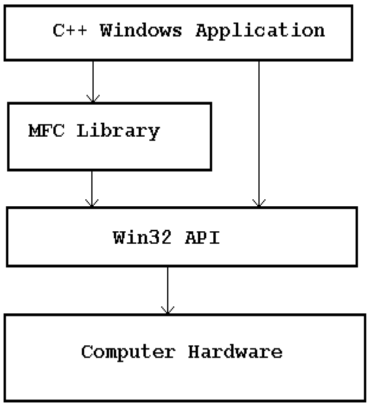
Introduction to Microsoft Windows MFC Programming: The Application/Window Approach

- Additional notes at:

  www.cs.binghamton.edu/~reckert/360/class14.htm

MFC Windows Programming

- **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



C++ Windows Application

MFC Library

Win32 API

Computer Hardware

The Relationship between Windows MFC and Win32 API Programming

Some characteristics of MFC

- 1. Convenience of reusable code
- 2. Many tasks common to all Windows apps are provided by MFC
  - e.g., WinMain, the Window Procedure, and the message loop are buried in the MFC Framework
- 3. Produce smaller executables:
  - Typically 1/3 the size of their API counterparts
- 4. Can lead to faster program development:
  - But there's a steep learning curve
- 5. MFC Programs must be written in C++ and require the use of classes
  - Instantiation, encapsulation, inheritance, polymorphism

Help on MFC Classes

✍ See Online Help (Index) on:

“MFC” | “classes”

“MFC classes (MFC)”

✍ Clicking on a class ✍ a document with a link to the class members

✍ Also look at

“MFC” | “hierarchy”

“hierarchy chart”

Base MFC Class

✍ ***CObject:*** At top of hierarchy ("Mother of almost all MFC classes")

✍ Provides features like:

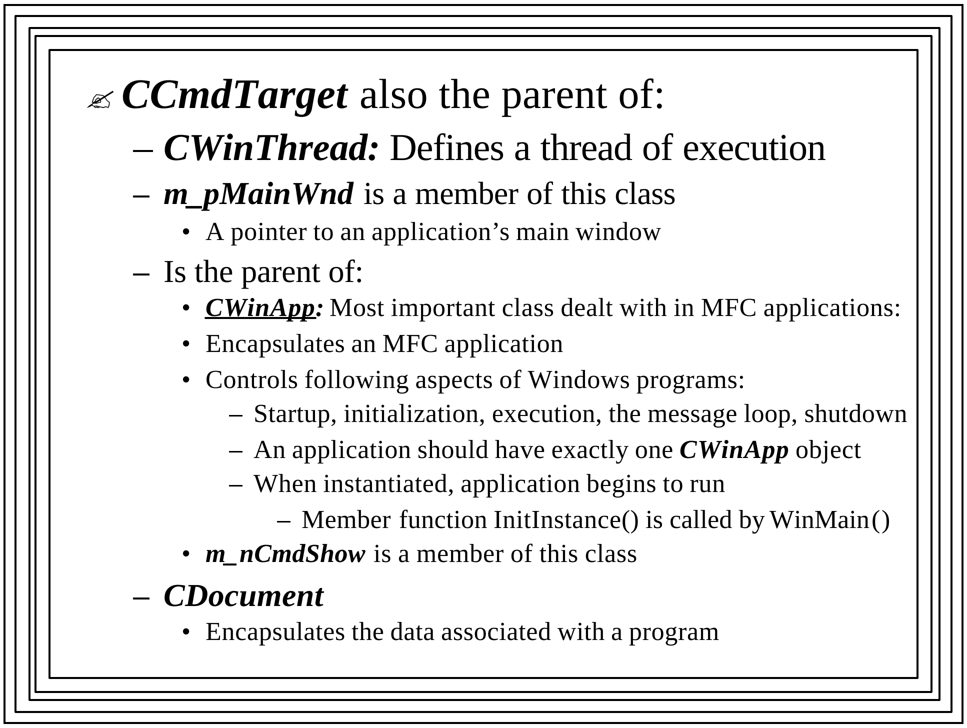
- Serialization
  - Streaming an object’s persistent data to or from a storage medium (disk reading/writing)
- Runtime class information
- Diagnostic & Debugging support
- Some important macros

✍ All its functionality is inherited by any classes derived from it

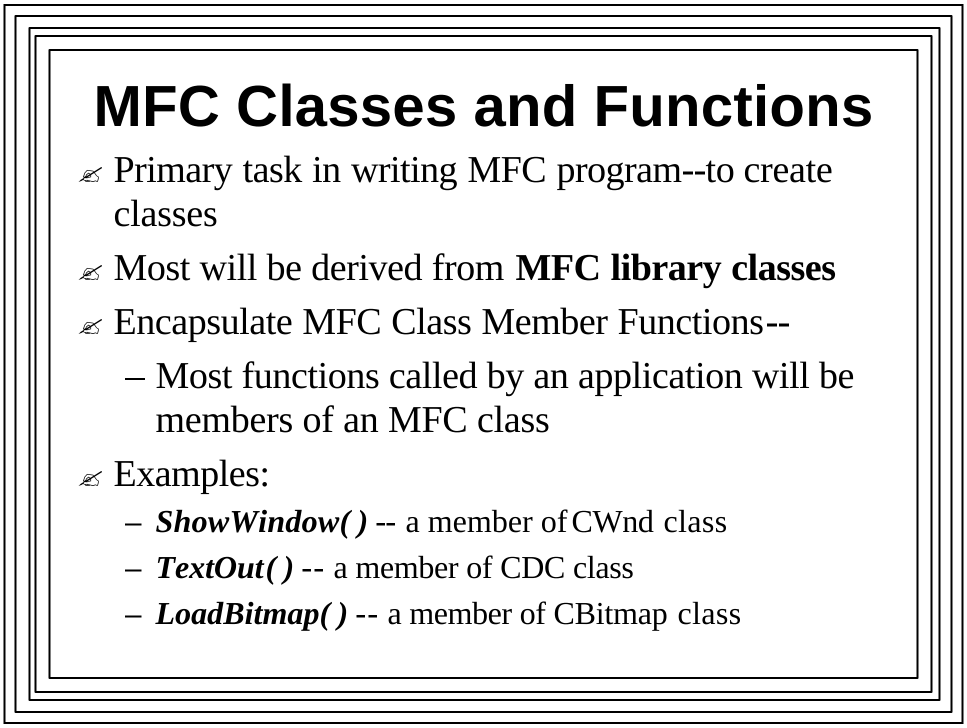
Some Important Derived Classes

- ***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 (CBrush, CPen, CFont, etc.)
- ***CMenu:*** Encapsulates menus and menu management

- ***CCmdTarget:*** Encapsulates message passing process and is parent of:
  - ***<u>CWnd</u>:*** Base class from which all windows are derived
  - Encapsulates many important windows functions and data members
  - Examples:
    - m_hWnd stores the window's handle
    - *Create(…)* creates a window
  - Most common subclasses:
    - ***<u>CFrameWindow</u>:*** Can contain other windows
      - ("normal" kind of window we've used)
    - ***CView:*** Encapsulates process of displaying and interacting with data in a window
    - ***CDialog:*** Encapsulates dialog boxes



- ***CCmdTarget*** also the parent of:
  - ***CWinThread:*** Defines a thread of execution
  - ***m_pMainWnd*** is a member of this class
    - A pointer to an application’s main window
  - Is the parent of:
    - ***<u>CWinApp</u>:*** Most important class dealt with in MFC applications:
    - Encapsulates an MFC application
    - Controls following aspects of Windows programs:
      - Startup, initialization, execution, the message loop, shutdown
      - An application should have exactly one ***CWinApp*** object
      - When instantiated, application begins to run
        - Member function InitInstance() is called by WinMain()
    - ***m_nCmdShow*** is a member of this class
  - ***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**
- Encapsulate 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 class
  - ***LoadBitmap( )*** -- a member of CBitmap class

- Applications 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
    - Good for debugging

Some Important Global Functions

- ***AfxAbort( )*** -- Unconditionally 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)

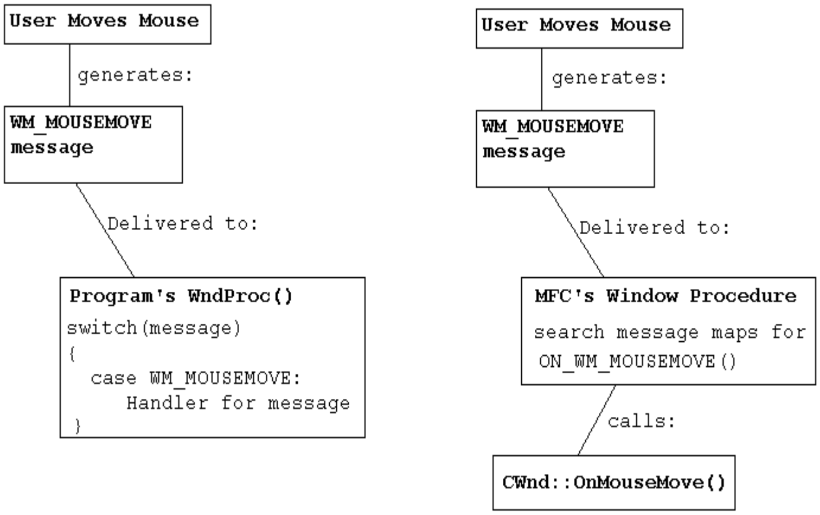
- Simplest MFC programs must contain two classes derived from the hierarchy:
  - 1. An application class derived from ***CWinApp***
    - Defines the application
    - provides the message loop
  - 2. A window class usually derived from ***CWnd*** or ***CFrameWnd***
    - Defines the application's main window
- To use these & other MFC classes you must have: #include <Afxwin.h> in the .cpp file

Message Processing under MFC

- Like API programs, MFC programs must handle messages from Windows
- API mechanism: switch/case statement in app’s ***WndProc()***
- In MFC, ***WndProc()*** is buried in the MFC library
- Message handling mechanism: “**Message Maps**"
  - lookup tables the MFC ***WndProc()*** searches
- Table entries:
  - Message number
  - Pointer to a message-processing function
    - These functions are members of ***CWnd***
    - We override the ones we want our program to respond to
    - Like virtual functions

Message Mapping

- Programs must:
  - Declare message-processing (handler) functions
    - e.g., ***OnWhatever( )*** for ***WM_WHATEVER*** message
  - Map them to messages program is going to respond to
    - Mapping is done by "message-mapping macros”
      - Bind a message to a handler function
      - e.g., ***ON_WM_WHATEVER( )***



```
switch(message)
{
  case WM_MOUSEMOVE:
     Handler for message
}
```

Win32 API Message Handling

MFC Message Handling

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

DECLARATION (.h)

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

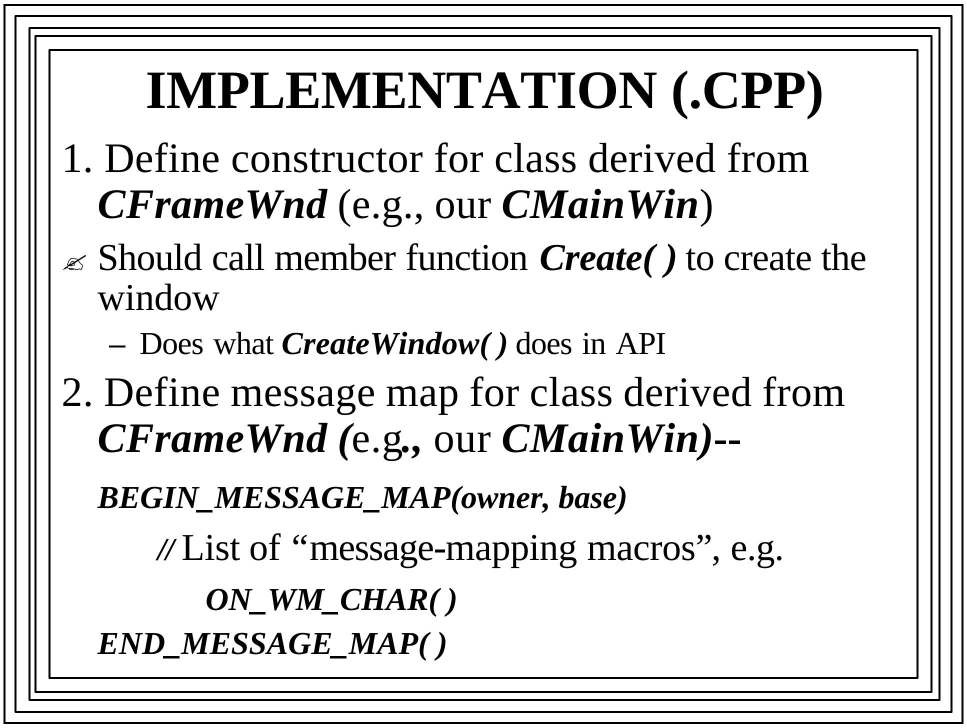
✍ Class Members:

- The constructor declaration
- Message-processing function declarations for messages the application will override and respond to
  - e.g., void ***OnChar(…)***
- ***DECLARE_MESSAGE_MAP( )*** macro:
  - Allows windows based on this class to respond to messages
  - Declares that a message map will be used to map messages to overriding handler functions in the application
  - 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 application class is instantiated
- Purpose is for application to initialize itself
- Good 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*** (e.g., our ***CMainWin***)

✍ Should call member function ***Create( )*** to create the window

- Does what ***CreateWindow( )*** does in API

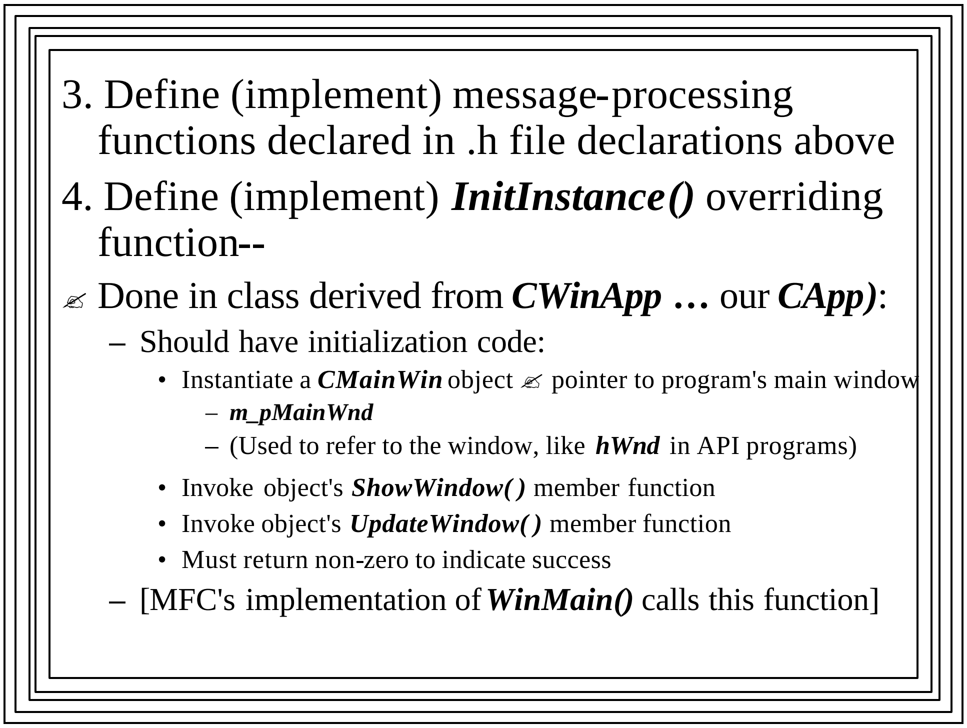
2. Define message map for class derived from ***CFrameWnd (***e.g**.,** our ***CMainWin)--***

BEGIN_MESSAGE_MAP(owner, base)

// List of “message-mapping macros”, e.g.

ON_WM_CHAR( )

END_MESSAGE_MAP( )



3. Define (implement) message-processing functions declared in .h file declarations above

4. Define (implement) ***InitInstance()*** overriding function**--**

✍ Done in class derived from ***CWinApp …*** our ***CApp)***:

- Should have initialization code:
  - Instantiate a ***CMainWin*** object ✍ pointer to program's main window
    - ***m_pMainWnd***
    - (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 …*** our ***CApp***

5. Instantiate the app class ***(**e.g., **our CApp)***

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

✍ After ***CWinApp::Run( )*** returns:

– (i.e., when the WM_QUIT message is received)

– ***AfxWinTerm ( )*** is called--

– which cleans up and exits

MSG2005 Example MFC Application: Mouse/Character Message Processing

✍ User presses mouse button ✍

– “L” or “R” displayed at current mouse cursor position

✍ Keyboard key pressed ✍

– Character displayed at upper left hand corner of client area

- Message map contains:
  - ***ON_WM_CHAR( )***
  - ***ON_WM_LBUTTONDOWN( )***
  - ***ON_WM_RBUTTONDOWN( )***
- To respond to messages:
  - ***WM_CHAR***
  - ***WM_LBUTTONDOWN***
  - ***WM_RBUTTONDOWN***
- So we need to define the following handler function overrides:
  - ***CWnd::OnChar(UINT ch, UINT count, UINT flags);***
  - ***CWnd::OnLButtonDown(UINT flags, CPoint loc);***
  - ***CWnd::OnRButtonDown(UINT flags, CPoint loc);***

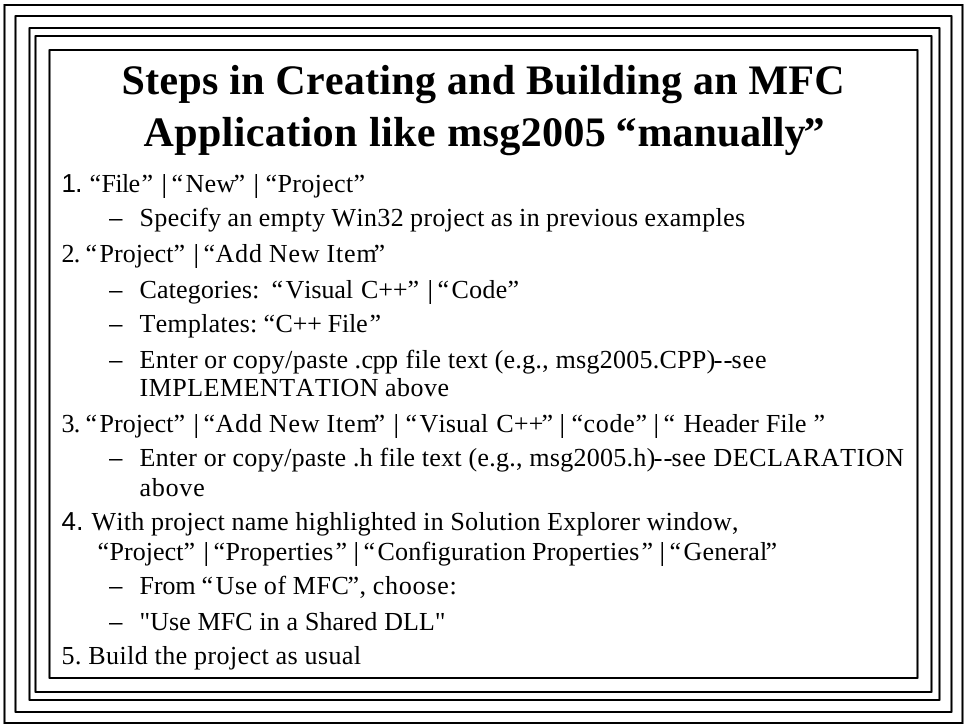
- In each handler we need to get a Device Context to draw on:

  CDC* pDC

  - Declare a pointer to a ***CDC*** object

  pDC = this->GetDC( );

  - Use ***GetDC( )*** member function of ‘this’ ***CWnd*** to get a device context to draw on
- And then display a string using ***TextOut( )***
  - If it’s a character, it must be formatted into a string first
  - Can use ***wsprintf( )***
    - Formats integers, characters, and other data types into a string



Steps in Creating and Building an MFC Application like msg2005 “manually”

1. “File” | “New” | “Project”
   - Specify an empty Win32 project as in previous examples
2. “Project” | “Add New Item”
   - Categories: “Visual C++” | “Code”
   - Templates: “C++ File”
   - Enter or copy/paste .cpp file text (e.g., msg2005.CPP)--see IMPLEMENTATION above
3. “Project” | “Add New Item” | “Visual C++” | “code” | “ Header File ”
   - Enter or copy/paste .h file text (e.g., msg2005.h)--see DECLARATION above
4. With project name highlighted in Solution Explorer window, “Project” | “Properties” | “Configuration Properties” | “General”
   - From “Use of MFC”, choose:
   - "Use MFC in a Shared DLL"
5. Build the project as usual