

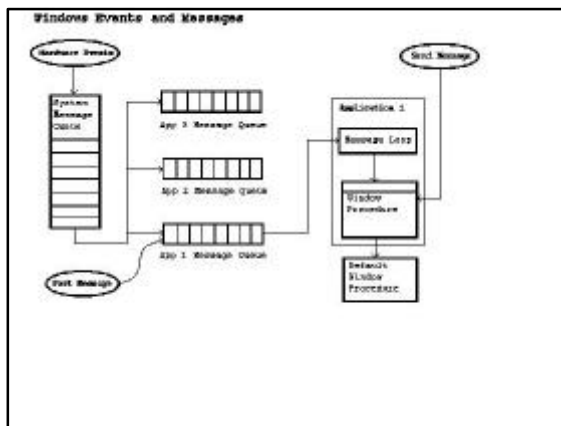
An Introduction to Windows Win32 API Programming

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Win32 API Programming

- Event-driven, graphics oriented
- Example: User clicks mouse over a program's window area--
 - Windows decodes HW signals from mouse
 - figures out which window user has selected
 - sends a message to that window's program:
 - "User has clicked over (X,Y)"
 - "Do something and return control to me"
 - Program reads message data, does what's needed, returns control to Windows

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Overview of Win32 API Program Structure--2 main tasks:

- Initial activities
- Process messages from Windows (the message loop)

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PSEUDOCODE

- Initialize variables, memory space
- Create & show program's Window
- Loop
 - Fetch any msg sent from Windows to this pgm
 - If message is QUIT
 - terminate program, return control to Windows
 - If message is something else
 - take actions based on message & parameters
 - return control to Windows
- End Loop

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Essential Parts of a Windows Pgm

- **I. The source program (.c/.cpp file):**
 - A. WinMain() function
 - 0. declarations, initialization, etc.
 - 1. register window class
 - 2. create a window based on a registered class
 - 3. show window, make it update its client area
 - 4. the message loop (get messages from Windows, dispatch back to Windows for forwarding to correct callback message-processing function)
 - B. WndProc(): the msg-processing function.

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• II. The resource script (.rc file):

- contains resource (Windows static) data
- separate from code and dynamic data
- compiled by a separate "Resource Compiler"
- Examples:
 - Keyboard Accelerators, Bitmaps, Cursors, Dialog Box specs, Fonts, Icons, Menus, String Tables
- Separation of resources and program code==>
 - reduced memory demands
 - separates tasks of programmer & designer
 - can change user interface w/o touching code

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Example Program

- See Windows Program: winapp2.cpp

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The WinMain() Function

- int PASCAL WinMain (HINSTANCE hInstance, HINSTANCE hPrevInstance, LPSTR lpszCmdLine, int nCmdShow);
- WinMain() starts first
- int exit code returned to Windows
- PASCAL l-to-r parameter passing on stack
- 4 parameters passed in from Windows
 - hInstance: a handle, identifies current pgm instance
 - lpszCmdLine: string containing command line args
 - nCmdShow: how window is to appear when shown

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Hungarian Notation

- help clarify variable types
- precede name with key letters representing type
- named after Hungarian Microsoft programmer, Charles Simonyi

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prefix data type

```
-----  
by  BYTE (unsigned char)  
b   BOOL (int, TRUE=1 FALSE=0)  
c   char  
dw  DWORD (4-byte unsigned long)  
fn  function  
h   handle  
l   long (4 bytes)  
n   short (int) near pointer  
p   pointer  
sz  null-terminated char string  
w   word (two bytes)  
lpsz long ptr to null-terminated str
```

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RegisterClass(&wndclass);

```
typedef struct tagWNDCLASS {  
    UINT style;  
    LRESULT CALLBACK lpfnWndProc();  
    int cbClsExtra;  
    int cbWndExtra;  
    HINSTANCE hInstance;  
    HICON hIcon;  
    HCURSOR hCursor;  
    HBRUSH hBackground;  
    LPSTR lpszMenuName  
    LPSTR lpszClassName } WNDCLASS;  
if (!RegisterClass (&wndclass)) return 0;
```

Sets general properties of all windows based on class

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CreateWindow() arguments:

window class name
window caption
window style (OR of style masks)
initial x , y position in pixels
initial width , height
parent window handle (if main window, NULL)
window menu handle (NULL if class menu used)
program instance handle (passed in from Windows)
creation parameters (for extra data, usually NULL)

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ShowWindow (hWnd,nCmdShow);

- makes window visible on screen
- hWnd: which window to make visible
- nCmdShow: how (normal, minimized, etc.)
 - set by Windows environment when program is started;
 - value is passed in from Windows;
 - "normal" can be overridden

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UpdateWindow (hWnd);

- Causes client area to be updated
- Painted with background brush

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The Message Loop

- User interaction-->a msg sent to a window
- Lots of other actions-->messages
- A message structure:
 - HWND hwnd; // target window handle
 - UINT message; // msg ID value--WM_***
 - WPARAM wParam; // data passed in msg
 - LPARAM lParam; // more data in msg
 - DWORD time; // time msg was sent
 - POINT pt; // mouse cursor position (x,y)

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GetMessage()

- Program must keep checking for messages
- Use message loop with GetMessage()
- BOOL GetMessage(
 - LPMSG lpMsg, //ptr to msg struct
 - HWND hWnd, //target window
 - UINT wParam, //1st msg in range
 - UINT lParam, //last msg in range)

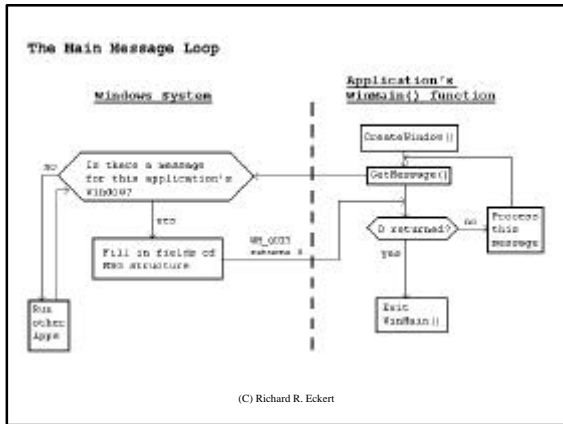
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GetMessage()

- Reads next msg from app's msg queue
- Fills MSG struct pointed to by first param.
- Place in a loop:

```
while (GetMessage(&msg, NULL, 0, 0))
{ ... }
return(msg.wParam);
```
- Returns non-0, except for WM_QUIT msg
- Terminates msg loop & returns control to Windows

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Message Processing

- What goes inside the message loop:
 - TranslateMessage (&msg)*--
"Cooks" keyboard input
Converts raw key codes to ANSI codes
 - DispatchMessage (&msg)*--
Sends message on to Windows, which forwards it to program's "Window Procedure":
WndProc()--
2nd member of WNDCLASS structure
Programmer must write this function

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The Window Procedure

- "callback" function (called by Windows)
- Should contain a switch/case statement :
 - Looks at message ID of current message
 - Acts appropriately on "interesting" messages
 - Forwards other messages to default Window procedure--`DefWindowProc()`

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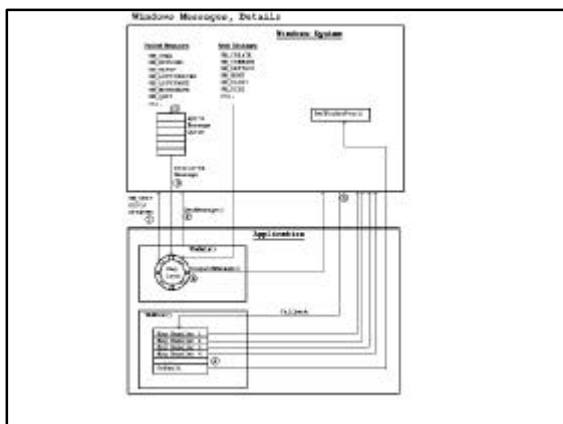
WndProc()

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

Parameters--
Same as first four fields of MSG structure:

- window associated with message
- message ID (what message is)
- message data (`wParam & lParam`)

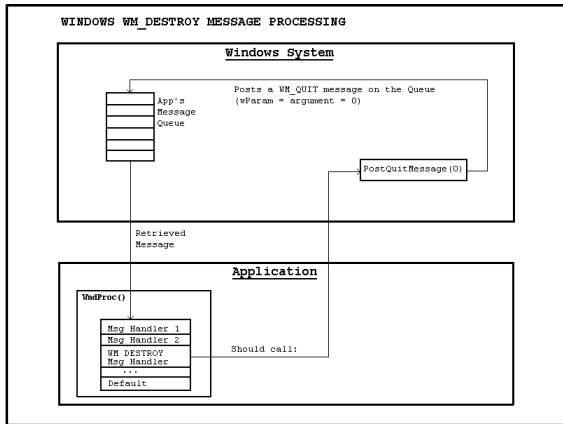
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The WM_DESTROY Message

- Sent when user does something to kill window
- `WndProc()` should respond by calling:
 - `PostQuitMessage();`
- Windows sends `WM_QUIT` msg to queue
- `wParam = 0` implies:
 - 0 returned by `GetMessage()` in `WinMain()`
 - so program exits `WinMain()`'s message loop
 - and return to Windows

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<Check out Winapp1.cpp code>

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- Some other important messages**
- WM_COMMAND--User clicked on menu item, LOWORD(wParam) = menu item ID
 - WM_*BUTTONDOWN--left/right mouse button pressed (* = L or R, lParam=x,y coordinates)
 - WM_MOUSEMOVE--mouse moved (lParam=x,y coords)
 - WM_CHAR--User pressed valid ANSI code character keyboard key combination (wParam=ANSI code)
 - WM_PAINT--Part of window was exposed & should be redrawn
 - WM_KEYDOWN--keyboard key pressed (wParam=virtual key code)
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II. The Resource Script (.rc file)

- Resources--static data
- Example: a menu
- Defined in a script (.rc) file--

```

#include "resource.h"
MYMENU MENU
BEGIN
    MENUITEM "&Circle",    IDM_CIRCLE
    MENUITEM "&Rectangle",  IDM_RECTANGLE
    MENUITEM "Clear &Screen",  IDM_CLEAR
    MENUITEM "&Quit",      IDM_QUIT
END
  
```

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The Resource header (.h file)

```

// resource.h
#define IDM_CIRCLE    40006
#define IDM_RECTANGLE 40007
#define IDM_CLEAR    40008
#define IDM_QUIT     40009
  
```

- Must be #included in .CPP & .RC files
- Can use Dev Studio's resource editors to prepare .rc & .h files visually
 - ID numbers generated automatically

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- Key idea with menus:**
- when menu item is selected
 - Windows sends a WM_COMMAND msg
 - low word of wParam=selected item ID
 - extract with macro LOWORD()
 - then do switch/case on LOWORD(wParam) to perform correct action
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TEXT AND GRAPHICS OUTPUT

- Displaying something in a window
- Text & graphics done one pixel at a time
- Any size/shape/position possible
- Design goal: Device Independence
 - Same program works with different HW
 - Windows takes care of HW interface
 - Programmer concentrates on program

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Device Independent Graphics Interface

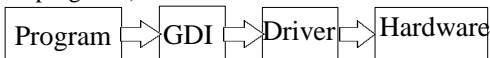
- Windows programs don't access hardware devices directly
- Make calls to generic drawing functions within the Windows 'Graphics Device Interface' (GDI) -- a DLL
- The GDI translates these into HW commands



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Device Independent Graphics Interface

- May use device drivers (HW control programs)



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

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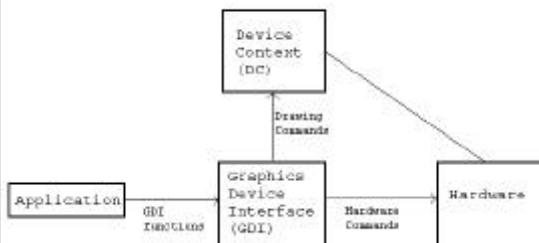
Device Context

- Windows programs don't draw directly on HW, but on a "Device Context" (DC)
 - Abstracts the device it represents
 - Like a painter's canvas
 - Specifies drawing attribute settings
 - e.g., text color
 - Contains drawing objects
 - e.g., pens, brushes, bitmaps, fonts
 - Must be obtained/released from Windows

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The DC and the GDI

Windows Drawing Using the GDI and the DC



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Some GDI Attribute Settings

ATTRIBUTE	DEFAULT	FUNCTION
Background color	white	SetBkColor()
Background mode	OPAQUE	SetBkMode()
Clipping Region	whole surf.	SelectClipRgn()
Current Position	(0,0)	MoveToEx()
Drawing Mode	R2COPYPEN	SetROP2()
Mapping Mode	MM_TEXT	SetMapMode()
Text Color	Black	SetTextColor()

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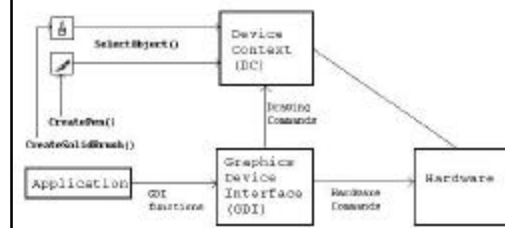
Some GDI Drawing Objects

Object	Default	What it is
Bitmap	none	image object
Brush	WHITE_BRUSH	area fill object
Font	SYSTEM_FONT	text font object
Pen	BLACK_PEN	line-drawing object
Color Palette	DEFAULT_PALETTE	color combinations

- Can be created with GDI functions
- Must be selected into a DC to be used

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Windows Drawing "Objects" and the DC



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Colors in Windows

- Uses four-byte numbers to represent colors
- Simplest method--direct color:

– typedef DWORD COLORREF;

 |0 | Blue (0-255) | Green (0-255) | Red (0-255) |

– MSB=0:

- ==> RGB color used (default)
- other bytes specify R, G, B intensities

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RGB() Macro

- Specify Red, Green, Blue intensities
- RGB() generates a COLORREF value
- can be used in color-setting functions, e.g.
 COLORREF cr;
 cr = RGB(0,0,255); /* blue */
- Example usage in a program
 SetTextColor(hDC,RGB(255,0,0)); //red text
 SetBkColor(hDC,RGB(0,0,255)); //blue bkgnd

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A typical sequence with objects:

```

HPEN hOldP, hNewP;
HDC hDC;
hDC = GetDC(hWnd);
hNewP = CreatePen(PS_SOLID, 3, RGB(0,0,71));
hOldP = (HPEN)SelectObject(hDC, hNewP);
// DO SOME DRAWING WITH THE NEW PEN
SelectObject(hDC,hOldP); //displace pen from DC
DeleteObject(hNewP); //now can be deleted
ReleaseDC(hWnd,hDC);
  
```

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Some GDI Drawing Primitives

- Arc(hDC,x1,y1,x2,y2,xStart,yStart,xEnd,yEnd);
- Ellipse (hDC, x1,y1,x2,y2);
- MoveToEx (hDC,x1,y1,lpPoint);
- LineTo (hDC,x1,y1);
- Polygon (hDC,points_array,nCount);
- Polyline (hDC,points_array,nCount);
- Rectangle (hDC,x1,y1,x2,y2);
- SetPixel (hDC,x1,y1,colref);
- Many more (see on-line help)

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Stock Objects

- **Predefined in Windows**
- **Obtain with GetStockObject();**
 - gets a handle to a predefined pen/brush/font
- **Stock objects are maintained by Windows**
 - should not be deleted!
- **Example**
SelectObject (hDC,
GetStockObject(BLACK_PEN));

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Some Stock Objects

Object Choices

Pen BLACK_PEN, WHITE_PEN, NULL_PEN
Brush DKGRAY_BRUSH, GRAY_BRUSH,
 BLACK_BRUSH, LTGRAY_BRUSH,
 NULL_BRUSH, WHITE_BRUSH
Font ANSI_FIXED_FONT, ANSI_VAR_FONT,
 DEVICE_DEFAULT_FONT, SYSTEM_FONT,
 OEM_FIXED_FONT, SYSTEM_FIXED_FONT

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The winapp2.cpp application

- **Details of WndProc()--**
 - menu item clicked==>WM_COMMAND msg
 - wParam==IDM_RECTANGLE ("Rectangle" menu item clicked):
 - draw red-outlined rectangle (pen) with solid cyan interior (brush)
 - wParam==IDM_CIRCLE ("Circle" clicked):
 - draw blue-outlined circle (pen) with crosshatched magenta interior (brush)

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- wParam==IDM_CLEAR ("Clear Screen" clicked):
 - call InvalidateRect() ==> Windows sends WM_PAINT msg
 - client area needs to be repainted
 - default Window Procedure repaints client area with class background brush
 - effectively erases window's client area
- wParam==IDM_QUIT ("Quit" clicked):
 - pgm calls DestroyWindow()
 - causes Windows to destroy window
 - and send a WM_DESTROY msg
 - which causes app to terminate

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- **left mouse button pressed ==> WM_LBUTTONDOWN msg**
 - get cursor's x,y coordinates from lParam
 - use LOWORD & HIWORD macros
 - output "L" at (x,y) on screen DC with TextOut()
- **right mouse button pressed ==> WM_RBUTTONDOWN msg**
 - output "R" at (x,y) on screen DC with TextOut()

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- User hits ANSI character keyboard key/s ==> WM_CHAR msg (wParam=char code)
 - copy character into a buffer
 - output buffer to upper left corner w/TextOut()
- User takes action to close window (double clicks on System menu or hits Alt-F4) ==> WM_DESTROY msg
 - post WM_QUIT msg to app's queue
 - causes program to exit event loop and return control to Windows

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<Look at Winapp2.cpp listing>

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Using Dev Studio to Create a Win32 API application visually

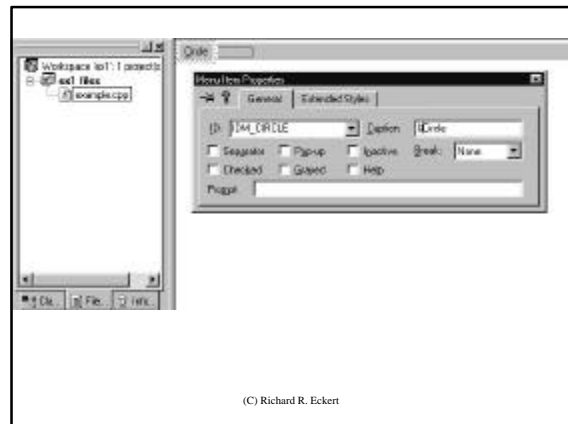
1. create .cpp source file with a text editor
 - must have: #include "resource.h"
2. Get into Developer Studio, open a new Workspace, & create an empty Win32 application
 - 'File | New | Projects tab | Win32 Application'
3. Enter or copy .cpp source file:
 - 'File | New | C++ Source' and paste in

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4. Create the .rc file using:

- 'File | New | Files Tab | Resource Script'
 - Give it the name winapp2.rc
- ### 5. Select 'Insert | Resource | Menu | New'
- Brings up menu editor
 - Double click in dotted rectangle on gray menu bar
 - In resulting "Menu Item Properties" box, remove Pop-up check mark
 - Enter ID: IDM_CIRCLE and Caption: &Circle
 - Do same for &Rectangle, Clear &Screen, &Quit menu items (IDs: IDM_RECTANGLE, IDM_CLEAR, and IDM_QUIT)

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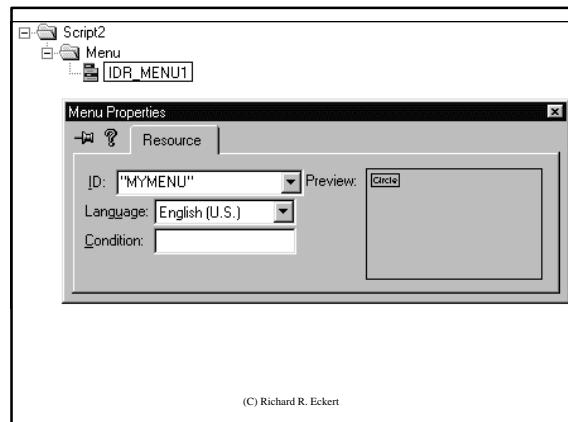


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6. Minimize Menu Editor box (menu name is IDR_MENU1)

- right click on that & click on "Properties" in resulting dialog box
 - brings up "Menu Properties" box"
 - change ID to "MYMENU" (must be in quotes)
- ### 7. Save your script file (should be called winapp2.rc).
- ### 8. Build the project

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