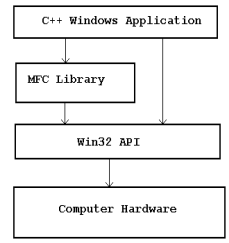
Introduction to Microsoft Windows MFC Programming: the Application/Window Approach

MFC Windows Programming (App/Window Approach)

- **The Microsoft Foundation Class (MFC) Library**
- A Hierarchy of C++ classes designed to facilitate Windows programming
- An alternative to using Win32 API functions
- A Visual C++ Windows application can use either Win32 API, MFC, or both



The Relationship between Windows MFC and Win32 API Programming

Microsoft Foundation Classes

- About 200 MFC classes (versus 2000+ API functions)
- Provide a framework upon which to build Windows applications
- Encapsulate most of the Win32 API in a set of logically organized classes

Some characteristics of MFC:

- 1. Convenience of reusable code:
  - Many tasks common to all Windows apps are provided by MFC
  - Our programs can inherit and modify this functionality as needed
  - We don't need to recreate these tasks
  - MFC handles many clerical details in Windows programs

MFC Characteristics, Continued

- 2. Produce smaller executables:
  - Typically 1/3 the size of their API counterparts
- 3. Can lead to faster program development:
  - But there's a steep learning curve--
  - Especially for newcomers to object-oriented programming

MFC Characteristics, Continued

- 4. MFC Programs must be written in C++ and require the use of classes
- Programmer must have good grasp of:
  - How classes are declared, instantiated, and used
  - Encapsulation
  - Inheritance
  - Polymorphism--virtual functions

MFC Class Hierarchy

- **(See online help on "Hierarchy Chart")--**

Some Important MFC Classes

- ***CObject:*** At top of hierarchy ("Mother of all classes")
- Provides features like:
  - Serialization
    - Streaming object's persistent data to or from a storage medium (disk reading/writing)
  - Diagnostic & Debugging support
- All its functionality is inherited by any classes derived from it

Important Derived Classes--

- ***CFile:*** Support for file operations
- ***CArchive:*** Works with ***CFile*** to facilitate serialization and file I/O
- ***CDC:*** Encapsulates the device context (Graphical Drawing)
- ***CGdiObject:*** Base class for various drawing objects (brushes, pens, fonts, etc.)
- ***CMenu:*** Encapsulates menu management

- ***CCmdTarget:*** Encapsulates message passing process & is parent of:
  - ***CWnd:*** Encapsulates many important windows functions and data members
  - Example: m_hWnd stores the window's handle
  - Base class all windows are derived from
  - Most common:
    - ***CFrameWindow:*** Can contain other windows
      - ("normal" kind of window we've used)
    - ***CView:*** Encapsulates process of displaying and interacting with data
    - ***CDialog:*** Encapsulates dialog boxes

- ***CCmdTarget*** also parent of:
  - ***CWinThread:*** Defines a thread of execution & is parent of:
    - ***CWinApp:*** Most important class dealt with in MFC applications:
    - Encapsulates an MFC application
    - Controls following aspects of Windows programs:
      - Startup, initialization, execution, shutdown
      - An application should have one CWinApp object
      - When instantiated, application begins to run
  - ***CDocument***
    - Encapsulates the data associated with a program

MFC Classes and Functions

- Primary task in writing MFC program--to create classes
- Most will be derived from MFC library classes
- **MFC Class Member Functions--**
  - Most functions called by an application will be members of an MFC class
- Examples:
- ***ShowWindow()***--a member of CWnd class
- ***TextOut()***--a member of CDC
- ***LoadBitmap()***--a member of CBitmap

- Apps can also call API functions directly
  - Use Global Scope Resolution Operator, for example:
  - ***::UpdateWindow(hWnd);***
- Usually more convenient to use MFC member functions

MFC Global Functions--

- Not members of any MFC class
- Begin with Afx prefix (**A**pplication **F**rameWor**KS**)
- Independent of or span MFC class hierarchy
- Example:
  - ***AfxMessageBox()***
  - Message boxes are predefined windows
  - Can be activated independently from the rest of an application

Some Important Global Functions

- AfxAbort() -- uconditionally terminate an app
- AfxBeginThread() -- Create & run a new thread
- AfxGetApp() -- Returns a pointer to the application object
- AfxGetMainWnd() -- Returns a pointer to application's main window
- AfxGetInstanceHandle() -- Returns handle to applications's current instance
- AfxRegisterWndClass() -- Register a custom WNDCLASS for an MFC app

A Minimal MFC Program (App/Window Approach)

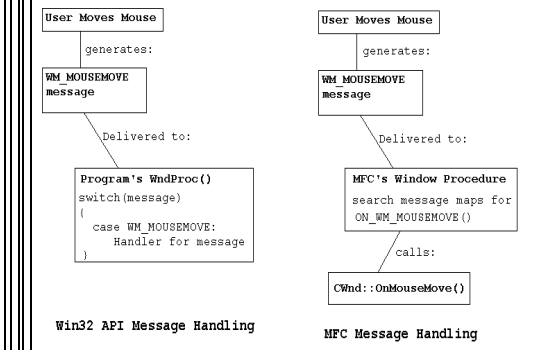
- Simplest MFC programs must contain two classes derived from hierarchy:
  - An application class derived from ***CWinApp***
    - Defines the application
    - provides the message loop
  - A window class usually derived from ***CFrameWnd***
    - Defines the application's main window
- These & other MFC classes brought in by using #include <Afxwin.h>

Message Processing under MFC

- Like API programs, MFC programs must handle messages from Windows
- API mechanism: big switch/case statement
- MFC mechanism: "**message maps**" (lookup tables)
- Table entries:
  - Message number
  - Pointer to a derived class member message-processing function
    - These are members of CWnd

Message Mapping

- Programs must:
  - Declare message-processing functions
    - e.g., OnWhatever() for WM_WHATEVER message
  - Map them to messages app is going to respond to
    - Mapping by "message-mapping macros"
    - Bind a message to a handler function
    - e.g., ON_WM_WHATEVER()
- Most MFC application windows use a window procedure, WndProc(), supplied by the library
- Message maps enable library window procedure to find the function corresponding to the current msg.



STEPS IN WRITING A SIMPLE MFC PROGRAM (App/Window Approach)

DECLARATIONS (.h)

1. Declare a window class derived from ***CFrameWnd*** (e.g., ***CMainWin***)--

- Class Members:
  - The constructor
  - Message-processing function declarations
    - e.g., void ***OnChar()***
  - ***DECLARE_MESSAGE_MAP()*** macro:
    - Allows windows based on this class to respond to messages
    - Declares that a msg map will be used to map messages to functions
    - Should be last class member declared

2. Declare an application class derived from ***CWinApp*** (e.g., ***CApp***)--

- Must override ***CWinApp***'s ***InitInstance()*** virtual function:
  - Called each time a new instance of application is started
  - i.e., when an object of this class is instantiated
  - Purpose is for application to initialize itself
  - Perfect place to put code that does stuff that has to be done each time program starts

IMPLEMENTATION (.CPP)

1. Define constructor for class derived from ***CFrameWnd*** (***CMainWin***)

- Should call member function ***Create()*** to create the window
- Does what ***CreateWindow()*** does in API

2. Define message map for class derived from ***CFrameWnd (CMainWin)***--

BEGIN_MESSAGE_MAP(owner, base)

List of "message macros" [e.g., ***ON_WM_CHAR()***]

END_MESSAGE_MAP()

3. Define (implement) message-processing functions declared in declarations (1) above
4. Define (implement) ***InitInstance()*** overriding function--

- Done in class derived from ***CWinApp (CApp)***:
  - Should have initialization code for each new app instance:
    - Create a ***CMainWin*** object → pointer to program's main window
      - (Used to refer to the window, like hWnd in API programs)
    - Invoke object's ***ShowWindow()*** member function
    - Invoke object's ***UpdateWindow()*** member function
    - Must return non-zero to indicate success
  - [MFC's implementation of ***WinMain()*** calls this function]

- Now Nature & form of simple window & application have been defined
- But neither exists--
- Must instantiate an application object derived from ***CWinApp (CApp)***

5. Create an instance of the app class ***(CApp)***

- Causes ***AfxWinMain()*** to execute
  - It's now part of MFC [WINMAIN.CPP]
- ***AfxWinMain()*** does the following:
  - Calls ***AfxWinInit()***--
    - which calls ***AfxRegisterClass()*** to register window class
  - Calls ***CApp::InitInstance()*** [virtual function overridden in 4 above]--
    - which creates, shows, and updates the window
  - Calls ***CWinApp::Run()***–
    - which calls ***CWinThread::PumpMessage()***--
    - which contains the ***GetMessage()*** loop

- After ***WinApp::Run()*** returns:
  - (i.e., when the WM_QUIT message is received)
- ***AfxWinTerm()*** is called--
  - which cleans up and exits

PROG1 Example MFC Application:

- **Just creates a skeleton frame window**

Steps in Creating and Building an MFC Application like PROG1 "manually"

1. "File | New", "Win32 Application" as always
   - Enter a Project Name and Location as usual
2. "File | New | C++"
   - Enter or copy/paste .cpp file text (e.g., PROG1.CPP)--see IMPLEMENTATION above
3. "File | New | C++ header"
   - Enter or copy/paste .h file text (e.g., PROG1.H)--see DECLARATION above
4. "Project | Settings | General"
   - From "Microsoft Foundation Classes:" combo box, choose:
   - "Use MFC in a Shared DLL"
5. Build the project as usual

How It Works

CApp object is created →
MFC's ***WinMain()*** executes →
Registers class (default)
Calls our ***CApp::InitInstance()*** →
Our override creates a ***CMainWin*** object
Our ***CMainWin*** constructor calls ***Create()*** → window created
Our ***CApp::InitInstance()*** override calls window's ***ShowWindow()*** → window is displayed
Our override calls ***UpdateWindow()*** → client area painted
WinMain() continues by calling its ***Run()*** function →
Call to ***PumpMessage ()***
Which starts the message loop

MSG1 Example MFC Application: Mouse/Character Message Processing

- User presses mouse button →
  - Left/Right Button down string displayed at current mouse cursor position
- Keyboard key pressed →
  - Character displayed at upper left hand corner of client area

MSG1

- Global integers to keep track of where text is to appear
- Global string to hold text to be displayed
- Getting a DC:
  - CPaintDC dc(this)
    - Constructor performs CWnd::BeginPaint()
    - Destructor performs CWnd::EndPaint()
    - 'this': points to the object from which the member function is called
    - Here it's a pointer to this window
    - So we construct a DC for this window