# Visual C++ Programming Workshop

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## Workshop Information

- Office: EB-N6
- Phone: 777-4365
- Office Hours:
  - Tue 1-3 p.m., Thur 10-11:30 a.m.
  - By appointment
- Email: reckert@binghamton.edu
- http://www.cs.binghamton.edu/~reckert/
  - “VC++ Programming Workshop” link for syllabus, notes, programs, assignments, etc.

## User Interfaces

- Connection between the computer and the user
- Two types:
  - Command Line
  - GUI--Graphical (Visual)

## Command Line Interfaces

- User types commands ==> must remember
- Results Scroll by
- Text-based
- “Interactive” but hard to use
- Flow of info: keyboard --> program--> Display
- No direct interaction between user and screen

## Visual (Graphical) Interfaces

- Show Graphical Objects (images, icons, buttons, scroll bars) on screen
- User interacts using pointing device
  - Direct, intuitive, intimate interaction
- Objects can be dragged, buttons pushed, etc....
- Better way of using screen space
  - Panes can overlap
  - Underlying panes can be brought to forefront
  - Desktop metaphor (like papers on a desk)
    - Well, not exactly!

## Graphical Interfaces, Continued

- Use graphics to organize user workspace
- Present user intuitive ways of accomplishing tasks
  - e.g., copy files by dragging
- Environment allows many tasks to be performed simultaneously
  - Different tasks share screen space
- Visually rich way of conveying information
- WYSIWYG display of documents

## Main Feature of GUIs:

- THE WINDOW
  - Rectangular area of screen onto which a program draws text and graphics.
  - User interacts with program using pointer device to select objects inside.
  - Some window components:
    - border, title bar, client area, menu bar, scroll bars, max/min/close buttons, tool bars, etc.

## Brief History of GUIs

- 1968, ARPA-funded Stanford Research Center (Doug Englebart)
- first windows (screen sliced up into overlapping panes)
- only textual info
- underlying windows can be popped to the top
- selection done with light pen
- invented the mouse

## Xerox PARC--Alto Computer

- 1970
- First GUI
- Cursor tracked position of mouse
- WYSIWYG
- Windows with precise text
- Displayed more than just text
- First interactive painting program

## Recent History (PCs)

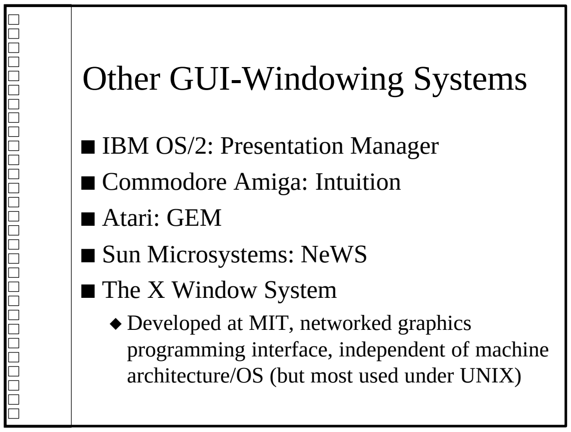
- 1983, Apple Lisa (failure)
- 1984 Apple Macintosh--standard for GUIs
- 1985 Microsoft releases Windows 1.0
  - Difficult to program
  - Prone to crashing
  - Needed hardware not yet available
- 1987 Windows 2.0 (still real mode only)
- 1988 Windows/386 (Virtual 86 mode on 386==>multiple DOS sessions in windows)

## Recent History (Microsoft)

- 1990 Windows 3.0
  - 80x86 protected mode, up to 16Meg memory, cooperative multitasking
- 1992 Windows 3.1, Windows for Workgroups 3.11
  - TrueType fonts, multimedia, protected mode only; Networking
- 1993 Windows NT
  - 32-bit flat memory space, 16 MB, thread-based pre-emptive multitasking, separate from DOS, multi-platform, networking, secure)

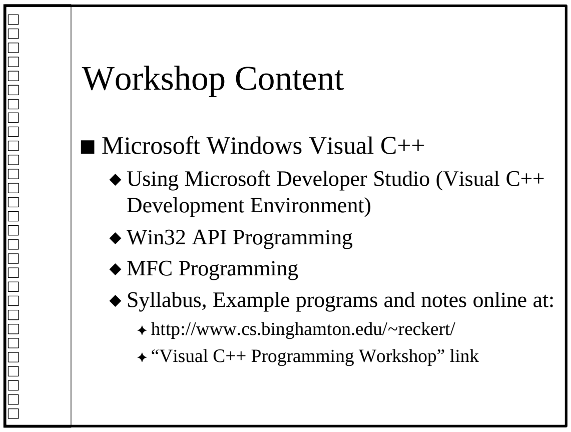
## Recent History (Microsoft)

- 1995 Windows 95
  - Runs on 4 Meg, long file names, plug and play, new controls, new desktop/window style
  - Hybrid 16/32 bit OS, depends on DOS, lacks security of NT, no portability to RISC
- 1998 Windows 98
  - Web-like interface, legal issues



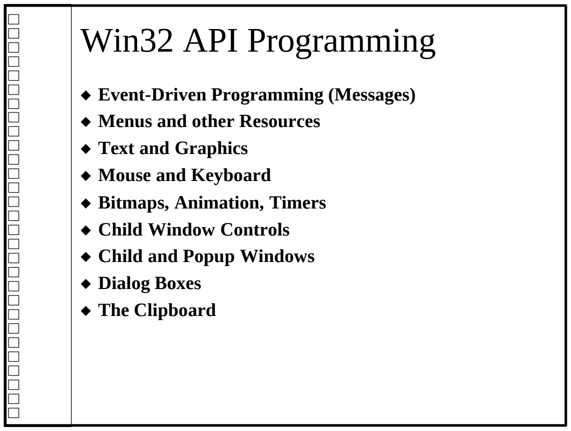
## Other GUI-Windowing Systems

- IBM OS/2: Presentation Manager
- Commodore Amiga: Intuition
- Atari: GEM
- Sun Microsystems: NeWS
- The X Window System
  - Developed at MIT, networked graphics programming interface, independent of machine architecture/OS (but most used under UNIX)



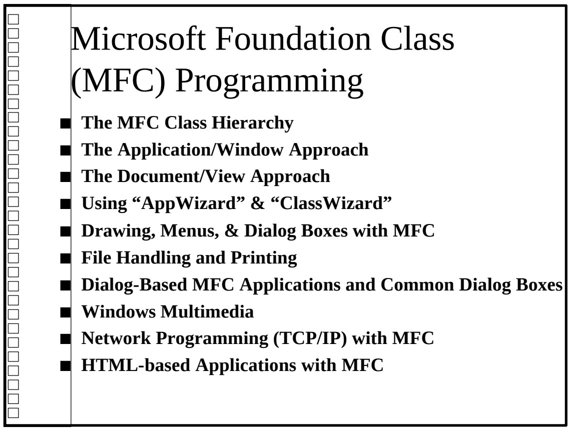
## Workshop Content

- Microsoft Windows Visual C++
  - Using Microsoft Developer Studio (Visual C++ Development Environment)
  - Win32 API Programming
  - MFC Programming
  - Syllabus, Example programs and notes online at:
    - http://www.cs.binghamton.edu/~reckert/
    - “Visual C++ Programming Workshop” link



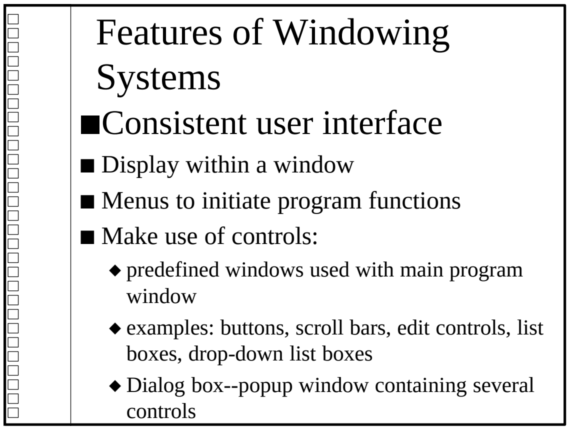
## Win32 API Programming

- **Event-Driven Programming (Messages)**
- **Menus and other Resources**
- **Text and Graphics**
- **Mouse and Keyboard**
- **Bitmaps, Animation, Timers**
- **Child Window Controls**
- **Child and Popup Windows**
- **Dialog Boxes**
- **The Clipboard**



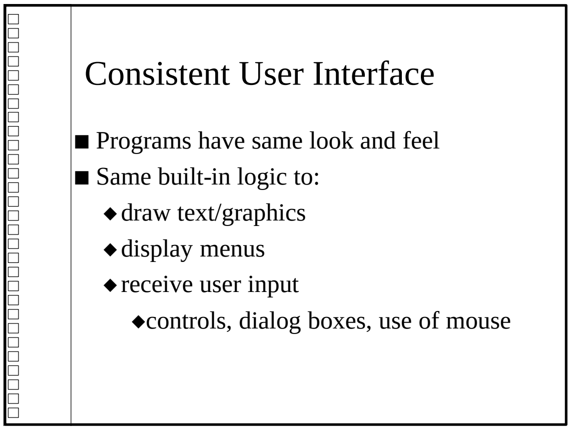
## Microsoft Foundation Class (MFC) Programming

- **The MFC Class Hierarchy**
- **The Application/Window Approach**
- **The Document/View Approach**
- **Using “AppWizard” & “ClassWizard”**
- **Drawing, Menus, & Dialog Boxes with MFC**
- **File Handling and Printing**
- **Dialog-Based MFC Applications and Common Dialog Boxes**
- **Windows Multimedia**
- **Network Programming (TCP/IP) with MFC**
- **HTML-based Applications with MFC**



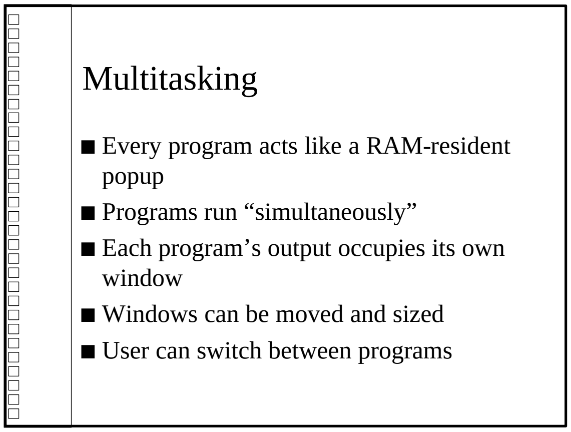
## Features of Windowing Systems

- Consistent user interface
- Display within a window
- Menus to initiate program functions
- Make use of controls:
  - predefined windows used with main program window
  - examples: buttons, scroll bars, edit controls, list boxes, drop-down list boxes
  - Dialog box--popup window containing several controls



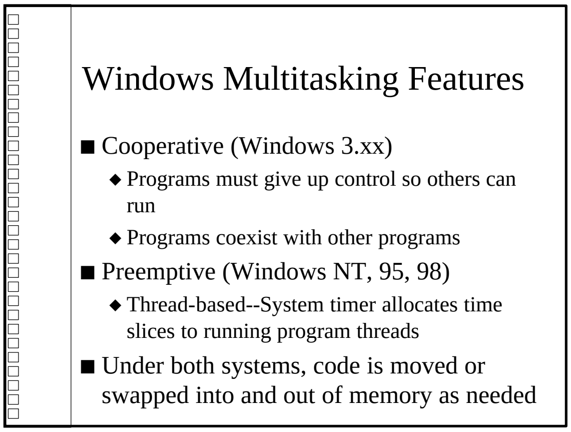
## Consistent User Interface

- Programs have same look and feel
- Same built-in logic to:
  - draw text/graphics
  - display menus
  - receive user input
    - controls, dialog boxes, use of mouse



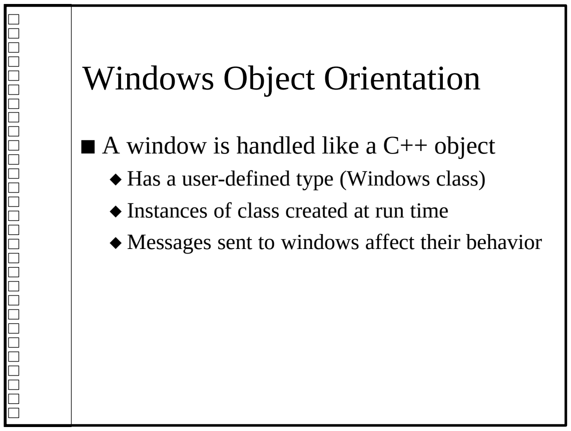
## Multitasking

- ■ Every program acts like a RAM-resident popup
- ■ Programs run “simultaneously”
- ■ Each program’s output occupies its own window
- ■ Windows can be moved and sized
- ■ User can switch between programs



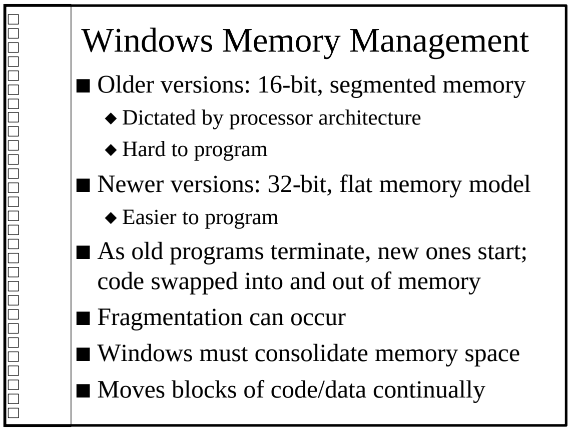
## Windows Multitasking Features

- ■ Cooperative (Windows 3.xx)
  - ◆ Programs must give up control so others can run
  - ◆ Programs coexist with other programs
- ■ Preemptive (Windows NT, 95, 98)
  - ◆ Thread-based--System timer allocates time slices to running program threads
- ■ Under both systems, code is moved or swapped into and out of memory as needed



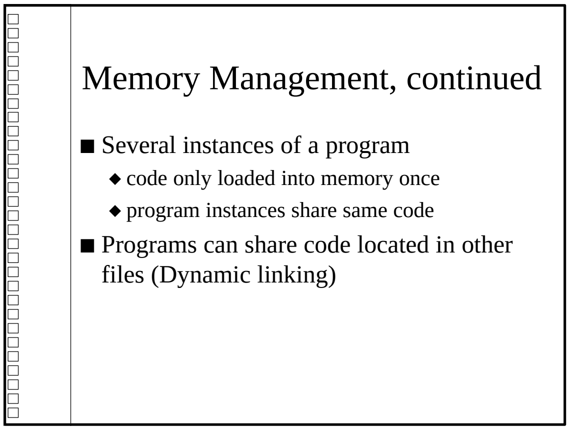
## Windows Object Orientation

- ■ A window is handled like a C++ object
  - ◆ Has a user-defined type (Windows class)
  - ◆ Instances of class created at run time
  - ◆ Messages sent to windows affect their behavior



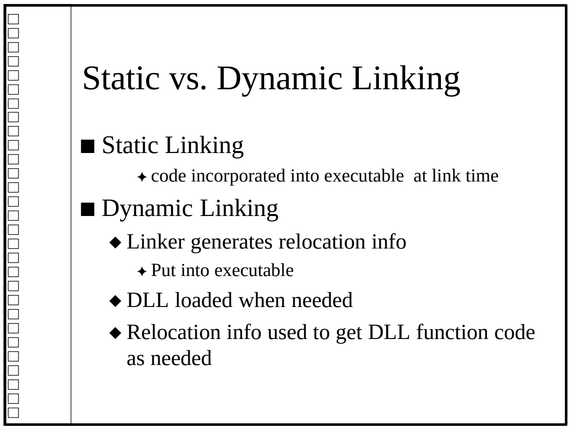
## Windows Memory Management

- ■ Older versions: 16-bit, segmented memory
  - ◆ Dictated by processor architecture
  - ◆ Hard to program
- ■ Newer versions: 32-bit, flat memory model
  - ◆ Easier to program
- ■ As old programs terminate, new ones start; code swapped into and out of memory
- ■ Fragmentation can occur
- ■ Windows must consolidate memory space
- ■ Moves blocks of code/data continually



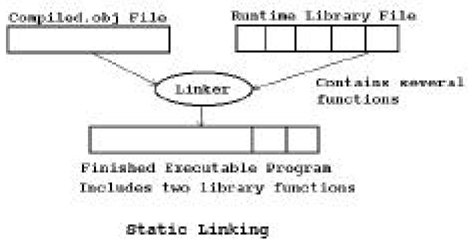
## Memory Management, continued

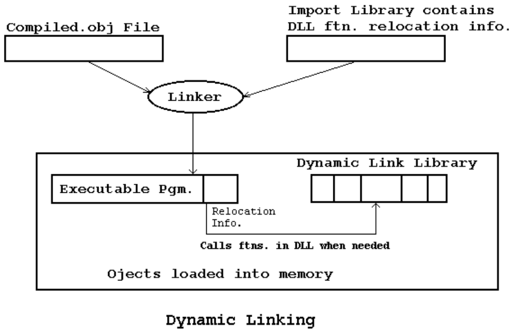
- ■ Several instances of a program
  - ◆ code only loaded into memory once
  - ◆ program instances share same code
- ■ Programs can share code located in other files (Dynamic linking)



## Static vs. Dynamic Linking

- ■ Static Linking
    - ✦ code incorporated into executable at link time
- ■ Dynamic Linking
  - ◆ Linker generates relocation info
    - ✦ Put into executable
  - ◆ DLL loaded when needed
  - ◆ Relocation info used to get DLL function code as needed


Compiled.obj File
Runtime Library File
Linker
Contains several functions
Finished Executable Program
Includes two library functions
Static Linking

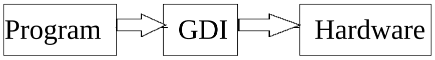


## Pros/Cons of Dynamic Linking

- Smaller programs (code is not there)
- DLL can be used by many programs with no memory penalty
  - Only loaded once!
- Updates to DLLs don't require recompilation of programs using them
- Disadvantage--DLL must be present at run time==>no standalone programs

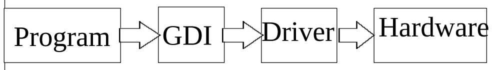
## Device Independent Graphics Interface

- Windows programs don't access hardware devices directly
- Make calls to generic functions within the Windows 'Graphics Device Interface' (GDI)
- The GDI translates these into HW commands


Program
GDI
Hardware

## Device Independent Graphics Interface

- May use device drivers (HW control programs)


Program
GDI
Driver
Hardware

- Thus graphics I/O done in a "standard" way
- Programs will run unaltered on other HW platforms

## Windows API

- The interface between an application and Windows
- A library of functions Windows programs can call
- Several versions
  - Win16 (16 bit apps for Windows 3.xx)
  - Win32 (32 bit apps for Windows NT/95)
  - Win32s (patches Win16 to create 32 bit apps that run under Windows 3.xx)

## Classical Windows programming

- Use C to access raw API functions directly
- No C++ class library wrappers to hide API
- Hard way to go, but most basic & flexible
- Provides understanding of how Windows and application program interact
- Establishes a firm foundation for MFC programming
- We will try to do both

## Class-based Windows programming

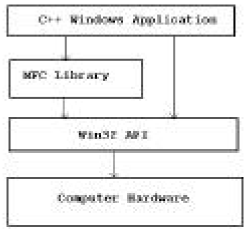
- Microsoft’s MFC Library
- Borland’s OWL Library
- Encapsulate the API functions into classes
- Provide a logical framework for building windows applications

## MFC Library

- Microsoft’s C++ Interface to Windows API
- O-O Approach to Windows Programming
- Some 200 classes
- API functions encapsulated in the MFC
- Classes derived from MFC do grunt work
- Just add data/functions to customize app
- Provides a uniform application framework

## Microsoft Visual C++

- 2 Windows app development systems
  - C programs using Win32 API
  - C++ programs using MFC
- Some Developer Studio IDE Components
  - Text/Resource Editors
  - C/C++, Resource Compilers
  - Linker
  - Debugger
  - Wizards
  - On-line Help



C++ Windows Application

MFC Library

Win32 API

Computer Hardware

The Relationship between Windows MFC and Win32 API Programming

## Some MFC Characteristics

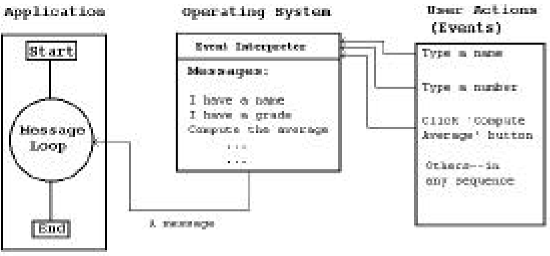
- Reusable code
- Smaller executables
- Faster program development
  - But a steep learning curve is required
  - And there is less flexibility
- Programs must be written in C++
- Require the use of classes==>
  - Programmer must know OOP

## Sequential Programming

- ■ Standard programming--program solicits input (polling loop)
- ■ Approach follows a structured sequence of events
- ■ Example--averaging grades:
  - ◆ Input name
  - ◆ Input first grade
  - ◆ Input second grade
  - ◆ Input third grade
  - ◆ Calculate average
  - ◆ Output average

## Event-Driven Programming

- ■ Designed to avoid limitations of sequential, procedure-driven methodologies
- ■ Process events as they happen--non-sequential
- ■ Program doesn't solicit input
- ■ OS detects an event has happened (e.g.., there's input) and sends a message to the program
- ■ Program then acts on the message
- ■ Messages can occur in any order



The Event-Driven Programming Paradigm

## Sequential vs. Event-Driven Programming

- ■ Standard Sequential programming:
  - ◆ Program does something & user responds
  - ◆ Program controls user (the tail wags the dog)
- ■ Event-Driven Programming:
  - ◆ Used by Windows
  - ◆ User can act at any time
  - ◆ User controls program (the dog wags the tail)
  - ◆ OS really is in control (coordinates message flow to different applications)
  - ◆ Good for apps with lots of user intervention