

User interface design

- 1 Designing effective interfaces for software systems

User interface design

- 1 User interface overview
- 1 User interface design principles
- 1 User interaction styles
- 1 Information presentation
- 1 Error messages and help systems
- 1 Interface evaluation

Question

- 1 What is the user interface?

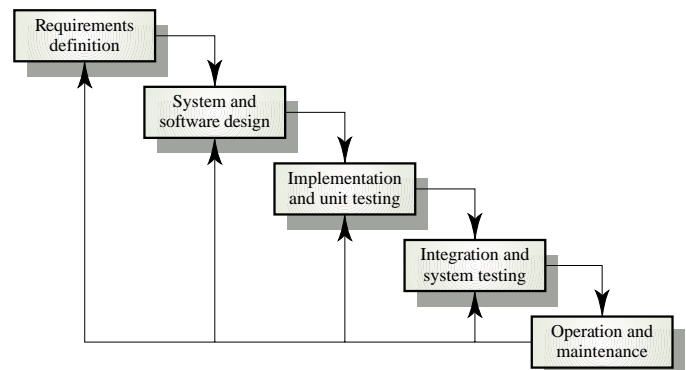
Question

- 1 What is the user interface?
 - Specific hardware features of machine
 - » e.g. type of display and input devices
 - General environment supplied by the machine
 - » E.g. dedicated word-processors vs general purpose computers
 - Content of displays
 - » What information is present? When and where is the information available? How is the information represented?
 - Behavior of software - procedures user must follow:
 - » Conventions or user interface standards for a machine or system
 - » Specific behavior of a particular application program.
 - » Specific behavior of the operating system
 - Supporting documentation, technical support, and help

The user interface

- 1 System users often judge a system by its ease of use rather than the functionality that is available but hard to use
- 1 A poorly designed interface can cause a user to make catastrophic errors
- 1 Poor user interface design is the reason why so many software systems are never used

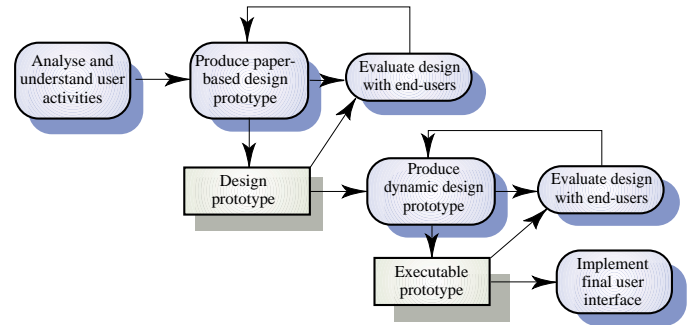
The interface should be considered in every activity of the software process, but this lecture focuses on the design activity.



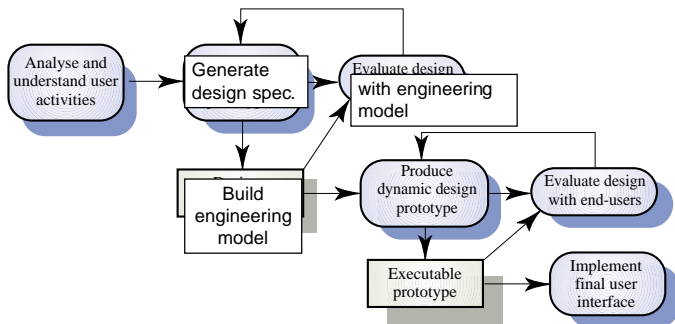
User-centered design

- 1 User-centered design is an approach to UI design where the needs of the user are paramount and where the user is involved in the design process
- 1 Good UI design always involves the development of prototype interfaces
- 1 The aim of this chapter is to educate software engineers to key issues underlying the design rather than the implementation of user interfaces

User interface design process



User interface design process



UI design principles

- 1 UI design must take account of the needs, experience and capabilities of the system users
- 1 Designers should be aware of people's physical and mental limitations (e.g. limited short-term memory) and should recognise that people make mistakes
- 1 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

- 1 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.
- 1 Consistency
 - The system should display an appropriate level of consistency. Commands and menus should have the same format, command punctuation should be similar, etc.
- 1 Minimal surprise
 - If a command operates in a known way, the user should be able to predict the operation of comparable commands

Design principles

- 1 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.
- 1 User guidance
 - Some user guidance such as help systems, on-line manuals, etc. should be supplied
- 1 User diversity
 - Interaction facilities for different types of user should be supported. For example, some users have visual impairments and could be aided by variable-sized text

User-system interaction

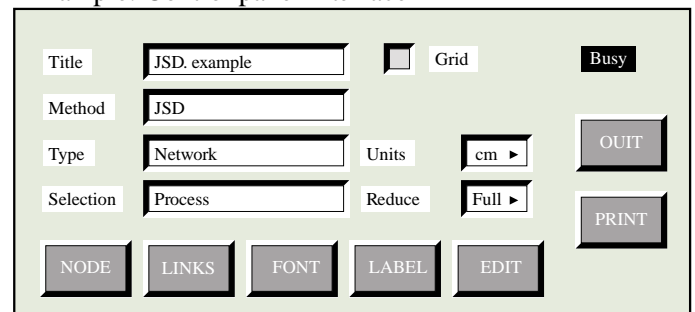
- 1 Two problems must be addressed in interactive systems design
 - How should information from the user be provided to the computer system?
 - How should information from the computer system be presented to the user?
- 1 User interaction and information presentation may be integrated through a coherent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

Interaction styles

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

Direct manipulation

The user interacts directly with objects on the screen.
Example: Control panel interface



Direct manipulation advantages

- 1 Designers are more likely to provide a consistent interface because gross inconsistencies will be very obvious.
- 1 Users get immediate feedback on their actions so mistakes can be quickly detected and corrected
- 1 Users feel in control of the computer and are less likely to be intimidated by it
- 1 User learning time is relatively short

Direct manipulation problems

- 1 The derivation of an appropriate information space model can be very difficult
- 1 Given that users have a large information space, what facilities for navigating around that space should be provided?
- 1 Direct manipulation interfaces can be complex to program and make heavy demands on the computer system

Menu systems

- 1 Users make a selection from a list of possibilities presented to them by the system
- 1 The selection may be made by pointing and clicking with a mouse, using cursor keys or by typing the name of the selection
- 1 May make use of simple-to-use terminals such as touchscreens

Advantages of menu systems

- 1 Users need not remember command names as they are always presented with a list of valid commands
- 1 Typing effort is minimal
- 1 User errors are trapped by the interface
- 1 Context-dependent help can be provided. The user's context is indicated by the current menu selection
- 1 Can be spoken by the computer, and used by people who can't look at a computer screen

Problems with menu systems

- 1 Actions which involve logical conjunction (and) or disjunction (or) are awkward to represent
- 1 Menu systems are best suited to presenting a small number of choices. If there are many choices, some menu structuring facility must be used
- 1 Experienced users find menus slower than command language

Form-based interface

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| Author | <input type="text"/> | Price <input type="text"/> |
| Publisher | <input type="text"/> | Publication date <input type="text"/> |
| Edition | <input type="text"/> | Number of copies <input type="text"/> |
| Classification | <input type="text"/> | Loan status <input type="text"/> |
| Date of purchase | <input type="text"/> | Order status <input type="text"/> |

Command interfaces

- 1 User types commands to give instructions to the system e.g. UNIX
- 1 May be implemented using cheap terminals.
- 1 Easy to process using parsing techniques
- 1 Commands of arbitrary complexity can be created by command combination
- 1 Concise interfaces requiring minimal typing can be created
- 1 Commands can be issued by someone who cannot look at the screen

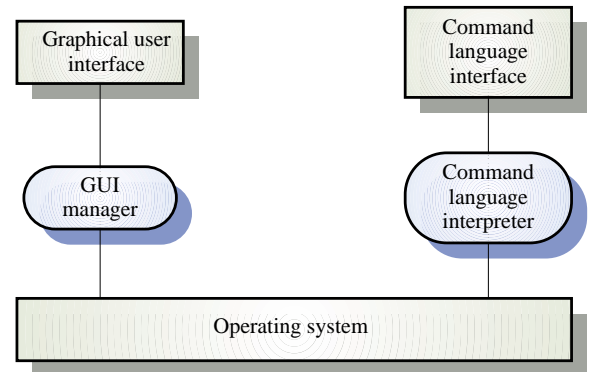
Problems with command interfaces

- 1 Users have to learn and remember a command language. Command interfaces are therefore unsuitable for occasional users
- 1 Users make errors in command. An error detection and recovery system is required
- 1 System interaction is through a keyboard so typing ability is required, or voice and so voice recognition is required

Natural language interfaces

- 1 The user types a command in a natural language. Generally, the vocabulary is limited and these systems are confined to specific application domains (e.g. timetable enquiries)
- 1 NL processing technology is now good enough to make these interfaces effective for casual users but experienced users find that they require too much typing

Multiple user interfaces



Graphical user interfaces

- 1 Combine direct manipulation, menus, forms.
- 1 Most users of business systems interact with these systems through graphical interfaces although, in some cases, legacy text-based interfaces are still used

GUI characteristics

| Characteristic | Description |
|----------------|---|
| Windows | Multiple windows allow different information to be displayed simultaneously on the user's screen. |
| Icons | Icons represent different types of information. On some systems, icons represent files; on others, icons represent processes. |
| Menus | Commands are selected from a menu rather than typed in a command language. |
| Pointing | A pointing device such as a mouse is used for selecting choices from a menu or indicating items of interest in a window. |
| Graphics | Graphical elements can be mixed with text on the same display. |

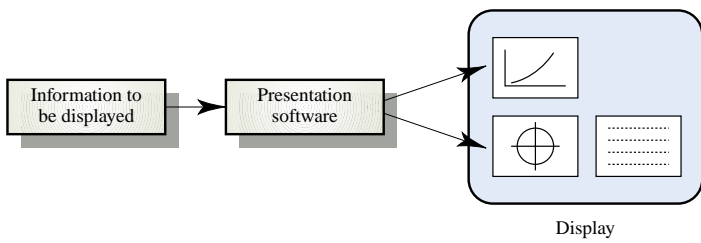
GUI advantages

- 1 They are easy to learn and use.
 - Users without experience can learn to use the system quickly.
- 1 The user may switch quickly from one task to another and can interact with several different applications.
 - Information remains visible in its own window when attention is switched.
- 1 Fast, full-screen interaction is possible with immediate access to anywhere on the screen

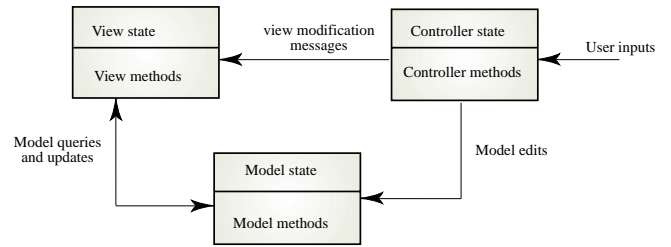
Information presentation

- 1 Information presentation is concerned with presenting system information to system users
- 1 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)
- 1 The Model-View-Controller approach is a way of supporting multiple presentations of data

Information presentation



Model-view-controller



- MVC design cleanly accommodates different interfaces to the same data
- View and controller are often combined into a single UI delegate

Information presentation

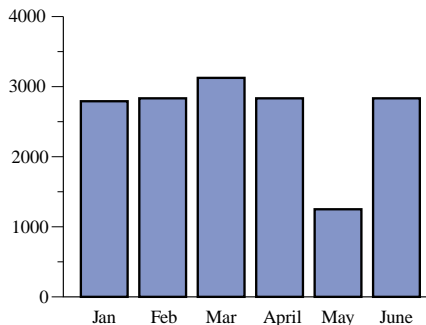
- 1 **Static information**
 - Initialised at the beginning of a session. It does not change during the session
 - May be either numeric or textual
- 1 **Dynamic information**
 - Changes during a session and the changes must be communicated to the system user
 - May be either numeric or textual

Information display factors

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

Alternative information presentations

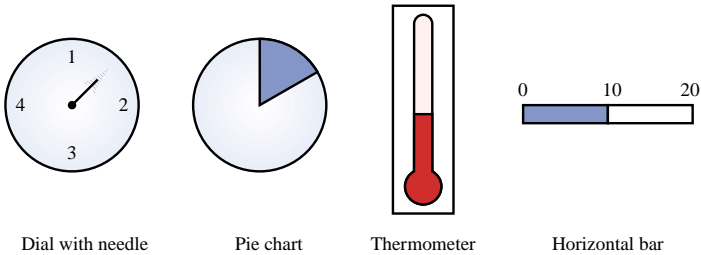
| Jan | Feb | Mar | April | May | June |
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Analogue vs. digital presentation

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

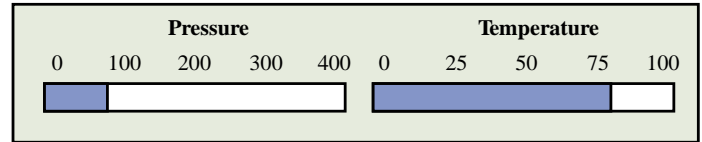
Dynamic information display



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Displaying relative values



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Question

- 15.5 Discuss the advantages of graphical information display and suggest four applications where it would be more appropriate to use graphical rather than digital displays of numeric information.

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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

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Color displays

- Color adds an extra dimension to an interface and can help the user understand complex information structures
- Can be used to highlight exceptional events
- Common mistakes in the use of color in interface design include:
 - The use of color to communicate meaning
 - Over-use of color in the display

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Color use guidelines

- Don't use too many colors
- Use color coding to support use tasks
- Design for monochrome then add color
- Use color coding consistently
- Avoid color pairings that cause strain
- Use color change to show status change
- Consider allowing users to control color coding

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Question

- 15.6 What are the guidelines which should be followed when using color in a user interface? Suggest how color might be used more effectively in the interface of an application that you use.

```

...
int i = 1;
C a = new D();
C b = new C();
// Primitives are passed by value.
System.out.println("1. i=" + i + ", C.j= " + C.j + ", a.k= " + a.k);
a.m1(i);
// All instance methods are "virtual" so "a" calls D's and "b" calls C's
a.generic_method();
...

```

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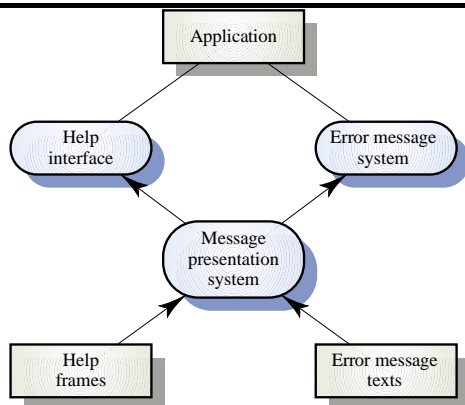
Error messages and help systems

- User guidance covers all system facilities to support users including on-line help, error messages, manuals etc.
- The user guidance system should be integrated with the user interface to help users when they need information about the system or when they make some kind of error
- The error message and help and systems should, if possible, be integrated

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Help and message system



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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

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Design factors in message wording

| | |
|-------------|---|
| Context | The user guidance system should be aware of what the user is doing and should adjust the output message to the current context. |
| Experience | As users become familiar with a system they become irritated by long, 'meaningful' messages. However, beginners find it difficult to understand short terse statements of the problem. The user guidance system should provide both types of message and allow the user to control message conciseness. |
| Skill level | Messages should be tailored to the user's skills as well as their experience. Messages for the different classes of user may be expressed in different ways depending on the terminology which 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. |

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Nurse input of a patient's name

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

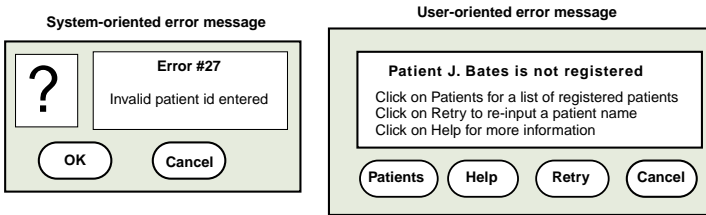
Bates, J.

OK
Cancel

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System and user-oriented error messages

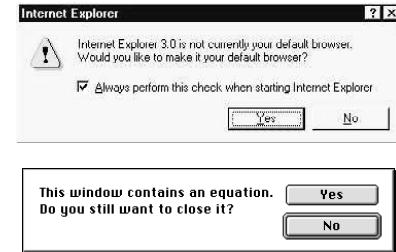


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Question

- 15.8 Consider the error messages produced by MS-Windows, Unix, MacOS or some other operating system. Suggest how these might be improved.



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Help system design

- 1 *Help?* means "help I want information"
- 1 *Help!* means "HELP. I'm in trouble"
- 1 Both of these requirements have to be taken into account in help system design
- 1 Different facilities in the help system may be required

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Help information

- Should not simply be an on-line manual
- Screens or windows don't map well onto paper pages.
- The dynamic characteristics of the display can improve information presentation.
- People are not so good at reading screen as they are text.

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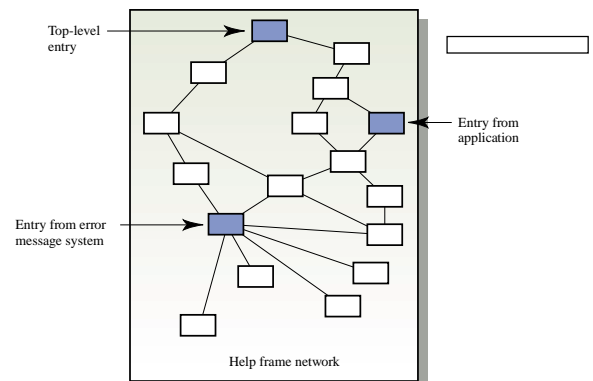
Help system use

- 1 Multiple entry points should be provided so that the user can get into the help system from different places.
- 1 Some indication of where the user is positioned in the help system is valuable.
- 1 Facilities should be provided to allow the user to navigate and traverse the help system.

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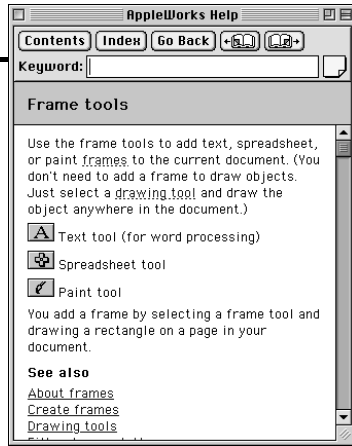
Entry points to a help system



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Help system windows



Apple Computer, 1999 and 1998

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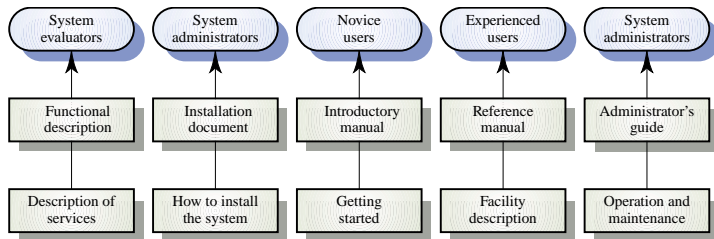
User documentation

- 1 As well as on-line information, paper documentation should be supplied with a system
- 1 Documentation should be designed for a range of users from inexperienced to experienced
- 1 As well as manuals, other easy-to-use documentation such as a quick reference card may be provided

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User document types



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Document types

- 1 Functional description
 - Brief description of what the system can do
- 1 Introductory manual
 - Presents an informal introduction to the system
- 1 System reference manual
 - Describes all system facilities in detail
- 1 System installation manual
 - Describes how to install the system
- 1 System administrator's manual
 - Describes how to manage the system when it is in use

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User interface evaluation

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

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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 user's work 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? |

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Simple evaluation techniques

- 1 User observation studies, with video recording of system use and subsequent tape evaluation.
- 1 Instrumentation of code to collect information about facility use and user errors.
- 1 Usability inspection methods
 - Such as....
 - Cognitive Walkthrough
 - GOMS (Goals, Operators, Methods, and Selection Rules) analyses
 - Heuristic Evaluation

Ten Steps for Conducting a User Observation Study

1. Introduce yourself and explain the purpose of the study.
2. Tell the participant that it is OK to quit at any time.
3. Tell them about the equipment
4. Explain how to think aloud.
5. Explain that you will not help.
6. Describe what the participant will be doing.
7. Ask for any questions.
8. Remind the participant to think aloud and don't help.
9. Debrief the participant.
10. Use the data.

Summary: User Interface Design

- 1 Interface design should be user-centered. An interface should be logical and consistent and help users recover from errors
- 1 Interaction styles include direct manipulation, menu systems form fill-in, command languages and natural language
- 1 Graphical displays should be used to present trends and approximate values. Digital displays when precision is required
- 1 Color should be used sparingly and consistently

Summary: User Interface Design

- 1 Systems should provide on-line help. This should include "help, I'm in trouble" and "help, I want information"
- 1 Error messages should be positive rather than negative.
- 1 A range of different types of user documents should be provided
- 1 The user interface must be evaluated before delivering the product