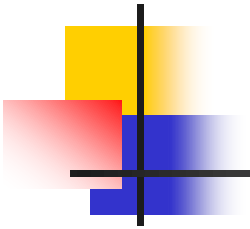


# GUI Design (cont.) and Coding

(Source)

**Dr. R. Mall**

# Important design considerations

- Be consistent in design:
  - users should be able to generalize knowledge about one part to another.
- Provide feedback
- Minimize error possibilities
- Provide error recovery opportunity

# Important design considerations

- Support multiple skill levels
- Minimize memorization
- Design based on metaphors
- Most common operations should be organized such that:
  - these are fastest to detect and use.

# Types of Widgets

- Different interface programming packages support different widget sets:
  - A surprising number of them contain similar kinds of widgets
  - we can think of a generic widget set which is applicable to most interfaces.

# Label Widget

- One of the simplest widgets.
- A label widget does nothing except to display a label (text):
  - it does not have any interaction capabilities
  - is not sensitive to mouse clicks.
- A label widget is often used as a part of other widgets.

# Container Widget

- Container widgets do not stand by themselves:
  - exist merely to contain other widgets.
  - other widgets are created as children of the container widget.
- When a container widget is moved or resized:
  - its children widgets also get moved or resized.

# Pop-up and pull-down menu

- Pop-up menus are transient and task specific.
- A pop-up menu appears when mouse button is pressed:
  - irrespective of the mouse position.
- Pull down menus are more permanent:
  - You have to move the cursor to a specific location and pull down this type of menu.

# Dialog boxes

- Dialog boxes help to select multiple elements from a selection list:
  - A dialog box remains visible until explicitly dismissed by the user.
  - A dialog box can include areas for entering text as well as values.
- If apply command is supported:
  - the effect of newly entered values can be tried out without dismissing the box.

# Dialog box Widget

- Most dialog boxes ask you to enter some information:
  - but some dialog boxes are merely informative,
  - alert you to some problem
    - or an error you have made.
  - Generally, these boxes ask you to read the information presented:
    - and then click OK to dismiss the box.

# Push button widget

- A push button contains some key word or picture:
  - describes the action it triggers.
- A push button usually acts immediately when you click the button:
  - unless it contains an ellipsis ....
  - A push button with an ellipsis indicates
    - another dialog box will appear.

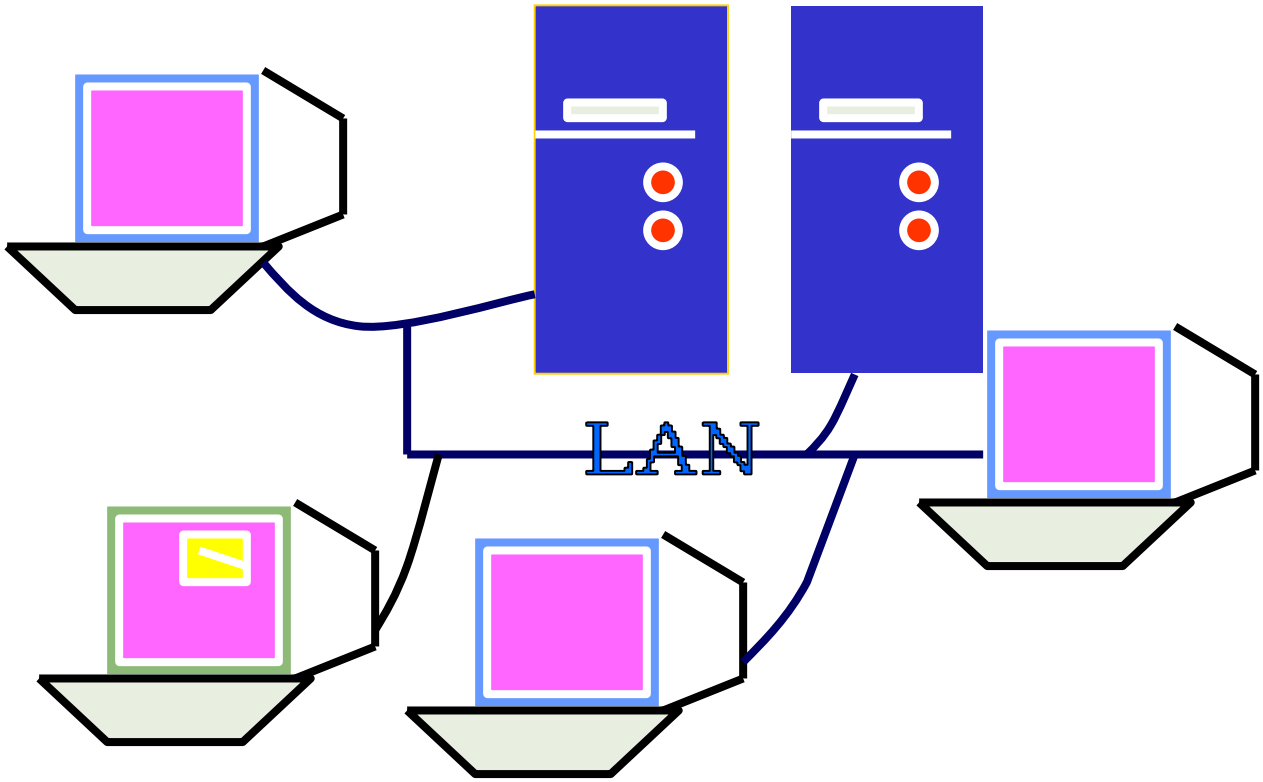
# Radio buttons

- Radio button:
  - a hollow circle followed by text.
- When a radio button is selected,
  - it appears filled and the previous selection from the group is unselected.
  - Only one radio button from a group can be selected at any time.

# An Overview of X-Window/MOTIF

- X-window system is extremely popular:
  - allows development of portable GUIs.
  - user interface is device-independent.
  - user interface is network independent
  - can display on a terminal connected anywhere on the network.

# Network Independent GUI



# An Overview of X-Window/MOTIF

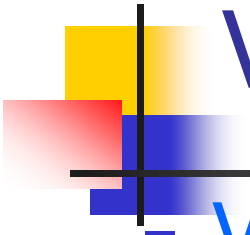
- X-window system is based on client-server model of computation.
- X-window system was developed at MIT (Massachusetts Institute of Technology)
  - with support from DEC (Digital Equipment Corporation).
- X-window system contains low level functions written in C language:
  - can be called from application programs.

# An Overview of X-Window/MOTIF

- Very few interface developers write programs:
  - directly using the X-windows library routines.
  - use higher level functions available in Xtoolkit:
    - Built on top of X-windows

# Motif

- Xtoolkit consists of:
  - a set of basic widgets
  - routines to stitch the widgets together into an interface.
- One of the most widely used widget sets is OSF/Motif.



# Visual BASIC and Visual C++

- Visual languages recognize user interface as an important program component.
- Visual BASIC and Visual C++ provide tools for building:
  - programs with window-based user interfaces.
  - Windows 3.X, Windows 95, and Windows NT environments.

# Visual BASIC and Visual C++

- In visual BASIC and Visual C++:
  - you design widgets such as menu bars, icons, and dialog boxes, etc. from a given choice list
  - then add them to your program
  - These objects are called resources.
- You can design:
  - shape, location, type, and size of dialog boxes
  - before writing any C++ or BASIC code for the application.

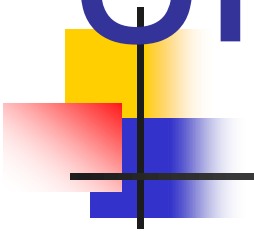
# Coding Phase

- Coding is undertaken once design phase is complete.
- During coding phase:
  - every module identified in the design document is coded and unit tested.
- Unit testing (aka module testing):
  - testing of different modules (aka units) of a system in isolation.

# Unit Testing

- Many beginners ask:
  - Why test each module in isolation first?
  - then integrate the modules and again test the set of modules?
  - why not just test the integrated set of modules once thoroughly?

# Unit Testing



- It is a good idea to test modules in isolation before they are integrated:
  - it makes debugging easier.

# Unit Testing

- If an error is detected when several modules are being tested together,
  - it would be difficult to determine which module has the error.
- Another reason:
  - the modules with which this module needs to interface may not be ready.

# Integration Testing

- After all modules of a system have been coded and unit tested:
  - integration of modules is done
    - according to an integration plan.

# Integration Testing

- The full product takes shape:
  - only after all the modules have been integrated.
- Modules are integrated together according to an integration plan:
  - involves integration of the modules through a number of steps.

# Integration Testing

- During each integration step,
  - a number of modules are added to the partially integrated system
    - and the system is tested.
- Once all modules have been integrated and tested,
  - system testing can start.

# System Testing

- During system testing:
  - the fully integrated system is tested against the requirements recorded in the SRS document.

# Coding

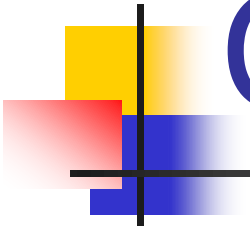
- The input to the coding phase is the design document.
- During coding phase:
  - modules identified in the design document are coded according to the module specifications.

# Coding

- At the end of the design phase we have:
  - module structure (e.g. structure chart) of the system
  - module specifications:
    - data structures and algorithms for each module.
- Objective of coding phase:
  - transform design into code
  - unit test the code.

# Coding Standards

- Good software development organizations require their programmers to:
  - adhere to some standard style of coding
  - called coding standards.



# Coding Standards

- Many software development organizations:
  - formulate their own coding standards that suits them most,
  - require their engineers to follow these standards rigorously.

# Coding Standards

- Advantage of adhering to a standard style of coding:
  - it gives a uniform appearance to the codes written by different engineers,
  - it enhances code understanding,
  - encourages good programming practices.

# Coding Standards

- A coding standard
  - sets out standard ways of doing several things:
    - the way variables are named,
    - code is laid out,
    - maximum number of source lines allowed per function, etc.

# Coding guidelines

- Provide general suggestions regarding coding style to be followed:
  - leave actual implementation of the guidelines:
    - to the discretion of the individual engineers.

# Code inspection and code walk throughs

- After a module has been coded,
  - code inspection and code walk through are carried out
  - ensures that coding standards are followed
  - helps detect as many errors as possible before testing.

# Code inspection and code walk throughs

- Detect as many errors as possible during inspection and walkthrough:
  - detected errors require less effort for correction
    - much higher effort needed if errors were to be detected during integration or system testing.

# Coding Standards and Guidelines

- Good organizations usually develop their own coding standards and guidelines:
  - depending on what best suits their organization.
- We will discuss some representative coding standards and guidelines.

# Representative Coding Standards

- Rules for limiting the use of globals:
  - what types of data can be declared global and what can not.
- Naming conventions for
  - global variables,
  - local variables, and
  - constant identifiers.

# Representative Coding Standards

- Contents of headers for different modules:
  - The headers of different modules should be standard for an organization.
  - The exact format for header information is usually specified.

# Representative Coding Standards

- Header data:
  - Name of the module,
  - date on which the module was created,
  - author's name,
  - modification history,
  - synopsis of the module,
  - different functions supported, along with their input/output parameters,
  - global variables accessed/modified by the module.

# Representative Coding Standards

- Error return conventions and exception handling mechanisms.
  - the way error and exception conditions are handled should be standard within an organization.
  - For example, when different functions encounter error conditions
    - should either return a  0 or 1 consistently.

# Representative Coding Guidelines

- Do not use too clever and difficult to understand coding style.
  - Code should be easy to understand.
- Many inexperienced engineers actually take pride:
  - in writing cryptic and incomprehensible code.

# Representative Coding Guidelines

- Clever coding can obscure meaning of the code:
  - hampers understanding.
  - makes later maintenance difficult.
- Avoid obscure side effects.

# Representative Coding Guidelines

- The side effects of a function call include:
  - modification of parameters passed by reference,
  - modification of global variables,
  - I/O operations.
- An obscure side effect:
  - one that is not obvious from a casual examination of the code.

# Representative Coding Guidelines

- Obscure side effects make it difficult to understand a piece of code.
- For example,
  - if a global variable is changed obscurely in a called module,
  - it becomes difficult for anybody trying to understand the code.

# Representative Coding Guidelines

- Do not use an identifier (variable name) for multiple purposes.
  - Programmers often use the same identifier for multiple purposes.
  - For example, some programmers use a temporary loop variable
    - also for storing the final result.

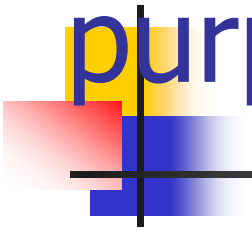
# Example use of a variable for multiple purposes

- for(i=1;i<100;i++)
  {.....}
  i=2*p*q;
  return(i);

# Use of a variable for multiple purposes

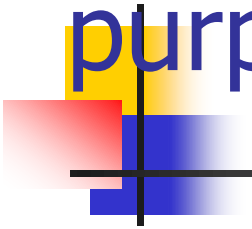
- The rationale given by programmers for such use:
  - memory efficiency:
  - e.g. three variables use up three memory locations,
  - whereas the same variable used in three different ways uses just one memory location.

# Use of a variable for multiple purposes



- There are several things wrong with this approach:
  - hence should be avoided.
- Each variable should be given a name indicating its purpose:
  - This is not possible if an identifier is used for multiple purposes.

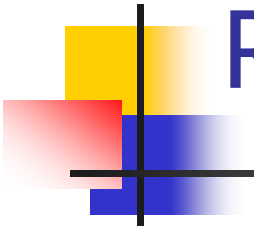
# Use of a variable for multiple purposes



- Leads to confusion and annoyance
  - for anybody trying to understand the code.
  - Also makes future maintenance difficult.

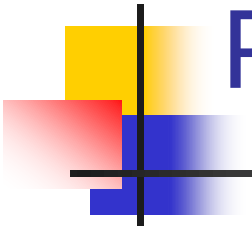
# Representative Coding Guidelines

- Code should be well-documented.
- Rules of thumb:
  - on the average there must be at least one comment line
    - for every three source lines.
  - The length of any function should not exceed 10 source lines.



# Representative Coding Guidelines

- Lengthy functions:
  - usually very difficult to understand
  - probably do too many different things.

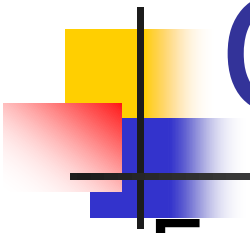


# Representative Coding Guidelines

- Do not use goto statements.
- Use of goto statements:
  - make a program unstructured
  - make it very difficult to understand.

# Code Walk Through

- An informal code analysis technique.
  - undertaken after the coding of a module is complete.
- A few members of the development team select some test cases:
  - simulate execution of the code by hand using these test cases.



# Code Walk Through

- Even though an informal technique:
  - several guidelines have evolved over the years
  - making this naive but useful analysis technique more effective.
  - These guidelines are based on
    - personal experience, common sense, and several subjective factors.

# Code Walk Through

- The guidelines should be considered as examples:
  - rather than accepted as rules to be applied dogmatically.
- The team performing code walk through should not be either too big or too small.
  - Ideally, it should consist of between three to seven members.

# Code Walk Through

- Discussion should focus on discovery of errors:
  - and not on how to fix the discovered errors.
- To foster cooperation:
  - avoid the feeling among engineers that they are being evaluated in the code walk through meeting,
  - managers should not attend the walk through meetings.

# Code Inspection

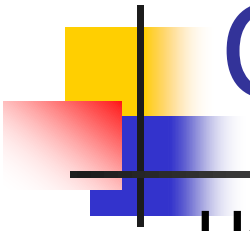
- In contrast to code walk throughs,
  - code inspection aims mainly at discovery of commonly made errors.
- During code inspection:
  - the code is examined for the presence of certain kinds of errors,
  - in contrast to the hand simulation of code execution done in code walk throughs.

# Code Inspection

- For instance, consider:
  - classical error of writing a procedure that modifies a formal parameter
  - while the calling routine calls the procedure with a constant actual parameter.
- It is more likely that such an error will be discovered:
  - by looking for this kind of mistakes in the code,
  - rather than by simply hand simulating execution of the procedure.

# Code Inspection

- Good software development companies:
  - collect statistics of errors committed by their engineers
  - identify the types of errors most frequently committed.
- A list of common errors:
  - can be used during code inspection to look out for possible errors.



# Commonly made errors

- Use of uninitialized variables.
- Nonterminating loops.
- Array indices out of bounds.
- Incompatible assignments.
- Improper storage allocation and deallocation.
- Actual and formal parameter mismatch in procedure calls.
- Jumps into loops.

# Code Inspection

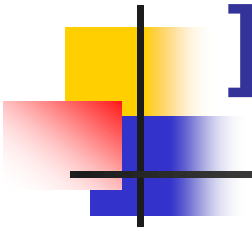
- Use of incorrect logical operators
  - or incorrect precedence among operators.
- Improper modification of loop variables.
- Comparison of equality of floating point values, etc.
- Also during code inspection,
  - adherence to coding standards is checked.

# Software Documentation

- When developing a software product we develop various kinds of documents :
  - In addition to executable files and the source code:
  - users' manual,
  - software requirements specification (SRS) document,
  - design document, test document,
  - installation manual, etc.
- All these documents are a vital part of good software development practice.

# Software Documentation

- Good documents enhance understandability and maintainability of a software product.
- Different types of software documents can be classified into:
  - internal documentation,
  - external documentation (supporting documents).



# Internal Documentation

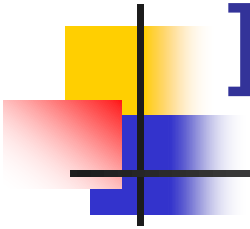
- Internal documentation:
  - documentation provided in the source code itself.
- External documentation:
  - documentation other than those present in the source code.

# Internal Documentation

- Internal documentation provided through:
  - use of meaningful variable names,
  - code indentation,
  - code structuring,
  - use of enumerated types and constant identifiers,
  - use of user-defined data types, etc.
  - module headers and comments

# Internal Documentation

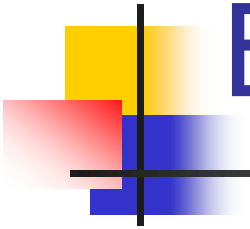
- Good software development organizations:
  - ensure good internal documentation
  - through coding standards and coding guidelines.
- Example of unhelpful documentation:
  - a = 10;  /* a made 10 */



# Internal Documentation

- Careful experimentation suggests:
  - meaningful variable names is the most useful internal documentation.

# External Documentation



- Users' manual,
- Software requirements specification document,
- Design document,
- Test documents,
- Installation instructions, etc.

# External Documentation

- A systematic software development style ensures:
  - all external documents are produced in an orderly fashion.
- An important feature of good documentation is consistency.

# External Documentation

- Unless all documents are consistent with each other,
  - a lot of confusion is created for somebody trying to understand the product.
- All the documents for a product should be up-to-date:
  - Even  a few out-of-date documents can create severe confusion.

# Textual Documents

- Readability is an important attribute of textual documents.
- Readability determines understandability
  - hence determines maintainability.
- A well-known readability measure of text documents:
  - Gunning's Fog Index.

# Gunning's Fog Index

$$F = 0.4 \left( \frac{\text{Number of Words}}{\text{Number of Sentences}} + \text{Percentage of words of 3 or more syllables} \right)$$

- F corresponds to the number of years of schooling to easily understand the document.

# Gunning's Fog Index

- A document is easy to understand if:
  - all sentences are small
    - use only 4 to 5 words each
  - small number of characters used per word:
    - normally not exceeding five or six characters.

# Summary

- Widgets are the building blocks of user interface design.
- To develop a modern GUI:
  - put together the widgets you require
  - stitch them together.
  - makes user interface development easy.

# Summary

- We discussed some standard widgets:
  - pull down menus
  - pop up menus
  - labels
  - dialog boxes
  - radio buttons
  - push buttons
  - containers

# Summary

- Coding standards:
  - enforce good coding practice
- Coding guidelines:
  - suggestions to programmers
  - exact implementation depends on discretion of the programmers.

# Summary

- It is necessary to adequately document a software product:
  - Helps in understanding the product
  - Helps in maintenance

# Summary

- Documentation
  - Internal
  - External
- Internal documentation
  - provided in the source code itself.
- Comprehensibility of text documents:
  - mesured using Gunning's Fog index.