User interface design

Objectives

- To suggest some general design principles for user interface design
- To explain different interaction styles and their use
- To explain when to use graphical and textual information presentation
- To explain the principal activities in the user interface design process
- To introduce usability attributes and approaches to system evaluation

Topics covered

- Design issues
- The user interface design process
- User analysis
- User interface prototyping
- Interface evaluation

The user interface

- User interfaces should be designed to match the skills, experience and expectations of its anticipated users.
- System users often judge a system by its interface rather than its functionality.
- A poorly designed interface can cause a user to make catastrophic errors.
- Poor user interface design is the reason why so many software systems are never used.

Human factors in interface design

- Limited short-term memory
  - People can instantaneously remember about 7 items of information. If you present more than this, they are more liable to make mistakes.
- People make mistakes
  - When people make mistakes and systems go wrong, inappropriate alarms and messages can increase stress and hence the likelihood of more mistakes.
- People are different
  - People have a wide range of physical capabilities. Designers should not just design for their own capabilities.
- People have different interaction preferences
  - Some like pictures, some like text.

UI design principles

- UI design must take account of the needs, experience and capabilities of the system users.
- Designers should be aware of people's physical and mental limitations (e.g. limited short-term memory) and should recognise that people make mistakes.
- UI design principles underlie interface designs although not all principles are applicable to all designs.

User interface design principles

Principle	Description
User familiarity	The interface should use terms and concepts which are drawn from the experience of the people who will make most use of the system.
Consistency	The interface should be consistent in that, wherever possible, comparable operations should be activated in the same way.
Minimal surprise	Users should never be surprised by the behaviour of a system.
Recoverability	The interface should include mechanisms to allow users to recover from errors.
User guidance	The interface should provide meaningful feedback when errors occur and provide context-sensitive user help facilities.
User diversity	The interface should provide appropriate interaction facilities for different types of system user.

Design principles

- User familiarity
  - The interface should be based on user-oriented terms and concepts rather than computer concepts. For example, an office system should use concepts such as letters, documents, folders etc. rather than directories, file identifiers, etc.
- Consistency
  - The system should display an appropriate level of consistency. Commands and menus should have the same format, command punctuation should be similar, etc.
- Minimal surprise
  - If a command operates in a known way, the user should be
    able to predict the operation of comparable commands

Design principles

- Recoverability
  - The system should provide some resilience to user errors and allow the user to recover from errors. This might include an undo facility, confirmation of destructive actions, 'soft' deletes, etc.
- User guidance
  - Some user guidance such as help systems, on-line manuals, etc. should be supplied
- User diversity
  - Interaction facilities for different types of user should be supported. For example, some users have seeing difficulties and so larger text should be available

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Design issues in UIs

- Two problems must be addressed in interactive systems design
  - How should information from the user be provided to the computer system?
  - How should information from the computer system be presented to the user?
- User interaction and information presentation may be integrated through a coherent framework such as a user interface metaphor.
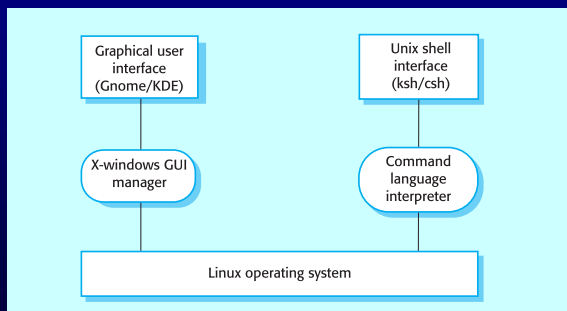

Interaction styles

- Direct manipulation
- Menu selection
- Form fill-in
- Command language
- Natural language

Interaction styles

Interaction style	Main advantages	Main disadvantages	Application examples
Direct manipulation	Fast and intuitive interaction. Easy to learn	May be hard to implement. Only suitable where there is a visual metaphor for tasks and objects.	Video games CAD systems
Menu selection	Avoids user error. Little typing required	Slow for experienced users. Can become complex if many menu options.	Most general-purpose systems
Form fill-in	Simple data entry. Easy to learn. Checkable	Takes up a lot of screen space. Causes problems where user options do not match the form fields.	Stock control, Personal loan processing
Command language	Powerful and flexible	Hard to learn. Poor error management.	Operating systems, Command and control systems
Natural language	Accessible to casual users. Easily extended	Requires more typing. Natural language und erstanding systems are unreliable.	Information retrieval systems

Multiple user interfaces

Graphical user interface (Gnome/KDE)

Unix shell interface (ksh/csh)

X-windows GUI manager

Command language interpreter

Linux operating system

LIBSYS interaction

- Document search
  - Users need to be able to use the search facilities to find the documents that they need.
- Document request
  - Users request that a document be delivered to their machine or to a server for printing.

Web-based interfaces

- Many web-based systems have interfaces based on web forms.
- Form field can be menus, free text input, radio buttons, etc.
- In the LIBSYS example, users make a choice of where to search from a menu and type the search phrase into a free text field.

LIBSYS search form

LIBSYS: Search

Choose collection   All

Keyword or phrase

Search using   Title

Adjacent words   ● Yes   ○ No

Search   Reset   Cancel

Information presentation

- Information presentation is concerned with presenting system information to system users.
- The information may be presented directly (e.g. text in a word processor) or may be transformed in some way for presentation (e.g. in some graphical form).
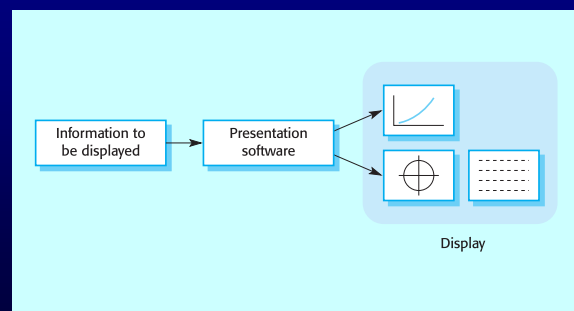- The Model-View-Controller approach is a way of supporting multiple presentations of data.

Information presentation

Information to be displayed

Presentation software

Display

Model-view-controller

User inputs → Controller state / Controller methods

view modification messages

View state / View methods

Model edits

Model state / Model methods

Model queries and updates
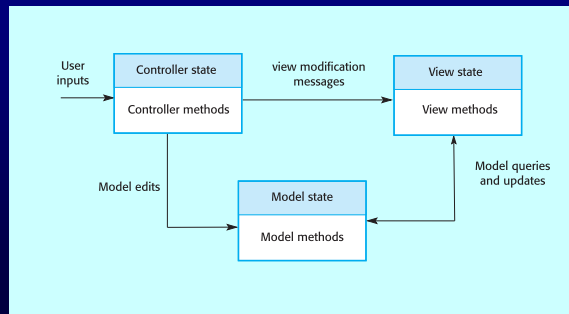
Information presentation

- Static information
  - Initialised at the beginning of a session. It does not change during the session.
  - May be either numeric or textual.
- Dynamic information
  - Changes during a session and the changes must be communicated to the system user.
 - May be either numeric or textual.

Information display factors

- Is the user interested in precise information or data relationships?
- How quickly do information values change? Must the change be indicated immediately?
- Must the user take some action in response to a change?
- Is there a direct manipulation interface?
- Is the information textual or numeric? Are relative values important?

Alternative information presentations
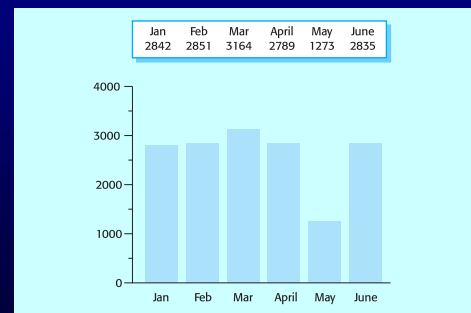
Jan	Feb	Mar	April	May	June
2842	2851	3164	2789	1273	2835

Analogue or digital presentation?

- Digital presentation
  - Compact - takes up little screen space;
  - Precise values can be communicated.
- Analogue presentation
  - Easier to get an 'at a glance' impression of a value;
  - Possible to show relative values;
  - Easier to see exceptional data values.

Presentation methods

Dial with needle   Pie chart   Thermometer   Horizontal bar
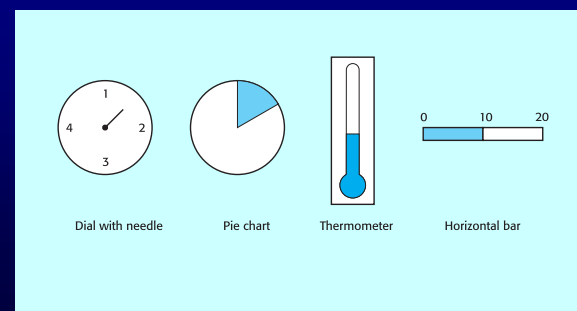
Displaying relative values

	Pressure					Temperature			
0	100	200	300	400	0	25	50	75	100

Data visualisation

- Concerned with techniques for displaying large amounts of information.
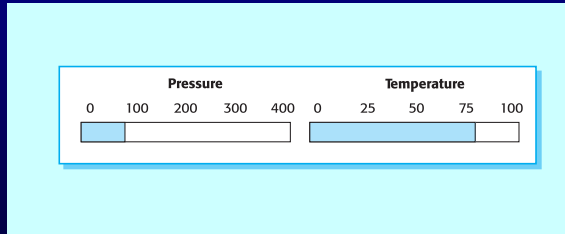- Visualisation can reveal relationships between entities and trends in the data.
- Possible data visualisations are:
  - Weather information collected from a number of sources;
  - The state of a telephone network as a linked set of nodes;
  - Chemical plant visualised by showing pressures and temperatures in a linked set of tanks and pipes;
  - A model of a molecule displayed in 3 dimensions;
  - Web pages displayed as a hyperbolic tree.

Colour displays

- Colour adds an extra dimension to an interface and can help the user understand complex information structures.
- Colour can be used to highlight exceptional events.
- Common mistakes in the use of colour in interface design include:
  - The use of colour to communicate meaning;
  - The over-use of colour in the display.

Colour use guidelines

- Limit the number of colours used and be conservative in their use.
- Use colour change to show a change in system status.
- Use colour coding to support the task that users are trying to perform.
- Use colour coding in a thoughtful and consistent way.
- Be careful about colour pairings.

Error messages

- Error message design is critically important. Poor error messages can mean that a user rejects rather than accepts a system.
- Messages should be polite, concise, consistent and constructive.
- The background and experience of users should be the determining factor in message design.

Design factors in message wording

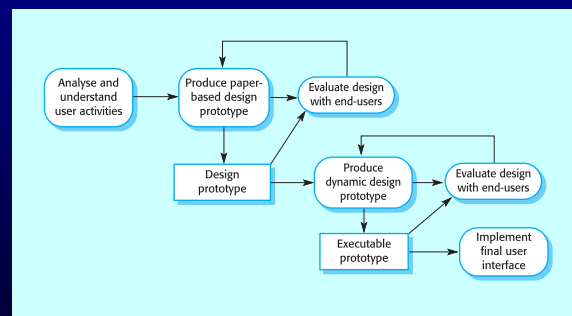| Factor	Description
Context	Wherever possible, the messages generated by the system should reflect the current user context. As far as is possible, the system should be aware of what the user is doing and should generate messages that are relevant to their current activity.
Experience	As users become familiar with a system they become irritated by long, ÒmeaningfulÓ messages. However, beginners find it difficult to understand short terse statements of a problem. You should provide both types of message and allow the user to control message conciseness.
Skill level	Messages should be tailored to the userÕsskills as well as their experience. Messages for the different classes of user may be expressed in different ways depending on the terminology that is familiar to the reader.
Style	Messages should be positive rather than negative. They should use the active rather than the passive mode of address. They should never be insulting or try to be funny.
Culture	Wherever possible, the designer of messages should be familiar with the culture of the country where the system is sold. There are distinct cultural differences between Europe, Asia and America. A suitable message for one culture might be unacceptable in another.

User error

- Assume that a nurse misspells the name of a patient whose records he is trying to retrieve.

Please type the patient's name in the box then click on OK

Patient's name

MacDonald, R.

OK   Cancel

Good and bad message design

System-oriented error message

?   Error #27

Invalid patient id

OK   Cancel

User-oriented error message

R. MacDonald is not a registered patient
Click on Patients for a list of patients
Click on Retry to re-input the patient's name
Click on Help for more information

Patients   Help   Retry   Cancel

The UI design process

- UI design is an iterative process involving close liaisons between users and designers.
- The 3 core activities in this process are:
  - User analysis. Understand what the users will do with the system;
  - System prototyping. Develop a series of prototypes for experiment;
  - Interface evaluation. Experiment with these prototypes with users.

The design process

Analyse and understand user activities → Produce paper-based design prototype → Evaluate design with end-users

Design prototype → Produce dynamic design prototype → Evaluate design with end-users

Executable prototype → Implement final user interface

User analysis

- If you don't understand what the users want to do with a system, you have no realistic prospect of designing an effective interface.
- User analyses have to be described in terms that users and other designers can understand.
- Scenarios where you describe typical episodes of use, are one way of describing these analyses.

User interaction scenario

Jane is a student of Religious Studies and is working on an essay on Indian architecture and how it has been influenced by religious practices. To help her understand this, she would like to access some pictures of details on notable buildings but can't find anything in her local library.

She approaches the subject librarian to discuss her needs and he suggests some search terms that might be used. He also suggests some libraries in New Delhi and London that might have this material so they log on to the library catalogues and do some searching using these terms. They find some source material and place a request for photocopies of the pictures with architectural detail to be posted directly to Jane.

Requirements from the scenario

- Users may not be aware of appropriate search terms so need a way of helping them choose terms.
- Users have to be able to select collections to search.
- Users need to be able to carry out searches and request copies of relevant material.

Analysis techniques

- Task analysis
  - Models the steps involved in completing a task.
- Interviewing and questionnaires
  - Asks the users about the work they do.
- Ethnography
  - Observes the user at work.

Hierarchical task analysis
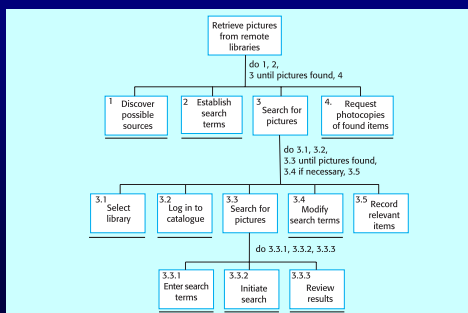
Interviewing

- Design semi-structured interviews based on open-ended questions.
- Users can then provide information that they think is essential; not just information that you have thought of collecting.
- Group interviews or focus groups allow users to discuss with each other what they do.

Ethnography

- Involves an external observer watching users at work and questioning them in an unscripted way about their work.
- Valuable because many user tasks are intuitive and they find these very difficult to describe and explain.
- Also helps understand the role of social and organisational influences on work.

Ethnographic records

Air traffic control involves a number of control 'suites' where the suites controlling adjacent sectors of airspace are physically located next to each other. Flights in a sector are represented by paper strips that are fitted into wooden racks in an order that reflects their position in the sector. If there are not enough slots in the rack (i.e. when the airspace is very busy), controllers spread the strips out on the desk in front of the rack.

When we were observing controllers, we noticed that controllers regularly glanced at the strip racks in the adjacent sector. We pointed this out to them and asked them why they did this. They replied that, if the adjacent controller has strips on their desk, then this meant that they would have a lot of flights entering their sector. They therefore tried to increase the speed of aircraft in the sector to 'clear space' for the incoming aircraft.

Insights from ethnography

- Controllers had to see all flights in a sector. Therefore, scrolling displays where flights disappeared off the top or bottom of the display should be avoided.
- The interface had to have some way of telling controllers how many flights were in adjacent sectors so that they could plan their workload.

User interface prototyping

- The aim of prototyping is to allow users to gain direct experience with the interface.
- Without such direct experience, it is impossible to judge the usability of an interface.
- Prototyping may be a two-stage process:
  - Early in the process, paper prototypes may be used;
  - The design is then refined and increasingly sophisticated automated prototypes are then developed.

Paper prototyping

- Work through scenarios using sketches of the interface.
- Use a storyboard to present a series of interactions with the system.
- Paper prototyping is an effective way of getting user reactions to a design proposal.

Prototyping techniques

- Script-driven prototyping
  - Develop a set of scripts and screens using a tool such as Macromedia Director. When the user interacts with these, the screen changes to the next display.
- Visual programming
  - Use a language designed for rapid development such as Visual Basic. See Chapter 17.
- Internet-based prototyping
  - Use a web browser and associated scripts.

User interface evaluation

- Some evaluation of a user interface design should be carried out to assess its suitability.
- Full scale evaluation is very expensive and impractical for most systems.
- Ideally, an interface should be evaluated against a usability specification. However, it is rare for such specifications to be produced.

Usability attributes

Attribute	Description
Learnability	How long does it take a new user to become productive with the system?
Speed of operation	How well does the system response match the userÔswork practice?
Robustness	How tolerant is the system of user error?
Recoverability	How good is the system at recovering from user errors?
Adaptability	How closely is the system tied to a single model of work?

Simple evaluation techniques

- Questionnaires for user feedback.
- Video recording of system use and subsequent tape evaluation.
- Instrumentation of code to collect information about facility use and user errors.
- The provision of code in the software to collect on-line user feedback.

Key points

- User interface design principles should help guide the design of user interfaces.
- Interaction styles include direct manipulation, menu systems form fill-in, command languages and natural language.
- Graphical displays should be used to present trends and approximate values. Digital displays when precision is required.
- Colour should be used sparingly and consistently.

Key points

- The user interface design process involves user analysis, system prototyping and prototype evaluation.
- The aim of user analysis is to sensitise designers to the ways in which users actually work.
- UI prototyping should be a staged process with early paper prototypes used as a basis for automated prototypes of the interface.
- The goals of UI evaluation are to obtain feedback on how to improve the interface design and to assess if the interface meets its usability requirements.