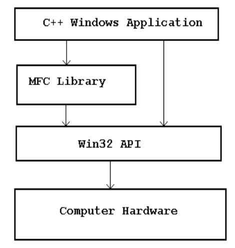
Introduction to Microsoft Windows MFC Programming: The Application/Window Approach

- 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



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, implemented (instantiated), extended, overridden, and used
    - Encapsulation
    - Inheritance
    - Polymorphism

Help on MFC Classes

- See Online Help (Index) on:

"MFC (Microsoft Foundation Class)"
"Hierarchy Chart"
"Hierarchy Chart"

- Each class name is a hot link
- At bottom each has a "Class Members" link
  - Clicking ✍ a document that lists all class members
- On the Web:

http:// msdn. microsoft.com/library/default.asp?url=/library/en-us/vcmfc98/html/_mfc_class_library_reference_introduction.asp

Base MFC Class

- ***CObject:*** At top of hierarchy ("Mother of almost all MFC classes")
- Provides features like:
  - Serialization
    - Streaming 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 menu management

- ***CCmdTarget:*** Encapsulates message passing process and is parent of:
  - ***CWnd:*** Base class from which all windows are derived
  - Encapsulates many important windows functions and data members
  - Example: m_hWnd stores the window's handle
  - Most common subclasses:
    - ***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 and is the parent of:
    - ***CWinApp:*** 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 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

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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

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A Minimal MFC Program (App/Window Approach)

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

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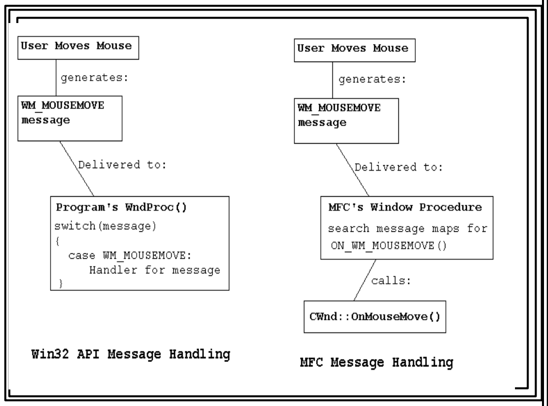
Message Processing under MFC

- Like API programs, MFC programs must handle messages from Windows
- API mechanism: switch/case statement in app's WndProc
- Under MFC, WndProc is buried in MFC framework
- Message handling mechanism: "**Message Maps**"
  - lookup tables the MFC WndProc searches
- Table entries:
  - Message number
  - Pointer to a message-processing function
    - These are members of CWnd
    - You override the ones you want your app to respond to

Message Mapping

- Programs must:
  - Declare message-processing (handler) functions
    - e.g., OnWhatever( ) for WM_WHATEVER message
  - Map them to messages app is going to respond to
    - Mapping done 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



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

```
search message maps for
ON_WM_MOUSEMOVE()
```

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 for messages the application will 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*** (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 (our CMainWin)--***

BEGIN_MESSAGE_MAP(owner, base)

List of "message-mapping macros“, e.g.

O***N_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 (our 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 (our CApp)***

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5. Create an instance of the app class ***(our 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( )*** [In THRDCORE.CPP]--
    - • 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

MSGNEW 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

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- ✍ 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 MSGNEW "manually"

1. "File" | "New" | "Project"
   - Specify an empty Win32 project as in previous examples
2. "Project" | "Add New Item"
   - Categories: "Visual C++" | "C++"
   - Templates: "C++ File"
   - Enter or copy/paste .cpp file text (e.g., MSGNEW.CPP)--see IMPLEMENTATION above
3. "Project" | "Add New Item" | "Visual C++" | "C++" | " Header File "
   - Enter or copy/paste .h file text (e.g., MSGNEW.H)--see DECLARATION above
4. "Project" | "Properties" | "General" (with msgnew highlighted in Solution Explorer window):
   - From "Use of MFC", 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