Lesson Tool 3: Design problems and solution

After studying this lesson tool, you should:

- Understand the problems of designing an interactive system and specifically:
  - How the natural evolution of design is obstructed
  - Common mistakes designers make
- Understand and be able to apply the design practices and tools to avoid the problems with the design of interactive systems, namely:
  - Mechanisms such as affordance, constraints, mapping, visibility and feedback
  - Design guidelines, principles and standards

A substantial part of this lesson tool is based on the work of Don Norman presented in his most important book "*The Design of Everyday" Things*.

❑Design Problems

- There are, potentially, many mistakes that designers can make.
- Norman (1999) points out the following as being the most problematic:
  - The forces that work against evolutionary design,
  - Putting aesthetics first (form over function) and
  - Designers regarding themselves as typical users.

HAMPERING THE NATURAL EVOLUTION OF DESIGN

- Norman (1999) coined term "**evolutionary design**".
  - Refers to the process whereby a product is gradually improved over time
  - Occurs when a design evolves through a cycle of testing, identifying problems, modification, redesign, retesting and remodification until a functional, aesthetically pleasing object is achieved.
    - Good features kept, bad features replaced with improved ones.

Three forces work against evolutionary design:

➢ The demands of time

- New version of object often released before old one has been updated.
- The release of a newer version with bugs - releasing on promised date is more important than providing a bug-free application - need for "service packs" and "hot fixes".

➢ Pressure to be distinctive

- Each design must have features to distinguish it from previous versions to lure consumers
- New model often doesn't include the good qualities of its former version.

➢ The curse of individuality and market differentiation

- Companies that manufacture the same type of product have to come up with a unique design which carries their signature.
- If a company perfects a product, other companies manufacturing same product often make an inferior product in the name of individuality.
- Quest for individuality can lead to innovative solutions to real problems
  - Main goal should be to improve product or solve the problem, not just stand out

❑ COMMON DESIGN MISTAKES

Lesson tool 2 addressed general mistake of designing for the typical user. Further issues: Overestimating importance of aesthetic (artistic) ,designers being considered typical users and problem with cluttered interfaces.

➢ Putting Aesthetics above Usability

- Apple paid special attention to the aesthetics of their products.
- Aesthetics should not take precedence over usability
- An interface need not be an artwork to be aesthetically pleasing.
  - One that is free of clutter, interface elements organised in logical and balanced way, and uses colour tastefully can provide visual pleasure to users
  - The target user group should be considered – adults vs young children
  - Culture may also determine what the user finds aesthetically pleasing.
- Google.com: Proof that a beautiful interface is not a prerequisite for a successful system.

➢ Thinking for the User

- Common Errors:
  - Designers subconsciously build interfaces according to their own preferences & knowledge. They believe they know what users want
- By time a system is complete, designers know it so well that they can't view it from perspective of someone who encounters it for the first time.
- Happens if designers do not involve real users in the design process
  - To mistake the client for the end user and base the designs on the requirements specified by the client.

➢ Cluttering the Interface

- Interfaces should provide users with enough information to allow them to perform their required task successfully.
- They should, however, avoid screen clutter:
  - Affects aesthetics of the design
  - Difficult for users to take in and understand the profusion(flooding) of objects on the screen
  - The more objects on the screen:
    - More meanings users will have to unravel (understand)
    - Harder for users to find the ones that they really need.
    - The smaller the average size of each object

Design Solutions

- Most basic principles for **good interface design** can be derived from Norman's (1999) good principles for the design of everyday things.

Below describes his well-known and widely accepted design concepts:

➢ **Affordance**

- The affordance of an object or interface refers to the perceived and actual properties that tell an observer or user how the object or interface can be used. E.g. Scissors
- The stronger the clues provided by the affordances, the better user will know what to do.

➢ **Constraints -** A constraint is a mechanism that restricts the allowed behaviour of a user when interacting with a computer system.

- **Physical** – relies on properties of the physical world for its use, e.g. ATM – card slot
  - Forcing function - type of physical constraint
    - Requires one action before a next can take place
- **Sematic** - rely on the meaning of the situation, e.g. Red robot
- **Cultural** – rely on accepted cultural conventions, e.g. green button (OK | Go)
- **Logical** - rely on logical relationships between functional and spatial aspects of a situation, e.g. natural mappings

➢ **Mapping**

- Mapping refers to the relationship between two things o E.g. relationship between a device's controls and their movements, and the results of the actual use of these controls.
- A good mapping enables users to determine the relationships between possible actions and their respective results.
- Natural mappings use physical analogy and cultural standards to support interpretation.

➢ **Visibility**

- The parts of a system that are essential for its use must be visible.
- Visible structure of well-designed objects gives user clues about how to operate them.
  - Clues take the form of affordances, constraints and mappings.
  - Visible signs (like letters or the colour)
- Absence of text labels to icons makes it difficult for users to interpret them.
- Sound can also be used to make interface elements more visible – beep on error messages

➢ Feedback

- Feedback is information that is sent back to the user about what action has actually been performed, and what the result of that action is.
- Operations that take time are often indicated by a progress bar or a message.
- Without constant feedback, the interaction process will be very unsatisfactory.
- Novices want informative feedback. Frequent users want less distracting feedback.
- Important Feedback Mechanisms:
  - **Sound** – E.g. cars – beeping (fasten belt or petrol empty)
  - **Absence of sound** – e.g. kettle, no sound means it's not working

GUIDELINES, PRINCIPLES AND STANDARDS

- The aim with design guidelines, standards and design principles
  - To help designers to improve the usability of their products by giving them rules according to which they can make design decisions
    - Such rules restrict range of design options and prevent designer from making choices likely to harm usability of the product
- Design rules are classified as standards or guidelines.

Standards - usually set by national or international bodies and are authoritative and limited in application.

Guidelines - more general in application.

There are 2 types of design guidelines:

- Low-level detailed rules
  - Instructions that are application specific and do not need much interpretation.
- High-level directing principles
  - Relatively abstract and apply to different systems

The difference between design principles and usability principles:

- Design principles usually inform the design of a system
- Usability principles
  - mostly used as basis for evaluating prototypes and complete systems
  - can be more prescriptive than design principles
- In practice, some design or usability principles are referred to as "**heuristics**"

Next are some of the most prominent sets of guidelines, namely those of Dix et al (2014), Preece et al (2007), Preece et al (2019) and Shneiderman (1998).

DIX, FINLAY, ABOWD AND BEALE

Dix et al (2014)

- Provide interface designers with a comprehensive set of high-level directing principles with the aim of improving the usability of interactive systems.

Divide principles into three categories

1. **Learnability** principles
2. **Flexibility** principles
3. **Robustness** principles

➢ **Learnability**

Refers to the ease where users can enter a new system and reach a maximal level of performance.

- Five principles affect the learnability of a computer-based system:

Principle	Definition	Related principles
Predictability	Support for the user to determine the effect of future action based on past interaction history.	Operation visibility
Synthesisability	Support for user to assess effect of past operations on the current state.	Immediate/eventual Honesty
Familiarity	Extent to which user's knowledge and experience in other real-world or computer-based domains can be applied when interacting with a new system.	Guessability, affordance
Generalisability	Support for user to extend knowledge of a specific interaction within and across applications to other similar situations.	
Consistency	Likeness in input-output behaviour arising from similar situations or similar task objectives.	

Principles that relate to Learnability principles

Principle	Explanation
Operation visibility	The way in which availability of possible next operations is shown to user and how the user is informed that certain operations are not available.
Honesty	Ability of user interface to provide an observable & informative account of any change an operation makes to the internal state of the system. • Immediate - notification requires no further interaction by user. • Eventual - user has to issue explicit directives to make changes observable.
Guessability and affordance	The way the appearance of the object stimulates a familiarity with its behaviour or function.

➢ Flexibility

- Refers to the many ways in which interaction between the user and the system can take place.

Principles that affect Flexibility

Principle	Definition	Related principles
Dialogue initiative	Allowing user freedom from artificial constraints on the input dialogue imposed by the system.	System/user Pre-emptiveness
Multi-threading	Ability of the system to support user interaction pertaining to more than one task at a time.	Concurrent vs interleaving, modality
Task migratability	Ability to pass control for execution of a given task so it becomes either internalised by user or system or is shared between them.	
Substitutivity	Allowing equivalent values of input and output to be arbitrarily substituted for each other.	Representation multiplicity, equal opportunity
Customisability	Modifiability of the user interface by the user or the system.	Adaptivity, adaptability

Principles that relate to Flexibility principles

Principle	Explanation
System pre-emptiveness	Occurs when system initiates all dialogue and user simply responds to requests for information. Hinders flexibility. May be necessary in multi-user systems where users should not be allowed to perform actions simultaneously.
User pre-emptiveness	Gives user freedom to initiate any action toward system. Promotes flexibility. Too much freedom may cause user to lose track of uncompleted tasks.
Concurrent/ interleaved multi-threading	Concurrent MT = allows simultaneous communication of information pertaining to separate tasks. Interleaved MT = permits a temporal overlap between separate tasks, but at any time the dialogue is restricted to a single task.
Multimodality	Separate modalities (channels of communication) are combined to form a single input or output expression.
Representation multiplicity	Flexibility for the rendering of state information. E.g in different formats or modes.
Equal opportunity	Blurs distinction between input and output at the interface –user has choice between what is input and what is output, Output can be reused as input.
Adaptability	Refers to user-initiated modification to adjust the form of input and output. E.g. Users may choose between different languages or complexity levels.
Adaptivity	Refers to a system-initiated modification to customise user interface automatically - observe users behaviour to adjust complexity level of tasks.

- **Robustness:** Refers to the level of support that users is given for the successful achievement and assessment of their goals.

Principles that affect Robustness

Principle	Definition	Related principles
Observability	Ability of user to evaluate internal state of the system from its perceivable representation. The user compares the current state with his or her intention within the task-action plan.	Browsability, static/dynamic defaults, reachability, persistence, operation visibility
Recoverability	Ability of the user to take corrective action once an error has been recognised.	Reachability,forward/backward recovery, commensurate effort
Responsiveness	How user perceives rate of communication with system. Response time is amount of time needed by a system to inform user of state changes. When not instantaneous, system should give indication that the task is in progress.	Stability
Task conformance	The degree to which system services support all of the tasks that the user wishes to perform and in the way the user understands them.	Task completeness, task adequacy.

Principles that relate to Robustness principles

Principle	Explanation
Browsability	Allows user to explore current internal state of the system via the limited view provided at the interface. User should be able to browse to some extent to get a clear picture of what is going on, but avoid negative side effects.
Static/Dynamic defaults	Static defaults are defined within the system or acquired at initialisation. Dynamic defaults evolve during the interactive session, e.g. user's preference
Reachability	The possibility of navigation through the observable system states.
Persistence	Deals with duration of effect of a communication act and ability of user to make use of that effect. Audio communication persists in user's memory where visual remains available for as long as the user can see the display.
Backward recovery	Involves an attempt to undo the effects of previous interaction in order to return to a prior state.
Forward recovery	Involves the acceptance of the current state and negotiation from that state towards the desired state.
Commensurate effort	If it is difficult to undo a given effect on the state, then it should have been difficult to do in the first place.
Stability	The invariance in response times for identical or similar computational resources.
Task completeness	Refers to the coverage of all the tasks of interest and whether or not they are supported in a way the user prefers.
Task adequacy	This addresses the user's understanding of the tasks.

Preece, Rogers and Sharp

Preece et al (2019) - 2 types of design goals in interaction design:

- **Usability goals**
  - Focus on aspects such as effectiveness and learnability
- **User experience goals**
  - Concerned with quality of user's experience with system
  - Focus on aspects such as aesthetics and enjoyment

➢ Usability Goals

- Preece et al (2019) identified six usability goals that will ensure that users' interaction with technology is effective and enjoyable.

Usability goal	Explanation
Effectiveness	General goal - refers to how well a system does what is what designed for.
Efficiency	How well a system supports users in carrying out their work. Focus: Productivity
Safety	Protecting the user from dangerous conditions and undesirable situations.
Utility	The extent to which a system provides the required functionality for the tasks it was intended to support. Users should be able to carry out all the tasks in the way they want to do them.
Learnability	How easily users learn to use the system.
Memorability	How easy it is to remember how to perform tasks that have been done before.

➢ User Experience Goals

- How user feels about a product, irrespective of efficiency, effectiveness, learnability and so on, plays an important role in it being well accepted or not.
- To provide users with positive experiences of interaction, designers should attend to features that will make the product:
    - satisfying, enjoyable, engaging, exciting, entertaining, helpful, motivating, aesthetically pleasing, supportive of creativity, cognitively stimulating, rewarding, provocative, surprising, emotionally fulfilling, challenging, sociability enhancing

Factors that may support the fulfilment of these user experience goals include

- Attention
- Pace
- Interactivity
- Engagement
- Style of narrative

➢ Design Principles

- According to Preece, design principles are prescriptive suggestions that help designers to explain or improve their designs.
- Instead of telling designer exactly how to design an interface, they inspire careful design by telling the designer what will work and what not.

Summary of Preece et al's (2019) discussion of design principles

Principle	Explanation
Visibility	The more visible the available functions are, the better users will be able to perform their next task.
Feedback	Involves providing information (audio, tactile, verbal or visual) about what action the user has performed and what the effect of that action was.
Constraints	These restrict the actions a user can take at a specific point during the interaction. This is an effective error prevention mechanism.
Mapping	The relationships between interface elements and their effect on the system. E.g. clicking on a left-pointing arrow at the top left-hand corner of the screen takes the user to the previous page.
Consistency	This is similar to consistency as defined by Dix et al (2004).
Affordance	Refers to an attribute of an object that tells users how it should be used. In an interface, it is the perceived affordance of an interface element that helps the user to see what it can be used for.

❑Shneiderman

- Shneiderman's principles for user-centred design (1998, 2014) are divided into 3 groups
  1. Recognition of diversity
  2. Golden rules
  3. Prevention of errors

Recognise Diversity

Before the task of designing a system can begin

- Information must be gathered about the intended users, their tasks, the environment of use and the frequency of use.

- Involves characterisation of 3 aspects relating to the intended system:

Usage profiles	Designers must understand intended users. Shneiderman lists several characteristics that should be described. • Young children: age, gender, physical abilities, level of education, cultural or ethnic background, and personality. Designers should find out whether or not all users are novices, if they have experience with kind of system. Different levels of expertise requires layered approach whereby novices are given few options and are more protected from making mistakes.
Task profiles	A complete task analysis should be executed and all task objects and actions should be identified. Tasks can also be categorised according to **frequencies**: • Frequent actions - special keys(arrow keys, insert and delete) • Less frequent actions - *Ctrl* or pull-down menus • Infrequent actions - changing the printer format
Interaction styles	Suitable interaction styles should be identified from those available. Shneiderman mentions menu selection, form fill-in, command language, natural language and direct manipulation.

The Eight Golden Rules for Interface Design

- Shneiderman et al (2014) suggested 8 principles of design applicable to most interactive systems.
- They overlap to some extent with those of Dix et al (2004) and Preece et al (2019)
- **8 Principles**

1. Strive for consistency.
2. Cater to universal usability, for example, enable frequent users to use shortcuts.
3. Offer informative feedback.
4. Design dialogues to yield closure (the completion of a group of actions).
5. Offer error prevention and simple error handling.
6. Permit easy reversal of actions.
7. Support an internal locus of control (user should feel in control of system)
8. Reduce short-term memory load.

Prevent Errors

- Errors are made by even the most experienced users,e.g, users of cellphones, e-mail, spreadsheets, air-traffic control systems and other interactive systems
- To reduce a loss in productivity due to errors
  - Improve the error messages provided by the computer system.
  - Effective approach is to **prevent the errors from occurring**.
    1. First step is to understand the nature of errors
    2. Next step is to organise screens and menus functionally by designing commands and menu choices that are distinctive and by making it difficult for users to perform irreversible actions.

3 techniques which can reduce errors by ensuring complete & correct actions (Shneiderman):

1. **Correct matching pairs** • E.g. when user types a left parenthesis, system displays a message that right parenthesis is missing, and message disappears when user types it.
2. **Complete sequences:**

- E.g. logging onto a network requires the user to perform a sequence of actions.
- When the user does this for the first time, the system can store the information and henceforth allow the user to trigger the sequence with a single action.
- The user is then not required to memorise the complete sequence.

3. **Correct commands**

- To help users to type commands correctly, a system can employ command completion which will display complete alternatives as soon as the user has typed the first few letters of a command.

Design Standards

- Standards concern prescribed ways of discussing, presenting or doing something.
- The aim is to **achieve consistency** across products of the same type.
- Standards for interactive system design are usually set by national or international bodies to ensure compliance with a set of design rules by a large community.
- Standards can apply to either hardware or software used to build the interactive system.

Standardisation in interface design offers various benefits:

- Provides a common terminology so designers know they are discussing same concept
- Facilitates program maintenance and allows for additional facilities to be added
- Gives similar systems the same look and feel so that elements are easily recognisable
- Reduces training needs - knowledge can be transferred between standardised systems
- Promotes health and safety of users who will be less likely to experience stress or surprise due to unexpected system behaviour

- A user interface design rule that is rigidly applied without taking the target user's skills, psychological and physical characteristics or preferences into account, may reduce a product's usability.
- Standards must therefore always be used together with more general interface design principles.

Conclusion

- Design guidelines do not provide recipes for designing successful systems. They only provide guidance and do not guarantee optimum usability. Even armed with very good guidelines, a designer should still make an effort to understand the technology and the tasks involved, the relevant psychological characteristics of the intended users, and what usability means in the context of the particular product.
- Guidelines can help designers to identify good and bad options for an interface. They also restrict the range of techniques that can be used while still conforming to a particular style, but they can be very difficult to apply. In many ways they are only as good as the person who uses them. This is a critical point, because many companies view guidelines as a solution.
- The way to improve an interface is not just to draft a set of rules about how many menu items to use or what colours make good backgrounds. We cannot emphasise enough that users' tasks and basic psychological characteristics must be taken into account. Unless you understand these factors, guidelines will be applied incorrectly.

The End!!!!!!