Chapter - Five

Universal Design and Evaluation Techniques

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Universal design

- People have different
  - Abilities and weaknesses; they come from different backgrounds and cultures;
  - Interests, viewpoints and experiences; they are different ages and sizes.
- All of these things have an impact on
  - The way in which an individual will use a particular computing application and,
  - Whether or not they can use it at all.
- **Universal design** is the process of designing products so that they can be used by as many people as possible in as many situations as possible

Universal Design Principles

- In reality, we may not be able to design everything to be accessible to everyone
  - but we can work toward the aim of universal design and try to provide an equivalent experience.
- The seven general principles of universal design may help us in this regard
  - Equitable use
  - Flexibility in use
  - Simple and intuitive to use
  - Perceptible information
  - Tolerance for error
  - Low physical effort
  - Size and space for approach and use

Con…

- **Equitable use**. The design is useful and marketable to people with diverse abilities.
  - ✓ Example: A professor's website is designed so that it is accessible to everyone, including students who are blind and using text-to-speech software.
- **Flexibility in use.** The design accommodates a wide range of individual preferences and abilities.
  - ✓ Provide choice in methods of use.
  - ✓ Example: A museum, visited as a field trip for a course, allows each student to choose to read or listen to a description of the contents of display cases.
- **Simple and intuitive use**. Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
  - ✓ Eliminate unnecessary complexity.
  - ✓ Be consistent with user expectations and insight.
  - ✓ Example: Control buttons on science equipment are labeled with text and symbols that are simple and intuitive to understand.
- **Perceptible information.** The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

Con…

Example: A video presentation projected in a course includes captions.

- **Tolerance for error.** The design minimizes hazards and the adverse consequences of accidental or unintended actions. **Example**: Educational software provides guidance and background information when the student makes an inappropriate response.
- **Low physical effort**. The design can be used efficiently, comfortably, and with a minimum of fatigue. **Example**: Doors to a lecture hall open automatically for people with a wide variety of physical characteristics.
- **Size and space for approach and use**. Appropriate size and space is provided for approach, reach, manipulation, and use regardless of the user's body size, posture, or mobility.
- **Example**: A flexible science lab work area has adequate workspace for students who are left- or right-handed and for those who need to work from a standing or seated position.

Evaluation

- Designers
  - Assume that if they and their colleagues can use the software and find it attractive, others will too.
  - Prefer to avoid doing evaluation because it adds development time and costs money.
- So why is evaluation important?
  - To be designers sure that ***their software is usable*** **and is what users want**.
  - It **saves effort** that would be spent fixing problems that are discovered after the systems have been shipped to customers
- Evaluation involves users directly and indirectly to understand their needs and psychology

Con…

- Evaluation
  - Tests usability and functionality of system
  - Occurs in laboratory, field and/or in collaboration with users
  - Evaluates both **design and implementation**
  - Should be considered at all stages in the design life cycle
    - Design proceeds through iterative cycles of ‘design-test-redesign’
  - Is a key ingredient for a successful design.

Goals of Evaluation

- **Assess degree of system functionality**
  - Does it satisfy requirements
  - system should enable users to perform their intended tasks more easily.
  - Involves matching the use of the system to the user's expectations
- **Assess effect of interface on user**
  - How easy the system is to learn, its usability, the user's satisfaction with it
  - May also include his/her enjoyment and emotional response
- **Identify specific problems**
  - Finding defects on both functionality and usability of the design

Evaluation Techniques

- Evaluation techniques can be broadly categorized into two
  - **Expert analysis:** number of methods have been proposed to evaluate interactive systems through **expert analysis**
    - Cognitive Walkthrough
    - Heuristic Evaluation
    - Model-based evaluation
  - **User participation**

Cognitive Walkthrough

- Expert 'walks through' design to identify potential problems
- Evaluates design on *how well it supports user in learning task*
- Usually *performed by expert* in cognitive psychology
- Using psychological principles
  - Focus of the cognitive walkthrough is to establish *how easy a system is to learn.*
- Walkthrough focuses on **goals and knowledge**
  - Does the design lead the user to generate the correct goals?

Cognitive Walkthrough….

- To do a walkthrough you need four things:
  A. A specification or prototype of the system
  B. A description of the task the user is to perform on the system
  C. A written list of the actions needed to complete the task with the proposed system
  D. An indication of who the users are and what kind of experience and knowledge the evaluators can assume about the users.
- The evaluators step through the action sequence in step C to critique the system and tell a believable story about its usability.

Cognitive Walkthrough….

- To do this, for each action, the evaluators try to answer the following four questions for each step in the action sequence,
- ✓ Is the effect of the action the same as the user's goal at that point?
- ✓ Will users see that the action is available?
- ✓ Once users have found the correct action, will they know it is the one they need?
- ✓ After the action is taken, will users understand the feedback they get?

Heuristic Evaluation

- A heuristic is a guideline or rule of thumb
  - That can guide a design decision or
  - That can be used to critique a decision that has already been made.
- Heuristic evaluation,
  - Is a method for structuring the critique of a system using a set of relatively simple and general heuristics.
  - Can be performed on a design specification, prototypes, storyboards and fully functioning systems.
  - It is flexible, relatively cheap approach-
  - Several evaluators (3 to 5) independently critique a system to come up with potential usability problems
- To aid the evaluators in discovering usability problems, a set of 10 heuristic (Nielsen's ten heuristics)are provided.

Phases of Heuristic Evaluation

1. **Training session**
   - Reviewers practice detailed heuristics
2. **Evaluation**
   - Each reviewer evaluates with a list of standard heuristics the interface - normally 4 iterations
   - Tests the general flows of tasks and functions of the various interface elements (not strictly task-oriented)
   - Observer takes notes of identified problems
   - Reviewers communicate only after their iterations
3. **Results and reviewer session**
   - Make list of problems (violated principles + reasons)
   - Detailed descriptions of the problems

Phases of Heuristic Evaluation…

4. **Problem assessment**
   - How serious and unavoidable is a usability problem?
   - Each reviewer assesses each identified problem with respect to its severity:
     - 0 - don‘t agree that this is a usability problem
     - 1 - cosmetic problem
     - 2 - minor usability problem
     - 3 - major usability problem - important to fix
     - 4 - usability catastrophe; imperative (very important) to fix
   - Final ranking of all problems

- ***Advantage of heuristic Evaluation:***
  - Fast, cheap, qualitatively good results
- ***Problems of heuristic* Evaluation:**
  - Experts aren‘t real users
  - Heuristics do not cover all possible problems

Nielsen's ten heuristics

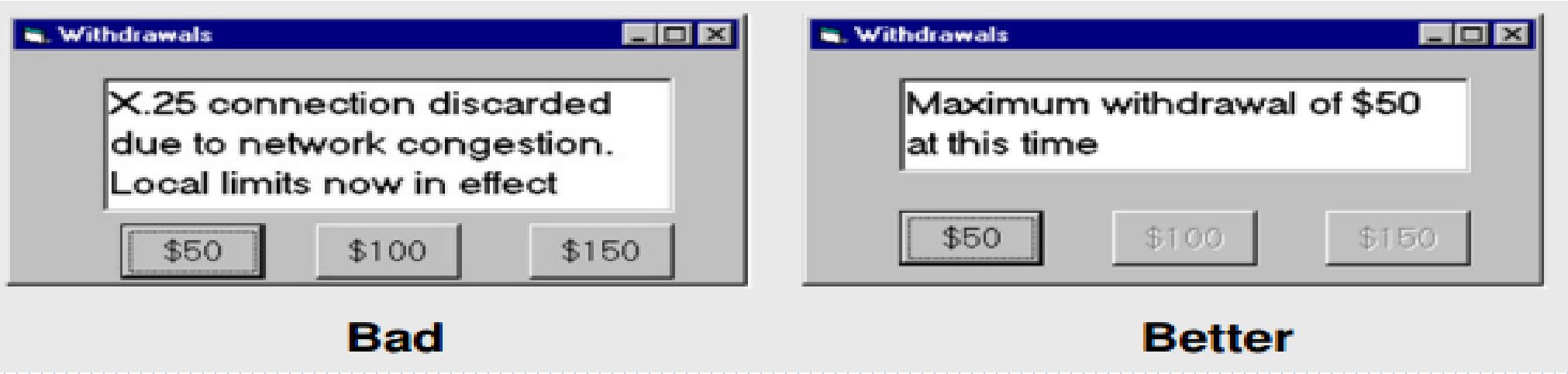
1. Visibility of system status

- The system should always keep users informed about what is going on through appropriate feedback within reasonable time.

Nielsen's ten heuristics …

2. Match Between System and Real World

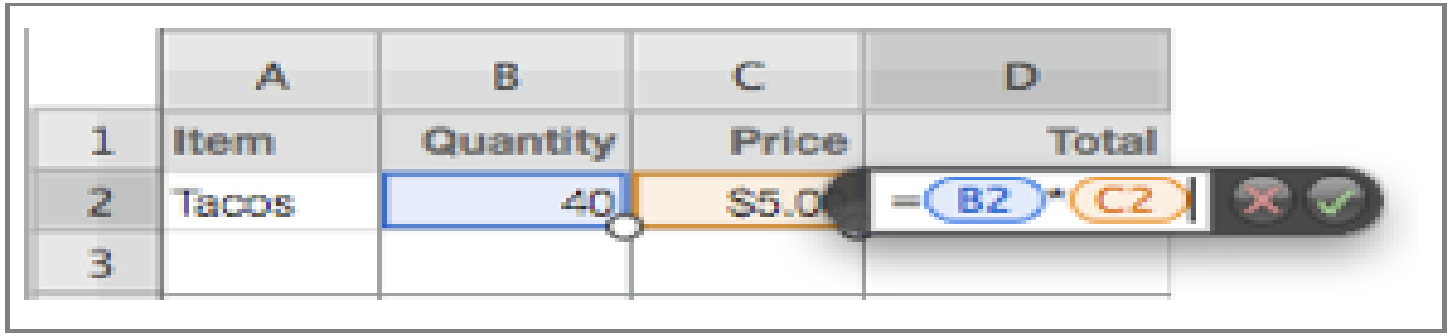
- The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms
- Follow real-world conventions, making information appear in a natural and logical order.



Nielsen's ten heuristics …

3. User Control and Freedom

- Users often choose system functions by mistake
- They will need a clearly marked "emergency exit" *to leave the unwanted state* without having to go through an extended dialogue
- E.g. Support **undo** and **redo**.

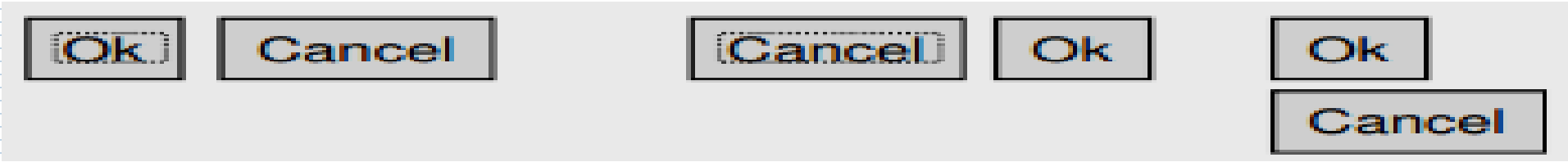


Clearly marks where the person is and where they can go by showing the selection in each menu

Nielsen's ten heuristics …

4. Consistency and Standards

- Users should not have to wonder whether different words, situations, or actions mean the same thing
- Follow platform conventions



Use same information/controls in same location on all screens / dialog boxes

5. Error Prevention

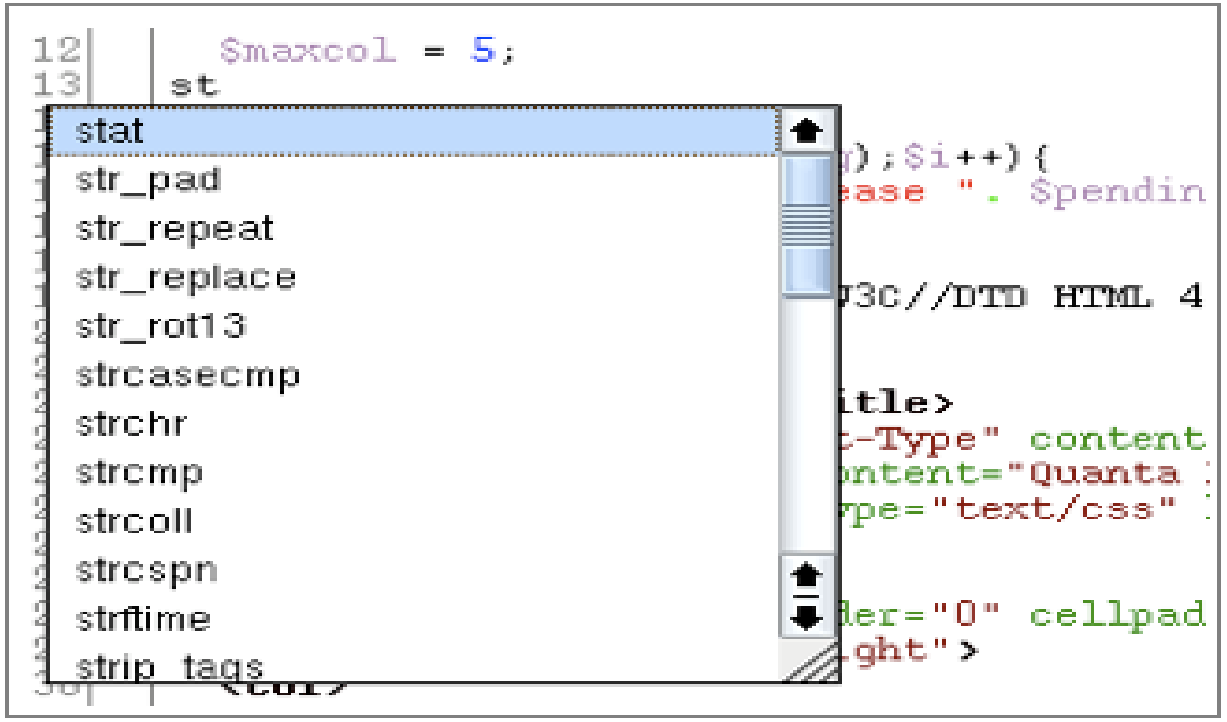
Make it difficult to make errors.

Even good error messages is a careful design that prevents a problem from occurring in the first place.

Nielsen's ten heuristics …

6. Recognition Rather Than Recall

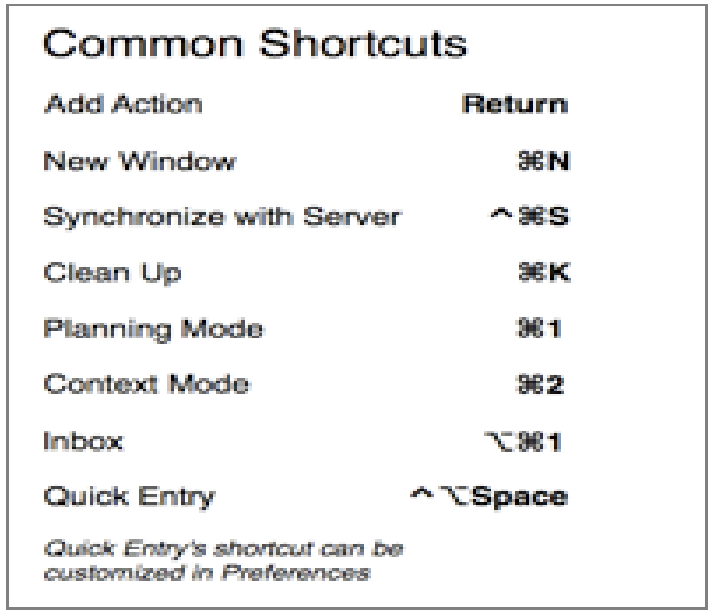
- Make objects, actions, and options visible - The user should not have to remember information from one part of the dialogue to another
- Instructions for use of the system should be visible or easily retrievable whenever appropriate

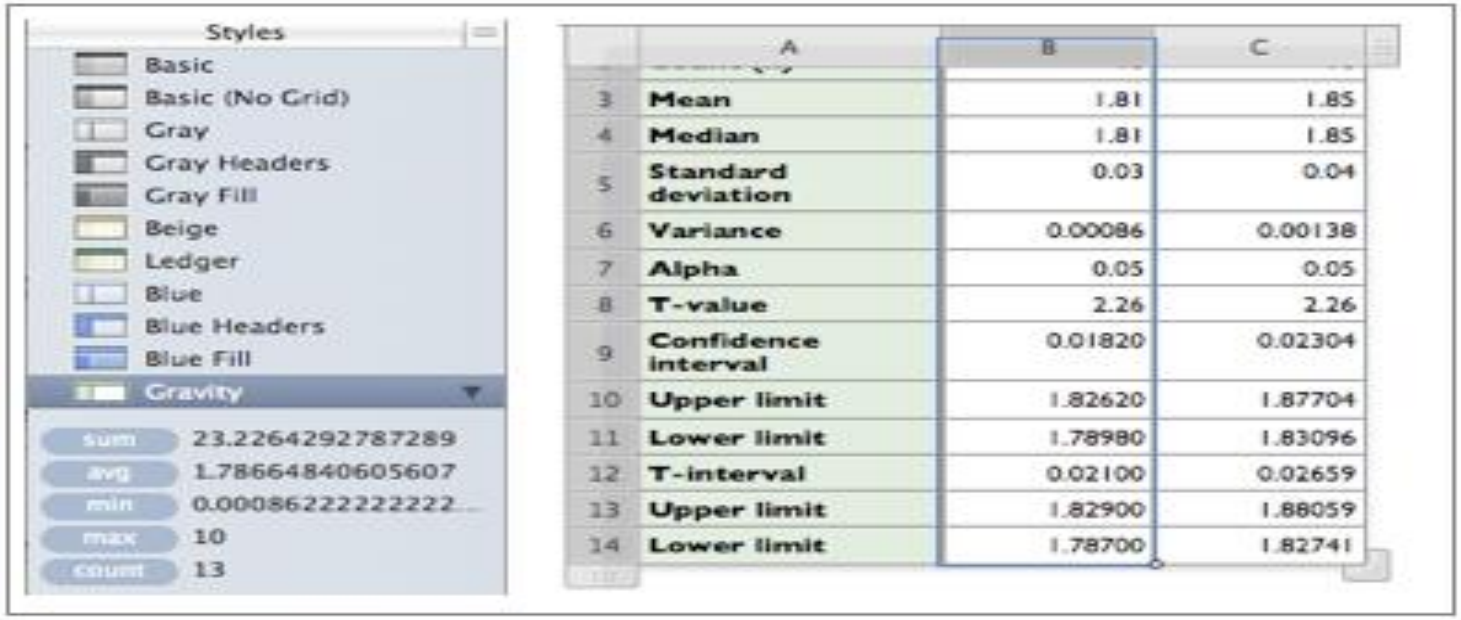


Nielsen's ten heuristics …

7. Flexibility and Efficiency of Use

- **Accelerators** --unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users
- Allow users to adapt frequent actions





Nielsen's ten heuristics …

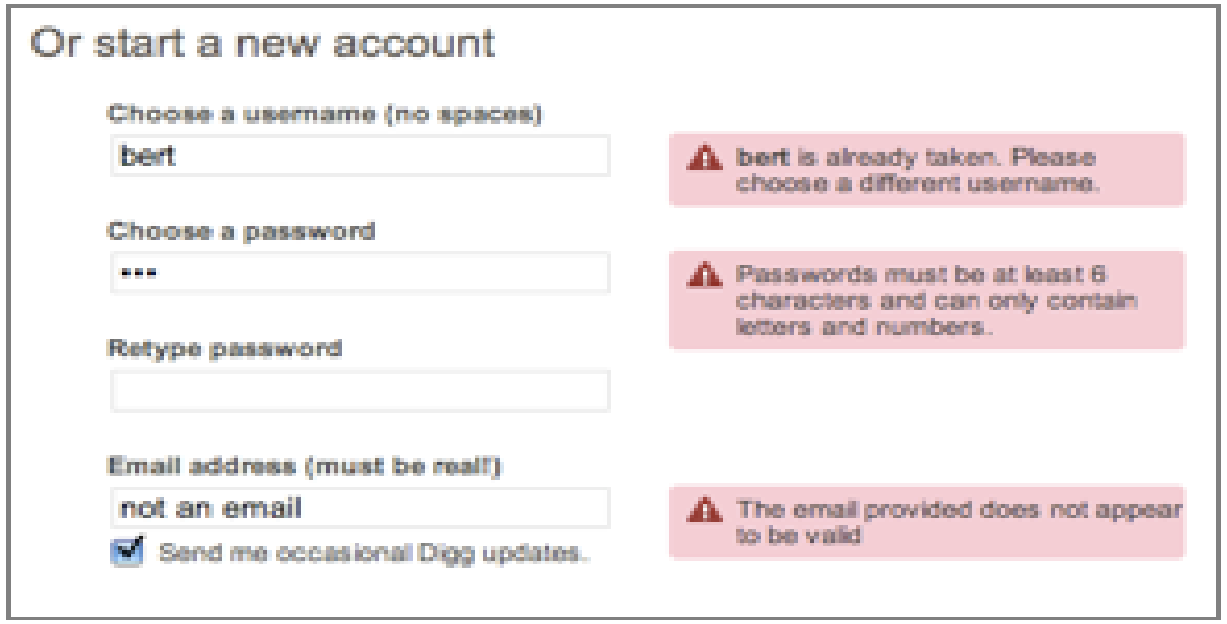
8. Aesthetic and Minimalist Design

- *Dialogues should not contain information which is irrelevant or rarely needed*
- Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

Nielsen's ten heuristics …

9. Help Users Recognise, Diagnose and Recover from Errors

- Error messages should:
  - Be expressed in plain language (no codes)
  - Precisely indicate the problem
  - Constructively suggest a solution



Nielsen's ten heuristics …

10. Help and Documentation

- It is better if the system can be used without documentation
- But it may be necessary to provide help and documentation
- Any such information should:
  - Be easy to search
  - Be focused on the user's task
  - List concrete steps to be carried out
  - Not be too large

Model-based evaluation

- Certain cognitive and design models provide a means of combining design specification and evaluation into the same framework.
  - *Example*
    - GOMS - predicts user performance
    - KLM (keystroke-level model) - provide predictions of the time users will take to perform low-level physical tasks.

Evaluation Through User participation

- There are different approaches to evaluation through user participation
  1. **Experimental methods**
  2. **Observational methods**
  3. **Query techniques**
  4. **Physiological methods**
- Most of the approaches are applied at later stages of development when there is at least *a working prototype of the system* in place

1. Experimental Evaluation

- Involves controlled *evaluation of specific aspects of interactive behaviour*
  - This provides empirical evidence to support a particular claim or hypothesis
- Any experiment has the same basic form
  - ***Evaluator chooses hypothesis to be tested***
  - A number of experimental conditions are considered which differ only in the value of some controlled variable.
  - Changes in behavioural measure are attributed to different conditions
- There are a number of factors that are important to the overall reliability of the experiment in experimental design: ***participants, variables, and hypothesis***

Experimental Evaluation…

A. Participants/Subjects

- The choice of participants is vital to the success of any experiment
  - Should be chosen to match the expected user population as closely as possible in age, level of education, etc
    - Testing with the actual users is highly acceptable but this is not always possible
  - Choose right sample size
    - Should be large enough to match the design of the experiment and the statistical methods chosen.

B. Variables

- Experiments manipulate and measure variables under controlled conditions, *in order to test the hypothesis.*
- Two types of variables: ***Dependant*** & ***Independent*** Variables

Experimental Evaluation

- **Independent variable (IV)**
  - Characteristic manipulated/changed to produce different conditions
    - e.g. interface style, number of menu items, level of help, …
  - Each value that is used in an experiment is known as a **level** of the variable
    - E.g. In an experiment that wants to test whether search speed improves as the number of menu items decreases may consider menus with five, seven, and ten items
  - More complex experiments may have more than one independent variable
    - E.g. the speed of the user's response depends on both the number of menu items and the choice of commands used on the menu.

Experimental Evaluation…

- **Dependent variable (DV)**
  - Are variables that can be measured in the experiment
  - Their value is 'dependent' on the changes made to the independent variable, and as far as possible, unaffected by other factors

    e.g. Time taken, Number of errors

C. **Hypothesis**

- Is a prediction of the outcome of an experiment- framed in terms of IV and DV

  e.g. ***"Error rate will increase as font size decreases"***
- The aim of the experiment is to show that this prediction is correct
- This is done by disproving the null hypothesis,
  - **Null hypothesis** - states that there is no difference in the dependent variable between the levels of the independent variable.
  - It says that there is no statistical significance between the two variables in the hypothesis

    e.g. null hypothesis ***"no change with font size"***

2. Observational Methods

- Involves gathering information about actual use of a system *while users interacting with it*
  - The evaluator watches and records the users' actions using a variety of techniques
- This method does not always give insight into their decision processes or attitude, so, users are asked to elaborate their actions by '*thinking aloud*'
- Techniques e.g.
  - Cooperative evaluation - user evaluates together with expert -*Both can ask each other questions*
  - Think aloud – observing user while performing task and asking to describe
    - What s/he is doing,
    - What s/he is expecting to happen
    - Why, what s/he thinks is happening etc.

3. Query Techniques

- Involves asking the user about the interface directly
  - E.g. Interview, Questionnaire
- This methods can be used in *evaluation* and *more widely to collect information about user requirements and tasks*
- Useful in eliciting detail of the user's view of a system.
  - Good to get the user's viewpoint directly and may reveal issues that have not been considered by the designer
  - Relatively simple and cheap to administer
- However,
  - The information gained is necessarily subjective
  - Difficult to get accurate feedback about alternative designs if the user has not experienced them

4. Physiological methods

- Drawback of most evaluation techniques is that we are reliant on
  - Observation and
  - The users telling us what they are doing and how they are feeling
- What if we were able to measure these things directly?
  - Interest grown on objective usability testing - *ways of monitoring physiological aspects of computer use*
- Advantages
  - Allow us not only to see more clearly exactly what users do when they interact with computers, *but also to measure how they feel.*
- Eye tracking and physiological measurement are examples
- *Physiological measurements* :- emotional response is closely tied to physiological changes. These include changes in heart rate, breathing and skin secretions

Thanks...