Design Principles of Human-Computer Interaction

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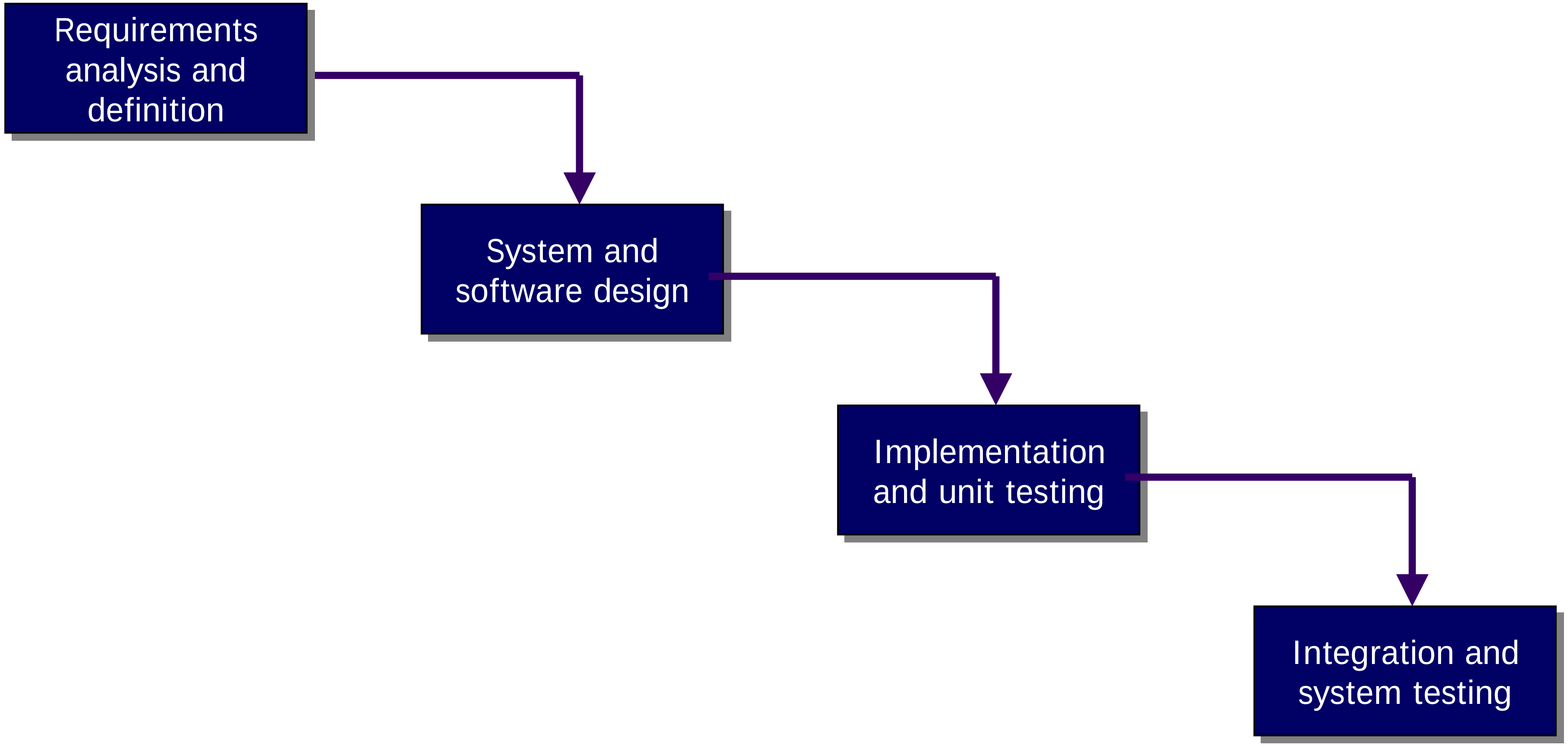
Outline

- Design process
  - What is design?
  - Traditional Waterfall Model vs. User-Centered Design
- Design principles, guidelines, rules and standards
  - Know the users and their tasks
  - Choose the right interaction model
  - Psychological principles of design
  - The eight golden rules of interface design
  - User interface guidelines
- Summary

What is Design?

- In general...
  - "Finding the right physical components of a physical structure."
  - "A goal-directed problem-solving activity."
  - "A creative activity – it involves bringing into being something new and useful that has not existed previously."
- Design is a *process*...
  - "Engineering design is the use of scientific principles, technical information and imagination in the definition of a mechanical structure, machine of system to perform pre-specified functions with the maximum economy and efficiency."

Design Process: The Waterfall Model


Requirements analysis and definition
System and software design
Implementation and unit testing
Integration and system testing

Problems with the Waterfall Model

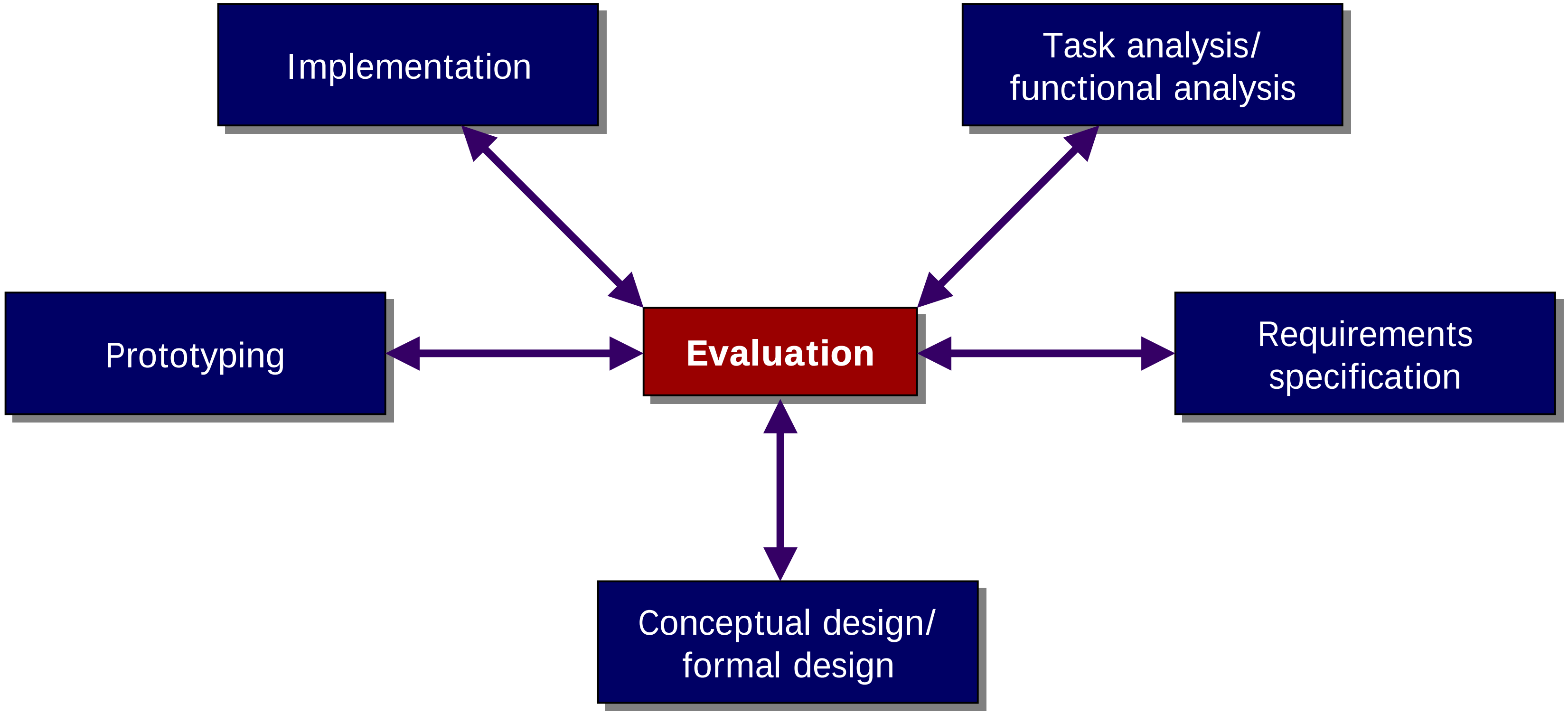
- Unrealistic: requirements are often incomplete and ambiguous.
- In practice, the stages overlap and there is feedback from a stage to the previous stage(s).
- The software process is not a simple linear model but involves a sequence of iterations of the development activities.
- Maintenance is an important stage, up to 60% of the total effort.
- Etc.

- Main problem: **not user-centered**
  - It is impossible to completely understand and express user requirements until a large amount of design has already been done.

Designing HCI

- HCI design model should:
  - be **user-centered** and involve users as much as possible so that they can influence the design,
  - **integrate** knowledge and expertise from the different disciplines that contribute to HCI design,
  - be highly **iterative** so that testing can be done to check that the design does indeed meet users’ requirements.

The Star Life Cycle


Implementation
Task analysis/ functional analysis
Prototyping
Evaluation
Requirements specification
Conceptual design/ formal design

User Centered Design

- External analysis
  - Know the users,
  - Know their tasks.

- Design and prototype
  - Design to fit the system to the users and their tasks.

- Evaluate and iterate
  - Evaluate the design,
  - Iterate until a good design is achieved.

Know the Users and their Tasks

- Know the users:
  - Novice and first time users,
  - Knowledgeable intermittent users,
  - Expert frequent users.
- Know their tasks:
  - Tasks: sequence of operations.
  - Should be determined before the design proceeds.
  - Design or implementation convenience should not dictate system functionality, features.

Choose the Interaction Style(s)

- Interaction styles:
  - Direct manipulation,
  - Menu selection,
  - Form fill-in,
  - Command language,
  - Natural language.

- When users and tasks are diverse, blend several interaction styles.

Interaction Styles, Cont.

Advantages	Disadvantages
Direct Manipulation	
Visually presents task concepts Allows easy learning, retention Allows errors to be avoided, encourages exploration Affords high subjective satisfaction	May be hard to program May require graphics display and pointing devices
Menu selection	
Shortens learning, reduces keystrokes Structures decision making Allows easy support of error handling	Presents danger of many menus May slow frequent users Consumes screen space, requires rapid display rate
Form fill-in	
Simplifies data entry, requires modest training Gives convenient assistance Permits use of form-management tools	Consumes screen space
Command language	
Is flexible, appeals to power users Supports user initiative Allows convenient creation of user-defined macros	Has poor error handling Requires substantial training and memorization
Natural language	
Relives burden of learning syntax	Requires clarification dialog May require more keystrokes, may not show context Is unpredictable

Design, Prototype, Evaluate

- Create a **design** using:
  - Principles of interaction,
  - Graphics design principles,
  - Following guidelines.
- Implement **prototype**s to:
  - Test the design,
  - Choose between alternatives,
  - Minimize the cost of experimentation.
- **Evaluate** the usability requirements:
  - Learnability,
  - Speed of performance,
  - Rate of errors by users,
  - Retention over time,
  - Subjective satisfaction.

Design Principles

- Sources of design principles:
  - Cognitive psychology,
  - Graphic design,
  - Designer’s knowledge and experience.
- Types of design support:
  - **Design principles**

    “High level” recommendations based on well established knowledge about human behaviour.
  - **Design standards**

    Generally stated requirements, imposed in some formal way.
  - **Design guidelines**

    Generally stated recommendations for user interface software,
    adopted by agreement among practitioners.
  - **Design rules**

    Explicit design specifications that do not require interpretation by design practitioners.

Norman's Seven Principles

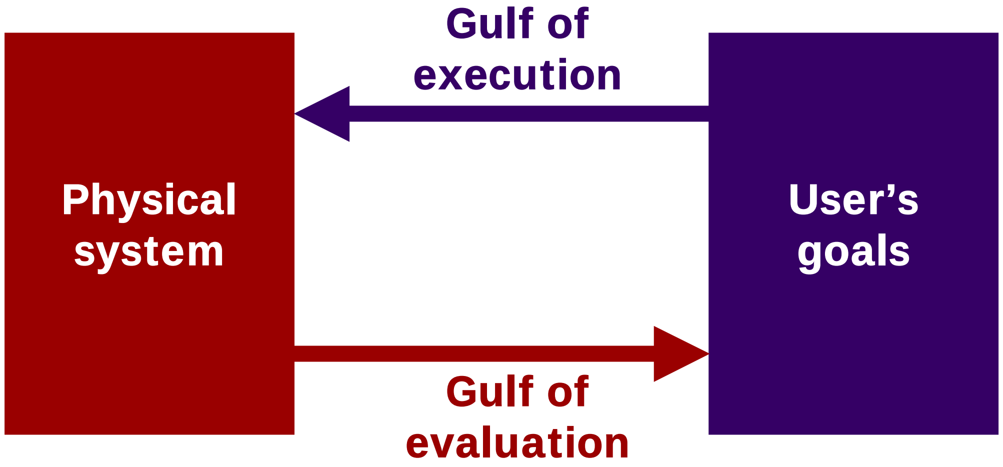
- "Seven principles for transforming difficult tasks into simple ones":
  1. Use both knowledge in the world and knowledge in the head.
  2. Simplify the structure of tasks.
  3. Make things visible.
  4. Get the mappings right.
  5. Exploit the power of constraints, both natural and artificial.
  6. Design for error.
  7. When all else fails, standardize.

3. Make Things Visible

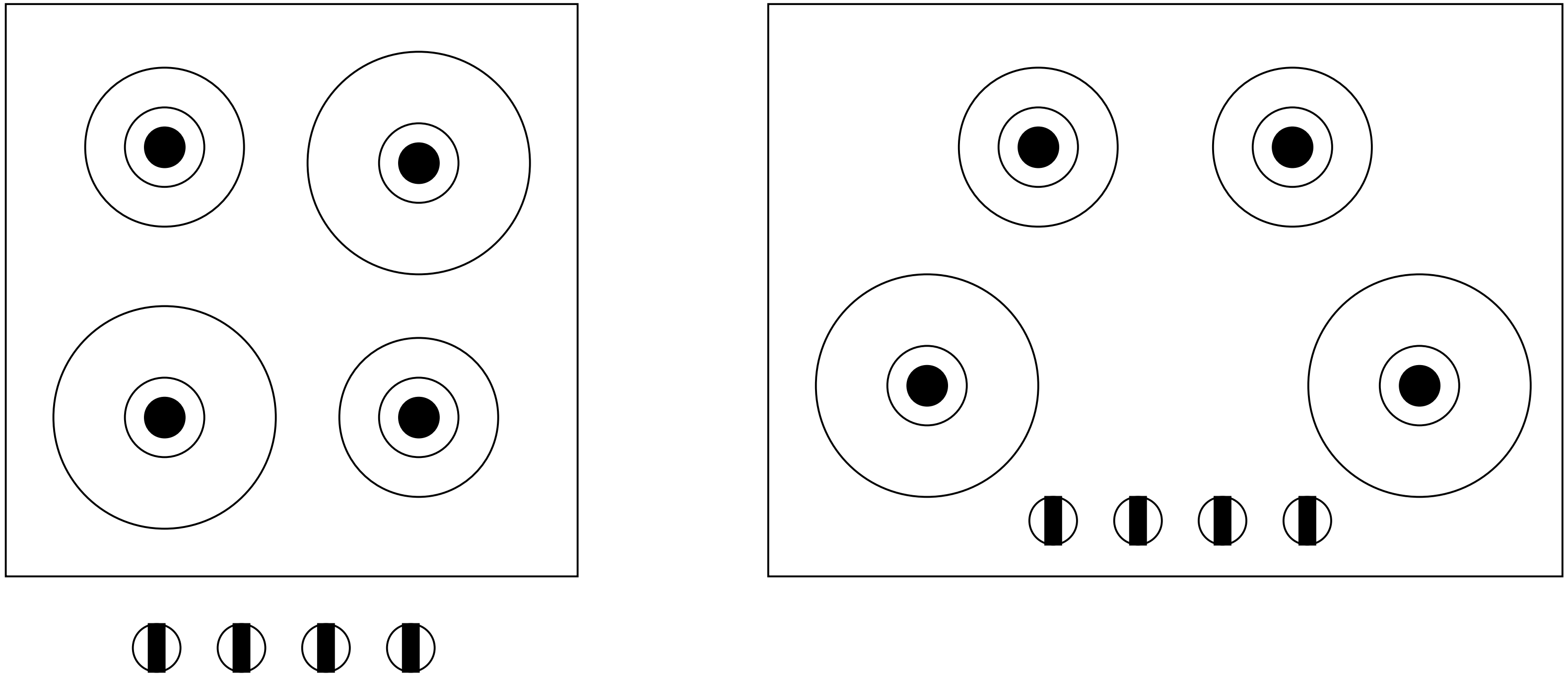
- **Gulf of execution:**
  the distance between the users goals and the means of achieving them through the system.

- **Gulf of evaluation:**
  the distance between the system’s behaviour and the user’s goals.

- **Bridge the gulfs** of execution and evaluation:
  reduce the discrepancy between the user’s goals and the system’s physical state and form.



4. Get the Mappings Right



Shneiderman’s Eight Golden Rules

- “Shneiderman’s eight golden rules of interface design”:

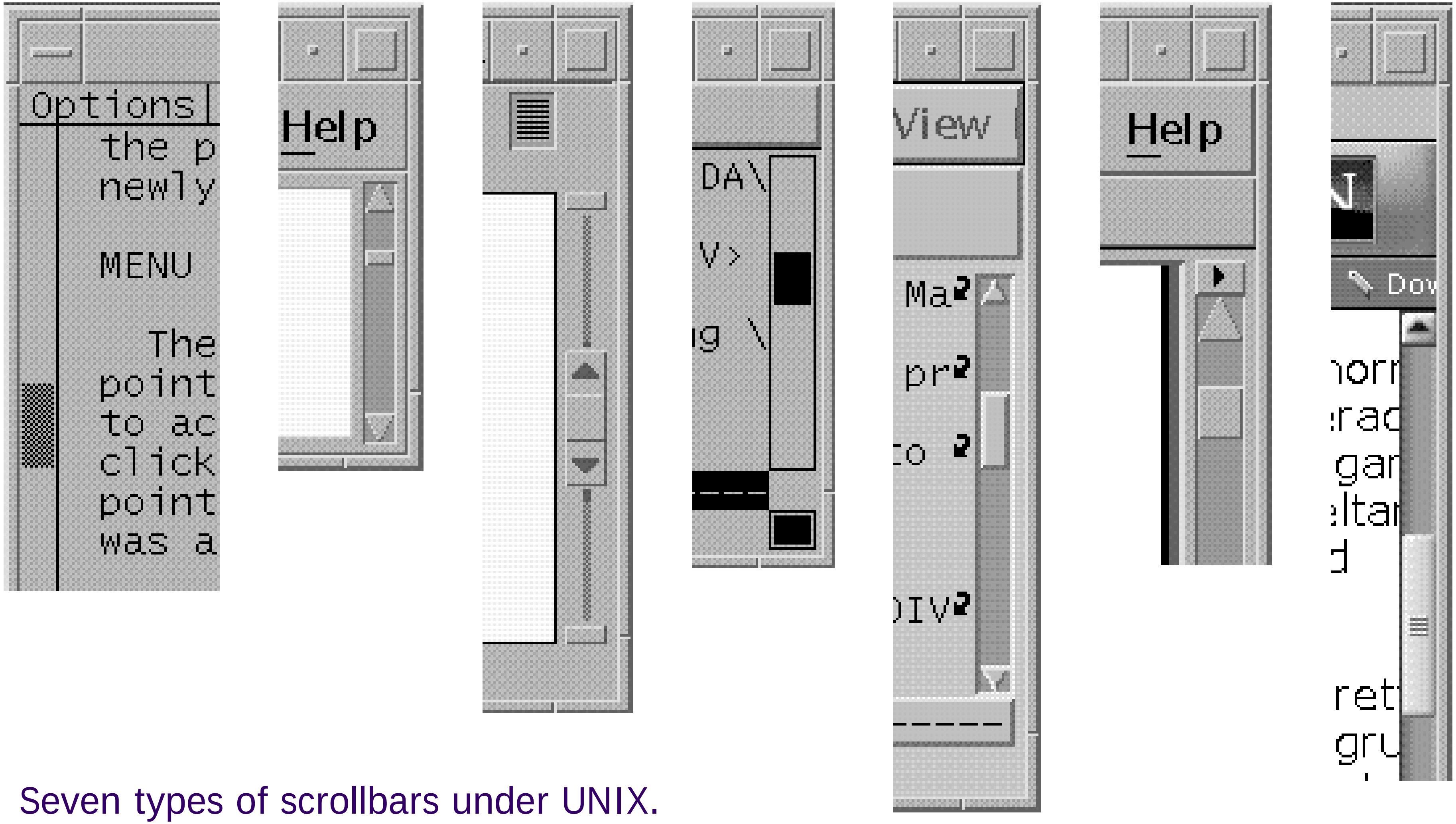
1. Strive for consistency.
2. Enable frequent users to use shortcuts.
3. Offer informative feedback.
4. Design dialogs to yield closure.
5. Offer error prevention and simple error handling.
6. Permit easy reversal of actions.
7. Support internal locus of control.
8. Reduce short-term memory load.

Consistency

- Frequently violated, difficult to follow.
- Many forms of consistency:
  - Consistent sequences of actions in similar situations.
  - Identical terminology across: prompts, menus, help screens.
  - Consistent color, layout, capitalization, fonts.

- Exceptions:
  - Echoing of passwords.
  - Confirmation of the delete command.

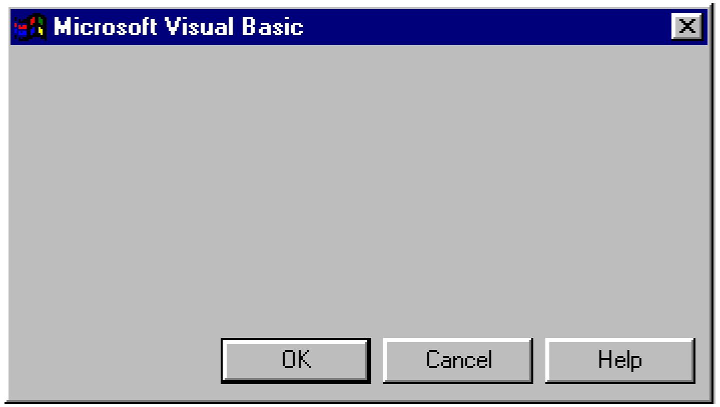
Consistency, Cont.

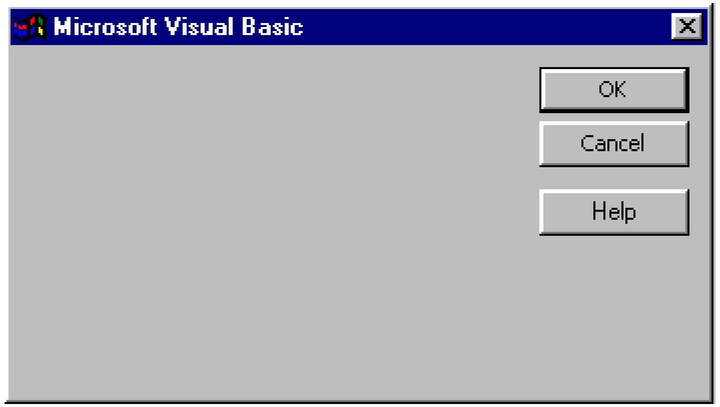


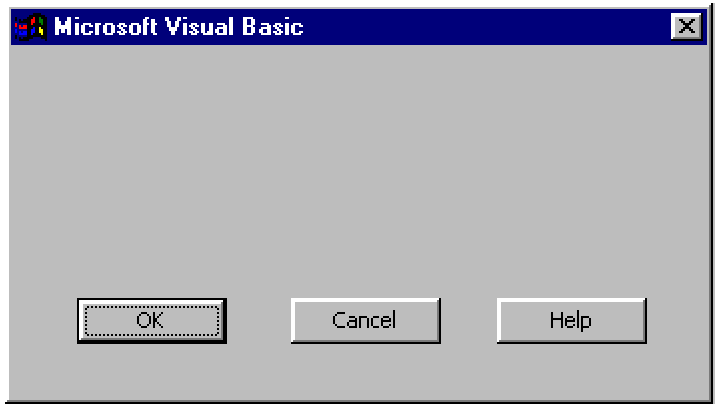
Seven types of scrollbars under UNIX.

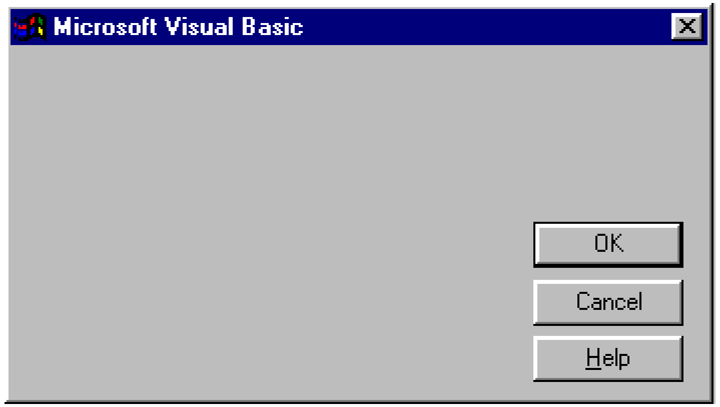
Consistency, Cont.

“consistency makes the interface familiar and predictable”,
The Windows User Interface Guidelines for Software Design, Microsoft Press



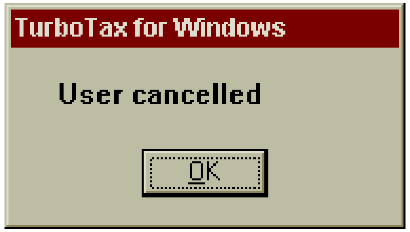






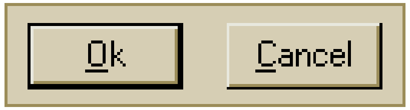
Consistency, Cont.

- Stupid consistency:
  - Cancel any function in Quicken's Turbo Tax, and the program will thoughtfully tell you that you cancelled the function.

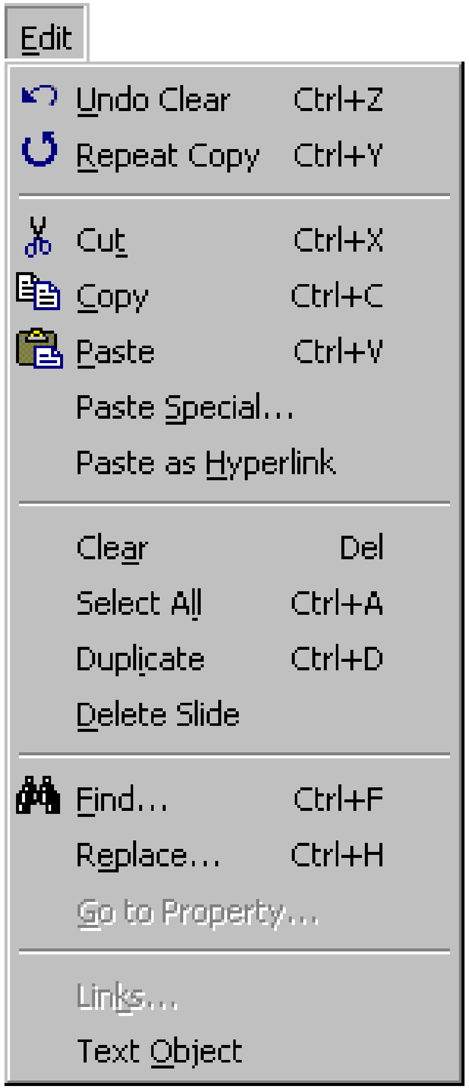


User cancelled

- GIFAnimator is “too consistent”:
  - Two controls in Windows applications do not have mnemonics assigned to them: the OK and Cancel buttons.
  - Both command buttons have built-in keyboard access.
  - Advantage: it frees up the characters to be used as mnemonics elsewhere in the application.



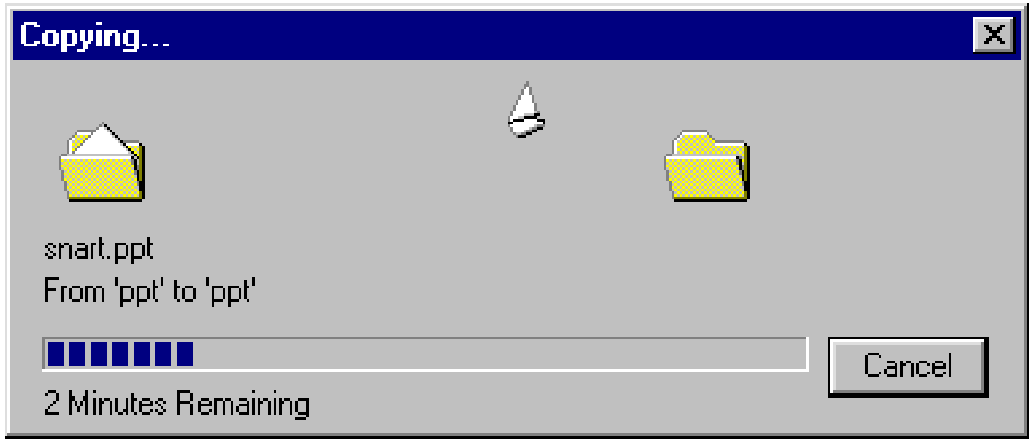
Shortcuts



- Enable frequent users to use shortcuts:
  - Abbreviations,
  - Special keys,
  - Hidden commands,
  - Macros,
  - Short response times,
  - Fast display rates.

Feedback

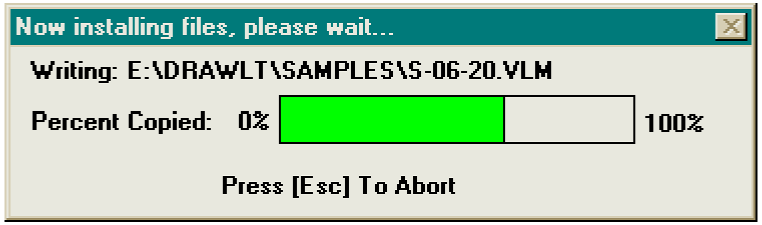
- Offer informative feedback:
  - For every user action, there should be system feedback.
  - For frequent and minor actions the response can be modest.
  - For infrequent and major actions the response should be more substantial.
  - Show changes on the visual represetation of the objects of interest.



snart.ppt
From 'ppt' to 'ppt'

2 Minutes Remaining

Feedback, Cont.



Now installing files, please wait...

Writing: E:\DRAWLT\SAMPLES\S-06-20.VLM

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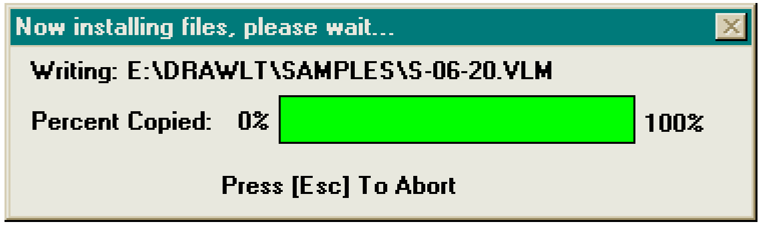
Press [Esc] To Abort



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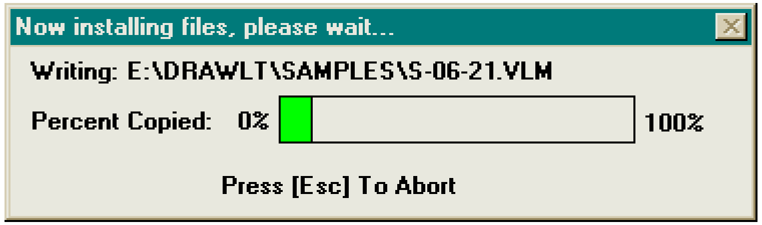

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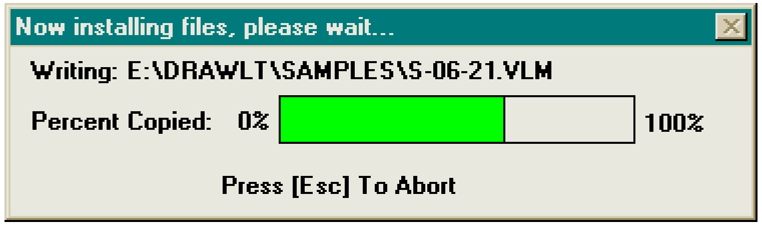

Now installing files, please wait...

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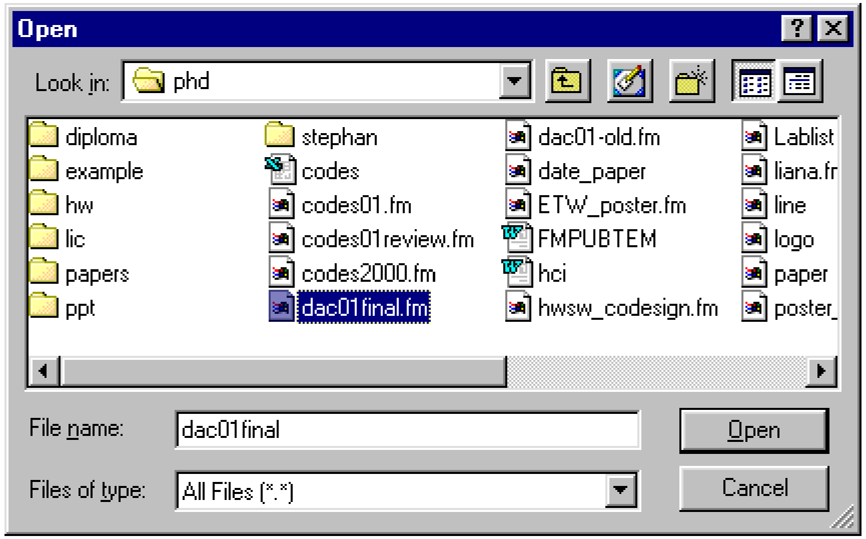
Press [Esc] To Abort

Design Dialogs to Yield Closure

- Dialogs should have:
  - beginning, select “File->Open”
  - middle, complete the dialog
  - end. press “Open”



File name: dac01final

Files of type: All Files (*.*)

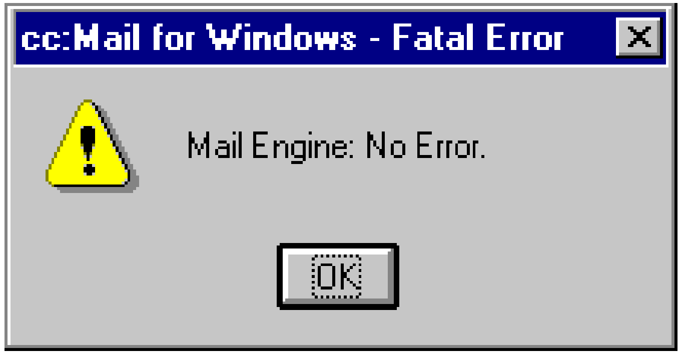
- The informative feedback at the competition of a group of actions:
  - gives operators the satisfaction of accomplishment,
  - a sense of relief,
  - the signal to drop contingency plans and options from their minds,
  - an indication that they can prepare for the next group of actions.

Error Prevention and Handling

- Error prevention:
  - Design the system so that users cannot make a serious error.
  - Use menu selection instead of form fill-in.
  - When using forms, do not allow alphabetic characters in numeric fields.
  - For command lines: correct matching pairs, complete sequences, etc.
- Error handling:
  - What happened?
  - Why did it happened?
  - How serious is it?
  - How can it be fixed?

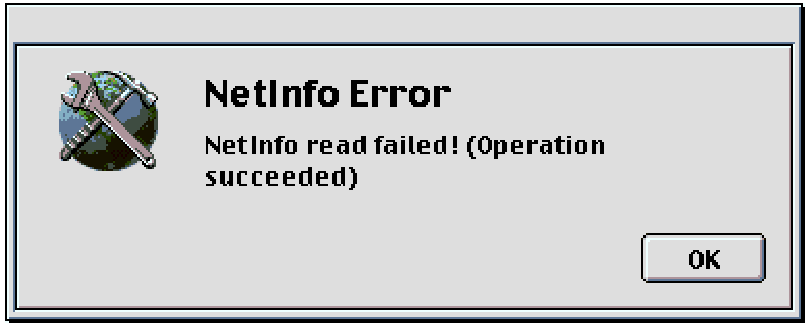
Error Messages

- **cc:Mail**
  When the user clicks on the OK button, cc:Mail terminates, which seems to indicate that having 'No Error' is a serious error in cc:Mail.


cc:Mail for Windows - Fatal Error

Mail Engine: No Error.

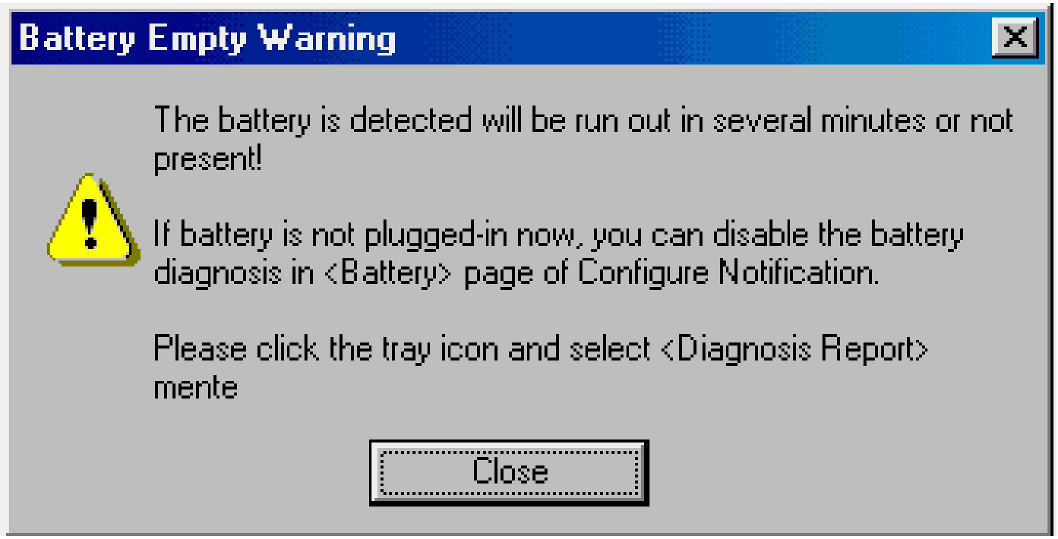
- **NetInfo**
  Messages warning of success are not restricted to the Windows operating system.


NetInfo Error

NetInfo read failed! (Operation succeeded)

Error Messages, Cont.

- MTC Diag, a power management application
  - What happened?
  - Why did it happened?
  - How serious is it?
  - How can it be fixed?

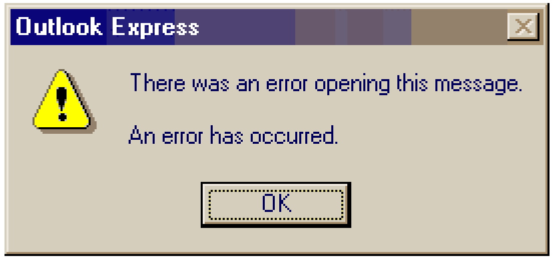


The battery is detected will be run out in several minutes or not present!

If battery is not plugged-in now, you can disable the battery diagnosis in <Battery> page of Configure Notification.

Please click the tray icon and select <Diagnosis Report> mente

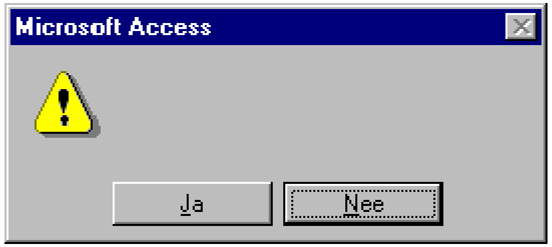
Error Messages, Cont.



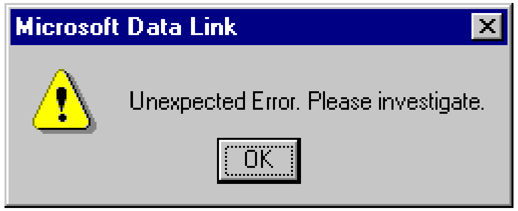
Outlook Express

There was an error opening this message.

An error has occurred.

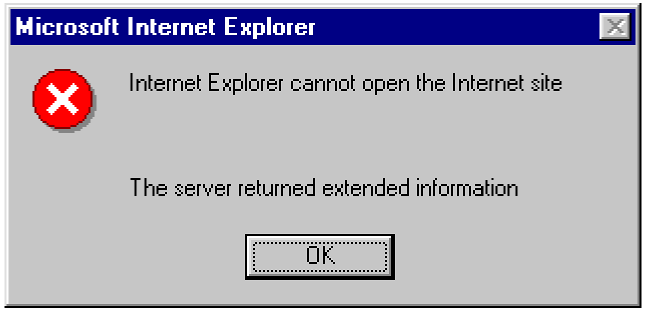


Microsoft Access



Microsoft Data Link

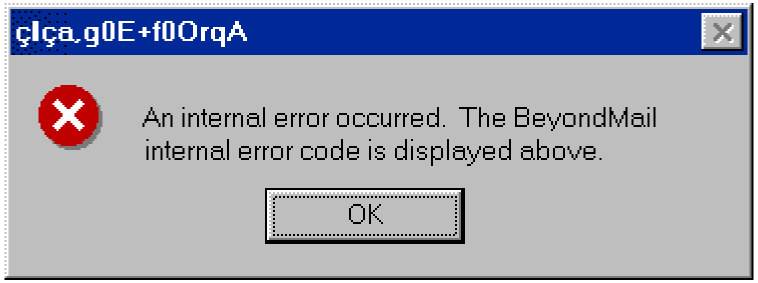
Unexpected Error. Please investigate.



Microsoft Internet Explorer

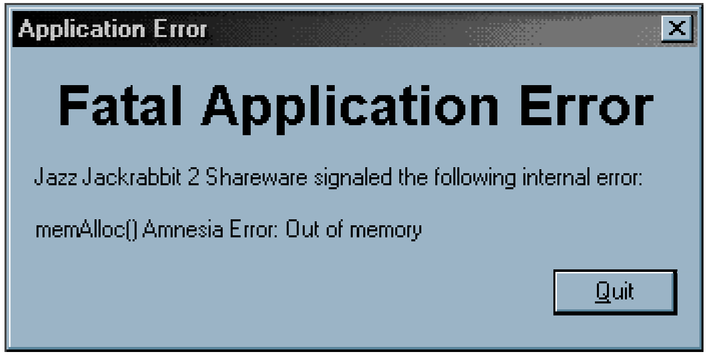
Internet Explorer cannot open the Internet site

The server returned extended information



çlça,g0E+f0OrqA

An internal error occurred. The BeyondMail internal error code is displayed above.

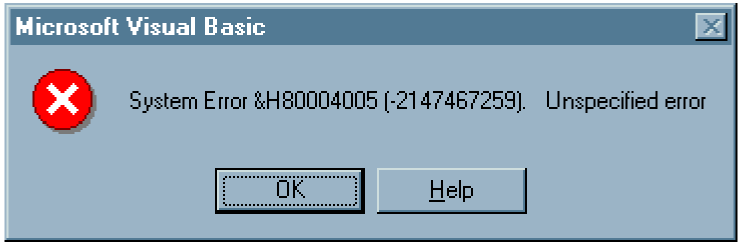


Application Error

Fatal Application Error

Jazz Jackrabbit 2 Shareware signaled the following internal error:

memAlloc() Amnesia Error: Out of memory

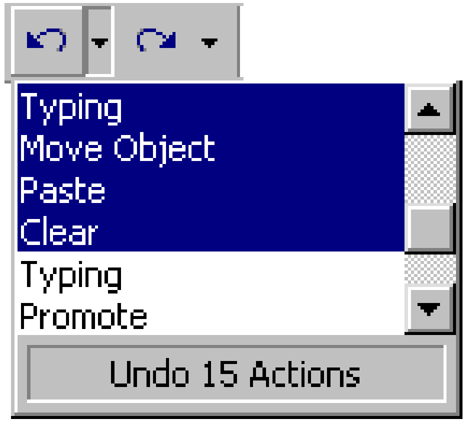


Microsoft Visual Basic

System Error &H80004005 (-2147467259). Unspecified error

Easy Reversal of Actions

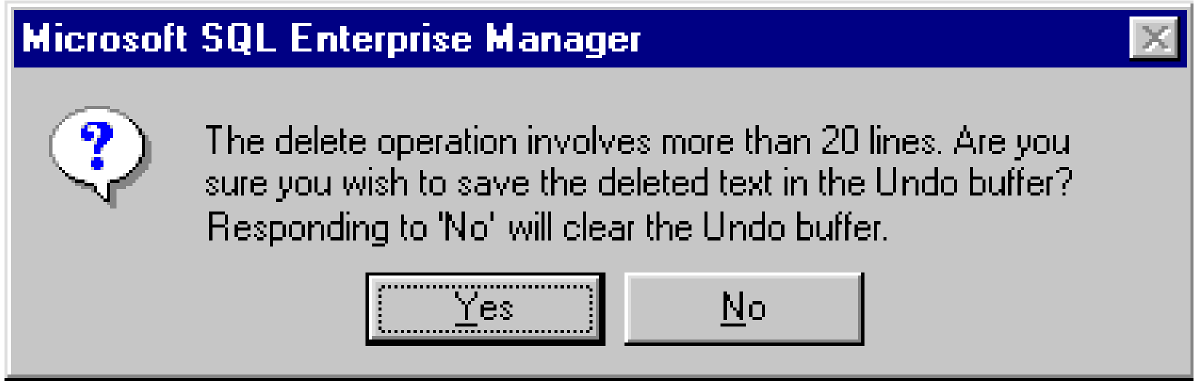
- Actions should be reversible:
  - Relieves anxiety.
  - Encourages exploration of unfamiliar options.
- Undo/Redo:
  - a single action,
  - a data-entry task,
  - complete group of actions, etc.



Typing
Move Object
Paste
Clear
Typing
Promote

Easy Reversal of Actions, Cont.

- Microsoft's SQL Server 6.5
  - If you select more than 20 lines of text from the query window, and then accidentally hit delete, you get this apparently helpful error message where you can hit "No" to avoid the delete.


Microsoft SQL Enterprise Manager

The delete operation involves more than 20 lines. Are you sure you wish to save the deleted text in the Undo buffer? Responding to 'No' will clear the Undo buffer.

  - However, hitting "No" actually causes the Delete operation to continue, but destroys the Undo buffer in the process, leaving no means of cancelling an accidental delete.

Locus of Control

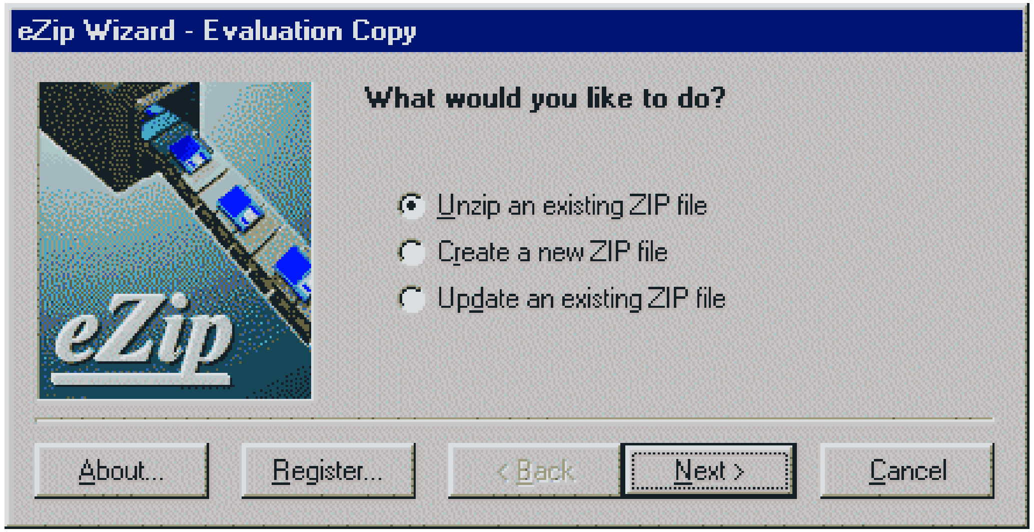
- Support internal locus of control:
  - Avoid *acausality*.
  - Users: *initiators* rather than the *responders* to actions.

- Problems:
  - Surprising system actions.
  - Tedious sequences of data entry.
  - Difficulty of obtaining necessary information.
  - Inability to produce the action desired.

Locus of Control, Cont.

- **eZip Wizard**

  Even the relatively simple process of adding or removing a file becomes an interrogation:
  What do you want to do?
  What options do you want?
  What name do you want to use? etc.



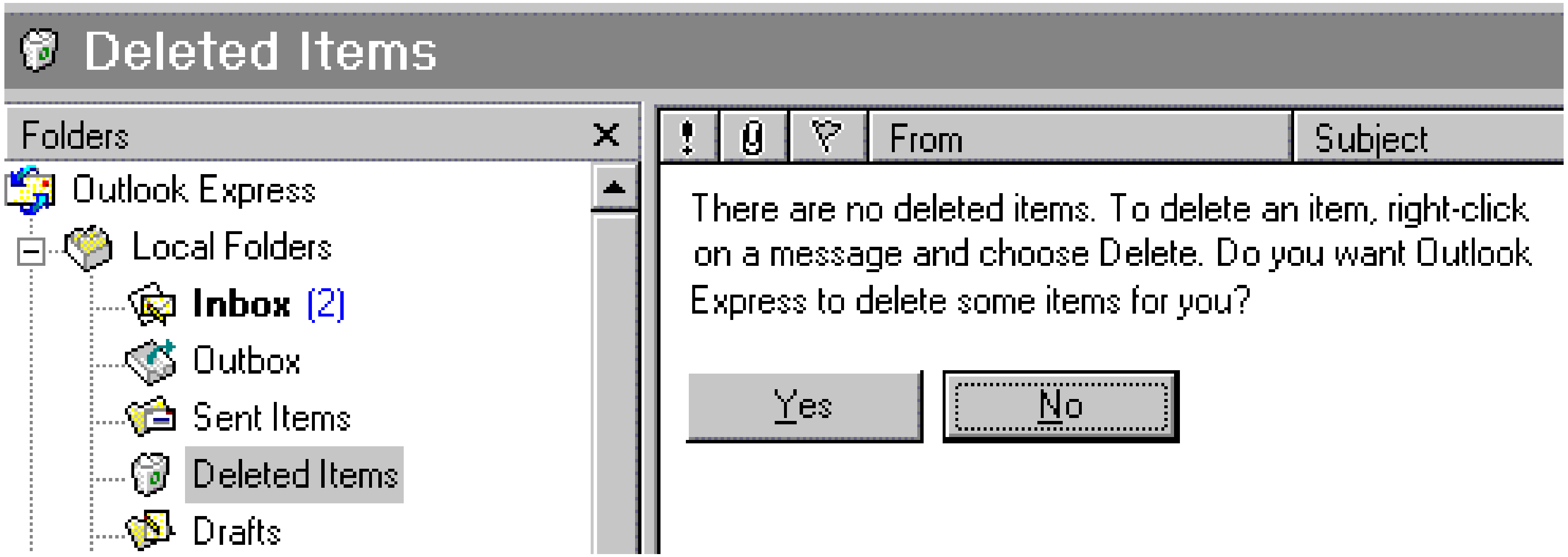
eZip Wizard - Evaluation Copy

What would you like to do?

● Unzip an existing ZIP file
○ Create a new ZIP file
○ Update an existing ZIP file

Locus of Control, Cont.

- **Microsoft Outlook Express 5.0**
  Why should somebody want Outlook to delete a randomly-selected piece of mail?



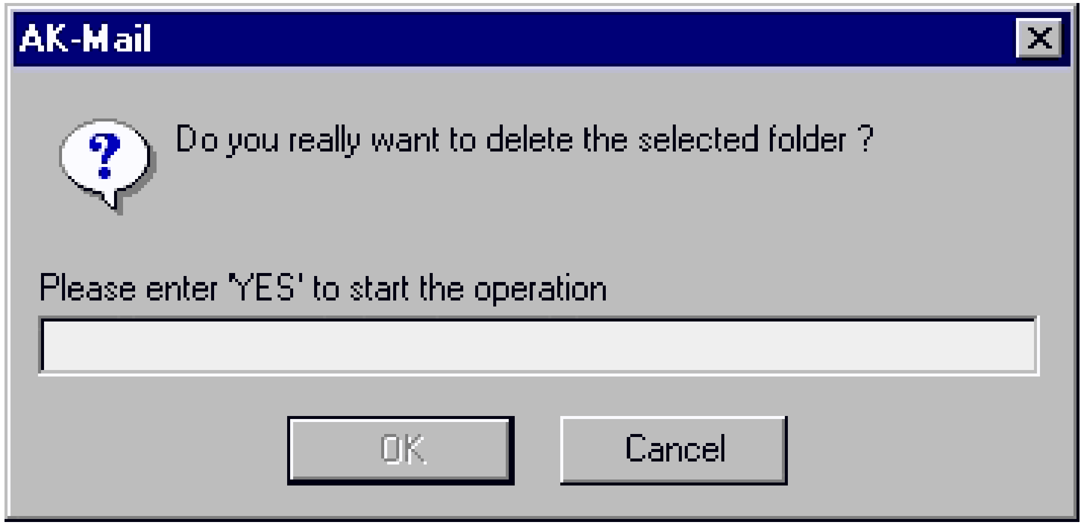
There are no deleted items. To delete an item, right-click on a message and choose Delete. Do you want Outlook Express to delete some items for you?

Locus of Control, Cont.

- **Ak-Mail**

  When the user attempts to delete a mail folder, the program requires the user to type the response "YES" into the text box

  ('Y' will not suffice; the OK button is disabled until all three letters are typed).



Do you really want to delete the selected folder ?

Please enter 'YES' to start the operation

Reduce Short-Term Memory Load

- Humans can **remember:**
  - "Seven-plus or minus-two chunks",
  - 1-2 things.

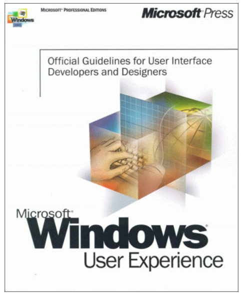
  } New stimuli push out old plans.

- Keep displays simple.
- Consolidate multiple page displays.
- Allow sufficient training.
- Online access to command-syntax forms, abbreviations, codes, etc.
- Don't make users note down codes:
  - If it has been already entered, the computer should know it.

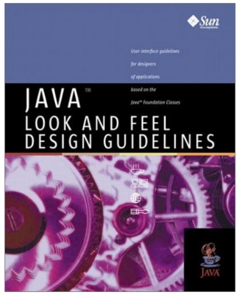
Nielsen's Heuristics

- Nielsen's ten usability heuristics:
  1. Visibility of system status.
  2. Match between system and the real world.
  3. User control and freedom.
  4. Consistency and standards.
  5. Error prevention.
  6. Recognition rather than recall.
  7. Flexibility and efficiency of use.
  8. Aesthetic and minimalist design.
  9. Help users recognize, diagnose, and recover from errors
  10. Help and documentation.

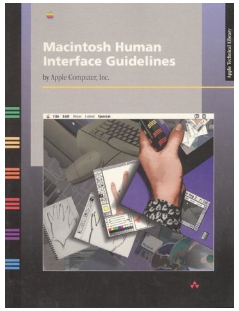
Guidelines


Microsoft Press
Official Guidelines for User Interface Developers and Designers
Microsoft Windows
User Experience

- **Microsoft Windows User Experience**
  http://msdn.microsoft.com/library/books/winguide/welcome.htm

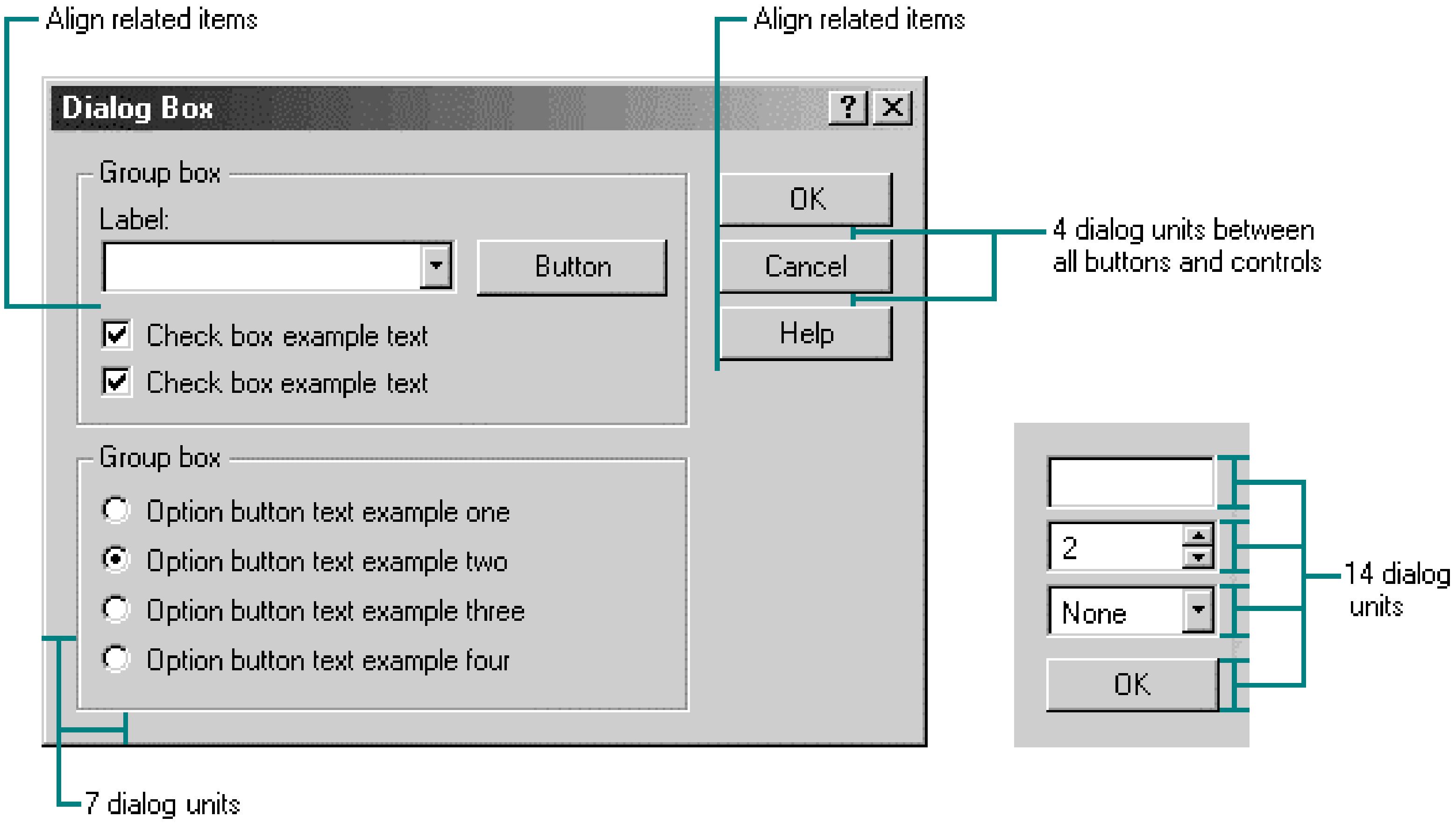


- **Java Look and Feel Design Guidelines**
  http://java.sun.com/products/jlf/dg/higtitle.alt.htm



- **Macintosh Human Interface Guidelines**
  http://www.devworld.apple.com/techpubs/mac/HIGuidelines/HIGuidelines-2.html

Guidelines, Cont.



☑ Check box example text

☑ Check box example text

○ Option button text example one

● Option button text example two

○ Option button text example three

○ Option button text example four

Align related items

Align related items

4 dialog units between all buttons and controls

14 dialog units

7 dialog units

Summary

- Design process
  - What is design?
  - Traditional Waterfall Model vs. User-Centered Design
- Design support
  - Users, tasks, interaction model
  - Norman’s seven principles
  - Shneiderman’s eight golden rules of interface design
  - Nielsen’s ten heuristics
  - User interface guidelines