques for human—computer interaction design have emerged since the rise of the field in the 1980s.Most design methodologies stem from a model for how users, designers, and technical systems interact.
Early methodologies, for example, treated users' cognitive processes as predictable and quantifiable and encouraged design practitioners to look to cognitive science results in areas such as memory and attention when designing user interfaces.
Modern models tend to focus on a constant feedback and conversation between users, designers, and engineers and push for technical systems to be wrapped around the types of experiences users want to have, rather than wrapping user experience around a completed system.

User-centered design:
User-centered design (UCD) is a modern, widely practiced design philosophy rooted in the idea that users must take center-stage in the design of any computer system. Users, designers and technical practitioners work together to articulate the wants, needs and limitations of the user and create a system that
addresses these elements. Often, user-centered design projects are informed by ethnographic studies of the environments in which users will be interacting with the system.

Display Design
Displays are human-made artifacts designed to support the perception of relevant system variables and to facilitate further processing of that information. Before a display is designed, the task that the display is intended to support must be defined (e.g. navigating, controlling, decision making, learning, entertaining, etc.). A user or operator must be able to process whatever information that a system generates and displays; therefore, the information must be displayed according to principles in a manner that will support perception, situation awareness, and understanding.

3. 3 THIRTEEN PRINCIPLES OF DISPLAY DESIGN

These are principles of human perception and information processing that can be utilized to create an effective display design.

A reduction in errors, a reduction in required training time, an increase in efficiency, and an increase in user satisfaction are a few of the many potential benefits that can be achieved through utilization of these principles.

Certain principles may not be applicable to different displays or situations. Some principles may seem to be conflicting, and there is no simple solution to say that one principle is more important than another. The principles may be tailored to a specific design or situation. Striking a functional balance among the principles is critical for an effective design.

The thirteen principles are:

Perceptual Principles

1. *Make displays legible (or audible)*
   A display's legibility is critical and necessary for designing a usable display. If the characters or objects being displayed cannot be discernible, then the operator cannot effectively make use of them.
2. *Avoid absolute judgment limits*
   Do not ask the user to determine the level of a variable on the basis of a single sensory variable (e.g. color, size, loudness). These sensory variables can contain many possible levels.
3. *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 assure that it is understood correctly.
4. *Redundancy gain*
   If a signal is presented more than once, it is more likely that it will 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.
5. *Similarity causes confusion: Use discriminable elements*
   Signals that appear to be similar will likely be confused. The ratio of similar features to different features causes signals to be similar. For example, A42 3B9 is more similar to A42 3B8 than 92 is to 9 3. Unnecessary similar features should be removed and dissimilar features should be highlighted.

Mental Model Principles

6. *Principle of pictorial realism*
   A display should look like the variable that it represents (e.g. high temperature on a thermometer shown as a higher vertical level). If there are multiple elements, they can be configured in a manner that looks like it would in the represented environment.
7. *Principle of the moving part*
   Moving elements should move in a pattern and direction compatible with the user's mental model of how it actually moves in the system. For example, the moving element on an altimeter should move upward with increasing altitude.

Principles Based on Attention

8. *Minimizing information access cost*
   When the user's attention is averted from one location to another to access necessary information, there is an associated cost in time or effort. A display design should minimize this cost by allowing for frequently accessed sources to be located at the nearest possible position. However, adequate legibility should not be sacrificed to reduce this cost.
9. *Proximity compatibility principle*
   Divided attention between two information sources may be necessary for the completion of one task. These sources must be mentally integrated and are defined to have close mental proximity. Information access costs should be low, which can be achieved in many ways (e.g. close proximity, linkage by common colors, patterns, shapes, etc.). However, close display proximity can be harmful by causing too much clutter.
10. *Principle of multiple resources*
    A user can more easily process information across different resources. For example, visual and auditory information can be presented simultaneously rather than presenting all visual or all auditory information.

Memory Principles

11. *Replace memory with visual information: knowledge in the world*
    A user should not need to retain important information solely in working memory or to retrieve it from long-term memory. A menu, checklist, or another display can aid the user by easing the use of their memory. However, the use of memory may sometimes benefit the user rather than the need for reference to some type of knowledge in the world (e.g. a expert computer operator would rather use direct commands from their memory rather than referring to a manual). The use of knowledge in a user's head and knowledge in the world must be balanced for an effective design.
12. *Principle of predictive aiding*
    Proactive actions are usually more effective than reactive actions. A display should attempt to eliminate resource-demanding cognitive tasks and replace them with simpler perceptual tasks to reduce the use of

    the user's mental resources. This will allow the user to not only focus on current conditions, but also think about possible future conditions.
    An example of a predictive aid is a road sign displaying the distance from a certain destination.
13. *Principle of consistency*
    Old habits from other displays will easily transfer to support processing of new displays if they are designed in a consistent manner. A user's long-term memory will trigger actions that are expected to be appropriate. A design must accept this fact and utilize consistency among different displays.

3.4 The Norman's 7Design Principles

1. *Use both knowledge in the world and knowledge in the head.*
2. *Simplify the structure of tasks.*
3. *Make things visible: bridge the gulfs of Execution and Evaluation.*
4. *Get the mappings right.*

5. *Exploit the power of constraints, both natural and artificial.*
6. *Design for error.*
7. *When all else fails, standardize.*

3.4.1 DESIGN PRINCIPLES FORMULATED TO SUPPORT USABILITY :

Principle of Learnability : This is the ease with which new users can begin effective interaction and achieve maximal performance
Principle of Flexibility: These are the multiplicity of ways the user and system exchange information Principle of Robustness: This is the level of support provided the user in determining successful achievement and assessment of goal-directed behaviour

The Principles of learnability are broken down into :
Predictability : This is determining effect of future actions based on past interaction history and its operation visibility
Synthesizability: This is assessing the effect of past actions, its immediate and its eventual honesty Familiarity: This is how prior knowledge applies to new system and how easy one can guess its affordance Generalizability: This is extending specific interaction knowledge to new situations Consistency: This concerns the likeness in input and output behaviour arising from similar situations or task objectives

Principles of flexibility comprise:
Dialogue initiative : This is the freedom from system imposed constraints on input dialogue and it compares the system against the user pre-emptiveness.
Multithreading: This is expressing the ability of the system to support user interaction for more than one task at a time. It also looks at the concurrent and interleaving multimodality.
Task migratability: This is passing responsibility for task execution between user and system Substitutivity: This allows equivalent values of input and output to be substituted for each other. It compares representation multiplicity and equal opportunity
Customizability: This is the modifiability and adaptability of the user interface by user or the modifiability and adaptivity of the user interface by the system.

Principles of robustness are made up of:
Observability: This is the ability of the user to evaluate the internal state of the system from its perceivable representation. It considers the browsability, the defaults, the reachability, the persistence , and the operation visibility.
Recoverability: This concerns the ability of the user to take corrective action once an error has been recognized. It looks at the reachability, the forward and backward recovery and the commensurate effort.
Responsiveness:This is how the user is the response.
Task conformance: This explains the task completeness and its adequacy.

3.5 THE DESIGN RATIONALE

Design rationale is an information th Benefits of design rationale are :

Communication exists throughout th

Reuse of design knowledge is made a cross products perceives the rate of communication with the system and how stable degree to which system services support all of the user's tasks, the at explains why a computer system is the way it is.

e life cycle

Design rationale enforces design disc ipline It presents arguments for design trade-offs It organizes potentially large design s pace It is used to capture contextual information

3.5.1 Types of Design Rationale:

Process-oriented: this preserves ord r of deliberation and decision-making

Structure-oriented: this emphasizes post hoc structuring of considered design alt ernatives Two examples design rationale are:

Issue-based information system (IBIS) and Design space analysis

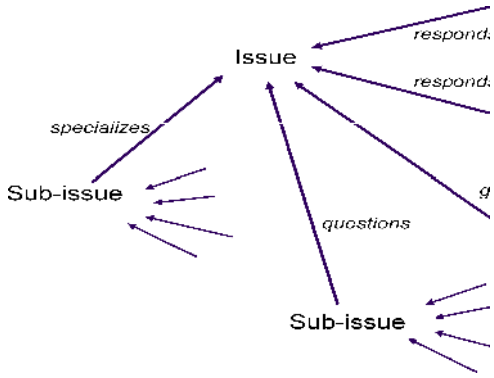
Issue-based information system (IBIS) provides basis for much of design rationale (IBIS) research and it is

The Issue-based information system are :

process-oriented. The main element al structure with one 'root' issue Issues: These describe the hierarchic

Positions: These contain the potential resolutions of an issue Arguments: These modify the relationship between positions and issues

The graphical version or structure of



Design space analysis This is structure-oriented

IBIS (gIBIS) is produced below

) is a hierarchical structure made up of questions (and sub-questions)
QOC (Questions, Options and Criterign and represent major issues of a desi ions to the
question while the criteria is the means to assess the The options provide alternative solute
options in order to make a choice

The QOC notation (Question, Option and Criterion)

5.2 Characteristics of psychological design raional

- To support task-artefact cycle in which user tasks are affected by the system
- It aims to make explicit consequences of design for users
- Designers identify tasks the system will support
- Various scenarios are suggested to test task
- Users are observed while using the system
- The psychological claims of the system are made explicit
- The negative aspects of the design can be used to improve next iteration

4.0 CONCLUSION

The various design principles mentioned can be used to guide or evaluate design at any time in the process. The principles can be re-fra med or re-structured to suit a particular com pany or project, or by professional designers.

5 . 0 SUMMARY

Experimental design principles are im portant to evaluate a current user interface interface.
They comprise the empirical measurement and iterative design.

Most design methodologies stem from a model on how users, designers, and technical systems interact.

User-centered design (UCD) is a modern, widely practiced design philosophy rooted in the idea that users must take center-stage in the design of any computer system

Displays are human-made artifacts designed to support the perception of relevan facilitate further processing of that information.

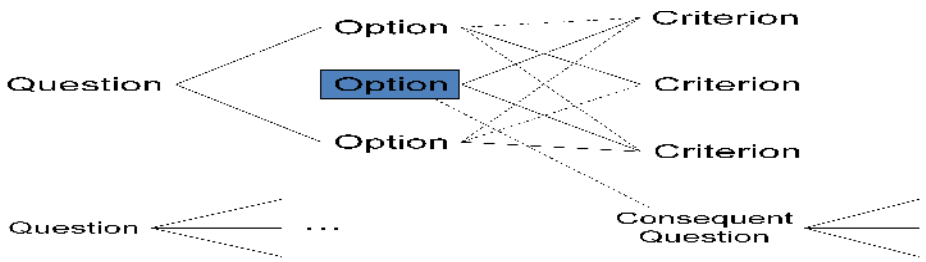
Principles of display design comprise the Perceptual Principles, the Mental Mode

Based on Attention, and the Memory it is, it could be Process-Principles

Design rationale is an information that explains why a computer system is the wa oriented and/or Structure-oriented.

6.0 Tutor Marked Assignment

1. Briefly describe the seven principles to be considered while designing a user interface
2. Explain the 5 aspects that gov ern the loop of human Computer interaction.
3. Why is it necessary for an int design? Mention some of the
   ractive designer to consider experimental d seesign principles during his principles
4. The thirteen principles of dislay design are Principles of human perception and
   information processing that can be utilised by the designer to create an effective display



3

(a) What are the potential bene

(b) Mention any 2 principles und Those based on attention an

5. Mention the five benefits of a
its achievable through utilization of these pinciples?
er each of the following categories (i) Perce dptual (ii) Mental model (iii)
(iv) memory design rationale

6. (a) What is the objective of a design rationale?
(b)Produce the graphical versions of an example of a design rationale. You given
examples of issue based information System (IBIS) or the Design space an

can select either the alysis

7. What are the characteristics of the psychological design rationale?

7.0 Further Readings / References

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