Windows & DirectX Programming #1

Kang, Seong-tae

Computer Graphics, 2008 Spring

Contents

- Basic Windows Programming
- Windows GDI
- Preparing for DirectX Programming

Prerequisites

- Windows 2000/XP or later
- Microsoft Visual Studio
  - Visual C++ 6 is not recommended
    - Too old - grammatical flaws and bugs
    - Microsoft's technical support expired in Sep. 2005
    - Recent DirectX SDKs don't support VC++ 6 any more
- Microsoft DirectX SDK
  - 9.0c or later
- A DirectX 9 compatible graphic card
  - ATI Radeon 9500+
  - Nvidia GeForce FX, 6/7/8 Series
  - Intel GMA900 integrated graphics or later
  - ATI Express-200 integrated graphics or later

Basic Windows Programming

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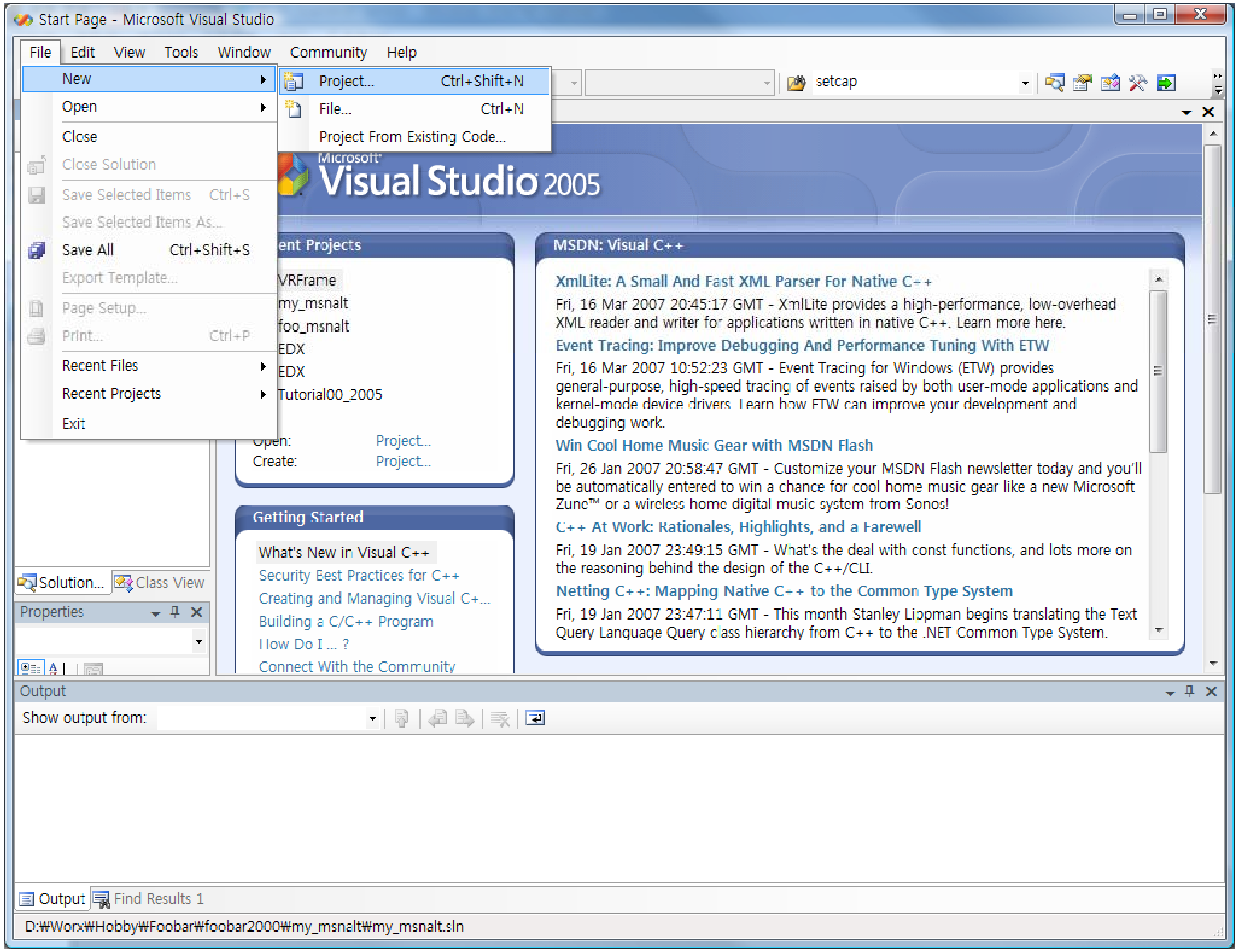
How to Program a Win32 Application

- Win32 API
  - The most primitive method
  - C-based definitions
- MFC(Microsoft Foundation Class)
  - Object oriented framework
  - C++ based encapsulation of Win32 API
  - Intuitive UI coding
  - Complicated internal structures
- Other third-party frameworks
  - Qt, GTK, GLUT…

- Win32 API is enough for this course. Using some framework is on your choice.

Creating a Win32 Project



XmlLite: A Small And Fast XML Parser For Native C++

Fri, 16 Mar 2007 20:45:17 GMT - XmlLite provides a high-performance, low-overhead XML reader and writer for applications written in native C++. Learn more here.

Event Tracing: Improve Debugging And Performance Tuning With ETW

Fri, 16 Mar 2007 10:52:23 GMT - Event Tracing for Windows (ETW) provides general-purpose, high-speed tracing of events raised by both user-mode applications and kernel-mode device drivers. Learn how ETW can improve your development and debugging work.

Win Cool Home Music Gear with MSDN Flash

Fri, 26 Jan 2007 20:58:47 GMT - Customize your MSDN Flash newsletter today and you'll be automatically entered to win a chance for cool home music gear like a new Microsoft Zune™ or a wireless home digital music system from Sonos!

C++ At Work: Rationales, Highlights, and a Farewell

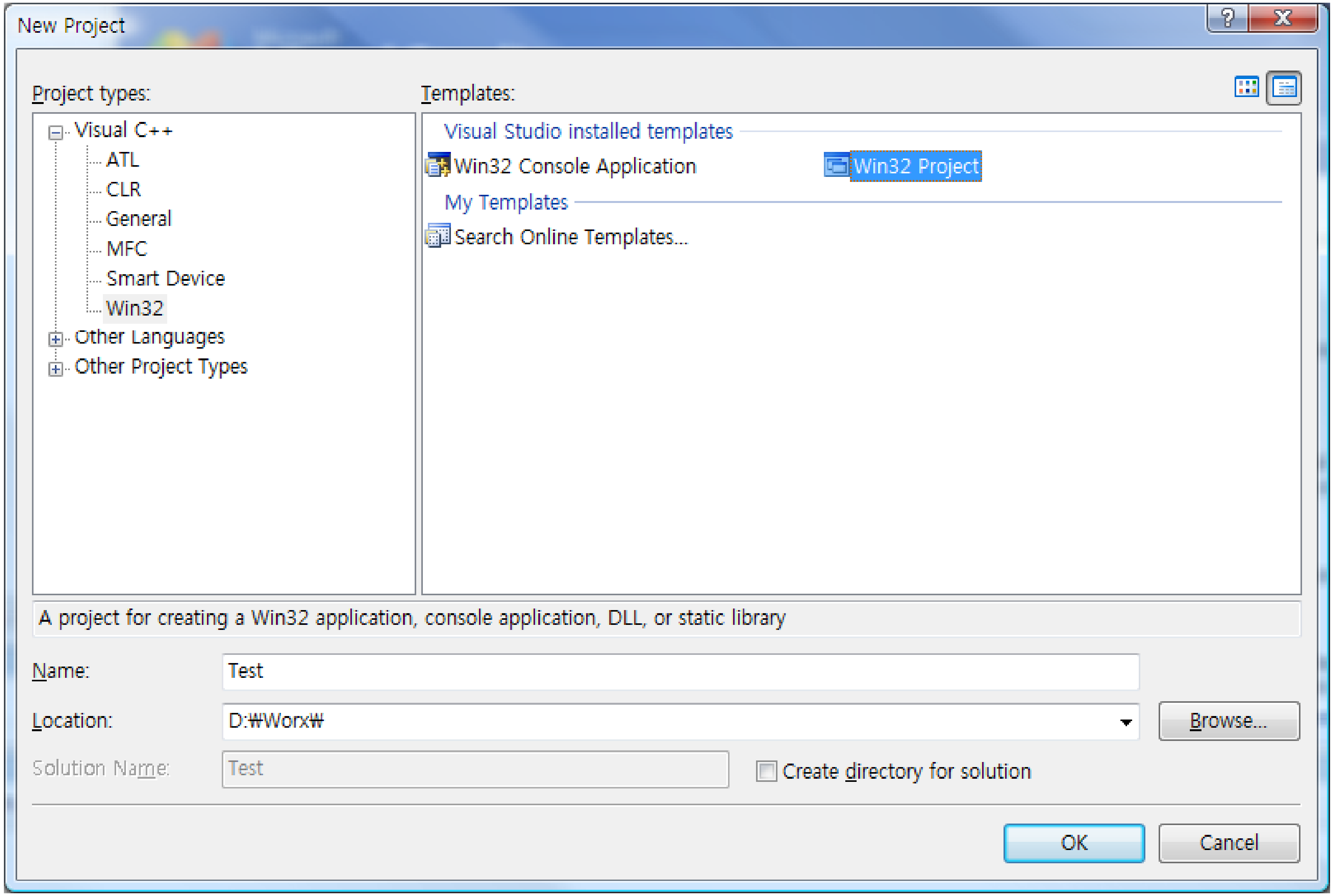
Fri, 19 Jan 2007 23:49:15 GMT - What's the deal with const functions, and lots more on the reasoning behind the design of the C++/CLI.

Netting C++: Mapping Native C++ to the Common Type System

Fri, 19 Jan 2007 23:47:11 GMT - This month Stanley Lippman begins translating the Text Query Language Query class hierarchy from C++ to the .NET Common Type System.

D:₩Worx₩Hobby₩Foobar₩foobar2000₩my_msnalt₩my_msnalt.sln

Creating a Win32 Project



A project for creating a Win32 application, console application, DLL, or static library

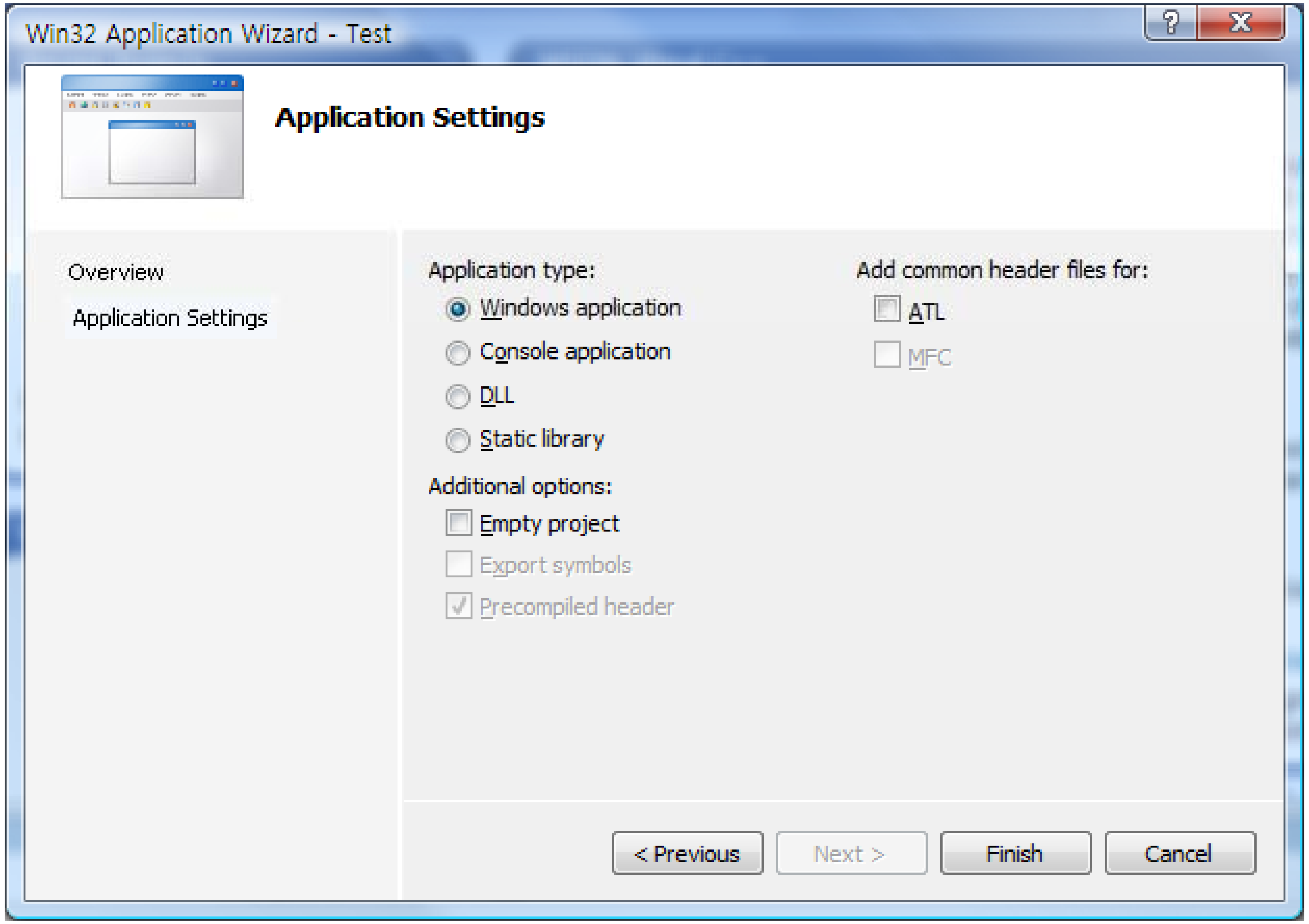
Name: Test

Location: D:₩Worx₩

Solution Name: Test

☐ Create directory for solution

Creating a Win32 Project



Win32 Application Wizard - Test

Application Settings

Overview

Application Settings

Application type:

- [✓ Windows application]
- Console application
- DLL
- Static library

Additional options:

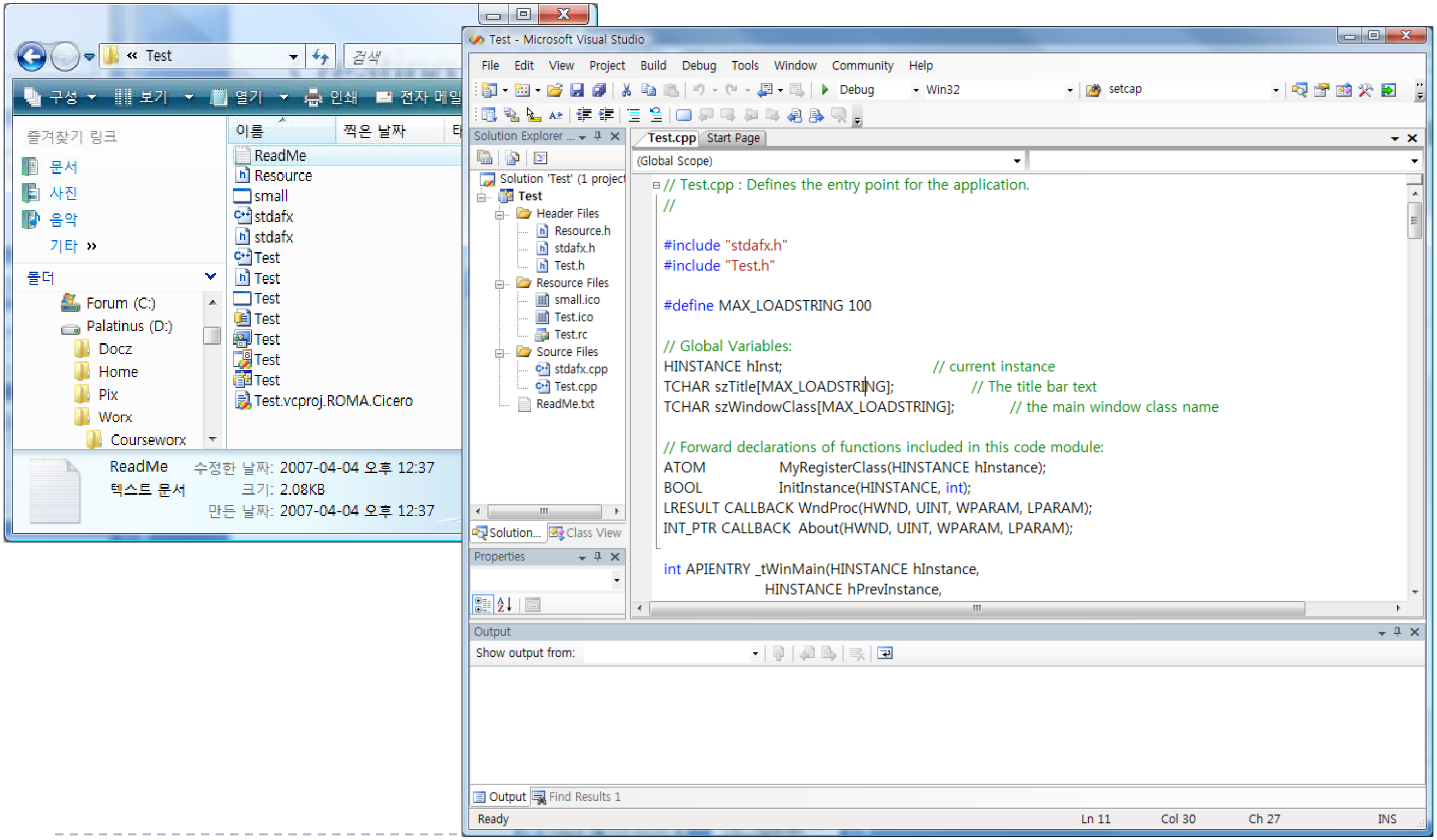
- ☐ Empty project
- ☐ Export symbols
- ✓ Precompiled header

Add common header files for:

- ☐ ATL
- ☐ MFC

▶ If you want an empty project and to write whole code, check ‘Empty project’.

Creating a Win32 Project



```
// Test.cpp : Defines the entry point for the application.
//

#include "stdafx.h"
#include "Test.h"

#define MAX_LOADSTRING 100

// Global Variables:
HINSTANCE hInst;                                // current instance
TCHAR szTitle[MAX_LOADSTRING];                  // The title bar text
TCHAR szWindowClass[MAX_LOADSTRING];            // the main window class name

// Forward declarations of functions included in this code module:
ATOM                MyRegisterClass(HINSTANCE hInstance);
BOOL                InitInstance(HINSTANCE, int);
LRESULT CALLBACK    WndProc(HWND, UINT, WPARAM, LPARAM);
INT_PTR CALLBACK    About(HWND, UINT, WPARAM, LPARAM);

int APIENTRY _tWinMain(HINSTANCE hInstance,
                     HINSTANCE hPrevInstance,
```

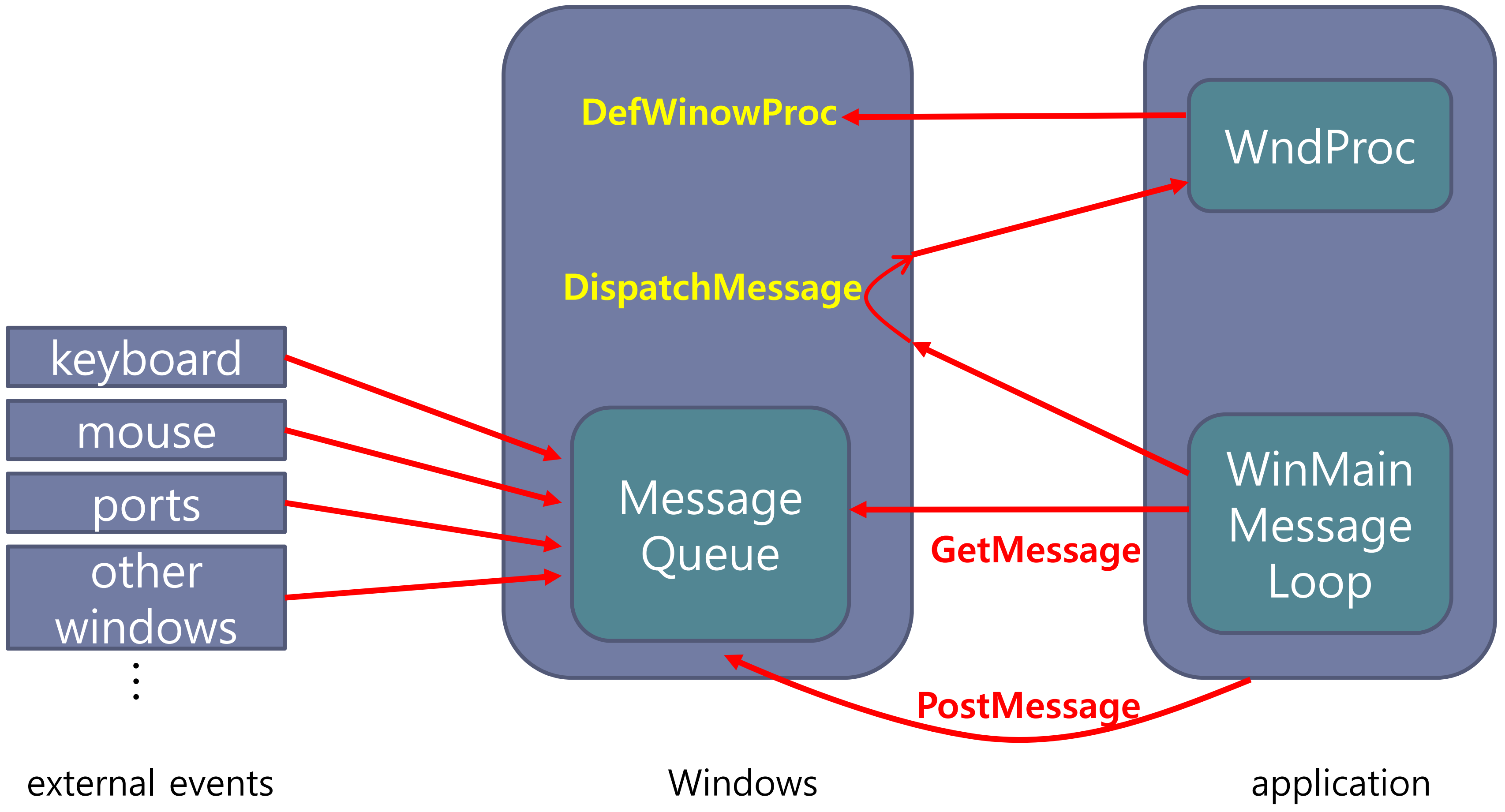
- If you are *really* not interested in Win32 API at all, this is all you should know.

Win32 Application Structure : Brief Description

- WinMain
  - Entry point : the application starts from here
  - Contains a message loop
- WndProc
  - Callback function
  - The actual message processing routine

Windows : Message-based System

- All of the Windows event is processed via message



WinMain Entry Function

```
int WinMain(HINSTANCE hInstance, HINSTANCE hPrevInstance, LPSTR lpCmdLine, int nCmdShow )
```

- Parameters
  - HINSTANCE hInstance : instance handle of the window
  - HINSTANCE hPrevInstace : not used in Win2000/XP
  - LPTSTR lpCmdLine : command line arguments
  - int nCmdShow : showing style of the window (maximized, minimized, etc.)
- wWinMain : unicode version
- _tWinMain : TCHAR version

_t, TCHAR and LPTSTR are macros for encoding. See 'TCHAR.H mappings' on MSDN.

WinMain Entry Function

- Registering a window class
  - Define characteristics of the window
  - Distinguished by “Class Name”

```
WNDCLASSEX wcex;

wcex.cbSize = sizeof(WNDCLASSEX);

wcex.style              = CS_HREDRAW | CS_VREDRAW;
wcex.lpfnWndProc        = WndProc;
wcex.cbClsExtra         = 0;
wcex.cbWndExtra         = 0;
wcex.hInstance          = hInstance;
wcex.hIcon              = LoadIcon(hInstance, MAKEINTRESOURCE(IDI_TEST));
wcex.hCursor            = LoadCursor(NULL, IDC_ARROW);
wcex.hbrBackground      = (HBRUSH)(COLOR_WINDOW+1);
wcex.lpszMenuName       = MAKEINTRESOURCE(IDC_TEST);
wcex.lpszClassName      = “MYAPPCLASS”;
wcex.hIconSm            = LoadIcon(wcex.hInstance, MAKEINTRESOURCE(IDI_SMALL));

return RegisterClassEx(&wcex);
```

WinMain Entry Function

- Creating a window
  - Create an instance of the registered window class
  - Show the created window
  - Redraw the window

```
HWND hWnd = CreateWindow("MYAPPCLASS", "My Application", WS_OVERLAPPEDWINDOW,
                                        CW_USEDEFAULT, 0, CW_USEDEFAULT, 0, NULL, NULL, hInstance, NULL);

if (!hWnd) return FALSE;

ShowWindow(hWnd, nCmdShow);

UpdateWindow(hWnd);
```

WinMain Entry Function

- Message loop
  - Get messages
    - GetMessage : waiting
    - PeekMessage : polling
  - Translates incoming messages
  - Dispatches translated messages to the **WndProc** function

```
MSG msg = {0};
do        // message loop
{
          if(PeekMessage(&msg, NULL, 0, 0, PM_REMOVE))          // if there's a delivered message
          {
                         TranslateMessage(&msg);
                         DispatchMessage(&msg);
          }
} while(WM_QUIT != msg.message);       // until 'quit the application' message is delivered
```

WndProc Message Callback Function

```
LRESULT CALLBACK WndProc(HWND hWnd, UINT message, WPARAM wParam, LPARAM lParam)
```

- Parameters
  - Identical to MSG structure
  - hWnd : handle of the window which dispatched the message
  - message : message type
  - wParam, lParam : additional event information
- e.g. mouse move event
  - message : WM_LBUTTONDOWN
  - wParam : state of function keys and mouse buttons
  - lParam : x and y coordinate

WndProc Message Callback Function

- DefWindowProc
  - Default message handler function
- PostQuitMessage
  - Issue WM_QUIT message

```
switch (message)
{
    case WM_PAINT:
        hdc = BeginPaint(hWnd, &ps);
        EndPaint(hWnd, &ps);
        break;
    case WM_DESTROY:
        PostQuitMessage(0);
        break;
    default:
        return DefWindowProc(hWnd, message, wParam, lParam);
}
```

Windows GDI

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GDI

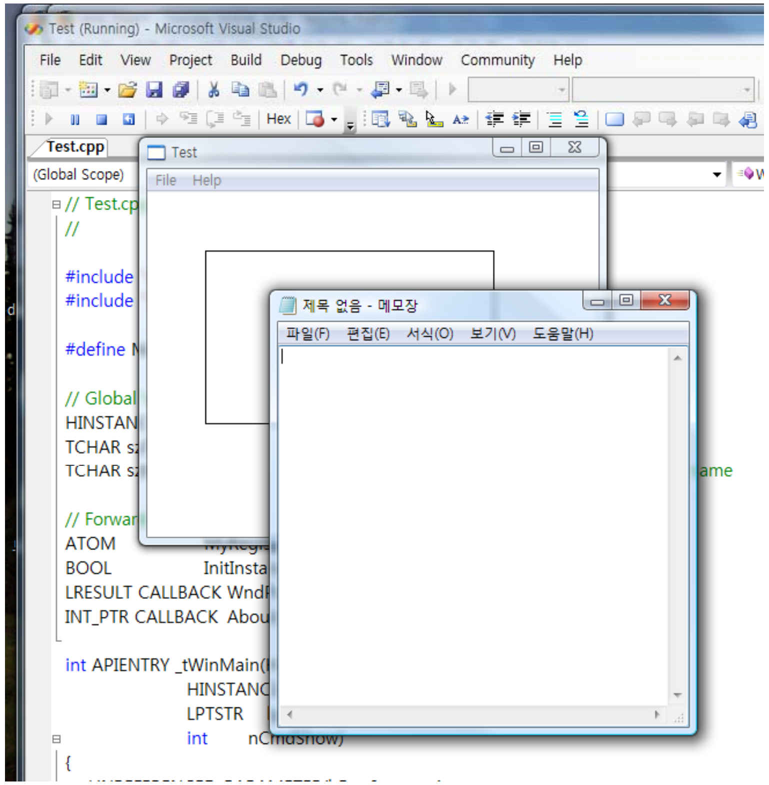
- Primitive Windows modules
  - Kernel
    - Memory management and process scheduling
  - User
    - UI and window management
  - GDI(Graphical Device Interface)
    - Output and graphical processing interface
    - Device-independent abstraction layer

GDI

- DC(Device Context)
  - Abstraction of 'output' devices
    - Screen
    - Printer
    - Memory (functioned as output buffer)
  - Contains all the information needed to output
- GDI Object
  - Abstraction of an information for output
    - Pen, Brush, Font, Bitmap…
    - Contains information of color, size, height…

Drawing on the Window

- Drawing once in WinMain or WM_CREATE handler
  - Problem
    - Does the Windows hold what is drawn in canvas?


Test (Running) - Microsoft Visual Studio
File Edit View Project Build Debug Tools Window Community Help
Hex
Test.cpp
(Global Scope)
Test
File Help
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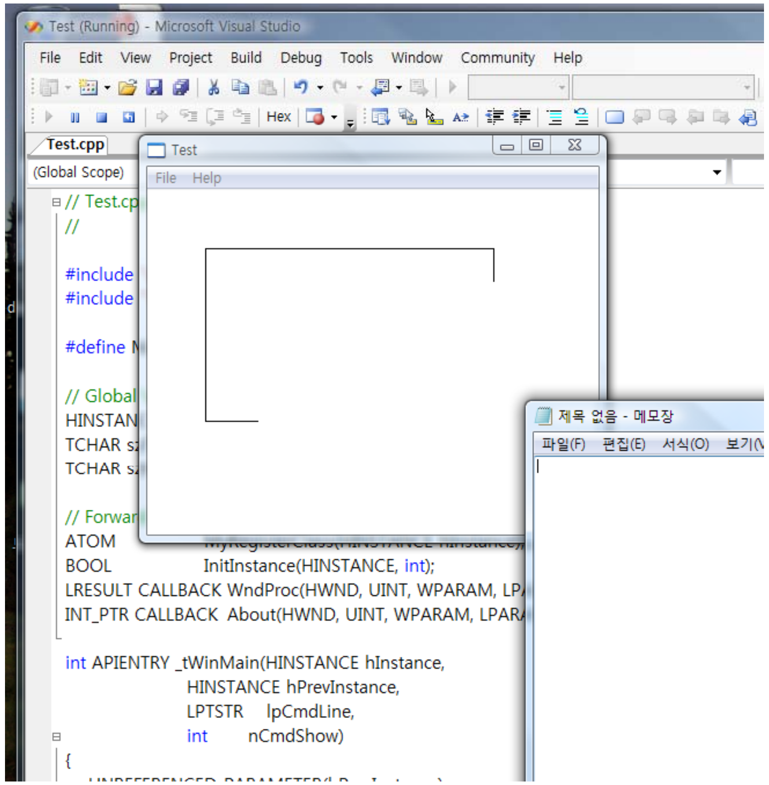
파일(F) 편집(E) 서식(O) 보기(V) 도움말(H)

```
// Test.cp
//

#include
#include

#define N

// Global
HINSTAN
TCHAR sz
TCHAR sz                                   ame

// Forwar
ATOM
BOOL            InitInsta
LRESULT CALLBACK WndP
INT_PTR CALLBACK Abou

int APIENTRY _tWinMain(
                HINSTANC
                LPTSTR
                int       nCmdShow)
{
```


Test (Running) - Microsoft Visual Studio
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```
// Test.cp
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#include
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// Global
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TCHAR s
TCHAR s

// Forwar
ATOM            MyRegisterClass(HINSTANCE hInstance);
BOOL            InitInstance(HINSTANCE, int);
LRESULT CALLBACK WndProc(HWND, UINT, WPARAM, LP
INT_PTR CALLBACK About(HWND, UINT, WPARAM, LPAR

int APIENTRY _tWinMain(HINSTANCE hInstance,
                HINSTANCE hPrevInstance,
                LPTSTR    lpCmdLine,
                int       nCmdShow)
{
```

Drawing on the Window

- WM_PAINT message
  - Issued when the window is need to be redrawn
  - UpdateWindow
    - Just issues WM_PAINT message to the window
- VS template code
  - BeginPaint prepares the window for painting
    - gets DC and information of the Window
  - EndPaint marks the end of painting

```
                                                  :
case WM_PAINT:
 {
     PAINTSTRUCT ps;
     HDC hdc = BeginPaint(hWnd, &ps);
     // TODO: Add any drawing code here...
     EndPaint(hWnd, &ps);
     break;
 }
                                                  :
```

Drawing on the Window

- SetPixel
  - Draw a pixel
  - GDI object is not necessary
  - Very slow

```
COLORREF SetPixel(
  HDC hdc,                       // handle to DC
  int X,                         // x-coordinate of pixel
  int Y,                         // y-coordinate of pixel
  COLORREF crColor               // pixel color
);
```

- COLORREF
  - X8B8G8R8 DWORD   e.g. 0x000000FF
  - RGB(r, g, b) macro   e.g. RGB(0,0,255)

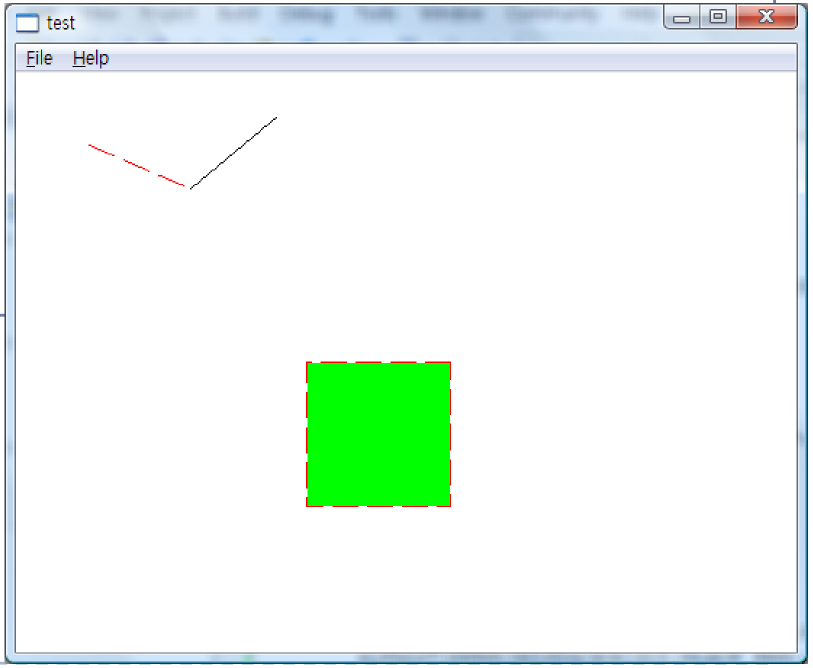
Using GDI objects

- Create GDI objects
  - Creation functions
    - CreatePen, CreateSolidBrush, …
    - Memory consuming objects → need to be deleted later
  - GetStockObject function
    - pre-defined objects
    - Deletion is not necessary (actually, not allowed!)
- Attach the new object to DC
  - SelectObject function
    - Returns the previous object handle
- Draw with attached objects
- Restore the previous object
- Delete created objects

A black solid pen and a null brush are default GDI objects attached to the window DC.

Using GDI objects

```
HPEN myPen, myPen2, oldPen;

myPen=CreatePen(PS_DASH, 1, RGB(255,0,0)); // create a red, 3-px-width, dashed pen
myPen2=(HPEN)GetStockObject(BLACK_PEN);                 // get the black solid pen

SelectObject(hdc, CreateSolidBrush(RGB(0, 255, 0)));    // use a green solid brush
oldPen=(HPEN)SelectObject(hdc, myPen);                  // use myPen

Rectangle(hdc, 200, 200, 300, 300);
MoveToEx(hdc, 50, 50, NULL);
LineTo(hdc, 120, 80);

SelectObject(hdc, myPen2);          // use myPen2

LineTo(hdc, 180, 30);

SelectObject(hdc, oldPen);          // use previous pen

DeleteObject(myPen);  // delete created objects
DeleteObject(SelectObject(hdc, GetStockObject(NULL_BRUSH)));
```



Buffered Drawing on GDI

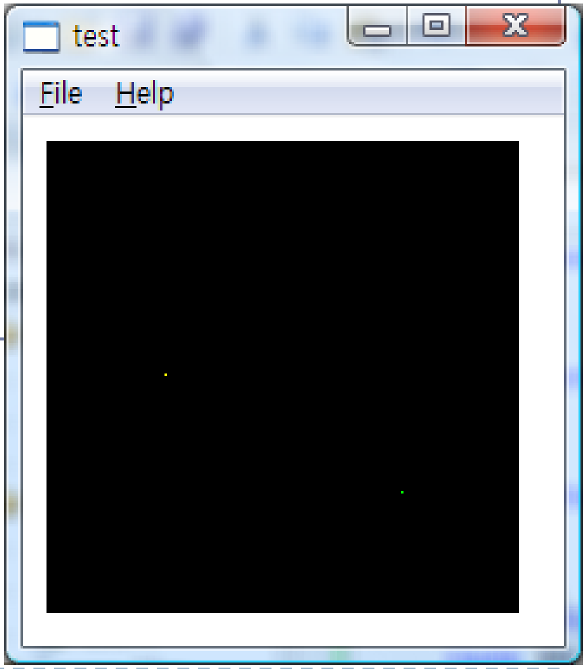
- Problems when drawing on the window directly
  - GDI drawing function is slow at all
    - flickering, tearing and shearing
- Buffering
  - Draw or do something with memory buffer
  - Write the buffer to the screen
- In Win32, buffering can be implemented with DIB and Memory DC

Using Bitmap and Memory DC

- Bitmap
  - One of the GDI object types
  - DDB(Device Dependent Bitmap)
  - DIB(Device Independent Bitmap)
    - BMP file
- Memory DC
  - Not attached to any actual device
  - Consumes memory
    - Delete using DeleteDC function after use
  - Can select BITMAP as a GDI object
    - Bitmap must be compatible with DC
    - The bound bitmap works as 'surface' of the DC
    - Impossible for actual device DCs
  - Can be copied to normal DC fast
    - BitBlt, StretchBlt, …

Using Bitmap and Memory DC

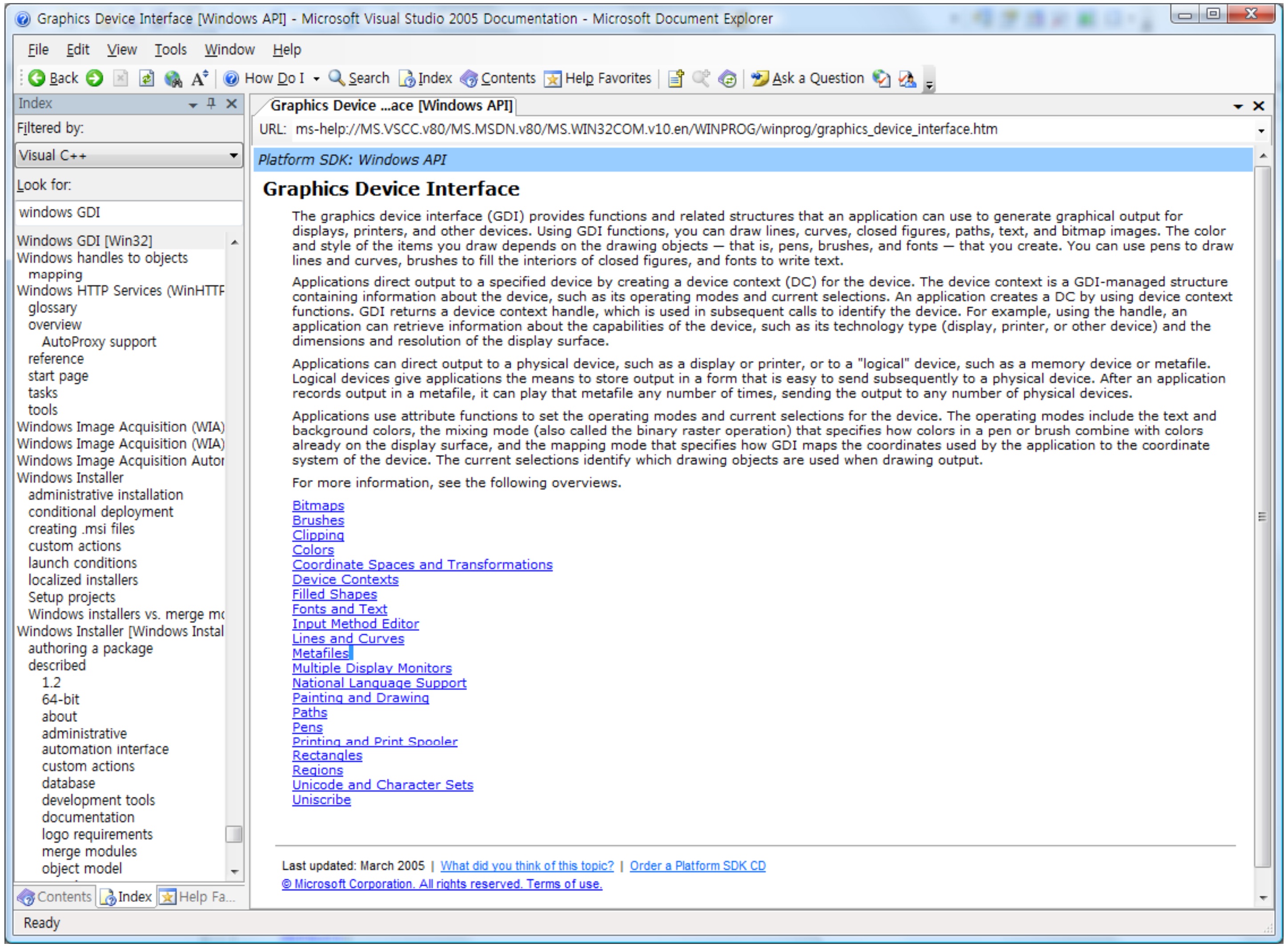
```
HDC mdc=CreateCompatibleDC(hdc);                        // Create a memory DC that is compatible with screen
BITMAPINFO bmi;                                         // bitmap header
// this is identical to BMP header. if you don't know about it, just change biWidth and biHeight
bmi.bmiHeader.biSize=sizeof(BITMAPINFO);
bmi.bmiHeader.biWidth=200;                              // bitmap width
bmi.bmiHeader.biHeight=200;                             // bitmap height
bmi.bmiHeader.biBitCount=32;                            // bit count of a pixel
bmi.bmiHeader.biCompression=BI_RGB;
bmi.bmiHeader.biSizeImage=0;
bmi.bmiHeader.biClrUsed=0;
DWORD *buf;
// create a DIB with the above header information. Actual buffer pixel data will be allocated to buf
HBITMAP myBitmap=CreateDIBSection(hdc, &bmi, DIB_RGB_COLORS, (void**)(&buf), NULL, NULL);
BITMAP myBitmapInfo;
GetObject(myBitmap, sizeof(BITMAP), &myBitmapInfo);
buf[200*100+50]=0x00FFFF00;          // Now you can access the buffer immediately.
buf[200*50+150]=0x0000FF00;          // The pixel format is X8R8G8B8.
SelectObject(mdc, myBitmap);
BitBlt(hdc, 10, 10, 200, 200, mdc, 0, 0, SRCCOPY);// copy from mdc to hdc
DeleteObject(myBitmap);              // delete bitmap. buf will be freed.
DeleteDC(mdc);                       // delete the memory DC
EndPaint(hWnd, &ps);
```



- Manipulating GDI Bitmaps is so complicated for its device-independent design concepts. If it's so difficult for you to understand, just use this sample code.

Other GDI features

- See MSDN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  glossary
  overview
    AutoProxy support
  reference
  start page
  tasks
  tools
Windows Image Acquisition (WIA)
Windows Image Acquisition (WIA)
Windows Image Acquisition Autor
Windows Installer
  administrative installation
  conditional deployment
  creating .msi files
  custom actions
  launch conditions
  localized installers
  Setup projects
  Windows installers vs. merge mo
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  authoring a package
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    1.2
    64-bit
    about
    administrative
    automation interface
    custom actions
    database
    development tools
    documentation
    logo requirements
    merge modules
    object model

URL: ms-help://MS.VSCC.v80/MS.MSDN.v80/MS.WIN32COM.v10.en/WINPROG/winprog/graphics_device_interface.htm

Platform SDK: Windows API

Graphics Device Interface

The graphics device interface (GDI) provides functions and related structures that an application can use to generate graphical output for displays, printers, and other devices. Using GDI functions, you can draw lines, curves, closed figures, paths, text, and bitmap images. The color and style of the items you draw depends on the drawing objects — that is, pens, brushes, and fonts — that you create. You can use pens to draw lines and curves, brushes to fill the interiors of closed figures, and fonts to write text.

Applications direct output to a specified device by creating a device context (DC) for the device. The device context is a GDI-managed structure containing information about the device, such as its operating modes and current selections. An application creates a DC by using device context functions. GDI returns a device context handle, which is used in subsequent calls to identify the device. For example, using the handle, an application can retrieve information about the capabilities of the device, such as its technology type (display, printer, or other device) and the dimensions and resolution of the display surface.

Applications can direct output to a physical device, such as a display or printer, or to a "logical" device, such as a memory device or metafile. Logical devices give applications the means to store output in a form that is easy to send subsequently to a physical device. After an application records output in a metafile, it can play that metafile any number of times, sending the output to any number of physical devices.

Applications use attribute functions to set the operating modes and current selections for the device. The operating modes include the text and background colors, the mixing mode (also called the binary raster operation) that specifies how colors in a pen or brush combine with colors already on the display surface, and the mapping mode that specifies how GDI maps the coordinates used by the application to the coordinate system of the device. The current selections identify which drawing objects are used when drawing output.

For more information, see the following overviews.

Bitmaps
Brushes
Clipping
Colors
Coordinate Spaces and Transformations
Device Contexts
Filled Shapes
Fonts and Text
Input Method Editor
Lines and Curves
Metafiles
Multiple Display Monitors
National Language Support
Painting and Drawing
Paths
Pens
Printing and Print Spooler
Rectangles
Regions
Unicode and Character Sets
Uniscribe

Last updated: March 2005 | What did you think of this topic? | Order a Platform SDK CD
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Summary

- Make full use of MSDN documents
- If you can't understand at all…
  - Just remind
    - How to create a window
    - How to draw a pixel
  - It will so slow, but you can complete the assignment #1 with only these features
- For reasonable execution time, using bitmap is recommended

Speed is not a grading factor, but debugging a "SetPixel program" will drain your endurance!

Preparing for DirectX Programming

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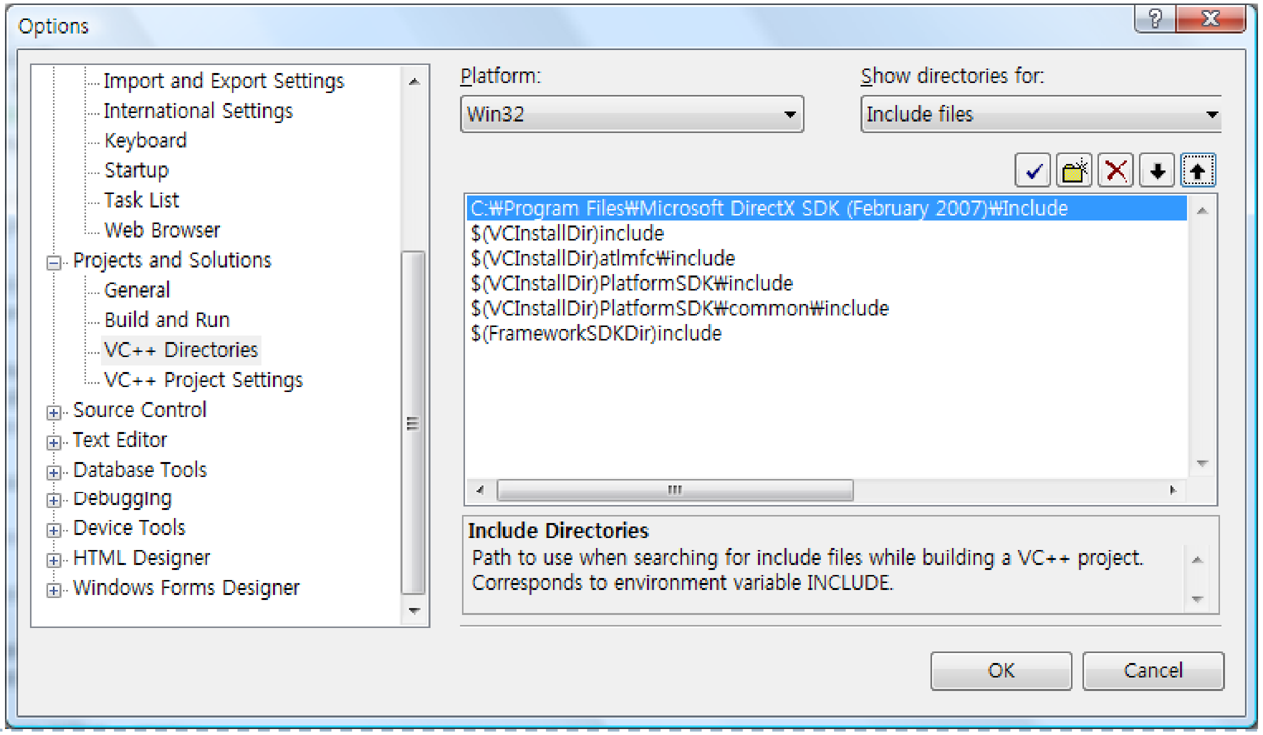
Preparing for DirectX Programming

- DirectX SDK
  - Development kit for DirectX application
  - Frequent updates
    - Recent update : Nov. 2007
      - http://www.microsoft.com/downloads/details.aspx?FamilyID=4B78A58A-E672-4B83-A28E-72B5E93BD60A&displaylang=en (427.8MB)
    - The latest version is recommended
- Supported language
  - Visual C/C++
  - .NET languages : Managed DirectX

Recent versions of DirectX SDK contain DX10 API for Windows Vista. We use DX9.

Preparing for DirectX Programming

- Visual Studio settings for DirectX
  - Register DirectX include and library directories
    - <Menu> Tools → Options
    - Move the DirectX directories to the top
      - Visual Studio contains old-version DX include and libraries



Platform: Win32

Show directories for: Include files

```
C:₩Program Files₩Microsoft DirectX SDK (February 2007)₩Include
$(VCInstallDir)include
$(VCInstallDir)atlmfc₩include
$(VCInstallDir)PlatformSDK₩include
$(VCInstallDir)PlatformSDK₩common₩include
$(FrameworkSDKDir)include
```

Include Directories
Path to use when searching for include files while building a VC++ project. Corresponds to environment variable INCLUDE.

References

- Windows Programming
  - Programming Windows Fifth Edition
    - Charles Petzold, Microsoft Press, 1998
  - MSDN Win32 Platform SDK Documents
    - Online available http://msdn.microsoft.com/library/default.asp?url=/library/en-us/sdkintro/sdkintro/devdoc_platform_software_development_kit_start_page.asp
- DirectX Programming
  - MSDN Direct3D 9 Documents
    - Included in DirectX SDK
    - Online available http://msdn2.microsoft.com/en-us/library/bb173023.aspx
    - This course will follow tutorials on this document

If you install the offline MSDN package, "Context-sensitive help" will help you to code more efficiently.

Any Question?