

USER INTERFACE & DATA VISUALIZATION

What it is and why it is important

What is an interface?

The term “user interface” specifies how the program and the user communicate.

Hildreth, (1982) gives two definitions. “The point or process which joins two or more system components:

- a shared boundary defined by common physical, signal and logical characteristics, across which data travel;
- a device that facilitates interpretation of two systems, as between data communications equipment and data processing equipment or terminal installations.”

The user interface

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

Interface Features

- Aesthetically pleasing
- Must use comprehensible language
- Use technologies and hardware (e.g. keyboard and mouse) that are manageable by the user.
- It must be accessible at all levels of user's skills and knowledge.

Graphical user interfaces

- 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 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

- They are easy to learn and use.
- Users without experience can learn to use the system quickly.
- Information remains visible in its own window when attention is switched.
- Fast, full-screen interaction is possible with immediate access to anywhere on the screen

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

User Computer Interaction Styles

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

Advantages and Disadvantages

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	Takes up a lot of screen space	Stock control, Personal loan processing
Command language	Powerful and flexible	Hard to learn Poor error management	Operating systems, Library information retrieval systems
Natural language	Accessible to casual users Easily extended	Requires more typing Natural language understanding systems are unreliable	Timetable systems WWW information retrieval systems

Direct manipulation

- Users feel in control of the computer and are less likely to be intimidated by it
- User learning time is relatively short
- Users get immediate feedback on their actions so mistakes can be quickly detected and corrected

Menu systems

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

Form-based interface

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date

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Loan
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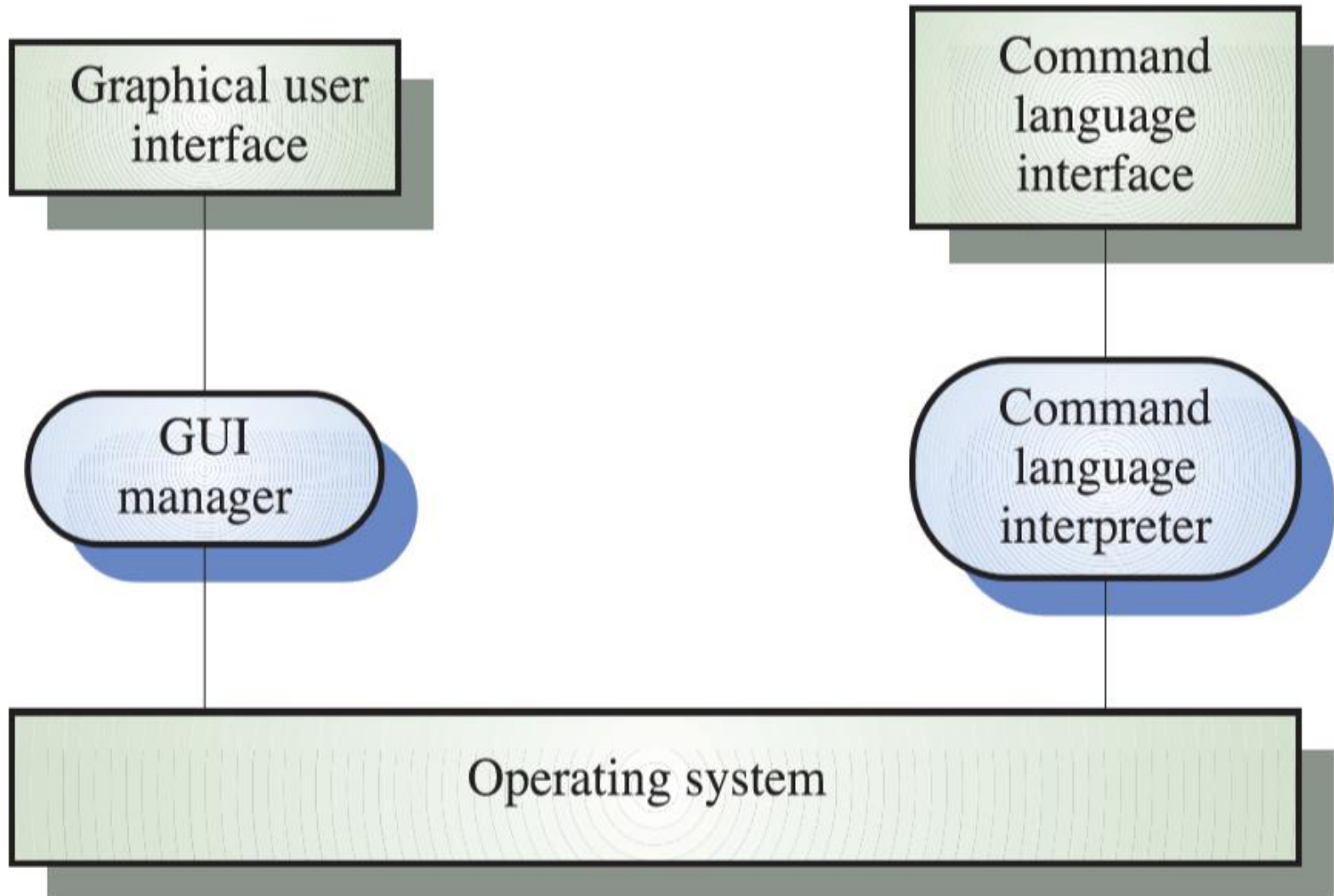
Command languages

- Often preferred by experienced users because they allow for faster interaction with the system
- Not suitable for casual or inexperienced users
- May be provided as an alternative to menu commands (keyboard shortcuts). In some cases, a command language interface and a menu-based interface are supported at the same time

Natural language (NL) interfaces

- 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)
- 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

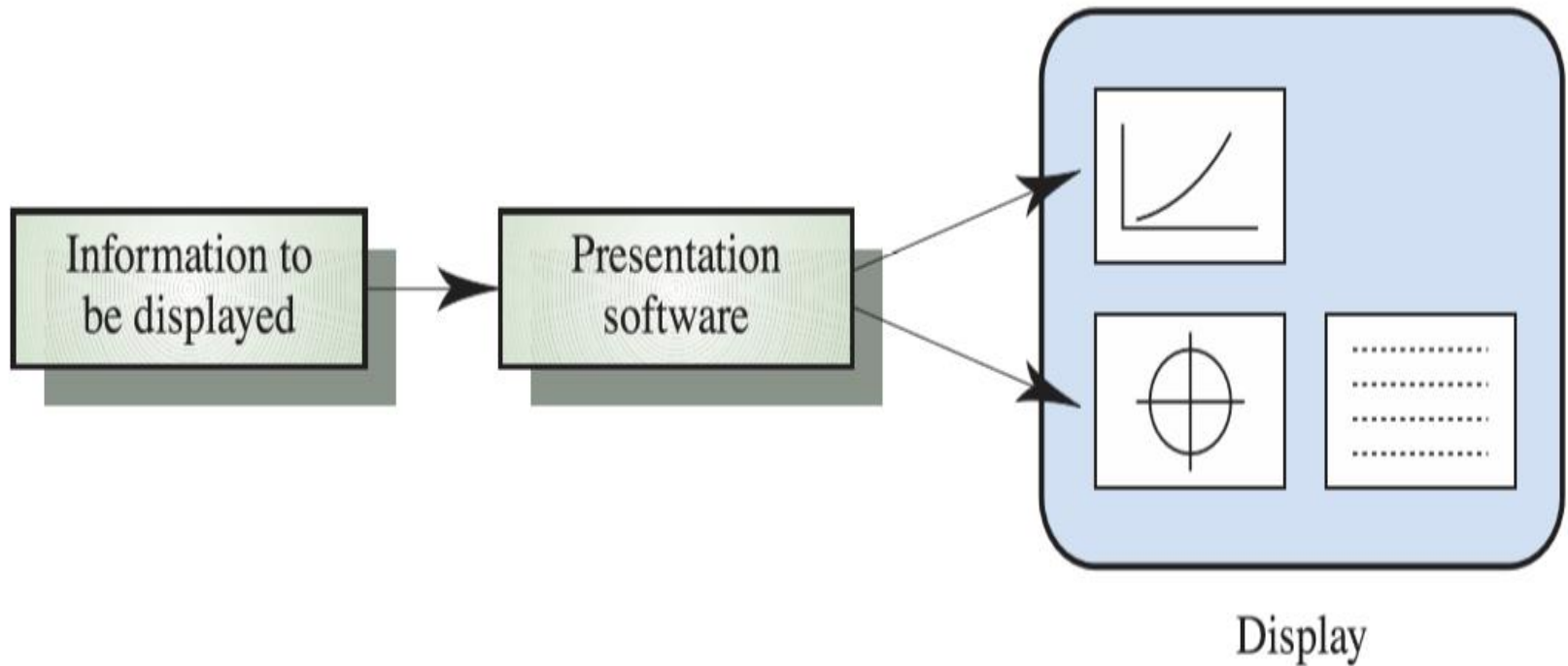
Multiple user interfaces



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)

Information presentation



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?

DATA VISUALIZATION

Data Visualization

- Data visualization is the presentation of data in a pictorial or graphical format.
- For centuries, people have depended on visual representations such as charts and maps to understand information more easily and quickly.
- Concerned with techniques for displaying large amounts of information.
- Visualization can reveal relationships between entities and trends in the data.

Data Visualization Applications

Possible data visualizations:

- Weather information collected from a number of sources
- The state of a telephone network as a linked set of nodes
- Chemical plant visualized by showing pressures and temperatures in a linked set of tanks and pipes
- A model of a car 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.
- 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
 - Over-use of colour in the display

Colour use guidelines

- Don't use too many colours
- Use colour coding to support use tasks
- Allow users to control colour coding
- Design for monochrome then add colour
- Use colour coding consistently
- Avoid colour pairings which clash
- Use colour change to show status change
- Be aware that colour displays are usually lower resolution

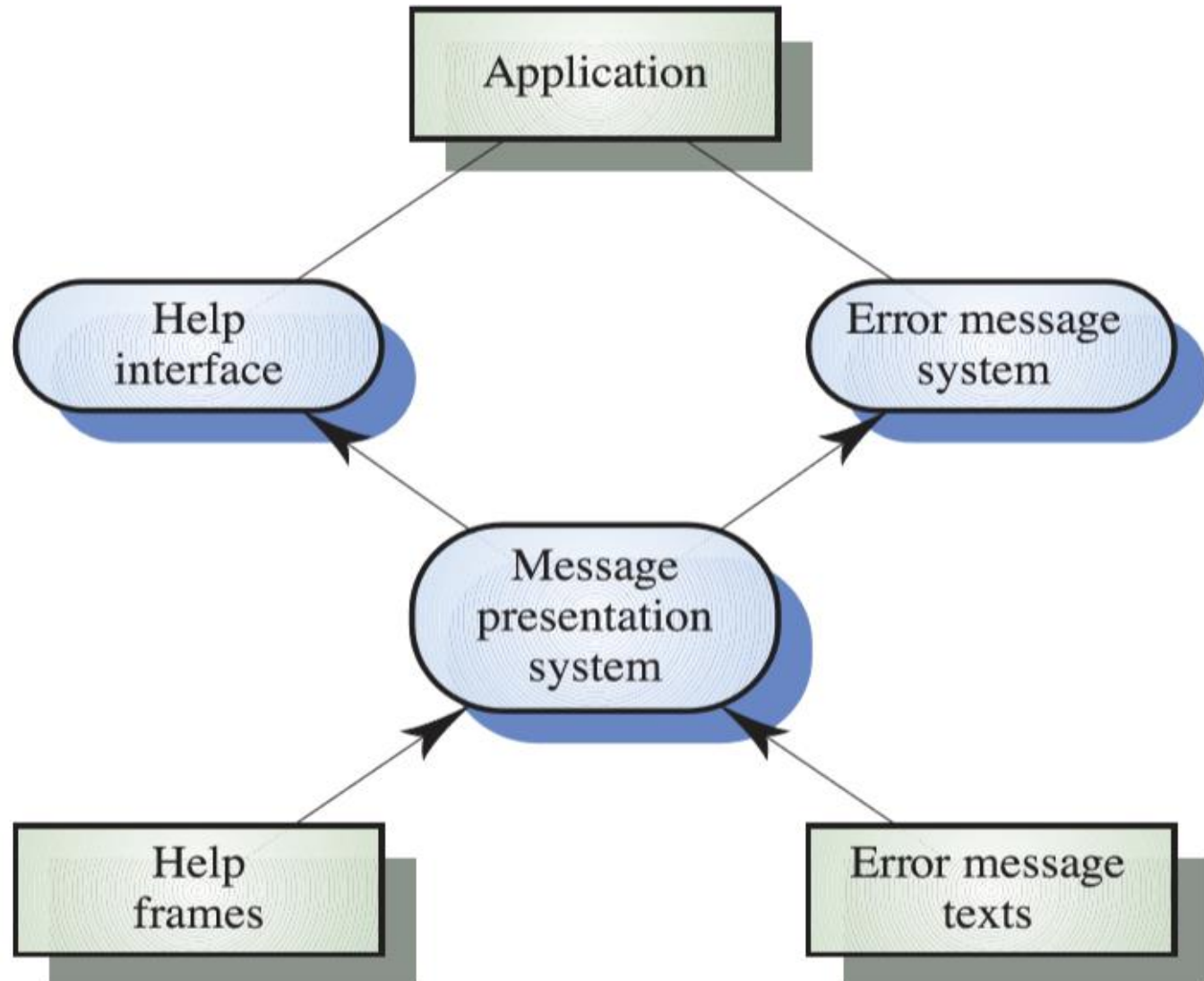
User support

λ User guidance covers all system facilities to support users including on-line help, error messages, manuals etc.

λ 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

λ The help and message system should, if possible, be integrated

Help and message system



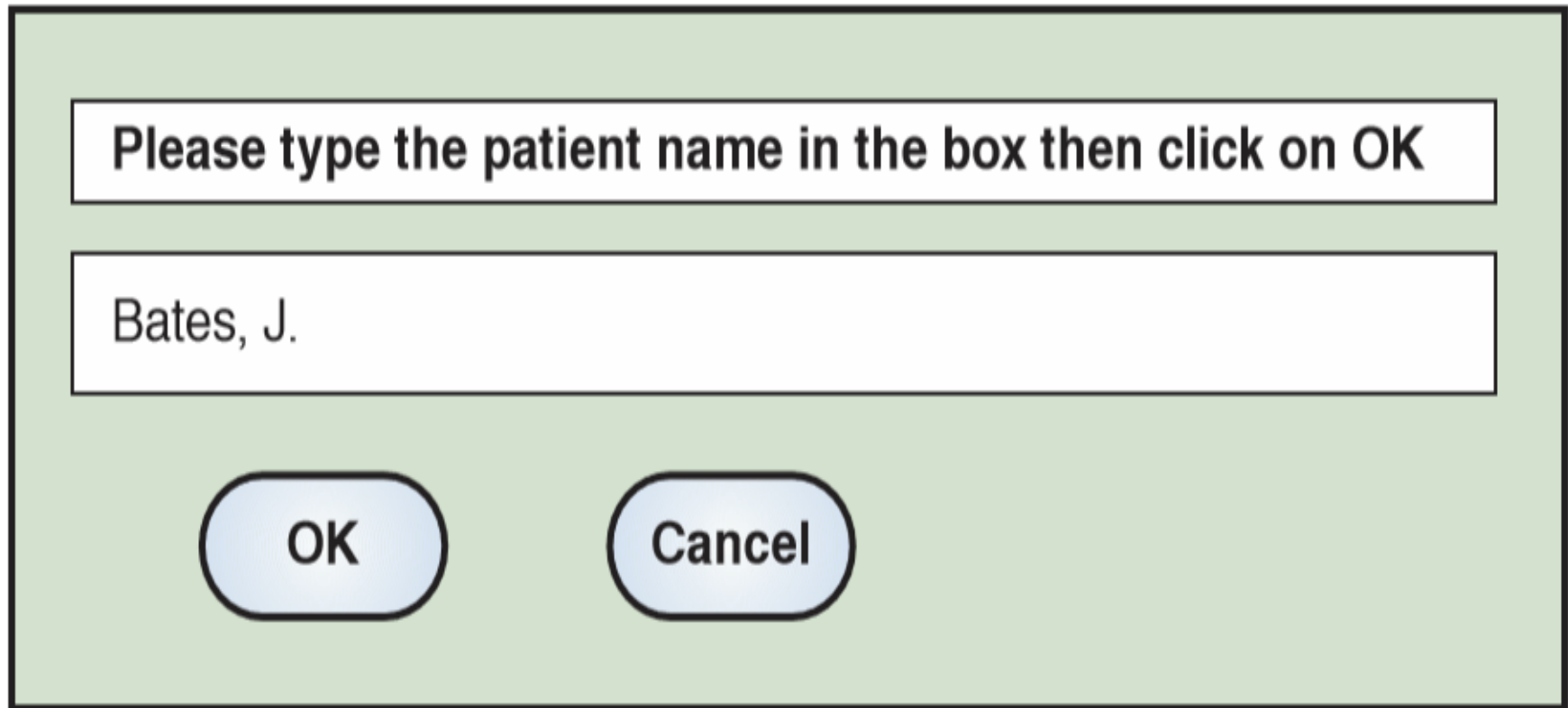
Error messages

- 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

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.

Nurse input of a patient's name



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

Bates, J.

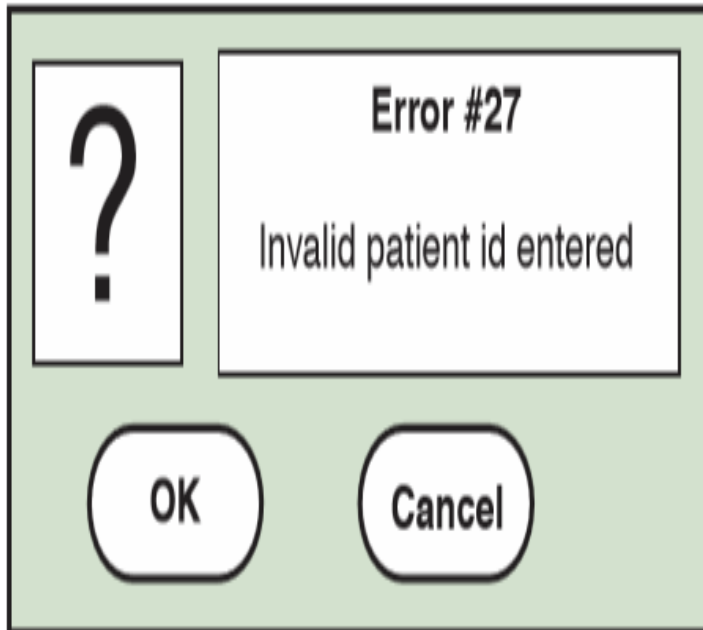
OK

Cancel

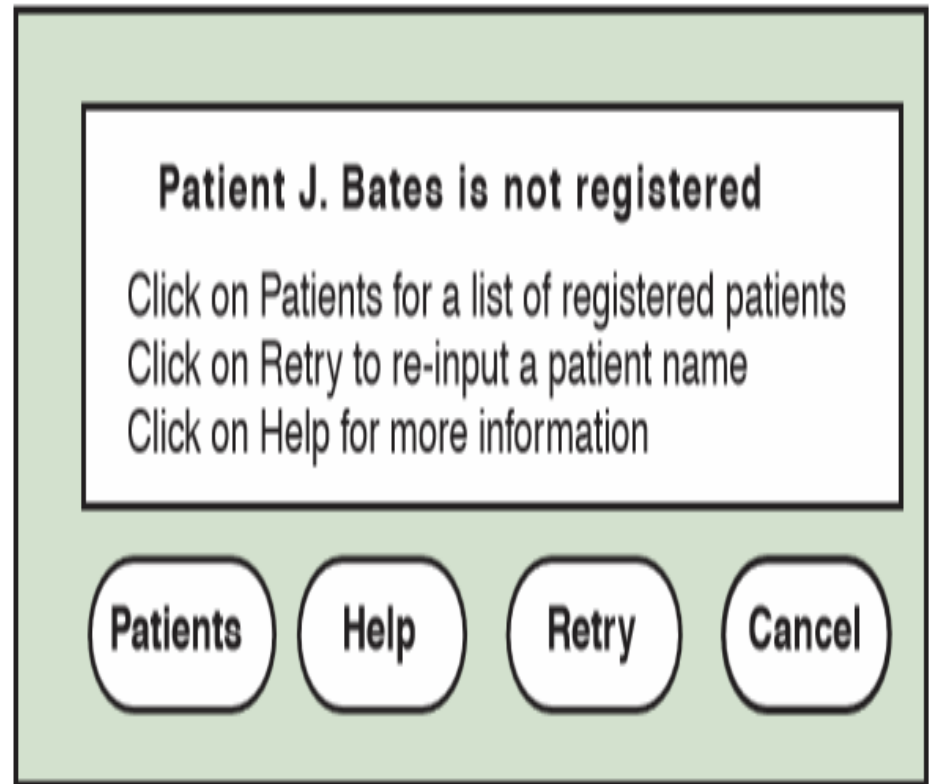
The image shows a standard software dialog box with a light green background. At the top, a white rectangular box contains the instruction "Please type the patient name in the box then click on OK". Below this, a larger white rectangular text input field contains the text "Bates, J.". At the bottom of the dialog, there are two light blue, rounded rectangular buttons with black outlines. The left button is labeled "OK" and the right button is labeled "Cancel".

System and user-oriented error messages

System-oriented error message



User-oriented error message



Help system design

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

Help information

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

User documentation

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

Document types

λ Functional description

- Brief description of what the system can do

λ Introductory manual

- Presents an informal introduction to the system

λ System reference manual

- Describes all system facilities in detail

λ System installation manual

- Describes how to install the system

λ System administrator's manual

- Describes how to manage the system when it is in use

User interface evaluation

- λ Some evaluation of a user interface design should be carried out to assess its suitability
- λ Full scale evaluation is very expensive and impractical for most systems
- λ 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 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?

Simple evaluation techniques

- λ Questionnaires for user feedback
- λ Video recording of system use and subsequent tape evaluation.
- λ Instrumentation of code to collect information about facility use and user errors.
- λ The provision of a grip button for on-line user feedback.

Key points

λ Interface design should be user-centred. An interface should be logical and consistent and help users recover from errors

λ Interaction styles include direct manipulation, menu systems form fill-in, command languages and natural language

λ Graphical displays should be used to present trends and approximate values. Digital displays when precision is required

λ Colour should be used sparingly and consistently

Key points

- λ Systems should provide on-line help. This should include “help, I’m in trouble” and “help, I want information”
- λ Error messages should be positive rather than negative.
- λ A range of different types of user documents should be provided
- λ Ideally, a user interface should be evaluated against a usability specification

Big Data Visualization

- Big Data: Data that is of such volume, variety, and velocity (or the pace at which it is changing) that it puts an organization outside of its comfort zone to technically derive intelligence for effective decisions.
- Open Knowledge (<https://okfn.org>) Opendata
- <http://in.okfn.org/> (Open Knowledge India)

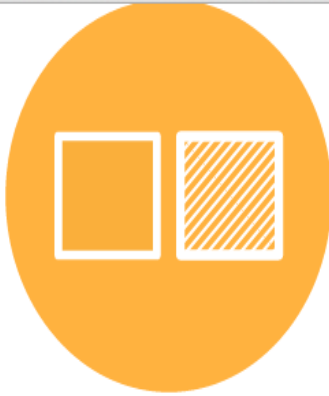
Benefits

- Improved decision-making
- Better ad-hoc data analysis
- Improved collaboration/ information sharing
- Provide self-service capabilities to end users
- Increased ROI
- Time savings
- Reduced burden on IT

Infographics

- **Infographics** are graphic visual representations of information, data or knowledge intended to present information quickly and clearly.
- They can improve cognition by utilizing graphics to enhance the human visual system's ability to see patterns and trends.
- <http://ebookfriendly.com/libraries-matter-library-infographics/>

Data Visualization Techniques



Comparisons



Proportions



Relationships



Hierarchy



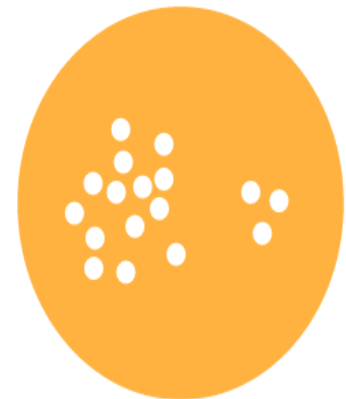
Concepts



Location



Part-to-a-whole



Distribution

Relationships



Arc Diagram



Bar Chart



Brainstorm



Bubble Chart



Chord Diagram



Line Graph



Marimekko Chart



Non-ribbon Chord Diagram



Radar Chart



Radial Bar Chart



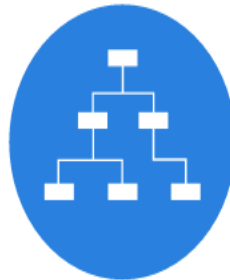
Scatterplot



Stacked Area Graph



Stacked Bar Graph



Tree Diagram



Venn Diagram

THE END