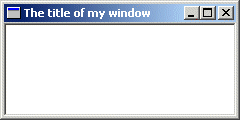
**A Simple Window**

Example: simple\_window

Sometimes people come on IRC and ask "How do I make a window?"...Well it's not entirely that simple I'm afraid. It's not difficult once you know what you're doing but there are quite a few things you need to do to get a window to show up; And they're more than can be simply explained over a chat room, or a quick note.

I always liked to do things first and learn them later...so here is the code to a simple window which will be explained shortly.

#include <windows.h>

const char g\_szClassName[] = "myWindowClass";

// Step 4: the Window Procedure

LRESULT CALLBACK WndProc(HWND hwnd, UINT msg, WPARAM wParam, LPARAM lParam)

{

switch(msg)

{

case WM\_CLOSE:

DestroyWindow(hwnd);

break;

case WM\_DESTROY:

PostQuitMessage(0);

break;

default:

return DefWindowProc(hwnd, msg, wParam, lParam);

}

return 0;

}

int WINAPI WinMain(HINSTANCE hInstance, HINSTANCE hPrevInstance,

LPSTR lpCmdLine, int nCmdShow)

{

WNDCLASSEX wc;

HWND hwnd;

MSG Msg;

//Step 1: Registering the Window Class

wc.cbSize = sizeof(WNDCLASSEX);

wc.style = 0;

wc.lpfnWndProc = WndProc;

wc.cbClsExtra = 0;

wc.cbWndExtra = 0;

wc.hInstance = hInstance;

wc.hIcon = LoadIcon(NULL, IDI\_APPLICATION);

wc.hCursor = LoadCursor(NULL, IDC\_ARROW);

wc.hbrBackground = (HBRUSH)(COLOR\_WINDOW+1);

wc.lpszMenuName = NULL;

wc.lpszClassName = g\_szClassName;

wc.hIconSm = LoadIcon(NULL, IDI\_APPLICATION);

if(!RegisterClassEx(&wc))

{

MessageBox(NULL, "Window Registration Failed!", "Error!",

MB\_ICONEXCLAMATION | MB\_OK);

return 0;

}

// Step 2: Creating the Window

hwnd = CreateWindowEx(

WS\_EX\_CLIENTEDGE,

g\_szClassName,

"The title of my window",

WS\_OVERLAPPEDWINDOW,

CW\_USEDEFAULT, CW\_USEDEFAULT, 240, 120,

NULL, NULL, hInstance, NULL);

if(hwnd == NULL)

{

MessageBox(NULL, "Window Creation Failed!", "Error!",

MB\_ICONEXCLAMATION | MB\_OK);

return 0;

}

ShowWindow(hwnd, nCmdShow);

UpdateWindow(hwnd);

// Step 3: The Message Loop

while(GetMessage(&Msg, NULL, 0, 0) > 0)

{

TranslateMessage(&Msg);

DispatchMessage(&Msg);

}

return Msg.wParam;

}

For most part this is the simplest windows program you can write that actually creates a functional window, a mere 70 or so lines. If you got the first example to compile then this one should work with no problems.

**Step 1: Registering the Window Class**

A *Window Class* stores information about a type of window, including it's *Window Procedure* which controls the window, the small and large icons for the window, and the background color. This way, you can register a class once, and create as many windows as you want from it, without having to specify all those attributes over and over. Most of the attributes you set in the window class can be changed on a per-window basis if desired.

A Window Class has NOTHING to do with C++ classes.

const char g\_szClassName[] = "myWindowClass";

The variable above stores the name of our window class, we will use it shortly to register our window class with the system.

WNDCLASSEX wc;

wc.cbSize = sizeof(WNDCLASSEX);

wc.style = 0;

wc.lpfnWndProc = WndProc;

wc.cbClsExtra = 0;

wc.cbWndExtra = 0;

wc.hInstance = hInstance;

wc.hIcon = LoadIcon(NULL, IDI\_APPLICATION);

wc.hCursor = LoadCursor(NULL, IDC\_ARROW);

wc.hbrBackground = (HBRUSH)(COLOR\_WINDOW+1);

wc.lpszMenuName = NULL;

wc.lpszClassName = g\_szClassName;

wc.hIconSm = LoadIcon(NULL, IDI\_APPLICATION);

if(!RegisterClassEx(&wc))

{

MessageBox(NULL, "Window Registration Failed!", "Error!",

MB\_ICONEXCLAMATION | MB\_OK);

return 0;

}

This is the code we use in WinMain() to register our window class. We fill out the members of a WNDCLASSEX structure and call RegisterClassEx().

The members of the struct affect the window class as follows:

cbSize

The size of the structure.

style

Class Styles (CS\_\*), not to be confused with Window Styles (WS\_\*) This can usually be set to 0.

lpfnWndProc

Pointer to the window procedure for this window class.

cbClsExtra

Amount of extra data allocated for this class in memory. Usually 0.

cbWndExtra

Amount of extra data allocated in memory *per window* of this type. Usually 0.

hInstance

Handle to application instance (that we got in the first parameter of WinMain()).

hIcon

Large (usually 32x32) icon shown when the user presses Alt+Tab.

hCursor

Cursor that will be displayed over our window.

hbrBackground

Background *Brush* to set the color of our window.

lpszMenuName

Name of a menu resource to use for the windows with this class.

lpszClassName

Name to identify the class with.

hIconSm

Small (usually 16x16) icon to show in the taskbar and in the top left corner of the window.

Don't worry if that doesn't make much sense to you yet, the various parts that count will be explained more later. Another thing to remember is to not try and remember this stuff. I rarely (never) memorize structs, or function parameters, this is a waste of effort and, more importantly, time. If you know the functions you need to call then it is a matter of seconds to look up the exact parameters in your help files. If you don't have help files, get them. You are lost without. Eventually you will come to know the parameters to the functions you use most.

We then call RegisterClassEx() and check for failure, if it fails we pop up a message which says so and abort the program by returning from the WinMain() function.

**Step 2: Creating the Window**

Once the class is registered, we can create a window with it. You should look up the paramters for CreateWindowEx() (as you should ALWAYS do when using a new API call), but I'll explain them briefly here.

HWND hwnd;

hwnd = CreateWindowEx(

WS\_EX\_CLIENTEDGE,

g\_szClassName,

"The title of my window",

WS\_OVERLAPPEDWINDOW,

CW\_USEDEFAULT, CW\_USEDEFAULT, 240, 120,

NULL, NULL, hInstance, NULL);

The first parameter (WS\_EX\_CLIENTEDGE) is the extended windows style, in this case I have set it to give it a sunken inner border around the window. Set it to 0 if you'd like to see the difference. Also play with other values to see what they do.

Next we have the class name (g\_szClassName), this tells the system what kind of window to create. Since we want to create a window from the class we just registered, we use the name of that class. After that we specify our window name or title which is the text that will be displayed in the *Caption*, or *Title Bar* on our window.

The parameter we have as WS\_OVERLAPPEDWINDOW is the *Window Style* parameter. There are quite a few of these and you should look them up and experiment to find out what they do. These will be covered more later.

The next four parameters (CW\_USEDEFAULT, CW\_USEDEFAULT, 320, 240) are the X and Y co-ordinates for the top left corner of your window, and the width and height of the window. I've set the X and Y values to CW\_USEDEFAULT to let windows choose where on the screen to put the window. Remeber that the left of the screen is an X value of zero and it increases to the right; The top of the screen is a Y value of zero which increases towards the bottom. The units are pixels, which is the smallest unit a screen can display at a given resolution.

Next (NULL, NULL, g\_hInst, NULL) we have the *Parent Window* handle, the menu handle, the application instance handle, and a pointer to window creation data. In windows, the windows on your screen are arranged in a heirarchy of parent and child windows. When you see a button on a window, the button is the *Child* and it is contained within the window that is it's *Parent*. In this example, the parent handle is NULL because we have no parent, this is our main or *Top Level* window. The menu is NULL for now since we don't have one yet. The instance handle is set to the value that is passed in as the first parameter to WinMain(). The creation data (which I almost never use) that can be used to send additional data to the window that is being created is also NULL.

If you're wondering what this magic NULL is, it's simply defined as 0 (zero). Actually, in C it's defined as ((void\*)0), since it's intended for use with pointers. Therefore you will possibly get warnings if you use NULL for integer values, depending on your compiler and the warning level settings. You can choose to ignore the warnings, or just use 0 instead.

Number one cause of people not knowing what the heck is wrong with their programs is probably that they didn't check the return values of their calls to see if they failed or not. CreateWindow() *will* fail at some point even if you're an experianced coder, simply because there are lots of mistakes that are easy to make. Untill you learn how to quickly identify those mistakes, at least give yourself the chance of figuring out where things go wrong, and **Always check return values!**

if(hwnd == NULL)

{

MessageBox(NULL, "Window Creation Failed!", "Error!",

MB\_ICONEXCLAMATION | MB\_OK);

return 0;

}

After we've created the window and checked to make sure we have a valid handle we show the window, using the last parameter in WinMain() and then update it to ensure that it has properly redrawn itself on the screen.

ShowWindow(hwnd, nCmdShow);

UpdateWindow(hwnd);

The nCmdShow parameter is optional, you could simply pass in SW\_SHOWNORMAL all the time and be done with it. However using the parameter passed into WinMain() gives whoever is running your program to specify whether or not they want your window to start off visible, maximized, minimized, etc... You will find options for these in the properties of windows shortcuts, and this parameter is how the choice is carried out.

**Step 3: The Message Loop**

This is the heart of the whole program, pretty much everything that your program does passes through this point of control.

while(GetMessage(&Msg, NULL, 0, 0) > 0)

{

TranslateMessage(&Msg);

DispatchMessage(&Msg);

}

return Msg.wParam;

GetMessage() gets a message from your application's message queue. Any time the user moves the mouse, types on the keyboard, clicks on your window's menu, or does any number of other things, messages are generated by the system and entered into your program's message queue. By calling GetMessage() you are requesting the next available message to be removed from the queue and returned to you for processing. If there is no message, GetMessage() *Blocks*. If you are unfamiliar with the term, it means that it waits untill there is a message, and then returns it to you.

TranslateMessage() does some additional processing on keyboard events like generating WM\_CHAR messages to go along with WM\_KEYDOWN messages. Finally DispatchMessage() sends the message out to the window that the message was sent to. This could be our main window or it could be another one, or a control, and in some cases a window that was created behind the scenes by the sytem or another program. This isn't something you need to worry about because all we are concerned with is that we get the message and send it out, the system takes care of the rest making sure it gets to the proper window.

**Step 4: the Window Procedure**

If the message loop is the heart of the program, the window procedure is the brain. This is where all the messages that are sent to our window get processed.

LRESULT CALLBACK WndProc(HWND hwnd, UINT msg, WPARAM wParam, LPARAM lParam)

{

switch(msg)

{

case WM\_CLOSE:

DestroyWindow(hwnd);

break;

case WM\_DESTROY:

PostQuitMessage(0);

break;

default:

return DefWindowProc(hwnd, msg, wParam, lParam);

}

return 0;

}

The window procedure is called for each message, the HWND parameter is the handle of your window, the one that the message applies to. This is important since you might have two or more windows of the same class and they will use the same window procedure (WndProc()). The difference is that the parameter hwnd will be different depending on which window it is. For example when we get the WM\_CLOSE message we destroy the window. Since we use the window handle that we received as the first paramter, any other windows will not be affected, only the one that the message was intended for.

WM\_CLOSE is sent when the user presses the Close Button [x] or types Alt-F4. This will cause the window to be destroyed by default, but I like to handle it explicitly, since this is the perfect spot to do cleanup checks, or ask the user to save files etc. before exiting the program.

When we call DestroyWindow() the system sends the WM\_DESTROY message to the window getting destroyed, in this case it's our window, and then destroys any remaining child windows before finally removing our window from the system. Since this is the only window in our program, we are all done and we want the program to exit, so we call PostQuitMessage(). This posts the WM\_QUIT message to the message loop. We never receive this message, because it causes GetMessage() to return FALSE, and as you'll see in our message loop code, when that happens we stop processing messages and return the final result code, the wParam of WM\_QUIT which happens to be the value we passed into PostQuitMessage(). The return value is only really useful if your program is designed to be called by another program and you want to return a specific value.

**Step 5: There is no Step 5**

Phew. Well that's it! If I haven't explained stuff clearly enough yet, just hang in there and hopefully things will become more clear as we get into more usefull programs.

|  |  |  |
| --- | --- | --- |
| |  | | --- | | **Handling Messages**  Example: window\_click  Alright, we've got a window, but it doesn't do anything except what DefWindowProc() allows it to, like be sized, maximised, etc... Not really all that exciting.  In the next section I am going to show you how to modify what you already have to do something new. This way I can just tell you *"Handle this message, and do this in it..."* and you will know what I mean and be able to do so without seeing an entire example. That's the hope anyway, so pay attention :P  Okay for starters take the example code for the last window we worked on and make sure it compiles and runs as expected. Then you can either keep working on it for the next little bit or copy it to a new project to modify.  We're going to add the capability to show the user what the name of our program is when they click on our window. Not very exciting, it's basically to get the hang of handling messages. Lets look at what we have in our WndProc():  LRESULT CALLBACK WndProc(HWND hwnd, UINT msg, WPARAM wParam, LPARAM lParam)  {  switch(msg)  {  case WM\_CLOSE:  DestroyWindow(hwnd);  break;  case WM\_DESTROY:  PostQuitMessage(0);  break;  default:  return DefWindowProc(hwnd, msg, wParam, lParam);  }  return 0;  }  If we want to handle mouse clicks, we need to add a WM\_LBUTTONDOWN handler (or WM\_RBUTTONDOWN, WM\_MBUTTONDOWN, for right and middle clicks respectively).  If I or someone else refers to *handling a message* they mean to add it into the WndProc() of your window class as follows:  LRESULT CALLBACK WndProc(HWND hwnd, UINT msg, WPARAM wParam, LPARAM lParam)  {  switch(msg)  {  case WM\_LBUTTONDOWN: // <-  // <- we just added this stuff  break; // <-  case WM\_CLOSE:  DestroyWindow(hwnd);  break;  case WM\_DESTROY:  PostQuitMessage(0);  break;  default:  return DefWindowProc(hwnd, msg, wParam, lParam);  }  return 0;  }  The order in which you handle your messages rarely matters. Just make sure you've got your break; after each one. As you can see we added another case into our switch(). Now we want something to happen when we get to this part of our program.  First I will present the code we want to add (that will show the user the filename of our program) and then I will integrate it into our program. Later on I will probably just show you the code and let you integrate it into your program. This is of course better for me as I don't have to type as much and it's better for you because you will be able to add the code into ANY program and not just the ones I present. **If you aren't sure how to do it, look at the example zip file included with the section.**  GetModuleFileName(hInstance, szFileName, MAX\_PATH);  MessageBox(hwnd, szFileName, "This program is:", MB\_OK | MB\_ICONINFORMATION);  Now this code does not stand on it's own, it can't just be slapped into our code any old place. We specifically want it to run when the user clicks the mouse button so this is how I would merge this small bit of code into our skeleton program:  LRESULT CALLBACK WndProc(HWND hwnd, UINT msg, WPARAM wParam, LPARAM lParam)  {  switch(msg)  {  case WM\_LBUTTONDOWN:  // BEGIN NEW CODE  {  char szFileName[MAX\_PATH];  HINSTANCE hInstance = GetModuleHandle(NULL);  GetModuleFileName(hInstance, szFileName, MAX\_PATH);  MessageBox(hwnd, szFileName, "This program is:", MB\_OK | MB\_ICONINFORMATION);  }  // END NEW CODE  break;  case WM\_CLOSE:  DestroyWindow(hwnd);  break;  case WM\_DESTROY:  PostQuitMessage(0);  break;  default:  return DefWindowProc(hwnd, msg, wParam, lParam);  }  return 0;  }  Note the new set of curly braces {} . These are required when declaring variables inside a switch() statement. This should be basic C knowledge but I thought I should point it out anyway for those of you doing things the hard way.  So if you've added in that code, compile it now. If it works, click on the window and you should see a box with the name of the .exe pop up.  You'll notice we've added two variables, hInstance and szFileName. Look up GetModuleFileName() and you will see that the first parameter is a HINSTANCE refering to the executable module (our program, the .exe file). Where do we get such a thing? GetModuleHandle() is the answer. The references for GetModuleHandle() indicate that passing in NULL will return us "*a handle to the file used to create the calling process*", which is exactly what we need, the HINSTANCE just mentioned. Putting all this information together we end up with the following declaration:  HINSTANCE hInstance = GetModuleHandle(NULL);  Now on to the second parameter, again turning to our trusty reference manual, we see that it is "*a pointer to a buffer that receives the path and file name of the specified module*" and the data type is LPTSTR (or LPSTR if your references are old). Since LPSTR is equivalent to char\* we can declare an array of char's like this:  char szFileName[MAX\_PATH];  MAX\_PATH is a handy macro included via <windows.h> that is defined to the maximum length of a buffer needed to store a filename under Win32. We also pass MAX\_PATH to GetModuleFileName() so it knows the size of the buffer.  After GetModuleFileName() is called, the buffer szFileName will be filled with a null terminated string containing the name of our .exe file. We pass this value to MessageBox() as an easy way of displaying it to the user.  So if you've added in that code, compile it now. If it works, click on the window and you should see a box with the name of the .exe pop up.  If it doesn't work, here's the full code to the program. Compare it to what you have and see what, if any, mistakes you made.  #include <windows.h>  const char g\_szClassName[] = "myWindowClass";  LRESULT CALLBACK WndProc(HWND hwnd, UINT msg, WPARAM wParam, LPARAM lParam)  {  switch(msg)  {  case WM\_LBUTTONDOWN:  {  char szFileName[MAX\_PATH];  HINSTANCE hInstance = GetModuleHandle(NULL);  GetModuleFileName(hInstance, szFileName, MAX\_PATH);  MessageBox(hwnd, szFileName, "This program is:", MB\_OK | MB\_ICONINFORMATION);  }  break;  case WM\_CLOSE:  DestroyWindow(hwnd);  break;  case WM\_DESTROY:  PostQuitMessage(0);  break;  default:  return DefWindowProc(hwnd, msg, wParam, lParam);  }  return 0;  }  int WINAPI WinMain(HINSTANCE hInstance, HINSTANCE hPrevInstance,  LPSTR lpCmdLine, int nCmdShow)  {  WNDCLASSEX wc;  HWND hwnd;  MSG Msg;  wc.cbSize = sizeof(WNDCLASSEX);  wc.style = 0;  wc.lpfnWndProc = WndProc;  wc.cbClsExtra = 0;  wc.cbWndExtra = 0;  wc.hInstance = hInstance;  wc.hIcon = LoadIcon(NULL, IDI\_APPLICATION);  wc.hCursor = LoadCursor(NULL, IDC\_ARROW);  wc.hbrBackground = (HBRUSH)(COLOR\_WINDOW+1);  wc.lpszMenuName = NULL;  wc.lpszClassName = g\_szClassName;  wc.hIconSm = LoadIcon(NULL, IDI\_APPLICATION);  if(!RegisterClassEx(&wc))  {  MessageBox(NULL, "Window Registration Failed!", "Error!",  MB\_ICONEXCLAMATION | MB\_OK);  return 0;  }  hwnd = CreateWindowEx(  WS\_EX\_CLIENTEDGE,  g\_szClassName,  "The title of my window",  WS\_OVERLAPPEDWINDOW,  CW\_USEDEFAULT, CW\_USEDEFAULT, 240, 120,  NULL, NULL, hInstance, NULL);  if(hwnd == NULL)  {  MessageBox(NULL, "Window Creation Failed!", "Error!",  MB\_ICONEXCLAMATION | MB\_OK);  return 0;  }  ShowWindow(hwnd, nCmdShow);  UpdateWindow(hwnd);  while(GetMessage(&Msg, NULL, 0, 0) > 0)  {  TranslateMessage(&Msg);  DispatchMessage(&Msg);  }  return Msg.wParam;  } | |  | |
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# Understanding the Message Loop

Understanding the message loop and entire message sending structure of windows programs is essential in order to write anything but the most trivial programs. Now that we've tried out message handling a little, we should look a little deeper into the whole process, as things can get very confusing later on if you don't understand why things happen the way they do.

### What is a Message?

A message is an integer value. If you look up in your header files (which is good and common practice when investigating the workings of API's) you can find things like:

#define WM\_INITDIALOG 0x0110

#define WM\_COMMAND 0x0111

#define WM\_LBUTTONDOWN 0x0201

...and so on. Messages are used to communicate pretty much everything in windows at least on basic levels. If you want a window or control (which is just a specialized window) to do something you send it a message. If another window wants you to do something it sends you a message. If an event happens such as the user typing on the keyboard, moving the mouse, clicking a button, then messages are sent by the system to the windows affected. If you are one of those windows, you handle the message and act accordingly.

Each windows message may have up to two parameters, wParam and lParam. Originally wParam was 16 bit and lParam was 32 bit, but in Win32 they are both 32 bit. Not every message uses these parameters, and each message uses them differently. For example the WM\_CLOSE message doesn't use either, and you should ignore them both. The WM\_COMMAND message uses both, wParam contains *two* values, HIWORD(wParam) is the notification message (if applicable) and LOWORD(wParam) is the control or menu id that sent the message. lParam is the HWND (window handle) to the control which sent the message or NULL if the messages isn't from a control.

HIWORD() and LOWORD() are macros defined by windows that single out the two high bytes (High Word) of a 32 bit value (0x**FFFF**0000) and the low word (0x0000**FFFF**) respectively. In Win32 a WORD is a 16bit value, making DWORD (or Double Word) a 32bit value.

To send a message you can use PostMessage() or SendMessage(). PostMessage() puts the message into the *Message Queue* and returns immediatly. That means once the call to PostMessage() is done the message may or may not have been processed yet. SendMessage() sends the message directly to the window and does not return untill the window has finished processing it. If we wanted to close a window we could send it a WM\_CLOSE message like this PostMessage(hwnd, WM\_CLOSE, 0, 0); which would have the same effect as clicking on the [x] button on the top of the window. Notice that wParam and lParam are both 0. This is because, as mentioned, they aren't used for WM\_CLOSE.

### Dialogs

Once you begin to use dialog boxes, you will need to send messages to the controls in order to communicate with them. You can do this either by using GetDlgItem() first to get the handle to the control using the ID and then use SendMessage(), OR you can use SendDlgItemMessage() which combines the steps. You give it a window handle and a child ID and it will get the child handle, and then send it the message. SendDlgItemMessage() and similar APIs like GetDlgItemText() will work on all windows, not just dialog boxes.

### What is the Message Queue

Lets say you were busy handling the WM\_PAINT message and suddenly the user types a bunch of stuff on the keyboard. What should happen? Should you be interrupted in your drawing to handle the keys or should the keys just be discarded? Wrong! Obviously neither of these options is reasonable, so we have the message queue, when messages are posted they are added to the message queue and when you handle them they are removed. This ensure that you aren't going to miss messages, if you are handling one, the others will be queued up untill you get to them.

### What is a Message Loop

while(GetMessage(&Msg, NULL, 0, 0) > 0)

{

TranslateMessage(&Msg);

DispatchMessage(&Msg);

}

1. The message loop calls GetMessage(), which looks in your message queue. If the message queue is empty your program basically stops and waits for one (it *Blocks*).
2. When an event occures causing a message to be added to the queue (for example the system registers a mouse click) GetMessages() returns **a positive value** indicating there is a message to be processed, and that it has filled in the members of the MSG structure we passed it. It returns 0 if it hits WM\_QUIT, and **a negative value** if an error occured.
3. We take the message (in the Msg variable) and pass it to TranslateMessage(), this does a bit of additional processing, translating virtual key messages into character messages. This step is actually optional, but certain things won't work if it's not there.
4. Once that's done we pass the message to DispatchMessage(). What DispatchMessage() does is take the message, checks which window it is for and then looks up the Window Procedure for the window. It then calls that procedure, sending as parameters the handle of the window, the message, and wParam and lParam.
5. In your window procedure you check the message and it's parameters, and do whatever you want with them! If you aren't handling the specific message, you almost always call DefWindowProc() which will perform the default actions for you (which often means it does nothing).
6. Once you have finished processing the message, your windows procedure returns, DispatchMessage() returns, and we go back to the beginning of the loop.

This is a very important concept for windows programs. Your window procedure is not magically called by the system, in effect *you call it yourself* indirectly by calling DispatchMessage(). If you wanted, you could use GetWindowLong() on the window handle that the message is destined for to look up the window's procedure and call it directly!

while(GetMessage(&Msg, NULL, 0, 0) > 0)

{

WNDPROC fWndProc = (WNDPROC)GetWindowLong(Msg.hwnd, GWL\_WNDPROC);

fWndProc(Msg.hwnd, Msg.message, Msg.wParam, Msg.lParam);

}

I tried this with the previous example code, and it does work, however there are various issues such as Unicode/ANSI translation, calling timer callbacks and so forth that this method will not account for, and very likely will break all but trivial applications. So do it to try it, but don't do it in real code :)

Notice that we use GetWindowLong() to retreive the window procedure associated with the window. Why don't we just call our WndProc() directly? Well our message loop is responsible for ALL of the windows in our program, this includes things like buttons and list boxes that have their own window procedures, so we need to make sure that we call the right procedure for the window. Since more than one window can use the same window procedure, the first parameter (the handle to the window) is used to tell the window procedure which window the message is intended for.

As you can see, your application spends the majority of it's time spinning round and round in this message loop, where you joyfully send out messages to the happy windows that will process them. But what do you do when you want your program to exit? Since we're using a while() loop, if GetMessage() were to return FALSE (aka 0), the loop would end and we would reach the end of our WinMain() thus exiting the program. This is exactly what PostQuitMessage() accomplishes. It places a WM\_QUIT message into the queue, and instead of returning a positive value, GetMessage() fills in the Msg structure and returns 0. At this point, the wParam member of Msg contains the value that you passed to PostQuitMessage() and you can either ignore it, or return it from WinMain() which will then be used as the exit code when the process terminates.

**IMPORTANT:** GetMessage() will return **-1** if it encounters an error. Make sure you remember this, or it will catch you out at some point... even though GetMessage() is defined as returning a BOOL, it can return values other than TRUE or FALSE, since BOOL is defined as UINT (unsigned int). The following are examples of code that may *seem* to work, but will not process certian conditions correctly:

while(GetMessage(&Msg, NULL, 0, 0))

while(GetMessage(&Msg, NULL, 0, 0) != 0)

while(GetMessage(&Msg, NULL, 0, 0) == TRUE)

**The above are all wrong!** It may be of note that I used to use the first of these throughout the tutorial, since as I just mentioned, it works fine as long as GetMessage() never fails, which when your code is correct it won't. However I failed to take into consideration that if you're reading this, your code probably won't be correct a lot of the time, and GetMessage() will fail at some point :) I've gone through and corrected this, but forgive me if I've missed a few spots.

while(GetMessage(&Msg, NULL, 0, 0) > 0)

This, or code that has the same effect should always be used.

I hope you now have a better understanding of the windows message loop, if not, do not fear, things will make more sense once you have been using them for a while.

# Using Resources

You may also want to refer to the Appendices at the end of this tutorial for more information on resources with VC++ and BC++.

Before we get any deeper I will cover the topic of resources so that I won't have to re-write it for each section.**You don't actually need to compile the stuff in this section, it's as example only.**

Resources are pre-defined bits of data stored in binary format inside your executable file. You create resources in a resources script, a file with an extension of ".rc". comercial compilers will have a visual resource editor which allows you to create resources without manually editing this file but sometimes editing it is the only way to go, especially if your compiler has no visual editor, it sucks, or doesn't support the exact feature you need.

Unfortunately different compiler suites handle resources differently. I will do the best I can to explain the common features needed to work with resources in general.

The resource editor included with MSVC++ makes it very difficult to edit the resources manually, since it enforces a proprietary format on them, and will totally mangle the file if you save one that you had created by hand. In general you shouldn't bother with creating .rc files from scratch, but knowing how to modify them manually can be very useful. Another annoyance is that MSVC++ will by default name the resource header file "resource.h" even if you wanted to call it something else. I will go with this for the sake of simplicity in this document, but will show you how to change this in the appendix on compilers.

First lets take a very simple resource script, with a single icon.

#include "resource.h"

IDI\_MYICON ICON "my\_icon.ico"

That's the entire file. IDI\_MYICON is the identifier of the resource, ICON is the type and "my\_icon.ico" is the name of the external file which contains it. This should work on any compiler.

Now what about this #include "resource.h" ? Well your program needs a way to identify the icon, and the best way to do that is to assign it a unique ID (IDI\_MYICON). We can do this by creating the file "resource.h" and including it in both our resource script, and our source file.

#define IDI\_MYICON 101

As you can see, we've assigned IDI\_MYICON the value of 101. We could just forget about the identifier and use 101 wherever we need to reference the icon, but IDI\_MYICON is a lot clearer as to what you are refering too, and easier to remember when you have large number of resources.

Now lets say we add a MENU resource:

#include "resource.h"

IDI\_MYICON ICON "my\_icon.ico"

IDR\_MYMENU MENU

BEGIN

POPUP "&File"

BEGIN

MENUITEM "E&xit", ID\_FILE\_EXIT

END

END

Again IDR\_MYMENU is the name of the resource and MENU is the type. Now a fine point, see the BEGIN and END up there? Some resource editors or compilers use { in place of BEGIN and } in place of END. If your compiler supports both feel free to pick which one you use. If it only supports one or the other, you will need to make the necessary replacements to get it to work.

We've also added a new identifier, ID\_FILE\_EXIT, so we need to add this to our resource header file, resource.h, in order to use it in our program.

#define IDI\_MYICON 101

#define ID\_FILE\_EXIT 4001

Generating and keeping track of all these ids can become a real chore with large projects, that's why most people use a visual resource editor which takes care of all this for you. They still screw up from time to time, and you could end up with multiple items with the same ID or a similar problem, and it's good to be able to go in and fix it yourself.

Now an example of how to use a resource in your program.

HICON hMyIcon = LoadIcon(hInstance, MAKEINTRESOURCE(IDI\_MYICON));

The first parameter of LoadIcon() and many other resource using functions is the handle to the current instance (which we are given in WinMain() and can also be retreived by using GetModuleHandle() as demonstrated in previous sections). The second is the identifier of the resource.

You're probably wondering what's up with MAKEINTRESOURCE() and possibly wondering why LoadIcon() takes a parameter of type LPCTSTR instead of say UINT when we're passing it an ID. All MAKEINTRESOURCE() does is cast from an integer (what our ID is) to LPCTSTR, which LoadIcon() expects. This brings us to the second way of identifying resources, and that's with strings. Almost nobody does this any more, so I won't go into details, but basically if you don't use #define to assign an integer value to your resources then the name is interpreted as a string, and can be referenced in your program like this:

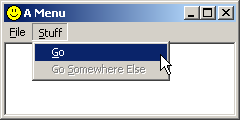
HICON hMyIcon = LoadIcon(hInstance, "MYICON");

LoadIcon() and other resource loading APIs can tell the difference between an integer passed in and a pointer to a string passed in by checking the high word of the value. If it's 0 (as would be the case of any integer with a value less than or equal to 65535) then it assumes it is a resource ID. This effectively limits your resources to using IDs below 65535, which unless you have a whole lot of resources, should not be a problem. If it's not 0 then it assumes the value is a pointer, and looks up the resource by name. Never rely on an API to do this unless it is explicitely stated in the documentation.

For example, this doesn't work for menu commands like ID\_FILE\_EXIT, since they can only be integers.

# Menus and Icons

Example: menu\_one

This is just a small section to show how to add basic menus to your window. Usually you use a pre-made menu resource. This will be in an .rc file and will be compiled and linked into your .exe. This is rather compiler specific, commercial compilers will have a resource editor that you can use to create your menus, but for this example I will show the text of the .rc file so you can add it in manually. I usually have an .h file as well which is included in both my .rc file and my .c source files. This file contains the identifiers for controls and menu items etc.

For this example you can start with the window code from simple\_window and add this code into it as instructed.

First the .h file. Usually called "resource.h"

#define IDR\_MYMENU 101

#define IDI\_MYICON 201

#define ID\_FILE\_EXIT 9001

#define ID\_STUFF\_GO 9002

Not much there, but our menu will be pretty simple. The names and values here are up to you for the choosing. Now we write our .rc file.

#include "resource.h"

IDR\_MYMENU MENU

BEGIN

POPUP "&File"

BEGIN

MENUITEM "E&xit", ID\_FILE\_EXIT

END

POPUP "&Stuff"

BEGIN

MENUITEM "&Go", ID\_STUFF\_GO

MENUITEM "G&o somewhere else", 0, GRAYED

END

END

IDI\_MYICON ICON "menu\_one.ico"

You will want to add the .rc file to your project or makefile depending on what tools you are using.

You also want to #include "resource.h" in your source file (.c) so that the menu command identifiers and the menu resource id will be defined.

The easiest way to attach the menu and icon to your window is to specify them when you register the window class, like this:

wc.lpszMenuName = MAKEINTRESOURCE(IDR\_MYMENU);

wc.hIcon = LoadIcon(GetModuleHandle(NULL), MAKEINTRESOURCE(IDI\_MYICON));

wc.hIconSm = (HICON)LoadImage(GetModuleHandle(NULL), MAKEINTRESOURCE(IDI\_MYICON), IMAGE\_ICON, 16, 16, 0);

Change that and see what happens. Your window should now have a File and Stuff menu with the respective items underneath. That is assuming your .rc file was properly compiled and linked into your program. (again, see compiler notes)

The icon in the top left of the window and on the task bar should now display the small custom icon that we specified. If you hit Alt-Tab, the large version of the icon should be displayed in the application list.

I've used LoadIcon() to load the large icon because it's simpler, however it will only load icons at the default resolution of 32x32, so in order to load the smaller image, we need to use LoadImage(). Be aware that icon files and resources can contain multiple images, and in this case the ones I've supplied contain the two sizes that I'm loading.

Example: menu\_two

An alternative to using a menu resource is to create one on the fly (or when your program runs). This is a bit more work programming wise, but adds flexibility and is sometimes necessary.

You can also use icons that aren't stored as resources, you could choose to store your icon as a seperate file and load it at runtime. This would also give you the option of allowing the user to select an icon of their choice with the common dialogs discussed later, or something to that effect.

Start again from simple\_window without the .h or .rc added. Now we will handle the WM\_CREATE message and add a menu to our window.

#define ID\_FILE\_EXIT 9001

#define ID\_STUFF\_GO 9002

Put these two id's at the top of your .c file this time, underneath your #includes. Next we add the following code into our WM\_CREATE handler.

case WM\_CREATE:

{

HMENU hMenu, hSubMenu;

HICON hIcon, hIconSm;

hMenu = CreateMenu();

hSubMenu = CreatePopupMenu();

AppendMenu(hSubMenu, MF\_STRING, ID\_FILE\_EXIT, "E&xit");

AppendMenu(hMenu, MF\_STRING | MF\_POPUP, (UINT)hSubMenu, "&File");

hSubMenu = CreatePopupMenu();

AppendMenu(hSubMenu, MF\_STRING, ID\_STUFF\_GO, "&Go");

AppendMenu(hMenu, MF\_STRING | MF\_POPUP, (UINT)hSubMenu, "&Stuff");

SetMenu(hwnd, hMenu);

hIcon = LoadImage(NULL, "menu\_two.ico", IMAGE\_ICON, 32, 32, LR\_LOADFROMFILE);

if(hIcon)

SendMessage(hwnd, WM\_SETICON, ICON\_BIG, (LPARAM)hIcon);

else

MessageBox(hwnd, "Could not load large icon!", "Error", MB\_OK | MB\_ICONERROR);

hIconSm = LoadImage(NULL, "menu\_two.ico", IMAGE\_ICON, 16, 16, LR\_LOADFROMFILE);

if(hIconSm)

SendMessage(hwnd, WM\_SETICON, ICON\_SMALL, (LPARAM)hIconSm);

else

MessageBox(hwnd, "Could not load small icon!", "Error", MB\_OK | MB\_ICONERROR);

}

break;

This creates a menu almost the same as the one we had in the resource and attaches it to our window. A menu that is assigned to a window is automatically removed when the program terminates, so we don't need to worry about getting rid of it later. If we did though, we could use GetMenu() and DestroyMenu().

The code for the icons is pretty simple, we call LoadImage() twice, to load the icon as both a 16x16 size and a 32x32 size. We can't use LoadIcon() at all because it will only load resources, not files. We specify NULL for the instance handle parameter because we aren't loading a resource from our module, and instead of a resource ID we pass in the name of the icon file we want to load. Finally, we pass in the LR\_LOADFROMFILE flag to indicate that we want the function to treat the string we give it as a filename and not a resource name.

If each call succeeds we assign the icon handle to our window with WM\_SETICON, and if it fails we pop up a message box letting us know something went wrong.

**NOTE:** that the LoadImage() calls will fail if the icon file isn't in the current working directory of the program. If you are using VC++ and you run the program from the IDE, the current working directory will be the one the project file is in. However if you run the program from the Debug or Release directories from explorer or the command shell, then you'll need to copy the icon file into that directory in order for the program to find it. If all else fails, specify the full path to the icon, "C:\\Path\\To\\Icon.ico".

Okay now that we have our menu, we need to make it do something. This is pretty simple, all we need to do is handle the WM\_COMMAND message. Also we'll need to check which command we are getting and act accordingly. Now our WndProc() should look something like this.

LRESULT CALLBACK WndProc(HWND hwnd, UINT Message, WPARAM wParam, LPARAM lParam)

{

switch(Message)

{

case WM\_CREATE:

{

HMENU hMenu, hSubMenu;

hMenu = CreateMenu();

hSubMenu = CreatePopupMenu();

AppendMenu(hSubMenu, MF\_STRING, ID\_FILE\_EXIT, "E&xit");

AppendMenu(hMenu, MF\_STRING | MF\_POPUP, (UINT)hSubMenu, "&File");

hSubMenu = CreatePopupMenu();

AppendMenu(hSubMenu, MF\_STRING, ID\_STUFF\_GO, "&Go");

AppendMenu(hMenu, MF\_STRING | MF\_POPUP, (UINT)hSubMenu, "&Stuff");

SetMenu(hwnd, hMenu);

hIcon = LoadImage(NULL, "menu\_two.ico", IMAGE\_ICON, 32, 32, LR\_LOADFROMFILE);

if(hIcon)

SendMessage(hwnd, WM\_SETICON, ICON\_BIG, (LPARAM)hIcon);

else

MessageBox(hwnd, "Could not load large icon!", "Error", MB\_OK | MB\_ICONERROR);

hIconSm = LoadImage(NULL, "menu\_two.ico", IMAGE\_ICON, 16, 16, LR\_LOADFROMFILE);

if(hIconSm)

SendMessage(hwnd, WM\_SETICON, ICON\_SMALL, (LPARAM)hIconSm);

else

MessageBox(hwnd, "Could not load small icon!", "Error", MB\_OK | MB\_ICONERROR);

}

break;

case WM\_COMMAND:

switch(LOWORD(wParam))

{

case ID\_FILE\_EXIT:

break;

case ID\_STUFF\_GO:

break;

}

break;

case WM\_CLOSE:

DestroyWindow(hwnd);

break;

case WM\_DESTROY:

PostQuitMessage(0);

break;

default:

return DefWindowProc(hwnd, Message, wParam, lParam);

}

return 0;

}

As you can see we've got our WM\_COMMAND all set up, and it even has another switch() in it. This switch()'s on the value of the low word of wParam, which in the case of WM\_COMMAND contains the control or menu id that sent the message.

We obviously want the Exit menu item to close the program. So in the WM\_COMMAND, ID\_FILE\_EXIT handler you can use the following code to do just that.

PostMessage(hwnd, WM\_CLOSE, 0, 0);

Your WM\_COMMAND handler should now look like this:

case WM\_COMMAND:

switch(LOWORD(wParam))

{

case ID\_FILE\_EXIT:

PostMessage(hwnd, WM\_CLOSE, 0, 0);

break;

case ID\_STUFF\_GO:

break;

}

break;

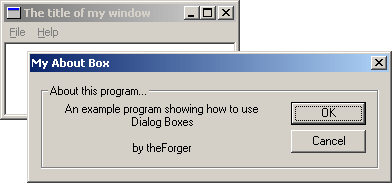
I leave it up to you to make the other menu command ID\_STUFF\_GO do something.

### The program file icon

You may have noticed that the menu\_one.exe file now shows up as the custom icon we added as a resource, whereas the menu\_two.exe file does not, since we are loading an external file. Windows Explorer simply displays the first icon (numerically by ID) in the program files resources, so since we only have one icon, that's what it is displaying. If you want to be sure that a certain icon is displayed with your program file, simply add it as a resource and assign it a very low ID... like 1. You don't even need to refer to the file in your program, and you can load completely different icons for your windows if you choose.

# Dialogs, GUI coders best friend

Example: dlg\_one

There's hardly a windows program out there that doesn't use dialog boxes. Just go File -> Open in any text editor or any other kind of editor for that matter and voila, you are presented with a dialog box, one that probably allows you to select a file to be opened.

Dialogs aren't limited to the standard open file ones, they can look like and do whatever you choose. The attractive point of dialogs is that they provide a quick way to arrange and create a GUI (Graphic User Interface) and even some default processing, cutting down on the amount of code you must write.

One thing to remember is that **dialogs are just windows**. The difference between a dialog and a "normal" window is that the system does some additional default processing for dialogs, such as creating and initialising controls, and handling tab order. Nearly all APIs that are applicable to "normal" windows will work just as well on dialogs, and vice versa!

The first step is to create the dialog resource. As with any resource how you do this will depend on your compiler/IDE. Here I will show you the plain text of the dilaog in the .rc file and let you incorporate it into your project.

IDD\_ABOUT DIALOG DISCARDABLE 0, 0, 239, 66

STYLE DS\_MODALFRAME | WS\_POPUP | WS\_CAPTION | WS\_SYSMENU

CAPTION "My About Box"

FONT 8, "MS Sans Serif"

BEGIN

DEFPUSHBUTTON "&OK",IDOK,174,18,50,14

PUSHBUTTON "&Cancel",IDCANCEL,174,35,50,14

GROUPBOX "About this program...",IDC\_STATIC,7,7,225,52

CTEXT "An example program showing how to use Dialog Boxes\r\n\r\nby theForger",

IDC\_STATIC,16,18,144,33

END

On this first line, IDD\_ABOUTDLG is the id of the resource. DIALOG is the resource type, and the four number are the Left, Top, Width and Height co-ordinates. These ARE NOT PIXELS, they are in Dialog Units, which are based on the size of the font used by the system (and chosen by the user). If you have a large font selected, the dialog will be large, if you use a smaller font, the dialog will be that much smaller. This is important as it makes sure that all of the controls are the proper size to display their text in the current font. You can convert dialog units to pixels at runtime using MapDialogRect(). DISCARDABLE tells the system it may swap the resource memory to disk when it's not being used in order to conserve system resources (essentially pointless).

The second line starts with STYLE and follows with the window styles that will be used to create the dialog. These should be explained under CreateWindow() in your help files. In order to use the predefined constants you may need to add #include "windows.h" to your .rc file, or in the case of VC++, winres.h or afxres.h will do. If you use the resource editor these files will certainly be included automatically if needed.

The CAPTION line should be self explanitory.

The FONT line specifies the size and name of the font you wish to use for this dialog box. This might not end up exactly the same on each computer as different people will have different fonts and may have specified different font sizes. You usually don't need to worry about that though.

Now we have the list of controls to create on the dialog

DEFPUSHBUTTON "&OK",IDOK,174,18,50,14

Here's the line for the OK button. The & in this case like with menus underlines the next letter "O", so that by pressing Alt+O the user can activate this control (part of the default processing I mentioned). IDOK is the control identifier. IDOK is pre-defined so we don't need to #define it ourselves. The four numbers at the end are the left, top, width and height, all in dialog units.

This information should be purely academic, as you almost always use a resource editor to create dialogs, but knowing how to do it from text is sometimes necessary, expecially if you have no visual editor.

Two of the controls have an ID of IDC\_STATIC (which is -1), this is used to indicate we never need to access them, so they have no need of an identifier. However it doesn't hurt to give them an ID and your resource editor might do so automatically.

The "\r\n" in the text of the static control is a CR-LF pair, the way windows represents a new line.

So! Having added that to your .rc file we need to write a Dialog Procedure to process message for this box. Don't worry this is nothing new, it's practicly the same as our main Window Procedure (but not exactly).

BOOL CALLBACK AboutDlgProc(HWND hwnd, UINT Message, WPARAM wParam, LPARAM lParam)

{

switch(Message)

{

case WM\_INITDIALOG:

return TRUE;

case WM\_COMMAND:

switch(LOWORD(wParam))

{

case IDOK:

EndDialog(hwnd, IDOK);

break;

case IDCANCEL:

EndDialog(hwnd, IDCANCEL);

break;

}

break;

default:

return FALSE;

}

return TRUE;

}

There are a few important differences between a dialog procedure and window procedure. One is that you DO NOT call DefWindowProc() for message you don't handle. With dialogs this is done automatically for you (and will really screw things up if you do it).

Secondly, in general you return FALSE for messages you don't process, and TRUE for messages you do process, UNLESS the message specifies you return something else. Note that this is what we do above, the default is to do nothing and return FALSE, while messages we do handle break the switch() and return TRUE.

Thirdy, You do not call DestroyWindow() to close a dialog, you call EndDialog(). The second paramter is the value that is returned to whatever code called DialogBox().

Finally, instead of handling WM\_CREATE, you handle WM\_INITDIALOG to do any processing that needs to be done before the dialog appears, and then return TRUE to have the keyboard focus set to the default control. (You can actually handle WM\_CREATE as well, but it is sent BEFORE any of the controls have been created, so you can't access them. In WM\_INITDIALOG the controls have already been created).

Enough chit-chat, lets create it....

case WM\_COMMAND:

switch(LOWORD(wParam))

{

case ID\_HELP\_ABOUT:

{

int ret = DialogBox(GetModuleHandle(NULL),

MAKEINTRESOURCE(IDD\_ABOUT), hwnd, AboutDlgProc);

if(ret == IDOK){

MessageBox(hwnd, "Dialog exited with IDOK.", "Notice",

MB\_OK | MB\_ICONINFORMATION);

}

else if(ret == IDCANCEL){

MessageBox(hwnd, "Dialog exited with IDCANCEL.", "Notice",

MB\_OK | MB\_ICONINFORMATION);

}

else if(ret == -1){

MessageBox(hwnd, "Dialog failed!", "Error",

MB\_OK | MB\_ICONINFORMATION);

}

}

break;

// Other menu commands...

}

break;

This is the code I used to create my about box, you can probably guess that this is to be merged into your WM\_COMMAND handler, if you aren't clear on this aspect, you might want to review the section on menus. ID\_HELP\_ABOUT is the identifier of my Help -> About menu item.

Since we want the menu on our main window to create the dialog, we obviously want to put this code in the WndProc() of our main window, not the dialog proc.

Now I stored the return value from the call to DialogBox(), this is just so you can observe the effects of pressing the two buttons, hitting Esc, Enter etc... from inside the dialog. It also illustrates how to use the return value from a dialog box to check for success, failure, a users choice, or whatever other information you choose to send back to the caller from the Dialog Procedure.

DialogBox(GetModuleHandle(NULL), MAKEINTRESOURCE(IDD\_ABOUT), hwnd, AboutDlgProc);

This is the only important part, and you can choose to put it wherever in your code that you want the dialog to come up. IDD\_ABOUT is the id of the dialog resource. hwnd is the handle to the parent window of the dialog. AboutDlgProc() is of course the dialog procedure to use to control the dialog.

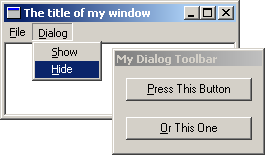
That's it! Sit IDD\_UBU, sit.

A perticularly astute reader might eventually wonder, if DialogBox() doesn't return untill the dialog closes we can't process messages while it's up, so how does it work? Well the nifty thing about DialogBox() is that it has it's own message loop, so while the dialog is displayed, our message loop is out of the picture and the default loop is handled by windows. This loop also takes care of fun things like moving the keyboard focus from control to control when you press Tab.

Another effect of using DialogBox is that your main window is disabled untill the dialog is dismissed. Sometimes this is what we want, and sometimes it isn't, such as when we want to use a dialog as a floating toolbar. In this case we want to be able to interact with both out dialog and our main window, and this will be the focus of the next section.

# Modeless Dialogs

Example: dlg\_two

Now we take a look at CreateDialog(), DialogBox()'s sister function. The difference is that while DialogBox() implements it's own message loop and does not return untill the dialog is closed, CreateDialog() acts more like a window created with CreateWindowEx() in that it returns immediately and depends on your message loop to pump the messages as it does for your main window. This is termed *Modeless*, whereas DialogBox() creates *Modal* dialogs.

You can create the dialog resource just like you did for the last dialog example, you might also want to set the "Tool window" extended style to give it's title bar the typical smaller caption of toolbars. The dialog resource I created follows:

IDD\_TOOLBAR DIALOGEX 0, 0, 98, 52

STYLE DS\_MODALFRAME | WS\_POPUP | WS\_CAPTION

EXSTYLE WS\_EX\_TOOLWINDOW

CAPTION "My Dialog Toolbar"

FONT 8, "MS Sans Serif"

BEGIN

PUSHBUTTON "&Press This Button",IDC\_PRESS,7,7,84,14

PUSHBUTTON "&Or This One",IDC\_OTHER,7,31,84,14

END

You may notice that the resource editor has replaced DIALOG with DIALOGEX indicating we want to set an EXSTYLE on our dialog.

Next we want to create the dialog when our program runs, I want the dialog visible right away so we do this in WM\_CREATE. We also want to declare a global variable to hold the window handle returned from CreateDialog() so that we can use it later. DialogBox() didn't return a handle to us since when DialogBox() returns the window has been destroyed.

HWND g\_hToolbar = NULL;

case WM\_CREATE:

g\_hToolbar = CreateDialog(GetModuleHandle(NULL), MAKEINTRESOURCE(IDD\_TOOLBAR),

hwnd, ToolDlgProc);

if(g\_hToolbar != NULL)

{

ShowWindow(g\_hToolbar, SW\_SHOW);

}

else

{

MessageBox(hwnd, "CreateDialog returned NULL", "Warning!",

MB\_OK | MB\_ICONINFORMATION);

}

break;

We check the return value, which is ALWAYS a good idea, and if it's valid (not NULL) we show the window with ShowWindow(), with DialogBox() this isn't necessary since the system calls ShowWindow() for us.

Now we need a dialog procedure for our toolbar.

BOOL CALLBACK ToolDlgProc(HWND hwnd, UINT Message, WPARAM wParam, LPARAM lParam)

{

switch(Message)

{

case WM\_COMMAND:

switch(LOWORD(wParam))

{

case IDC\_PRESS:

MessageBox(hwnd, "Hi!", "This is a message",

MB\_OK | MB\_ICONEXCLAMATION);

break;

case IDC\_OTHER:

MessageBox(hwnd, "Bye!", "This is also a message",

MB\_OK | MB\_ICONEXCLAMATION);

break;

}

break;

default:

return FALSE;

}

return TRUE;

}

Most of the same message handling rules apply to dialogs created with CreateDialog() as with DialogBox(), don't call DefWindowProc(), return FALSE for messages you don't handle and TRUE for those you do.

One change is that we don't call EndDialog() for modeless dialogs, we can use DestroyWindow() just like for regular windows. In this case I destroy the dialog when the main window is destroyed. In the main window's WndProc()...

case WM\_DESTROY:

DestroyWindow(g\_hToolbar);

PostQuitMessage(0);

break;

Last but not least, we want to be able to display and hide our toolbar whenever we choose so I've added two commands to my menu to do this, and handled them so:

case WM\_COMMAND:

switch(LOWORD(wParam))

{

case ID\_DIALOG\_SHOW:

ShowWindow(g\_hToolbar, SW\_SHOW);

break;

case ID\_DIALOG\_HIDE:

ShowWindow(g\_hToolbar, SW\_HIDE);

break;

//... other command handlers

}

break;

You should be able to create your own menu using the resource editor or manually, but if not (as always) take a look at the example project dlg\_two provided with the tutorial.

Now when you run the program, you should be able to access both the dialog window, and main window at the same time.

If you've run the program at this point and tried tabbing between the two buttons, you have probably noticed it doesn't work, neither does hitting Alt-P or Alt-O to activate the buttons. Why not? Whereas DialogBox() implements it's own message loop and handles these events by default, CreateDialog() does not. We can do it ourselves though, by calling IsDialogMessage() in our message loop which will do the default processing for us.

while(GetMessage(&Msg, NULL, 0, 0))

{

if(!IsDialogMessage(g\_hToolbar, &Msg))

{

TranslateMessage(&Msg);

DispatchMessage(&Msg);

}

}

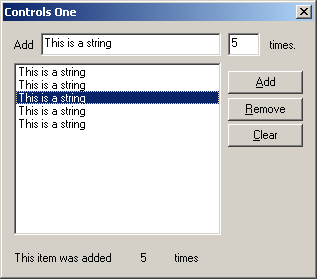
Here we first pass the message to IsDialogMessage(), if the message is destined for our toolbar (indicated by the window handle we pass in) the system will perform the default processing and return TRUE. Is this case the message has already been handled so we don't want to call TranslateMessage() or DispatchMessage(). If the message is for another window we process as usual.

It's also worth noting that IsDialogMessage() can also be used with windows that aren't dialogs in order to to give them dialog-like behaviour. Remember, a dialog is a window, and most (if not all) dialog APIs will work on any window.

And that is pretty much all there is to modeless dialogs! One issue that may arise is if you have more than one toolbar... what do you do? Well one possible solution is to have a list (either an array, an STL std::list, or similar) and loop through it in your message loop passing each handle to IsDialogMessage() until the right one is found, and if none, do the regular processing. This is a generic programming problem, not one that is Win32 related, and is left as an excersize to the reader.

# Standard Controls: Button, Edit, List Box

Example: ctl\_one

I realize I've already used buttons in previous examples, so you should already be more or less familiar with them, however I figured that since I was using them in this example I might as well add it to the title for the sake of being complete.

### Controls

One thing to remember about controls is that **they are just windows**. Like any other window they have a window procedure, a window class etc... that is registered by the system. Anything you can do with a normal window you can do with a control.

### Messages

As you may remember from our earlier discussion of the message loop, windows communicate using messages, you send them to get a control to do something, and when an event occurs on the control it will send you a notification message back. For the standard controls this notification will be a WM\_COMMAND message as we've already seen with buttons and menus. For the *Common Controls* which I may get to later, it will be WM\_NOTIFY.

The messages you send are widely varied between each control, and each control has it's own set of messages. Once in a while the same message will be used for more than one kind of control, but in general they will only work on the control they are intended for. This is especially annoying with the listbox and combobox messages (LB\_\* and CB\_\*) which although they perform nearly identical tasks, are NOT interchangeable, and I accidently get them mixed up more than I'd like to admit :)

On the other hand, generic messages like WM\_SETTEXT are supported by almost all controls. A control is just a window after all.

You can send messages using the SendMessage() API, and use GetDlgItem() to retreive the handle to the control, or you can use SendDlgItemMessage() which does both steps for you, the results of both methods are identical.

## Edits

One of the most commonly used controls in the windows environment, the EDIT control, is used to allow the user to enter, modify, copy, etc... text. Windows Notepad is little more than a plain old window with a big edit control inside it.

Here is the code used to interface with the edit control in this example:

SetDlgItemText(hwnd, IDC\_TEXT, "This is a string");

That's all it takes to change the text contained in the control (this can be used for pretty much any control that has a text value associated with it, STATICs, BUTTONs and so on).

Retreiving the text *from* the control is easy as well, although slightly more work than setting it...

int len = GetWindowTextLength(GetDlgItem(hwnd, IDC\_TEXT));

if(len > 0)

{

int i;

char\* buf;

buf = (char\*)GlobalAlloc(GPTR, len + 1);

GetDlgItemText(hwnd, IDC\_TEXT, buf, len + 1);

//... do stuff with text ...

GlobalFree((HANDLE)buf);

}

First of all, we need to allocate some memory to store the string in, it won't just return us a pointer to the string already in memory. In order to do this, we first need to know how much memory to allocate. There isn't a GetDlgItemTextLength(), but there is a GetWindowTextLength(), so all we need to do is get the handle to the control using GetDlgItem().

Now that we have the length, we can allocate some memory. Here I've added a check to see if there is any text to begin with, since most likely you don't want to be working with an empty string... sometimes you might, but that's up to you. Assuming that there *is* something there to work with, we call GlobalAlloc() to allocate some memory. GlobalAlloc() **as I've used it here** is equivalent to calloc(), if you're used to DOS/UNIX coding. It allocates some memory, initializes it's contents to 0 and returns a pointer to that memory. There are different flags you can pass as the first paramter to make it behave differently for different purposes, but this is the only way I will be using it in this tutorial.

Note that I added 1 to the length in two places, what's up with that? Well, GetWindowTextLength() returns the number of characters of text the control contains NOT INCLUDING the null terminator. This means that if we were to allocate a string without adding 1, the text would fit, but the null terminator would overflow the memory block, possibly corrupting other data, causing an access violation, or any number of other bad things. You must be careful when dealing with string sizes in windows, some APIs and messages expect text lengths to include the null and others don't, always read the docs thoroughly.

*If I lost you talking about null terminators, please refer to a basic C book or tutorial which discusses strings.*

Finally we can call GetDlgItemText() to retrieve the contents of the control into the memory buffer that we've just allocated. This call expects the size of the buffer INCLUDING the null terminator. The return value, which we ignored here, is the number of characters copied, NOT including the null terminator.... fun eh? :)

After we're all done using the text (which we'll get to in a moment), we need to free up the memory that we allocated so that it doesn't leak out and drip down onto the CPU and short circuit your computer. To accomplish this, we simply call GlobalFree() and pass in our pointer.

You may be or become aware of a second set of APIs named LocalAlloc(), LocalFree(), etc... which are legacy APIs from 16-bit windows. In Win32, the Local\* and Global\* memory functions are identical.

### Edits with Numbers

Entering text is all well and fine, but what if you want the user to enter in a number? This is a pretty common task, and fortunately there is an API to make this simpler, which takes care of all the memory allocation, as well as converting the string to an integer value.

BOOL bSuccess;

int nTimes = GetDlgItemInt(hwnd, IDC\_NUMBER, &bSuccess, FALSE);

GetDlgItemInt() works much like GetDlgItemText(), except that instead of copying the string to a buffer, it converts it internally into an integer and returns the value to you. The third parameter is optional, and takes a pointer to a BOOL. Since the function returns 0 on failure, there is no way to tell just from that whether or not the function failed or the user just entered 0. If you are fine with a value of 0 in the event of an error, then feel free to ignore this parameter.

Another useful feature is the ES\_NUMBER style for edit controls, which allows only the characters 0 through 9 to be entered. This is very handy if you only want positive integers, otherwise it's not much good, since you can't enter any other characters, including - (minus) . (decimel) or , (comma).

## List Boxes

Another handy control is the list box. This is the last standard control that I'm going to cover for now, cause frankly they aren't that interesting, and if you aren't bored yet well, I am :)

### Adding Items

The first thing you'll want to do with a listbox is add items to it.

int index = SendDlgItemMessage(hwnd, IDC\_LIST, LB\_ADDSTRING, 0, (LPARAM)"Hi there!");

As you can see, this is a pretty simple task. If the listbox has the LBS\_SORT style, the new item will be added in alphabetical order, otherwise it will just be added to the end of the list.

This message returns the index of the new item either way, and we can use this to perform other tasks on the item, such as associating some data with it. Usually this will be things like a pointer to a struct containing more information, or maybe an ID that you will use to identify the item, it's up to you.

SendDlgItemMessage(hwnd, IDC\_LIST, LB\_SETITEMDATA, (WPARAM)index, (LPARAM)nTimes);

### Notifications

The whole purpose of listboxes is to allow the user to select things from a list. Now sometimes we don't care when exactly they do this, for example with our Remove button, we don't need to know when the selection changes right away, we just check when the user activates the button.

However, sometimes you want to be able to do something right away, perhaps display different or updated information based on what items are selected. In order to do this we need to handle the notification messages that the listbox passes to us. In this case, we are interested in LBN\_SELCHANGE, which tells us that the selection has been modified by the user. LBN\_SELCHANGE is sent via WM\_COMMAND but unlike handling the WM\_COMMAND from buttons or menu's, which are usually only in response to a click, a list box sends WM\_COMMAND for various reasons, and we need a second check to find out what it's telling us. The *Notification Code* is passed as the HIWORD of wParam, the other half of the parameter that gave us the control ID in the first place.

case WM\_COMMAND:

switch(LOWORD(wParam))

{

case IDC\_LIST:

// It's our listbox, check the notification code

switch(HIWORD(wParam))

{

case LBN\_SELCHANGE:

// Selection changed, do stuff here.

break;

}

break;

// ... other controls

}

break;

### Getting Data from the ListBox

Now that we know the selection has changed, or at the request of the user, we need to get the selection from the listbox and do something useful with it.

In this example I've used a multiselection list box, so getting the list of selected items is a little trickier. If it were a single selection listbox, than you could simply send LB\_GETCURSEL to retrieve the item index.

First we need to get the number of selected items, so that we can allocate a buffer to save the indexes in.

HWND hList = GetDlgItem(hwnd, IDC\_LIST);

int count = SendMessage(hList, LB\_GETSELCOUNT, 0, 0);

Then we allocate a buffer based on the number of items, and send LB\_GETSELITEMS to fill in the array.

int \*buf = GlobalAlloc(GPTR, sizeof(int) \* count);

SendMessage(hList, LB\_GETSELITEMS, (WPARAM)count, (LPARAM)buf);

// ... Do stuff with indexes

GlobalFree(buf);

In this example, buf[0] is the first index, and so on up to buf[count - 1].

One of the things you would likely want to do with this list of indexes, is retreive the data associated with each item, and do some processing with it. This is just as simple as setting the data was originally, we just send another message.

int data = SendMessage(hList, LB\_GETITEMDATA, (WPARAM)index, 0);

If the data was some other type of value (anything that is 32-bits) you could simply cast to the appropriate type. For example if you stored HBITMAPs instead of ints...

HBITMAP hData = (HBITMAP)SendMessage(hList, LB\_GETITEMDATA, (WPARAM)index, 0);

## Statics

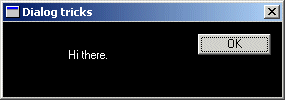
Like buttons, static controls are largely trivial, but for the sake or being complete I include them here. Static controls are usually just that, static, meaning they don't change or really do anything else very special, they're largely for displaying text to the user. However you can make them slightly more useful by assigning them a unique ID (VC++ assigns a default ID of IDC\_STATIC, which is -1 and effectively means "No ID") and then setting the text at runtime to present dynamic data to the user.

In the example code, I use one to display the data of the item selected in the list box, assuming one and only one is selected.

SetDlgItemInt(hwnd, IDC\_SHOWCOUNT, data, FALSE);

# Dialog FAQ

Example: dlg\_three

Now don't get me wrong, this is a *Tutorial*, not a *Reference*, but some questions people ask SO often that I figured I might as well include them here.

## Changing Colours

In general, the only reason you'd want to do this is to simulate an link on a dialog box or some similar task, because otherwise you're probably just making your program ugly and hard on the eyes if you go adding a bunch of colors to the dialogs, but that doesn't stop people from doing it, and there are actually a few valid reasons, so here you go :)

Windows sends a variety of messages related to colours to your dialog procedure, and by handling these messages you can change what colour certain things are displayed in. For example, to change the color of the dialog box itself, you can handle WM\_CTLCOLORDLG, to change the colors for a static control you handle WM\_CTLCOLORSTATIC and so on.

First you can create a brush to use to paint the background and store it for later. the WM\_CTLCOLORDLG and related messages will get called often during the course of your program, and if you created a new brush every time, eventually you would use up a great deal of RAM with dead brushes. This way we have more control, and we can delete it when the dialog is destroyed and we know we won't need it any more.

HBRUSH g\_hbrBackground = CreateSolidBrush(RGB(0, 0, 0));

case WM\_CTLCOLORDLG:

return (LONG)g\_hbrBackground;

case WM\_CTLCOLORSTATIC:

{

HDC hdcStatic = (HDC)wParam;

SetTextColor(hdcStatic, RGB(255, 255, 255));

SetBkMode(hdcStatic, TRANSPARENT);

return (LONG)g\_hbrBackground;

}

break;

Notice the line that sets the background mode to transparent... if you leave this line off the background will be filled in with the brush you specify, but when the control draws the text it will get written over with the default background color! Setting the text drawing mode to transparent fixes this problem. The other option would be to SetBkColor() to the same color as our background brush, but I like this solution better.

Changing the colors on pretty much any other standard control works the same way, just look up the WM\_CTLCOLOR\* messages in your Win32 reference. Note that an edit control will send a WM\_CTLCOLORSTATIC if it is read only, and WM\_CTLCOLOREDIT if it isn't.

If you have more than one static (or other) control that you want to be different colours, then you'll need to check the ID of the control you are getting the message from and change your colours based on that. You are passed the HWND of the control in lParam, and you can get the ID of the control from this using GetDlgCtlrID(). Note that static controls are all given a default ID of IDC\_STATIC (-1) by the resource editor, so if you want to be able to tell them apart you'll need to assign them new IDs.

## Giving the Dialog an Icon

A fairly simple task, you just need to send WM\_SETICON to your dialog. Since windows uses two icons however, you need to call it twice, once for the small icon displayed in the corner of the window, and once for the large one displayed when you hit Alt-Tab. You can just send the same handle both times unless you have multi-sized icons.

To just set the default application icon, you can use the following code:

SendMessage(hwnd, WM\_SETICON, ICON\_SMALL, (LPARAM)LoadIcon(NULL, MAKEINTRESOURCE(IDI\_APPLICATION)));

SendMessage(hwnd, WM\_SETICON, ICON\_BIG, (LPARAM)LoadIcon(NULL, MAKEINTRESOURCE(IDI\_APPLICATION)));

When you substitute your own icon resource for the default, remember to change the HINSTANCE parameter of LoadIcon() to your applications instance (you can get it by calling GetModuleHandle(NULL) if you don't have it stored from WinMain()).

## Why Doesn't my Combo Box Work?

An all-too-common problem is people adding a combo box to their dialog and they can't figure out why the list doesn't show up when they run their program and click the little arrow. This is understandable, since the solution is not very intuitive.

When you create a combo box and specify it's height, you are actually specifying the entire height, drop-down list included, NOT the height of the control when it is collapsed which is determined by the system based on the size of the font used.

For example, giving the control a height of 100 pixels, the system sizes the control itself to the default (lets say 30 in this case), and when you click on the arrow, the drop down list would be 70 pixels high, for a total of 100 pixels.

If you use the VC++ resource editor to place the combo on your dialog, you will notice you can't size it vertically. Unless you click on the arrow in the editor, and it will then change the focus rectangle to indicate you are sizing the dropdown list, and you can set the height to whatever you want.

## What about all the other controls!

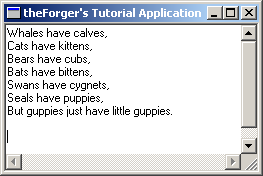
Well I could give examples of all of the other controls, but that's what MSDN and Petzold are for :) If you can't figure out how to use them, you probably need to re-read some parts of this tutorial, or get a book which will explain things more thouroughly.

I'd like to give you a link to a useful page on MSDN, but Microsoft seems to be determined to prevent me from doing so as links to individual MSDN pages either change rapidly or don't work period. Therefor you'll probably have to figure out how to get around yourself, look around for sections like *User Interface Services*, and *Windows Controls*, sometimes under a *Platform SDK* section.

[MSDN - Windows Controls](http://msdn.microsoft.com/library/?url=/library/en-us/shellcc/platform/commctls/indivcontrol.asp)

# App Part 1: Creating controls at runtime

Example: app\_one

I thought that since an example on creating controls on the fly, although usefull, would be quite pointless unless the application actually did something, so in this entry I will start the workings of a text editor and build upon it untill we reach a nearly useful program that supports opening, editing and saving text documents.

The first step, which this particular page covers will be simply creating the window and the EDIT control that will serve as the center of our program.

Starting with the skeleton code from the Simple Window application we add a #define as our control ID and the following two message handlers into our window procedure:

#define IDC\_MAIN\_EDIT 101

case WM\_CREATE:

{

HFONT hfDefault;

HWND hEdit;

hEdit = CreateWindowEx(WS\_EX\_CLIENTEDGE, "EDIT", "",

WS\_CHILD | WS\_VISIBLE | WS\_VSCROLL | WS\_HSCROLL | ES\_MULTILINE | ES\_AUTOVSCROLL | ES\_AUTOHSCROLL,

0, 0, 100, 100, hwnd, (HMENU)IDC\_MAIN\_EDIT, GetModuleHandle(NULL), NULL);

if(hEdit == NULL)

MessageBox(hwnd, "Could not create edit box.", "Error", MB\_OK | MB\_ICONERROR);

hfDefault = GetStockObject(DEFAULT\_GUI\_FONT);

SendMessage(hEdit, WM\_SETFONT, (WPARAM)hfDefault, MAKELPARAM(FALSE, 0));

}

break;

case WM\_SIZE:

{

HWND hEdit;

RECT rcClient;

GetClientRect(hwnd, &rcClient);

hEdit = GetDlgItem(hwnd, IDC\_MAIN\_EDIT);

SetWindowPos(hEdit, NULL, 0, 0, rcClient.right, rcClient.bottom, SWP\_NOZORDER);

}

break;

### Creating controls

Creating controls, like creating any other window, is done through the CreateWindowEx() API. We pass in pre-registered class that we want, in this case the "EDIT" control class, and we get a standard edit control window. When using dialogs to create our controls, we are basically writing a list of controls to create so that then you call DialogBox() or CreateDialog() the system reads through the list of controls in the dialog resource and calls CreateWindowEx() for each one with the position and styles that were defined in the resource.

hEdit = CreateWindowEx(WS\_EX\_CLIENTEDGE, "EDIT", "",

WS\_CHILD | WS\_VISIBLE | WS\_VSCROLL | WS\_HSCROLL | ES\_MULTILINE | ES\_AUTOVSCROLL | ES\_AUTOHSCROLL,

0, 0, 100, 100, hwnd, (HMENU)IDC\_MAIN\_EDIT, GetModuleHandle(NULL), NULL);

if(hEdit == NULL)

MessageBox(hwnd, "Could not create edit box.", "Error", MB\_OK | MB\_ICONERROR);

You can see that this call to CreateWindowEx() specifies quite a few styles, and it's not uncommon to have many more, especially for the Common Controls which have a hearty list of options. The first 4 WS\_ styles should be fairly obvious, we are creating the control as a child of our window, we want it to be visible, and have vertical and horizontal scroll bars.

The 3 styles that are specific to EDIT controls (ES\_MULTILINE | ES\_AUTOVSCROLL | ES\_AUTOHSCROLL) specify that the EDIT control should contain multiple lines of text, and scroll automatically as you type beyond the bottom and right hand side of the control respectively.

The regular window styles (WS\_\*) are [listed here](http://msdn.microsoft.com/library/default.asp?url=/library/en-us/winui/windows_2v90.asp). And the extended windows styles (WS\_EX\_\*) are explained under the [CreateWindowEx()](http://msdn.microsoft.com/library/default.asp?url=/library/en-us/winui/windows_1w6w.asp) reference in MSDN, where you can also find links to the styles that are specific to each control (ES\_\* in our case of the edit control).

We have specified our window handle as the parent of the control, and assigned it an ID of IDC\_MAIN\_EDIT which we'll use later on to refer to the control just as you would if the control had been created on a dialog. The position and size parameters don't mean too much at the moment since we will be resizing the control dynamically in the WM\_SIZE message so that it will always fit our window.

### Sizing of dynamically created controls

Generally if your window is sizeable you'll want some code to resize or reposition the controls you created within it so that they are always layed out properly.

GetClientRect(hwnd, &rcClient);

hEdit = GetDlgItem(hwnd, IDC\_MAIN\_EDIT);

SetWindowPos(hEdit, NULL, 0, 0, rcClient.right, rcClient.bottom, SWP\_NOZORDER);

Since we only have one control for now, the task is relatively simple. We use GetClientRect() to get the dimentions of the Client Area of the window, the big (up untill now) blank area that does not include the borders, menu or caption. This will fill in our RECT structure with the value, the left and top values will always be 0, so you can usually just ignore them. The right and bottom values will give you the width and the hight of the client area.

Next we simply get a handle to our edit control using GetDlgItem() which works just as well on regular windows as it does on dialogs, and the call SetWindowPos() to move and size it to fill the entire client area. You can of course change the values you pass into SetWindowPos() to do something like only fill half of the window's height, leaving the bottom free to place other controls.

### Creating other controls at runtime

I'm not going to give examples of dynamically creating the other controls like LISTBOX, BUTTON, etc... because it's basically the same and it gets kinda boring after a while :) If you follow the links into MSDN above, or look in your local Win32 API reference you will be able to find all of the information needed to create any of the other standard controls.

We'll be doing more of this with the common controls in the next couple of sections so you'll get more practice eventually.

# App Part 2: Using files and the common dialogs

Example: app\_two

## The Common File Dialogs

The first step to opening or saving files is finding out the filename to use... of course you could always hard code the name of the file into your program, but honestly that doesn't make for very useful programs most of the time.

Since this is such a common task, there are predefined system dialogs that you can use to allow the user to select a file name. The most common open and save file dialogs are accessed through GetOpenFileName() and GetSaveFileName() respectively, both of which take an OPENFILENAME struct.

OPENFILENAME ofn;

char szFileName[MAX\_PATH] = "";

ZeroMemory(&ofn, sizeof(ofn));

ofn.lStructSize = sizeof(ofn); // SEE NOTE BELOW

ofn.hwndOwner = hwnd;

ofn.lpstrFilter = "Text Files (\*.txt)\0\*.txt\0All Files (\*.\*)\0\*.\*\0";

ofn.lpstrFile = szFileName;

ofn.nMaxFile = MAX\_PATH;

ofn.Flags = OFN\_EXPLORER | OFN\_FILEMUSTEXIST | OFN\_HIDEREADONLY;

ofn.lpstrDefExt = "txt";

if(GetOpenFileName(&ofn))

{

// Do something usefull with the filename stored in szFileName

}

Note that we call ZeroMemory() on the struct in order to initialise it to 0. This is generally a wise practice, as some APIs are very picky about members that you don't use being set to NULL. This way you don't need to explicitely set each member that you don't use.

You can easily find out the meanings of the various members by looking them up in your documentation. The lpstrFilter value points to a double-NULL terminated string, and you can see from the example that there are several "\0" throughout it, including one at the end... the compiler will add the second one at the end as it always does with string constants (that's what you generally don't need to put them in yourself). The NULLs in this string break it up into filters, each one is two parts. The first filter has the description "Text Files (\*.txt)", the wildcard isn't required here I just put it in because I felt like it. The next part is the actual wildcard for the first filter, "\*.txt". We do the same thing with the second filter except that this is a generic filter for all files. You can add as many different filters as you'd like.

The lpstrFile points to the buffer we have allocated to store the name of the file, since filenames can't be larger than MAX\_PATH this is the value that I've chosen for the buffer size.

The flags indicate that the dialog should only allow the user to enter filenames that already exist (since we want to open them, not create them) and to hide the option to open the file in readonly mode, which we aren't going to support. Finally we provide a default extention, so if the user types in "foo" and the file is not found, it will try to open "foo.txt" before finally giving up.

To select a file for saving instead of opening, the code is nearly the same, except for calling GetSaveFileName() we need only change the flags member to options more suitable for saving.

ofn.Flags = OFN\_EXPLORER | OFN\_PATHMUSTEXIST | OFN\_HIDEREADONLY | OFN\_OVERWRITEPROMPT;

In this case we no longer want to require the file exist, but we do want the directory to exist since we aren't going to try and create it first. We'll also prompt the user if they select an existing file to make sure they want to overwrite it.

**NOTE:** MSDN States the following for the lStructSize member:

**lStructSize**

Specifies the length, in bytes, of the structure.

**Windows NT 4.0:** In an application that is compiled with WINVER and \_WIN32\_WINNT >= 0x0500, use OPENFILENAME\_SIZE\_VERSION\_400 for this member.

**Windows 2000/XP:** Use sizeof (OPENFILENAME) for this parameter.

Basically what this means is that as of Windows 2000 they added some members to this struct, and so it's size changed. If the code above doesn't work for you it's possibly because the size that your compiler used and the size that your operating system (ie. Windows 98, Windows NT4) expected were different and so the call failed. If this happens, try using OPENFILENAME\_SIZE\_VERSION\_400 instead of sizeof(ofn). Thanks to people that pointed this out to me.

## Reading and Writing Files

In windows you have a few options as to how you want to access files. You can use the old io.h open()/read()/write(), you can use stdio.h fopen()/fread()/fwrite(), and if you are in C++ use can use iostreams.

However in windows all of these method ultimately call the Win32 API functions, which are what I will use here. If you are already comfortable using file IO with another method it should be fairly easy to pick up, or if you want simply use your method of choice to access files.

To open files, you can use OpenFile() or CreateFile(). MS recommends using only CreateFile() as OpenFile() is now "obsolete". CreateFile() is a much more versatile function and provides a great deal of control over the way you open files.

### Reading

Say for example you have allowed the user to select a file using GetOpenFileName()...

BOOL LoadTextFileToEdit(HWND hEdit, LPCTSTR pszFileName)

{

HANDLE hFile;

BOOL bSuccess = FALSE;

hFile = CreateFile(pszFileName, GENERIC\_READ, FILE\_SHARE\_READ, NULL,

OPEN\_EXISTING, 0, NULL);

if(hFile != INVALID\_HANDLE\_VALUE)

{

DWORD dwFileSize;

dwFileSize = GetFileSize(hFile, NULL);

if(dwFileSize != 0xFFFFFFFF)

{

LPSTR pszFileText;

pszFileText = GlobalAlloc(GPTR, dwFileSize + 1);

if(pszFileText != NULL)

{

DWORD dwRead;

if(ReadFile(hFile, pszFileText, dwFileSize, &dwRead, NULL))

{

pszFileText[dwFileSize] = 0; // Add null terminator

if(SetWindowText(hEdit, pszFileText))

bSuccess = TRUE; // It worked!

}

GlobalFree(pszFileText);

}

}

CloseHandle(hFile);

}

return bSuccess;

}

There is a complete function to read a text file into an edit control. It takes as paramters the handle to the edit control and the name of the file to read in. This perticular function has a fair bit of error checking, file IO is one place where a lot of things can go wrong, and so you need to be on the lookout for errors.

**Note** the variable dwRead. We don't use it except as a paramter in ReadFile(). This parameter *MUST* be provided, the call will fail without it.

In the call to CreateFile() GENERIC\_READ means we only want read access. FILE\_SHARE\_READ means it's okay if other programs open the file at the same time we do, but ONLY if they want to read as well, we don't want them writing to the file while we are reading it. And OPEN\_EXISTING means only open the file if it already exists, don't create it, and don't overwrite it.

Once we've opened the file and chacked to see that CreateFile() succeeded, we check the size of the file so we'll know how much memory we need to allocate in order to read the entire thing. We then allocate the memory, check to make sure the allocation succeeded, and then call ReadFile() to load the contents from disk into our memory buffer. The API file functions have no concept of *Text Files* so they won't do things like read a single line of text, or add NULL terminators to the end of our strings. This is why we've allocated an extra byte and after we read in the file we add the NULL ourselves so that we can then pass the memory buffer as a string to SetWindowText().

Once all that has succeeded we set out success variable to TRUE, and clean up as we reach the end of the function, freeing the memory buffer and closing the file handle before finally returning to the caller.

### Writing

BOOL SaveTextFileFromEdit(HWND hEdit, LPCTSTR pszFileName)

{

HANDLE hFile;

BOOL bSuccess = FALSE;

hFile = CreateFile(pszFileName, GENERIC\_WRITE, 0, NULL,

CREATE\_ALWAYS, FILE\_ATTRIBUTE\_NORMAL, NULL);

if(hFile != INVALID\_HANDLE\_VALUE)

{

DWORD dwTextLength;

dwTextLength = GetWindowTextLength(hEdit);

// No need to bother if there's no text.

if(dwTextLength > 0)

{

LPSTR pszText;

DWORD dwBufferSize = dwTextLength + 1;

pszText = GlobalAlloc(GPTR, dwBufferSize);

if(pszText != NULL)

{

if(GetWindowText(hEdit, pszText, dwBufferSize))

{

DWORD dwWritten;

if(WriteFile(hFile, pszText, dwTextLength, &dwWritten, NULL))

bSuccess = TRUE;

}

GlobalFree(pszText);

}

}

CloseHandle(hFile);

}

return bSuccess;

}

Very similar to reading files, the function to write files has a few changes. First of all when we call CreateFile() we specify that we want Read access, that the file should always be created new (and if it exists it will be erased as it's opened) and that if it doesn't exist, it will be created with the normal file attributes.

Next we get the length of the memory buffer needed from the edit control, since this is the source of the data. Once we've allocated the memory, we request the string from the edit control using GetWindowText() and then write it to the file with WriteFile(). Again, like with ReadFile() the parameter that returns how much was actually written is required, even though we don't use it.

# App Part 3: Tool and Status bars

Example: app\_three

### An IMPORTANT Word on Common Controls

As with all common controls, you must call InitCommonControls() *BEFORE* you try and use them. You will need to #include <commctrl.h> in order to use this function and to get the functions and declarations necessary for use of the Common Controls. You will also need to add comctl32.lib to your linker settings if it is not already there. Note that InitCommonControls() is an older API, and for more control you can use InitCommonControlsEx() (aka *InitCommonControlSex()*) which is also required for the most recent common controls. However since I'm not using any of the advanced features, InitCommonControls() is adequate and simpler.

## Toolbars

You can create a toolbar using CreateToolbarEx() but I'm not going to, so there. First thing you need to do is actually create the toolbar...

hTool = CreateWindowEx(0, TOOLBARCLASSNAME, NULL, WS\_CHILD | WS\_VISIBLE, 0, 0, 0, 0,

hwnd, (HMENU)IDC\_MAIN\_TOOL, GetModuleHandle(NULL), NULL);

That's simple enough, TOOLBARCLASSNAME is a constant defined by the common control headers. hwnd is the parent window, the one you want to put the toolbar in. IDC\_MAIN\_TOOL is an identifier that you can use later to get the HWND of the toolbar using GetDlgItem(), if you so desire.

// Send the TB\_BUTTONSTRUCTSIZE message, which is required for

// backward compatibility.

SendMessage(hTool, TB\_BUTTONSTRUCTSIZE, (WPARAM)sizeof(TBBUTTON), 0);

This message is required to let the system figure out which version of the common controls library you are using. Since new versions add new stuff to the structure, by giving it the size it can figure out what behaviour you are expecting.

### Toolbar buttons

Button bitmaps on basic toolbars come in two varieties, standard buttons that are provided by comctl32, and user defined buttons that you create yourself. **NOTE:** Buttons and bitmaps are added to toolbars seperately... first you add a list of images to use, and THEN you add a list of buttons, and telling it which button uses which image.

### Adding Standard Buttons

Now that we have a toolbar created, we need to add some buttons to it. The most common bitmaps are available in the common control library itself, so we don't need to recreate them or add them to every exe that uses them.

First we declare a TBBUTTON and TBADDBITMAP

TBBUTTON tbb[3];

TBADDBITMAP tbab;

And then we add the standard bitmaps to the toolbar, using the imagelist predefined in the common control library...

tbab.hInst = HINST\_COMMCTRL;

tbab.nID = IDB\_STD\_SMALL\_COLOR;

SendMessage(hTool, TB\_ADDBITMAP, 0, (LPARAM)&tbab);

Now that we have our images loaded up, we can add some buttons that use them...

ZeroMemory(tbb, sizeof(tbb));

tbb[0].iBitmap = STD\_FILENEW;

tbb[0].fsState = TBSTATE\_ENABLED;

tbb[0].fsStyle = TBSTYLE\_BUTTON;

tbb[0].idCommand = ID\_FILE\_NEW;

tbb[1].iBitmap = STD\_FILEOPEN;

tbb[1].fsState = TBSTATE\_ENABLED;

tbb[1].fsStyle = TBSTYLE\_BUTTON;

tbb[1].idCommand = ID\_FILE\_OPEN;

tbb[2].iBitmap = STD\_FILESAVE;

tbb[2].fsState = TBSTATE\_ENABLED;

tbb[2].fsStyle = TBSTYLE\_BUTTON;

tbb[2].idCommand = ID\_FILE\_SAVEAS;

SendMessage(hTool, TB\_ADDBUTTONS, sizeof(tbb)/sizeof(TBBUTTON), (LPARAM)&tbb);

Here we've added a New, Open and Save As button using the standard images, which is always a good idea since people are used to seeing them and they know what they mean.

The indexes of each image in the imagelist are defined in the common control headers and are listed in MSDN.

We have assigned each button an ID (ID\_FILE\_NEW etc...) which is identical to the IDs of the equivalent menu items. These buttons will generate WM\_COMMAND messages identical to the menu, so no extra processing is required! If we were adding a button for a command that didn't already have a menu item, we would simply pick a new ID for it and add a handler to WM\_COMMAND.

If you're wondering what's up with the funky wParam I passed to TB\_ADDBUTTONS it's doing a calculation of the number of buttons in the array tbb so that we don't need to hardcode a value. If I put in 3 instead it would still be correct, but as soon as I added another button I'd have to change it to 4 and in programming that's bad... you want one change to cause as few other changes as possible. For example if the sizeof(TBBUTTON) was 16 bytes (I made that up, it actually varies by platform) then since we have 3 buttons the sizeof(tbb) would be 16 \* 3 or 48. Therefor 48/16 gives us the number of buttons, 3.

## Status bars

Something often found in apps with toolbars are status bars, the little things at the bottom of the window that display information. They're pretty simple to use, just create...

hStatus = CreateWindowEx(0, STATUSCLASSNAME, NULL,

WS\_CHILD | WS\_VISIBLE | SBARS\_SIZEGRIP, 0, 0, 0, 0,

hwnd, (HMENU)IDC\_MAIN\_STATUS, GetModuleHandle(NULL), NULL);

And then (optionally) set the number of sections that you want. If you don't set any, it will simply have one section using the entire width of the bar, and you can set and retreive the text with SetWindowText() as with many other controls. For more than one part, you need to give the widths of each section, and then use SB\_SETTEXT to set the text of each one.

To define the widths, we declare an array of ints, where each value is the width in pixels of a section. If you want one section to use up any remaining space, set it's width to -1.

int statwidths[] = {100, -1};

SendMessage(hStatus, SB\_SETPARTS, sizeof(statwidths)/sizeof(int), (LPARAM)statwidths);

SendMessage(hStatus, SB\_SETTEXT, 0, (LPARAM)"Hi there :)");

The wParam again is our calculation of how many elements are in the array. Once we're done adding sections, we set the first one (index 0) to see it in action.

## Proper Sizing

Unlike menus, tool and status bars are seperate controls that live inside the parent window's client area. Therefor if we just leave our WM\_SIZE code from before, they are going to overlap with the edit control we added in the previous examples. This is a simple matter to correct... in WM\_SIZE, we move the tool and status bars into position, and then subtract their heights and positions from the client area so that we can move our edit control to fill the remaining space...

HWND hTool;

RECT rcTool;

int iToolHeight;

HWND hStatus;

RECT rcStatus;

int iStatusHeight;

HWND hEdit;

int iEditHeight;

RECT rcClient;

// Size toolbar and get height

hTool = GetDlgItem(hwnd, IDC\_MAIN\_TOOL);

SendMessage(hTool, TB\_AUTOSIZE, 0, 0);

GetWindowRect(hTool, &rcTool);

iToolHeight = rcTool.bottom - rcTool.top;

// Size status bar and get height

hStatus = GetDlgItem(hwnd, IDC\_MAIN\_STATUS);

SendMessage(hStatus, WM\_SIZE, 0, 0);

GetWindowRect(hStatus, &rcStatus);

iStatusHeight = rcStatus.bottom - rcStatus.top;

// Calculate remaining height and size edit

GetClientRect(hwnd, &rcClient);

iEditHeight = rcClient.bottom - iToolHeight - iStatusHeight;

hEdit = GetDlgItem(hwnd, IDC\_MAIN\_EDIT);

SetWindowPos(hEdit, NULL, 0, iToolHeight, rcClient.right, iEditHeight, SWP\_NOZORDER);

Unfortunately it's a somewhat long code snippet, but it's quite simple... toolbars will auto position themselves when sent the TB\_AUTOSIZE message, and status bars will do the same if you send them WM\_SIZE (the common control libraries are not known for consistancy).

# Text and Fonts

Example: font\_one

## Loading Fonts

The Win32 GDI has some remarkable capabilites for dealing with vastly different typefaces, styles, languages and characters sets. One of the drawbacks of this is that dealing with fonts can look rather intimidating to the newcomer. CreateFont(), the primary API when it comes to fonts, has 14 parameters for specifying height, style, weight, family, and various other attributes.

Fortunately, it's not really has hard as it might appear, and a large portion of the work involved is taken care of my sensible default values. All but 2 of the parameters to CreateFont() can be set to 0 or NULL, and the system will simply use a default value giving you a plain ordinary font.

CreateFont() creates an HFONT, a handle to a *Logical Font* in memory. The data held by this handle can be retreived into a LOGFONT structure using GetObject() just as a BITMAP struct can be filled from an HBITMAP.

The members of the LOGFONT are identical to the parameters to CreateFont() and for convenience you can create a font directly from an existing LOGFONT structure using CreateFontIndirect(). This is very handy, since it makes it simple to create a new font from an existing font handle when you only want to alter certain aspects of it. Use GetObject() to fill a LOGFONT, alter the members that you wish, and create a new font with CreateFontIndirect().

HFONT hf;

HDC hdc;

long lfHeight;

hdc = GetDC(NULL);

lfHeight = -MulDiv(12, GetDeviceCaps(hdc, LOGPIXELSY), 72);

ReleaseDC(NULL, hdc);

hf = CreateFont(lfHeight, 0, 0, 0, 0, TRUE, 0, 0, 0, 0, 0, 0, 0, "Times New Roman");

if(hf)

{

DeleteObject(g\_hfFont);

g\_hfFont = hf;

}

else

{

MessageBox(hwnd, "Font creation failed!", "Error", MB\_OK | MB\_ICONEXCLAMATION);

}

This is the code used to create the font in the example image. This is *Times New Roman* at *12 Point* with the *Italics* style set. The italics flag is the 6th parameter to CreateFont() which you can see we have set to TRUE. The name of the font we want to use is the last parameter.

The one bit of trickery in this code is the value used for the size of the font, the lfHeight parameter to CreateFont(). Usually people are used to working with *Point* sizes, Size 10, Size 12, etc... when dealing with fonts. CreateFont() however doesn't accept point sizes, it wants Logical Units which are different on your screen than they are on your Printer, and even between Printers and screens.

The reason this situation exists is because the resolution of different devices is so vastly different... Printers can easily display 600 to 1200 pixels per inch, while a screen is lucky to get 200... if you used the same sized font on a printer as on a screen, you likely wouldn't even be able to see individual letters.

All we have to do is convert from the point size we want, into the appropriate logical size for the device. In this case the device is the screen, so we get the HDC to the screen, and get the number of logical pixels per inch using GetDeviceCaps() and slap this into the formula so generously provided in MSDN which uses MulDiv() to convert from our pointsize of 12 to the correct logical size that CreateFont() expects. We store this in lfHeight and pass it as the first parameter to CreateFont().

### Default Fonts

When you first call GetDC() to get the HDC to your window, the default font that is selected into it is *System*, which to be honest isn't all that attractive. The simplest way to get a reasonable looking font to work with (without going through the CreateFont() hassle) is to call GetStockObject() and ask for the DEFAULT\_GUI\_FONT.

This is a system object and you can get it as many times as you want without leaking memory, and you can call DeleteObject() on it which won't do anything, which is good because now you don't need to keep track of whether your font is one from CreateFont() or GetStockObject() before trying to free it.

## Drawing Text

Now that we have a handy-dandy font, how do we get some text on the screen? This is assuming that we don't just want to use an Edit or Static control.

Your basic options are TextOut() and DrawText(). TextOut() is simpler, but has less options and doesn't do word wrapping or alignment for you.

char szSize[100];

char szTitle[] = "These are the dimensions of your client area:";

HFONT hfOld = SelectObject(hdc, hf);

SetBkColor(hdc, g\_rgbBackground);

SetTextColor(hdc, g\_rgbText);

if(g\_bOpaque)

{

SetBkMode(hdc, OPAQUE);

}

else

{

SetBkMode(hdc, TRANSPARENT);

}

DrawText(hdc, szTitle, -1, prc, DT\_WORDBREAK);

wsprintf(szSize, "{%d, %d, %d, %d}", prc->left, prc->top, prc->right, prc->bottom);

DrawText(hdc, szSize, -1, prc, DT\_SINGLELINE | DT\_CENTER | DT\_VCENTER);

SelectObject(hdc, hfOld);

First thing we do is use SelectObject() to get the font we want to use into our HDC and ready for drawing. All future text operations will use this font untill another one is selected in.

Next we set the Text and Background colours. Setting the background colour doesn't actually make the *whole* background this colour, it only affects certain operations (text being one of them) that use the background colour to draw with. This is also dependant on the current *Background Mode*. If it is set to OPAQUE (the default) then any text drawn is filled in behing with the background colour. If it is set to TRANSPARENT then text is drawn without a background and whatever is behind will show through and in this case the background colour has no effect.

Now we actually draw the text using DrawText(), we pass in the HDC to use and the string to draw. The 3rd parameter is the length of the string, but we've passed -1 because DrawText() is smart enough that it will figure out how long the text is itself. In the 4th parameter we pass in prc, the pointer to the client RECT. DrawText() will draw inside this rectangle based on the other flags that you give it.

In the first call, we specify DT\_WORDBREAK, which defaults to aligned to the top left, and will wrap the text it draws automatically at the edge of the rectangle... very useful.

For the second call, we're only printing a single line without wrapping, and we want it to be centered horizontally as well as vertically (which DrawText() will do only when drawing a single line).

#### Client Redraw

Just a note about the example program... when the WNDCLASS is registered I have set the CS\_VREDRAW and CS\_HREDRAW class styles. This causes the entire client area to be redrawn if the window is resized, whereas the default is to only redraw the parts that have changed. That looks really bad since the centered text moves around when you resize and it doesn't update like you'd expect.

## Choosing Fonts

In general, any program that deals with fonts will want to let the user choose their own font, as well as the colour and style attribute to use when displaying it.

Like the common dialogs for getting open and save file names, there is a common dialog for choosing a font. This is, oddly enough, called ChooseFont() and it works with the CHOOSEFONT structure for you to set the defaults it should start with as well as returning the final result of the users selection.

HFONT g\_hfFont = GetStockObject(DEFAULT\_GUI\_FONT);

COLORREF g\_rgbText = RGB(0, 0, 0);

void DoSelectFont(HWND hwnd)

{

CHOOSEFONT cf = {sizeof(CHOOSEFONT)};

LOGFONT lf;

GetObject(g\_hfFont, sizeof(LOGFONT), &lf);

cf.Flags = CF\_EFFECTS | CF\_INITTOLOGFONTSTRUCT | CF\_SCREENFONTS;

cf.hwndOwner = hwnd;

cf.lpLogFont = &lf;

cf.rgbColors = g\_rgbText;

if(ChooseFont(&cf))

{

HFONT hf = CreateFontIndirect(&lf);

if(hf)

{

g\_hfFont = hf;

}

else

{

MessageBox(hwnd, "Font creation failed!", "Error", MB\_OK | MB\_ICONEXCLAMATION);

}

g\_rgbText = cf.rgbColors;

}

}

The hwnd in this call is simply the window you want to use as the parent for the font dialog.

The easiest way to use this dialog is in conjunction with an existing LOGFONT structure, which is most likely from whichever HFONT you are currently using. We set the lpLogFont member of the structure to point to the LOGFONT that we just filled with our current information and also added the CF\_INITTOLOGFONTSTRUCT flag so that ChooseFont() knows to use this member. The flag CF\_EFFECTS tells ChooseFont() to allow the user to select a colour, as well as Underline and Strikeout attributes.

Oddly enough, the Bold and Italics styles don't count as effects, they are considered part of the font itself and in fact some fonts only come in Bold or Italics. If you want to check or prevent the user from selecting a bold or italic font you can check the lfWeight and lfItalic members of the LOGFONT respectively, after the user has made their selection. You can then prompt the user to make another selection or something change the members before calling CreateFontIndirect().

The colour of a font is not associated with an HFONT, and therefor must be stored seperately, the rgbColors member of the CHOOSEFONT struct is used both to pass in the initial colour and retreive the new colour afterward.

CF\_SCREENFONTS indicates that we want fonts designed to work on the screen, as opposed to fonts that are designed for printers. Some support both, some only one or the other. Depending on what you're going to be using the font for, this and many other flags can be found in MSDN to limit exactly which fonts you want the user to be able to select.

## Choosing Colours

In order to allow the user to change just the colour of the font, or to let them pick a new colour for anything at all, there is the ChooseColor() common dialog. This is the code used to allow the user to select the background colour in the example program.

COLORREF g\_rgbBackground = RGB(255, 255, 255);

COLORREF g\_rgbCustom[16] = {0};

void DoSelectColour(HWND hwnd)

{

CHOOSECOLOR cc = {sizeof(CHOOSECOLOR)};

cc.Flags = CC\_RGBINIT | CC\_FULLOPEN | CC\_ANYCOLOR;

cc.hwndOwner = hwnd;

cc.rgbResult = g\_rgbBackground;

cc.lpCustColors = g\_rgbCustom;

if(ChooseColor(&cc))

{

g\_rgbBackground = cc.rgbResult;

}

}

This is fairly straightforward, again we're using the hwnd parameter as the parent to the dialog. The CC\_RGBINIT parameter says to start off with the colour we pass in through the rgbResult member, which is also where we get the colour the user selected when the dialog closes.

The g\_rgbCustom array of 16 COLORREFs is required to store any values the user decides to put into the custom colour table on the dialog. You could potentially store these values somewhere like the registry, otherwise they will simply be lost when your program is closed. This parameter is not optional.

## Control Fonts

Something else you might want to do at some point is change the font on the controls on your dialog or window. This is usually the case when using CreateWindow() to create controls as we've done in previous examples. Controls like windows use System by default, so we used WM\_SETFONT to set a new font handle (from GetStockObject()) for the control to use. You can use this method with fonts you create from CreateFont() as well. Simply pass the font handle as wParam and set lParam to TRUE to make the control redraw.

I've done this in previous examples, but it makes sense to mention it here because it's relevant and very short:

SendDlgItemMessage(hwnd, IDC\_OF\_YOUR\_CONTROL, WM\_SETFONT, (WPARAM)hfFont, TRUE);

Where hfFont is of course the HFONT you want to use, and IDC\_OF\_YOUR\_CONTROL is the ID of whichever control you want to change the font of.

# Bitmaps, Device Contexts and BitBlt

Example: bmp\_one

## GDI

The really great thing about MS Windows is that unlike DOS, you don't need to know anything about what video hardware you are using to display graphics. Instead, windows provides an API called the Graphics Device Interface, or GDI. The GDI uses a set of generic graphics objects that can be used to draw to the screen, to memory, or even to printers.

### Device Contexts

The GDI revolves around an object called the Device Context (DC), represented by the data type HDC (Handle to Device Context). An HDC is basically a handle to something you can draw on; it can represent the entire screen, an entire window, the client area of a window, a bitmap stored in memory, or a printer. The nice part is that you don't even need to know which one it refers to, you can use it basically the same way, which is especially handy for writing custom drawing functions which you can then use on any of these devices without changing it for each one.

An HDC like most GDI objects is opaque, meaning that you can't access it's data directly... but you can pass it to various GDI functions that will operate on it, either to draw something, get information about it, or change the object in some way.

For example, if you wanted to draw on a window, first you would retreive an HDC representing the window with GetDC(), then you could use any of the GDI functions that take an HDC like BitBlt() for drawing images, TextOut() for drawing text, LineTo() for lines and so on.

### Bitmaps

Bitmaps can be loaded much like icons in earlier examples, there is LoadBitmap() for the most basic functionality of simply loading a bitmap resource, and LoadImage() can be used to load bitmaps from a \*.bmp file just as it can for icons.

One of the quirks of GDI is that you can't draw to bitmap objects (HBITMAP type) directly. Remember that drawing operations are abstracted by Device Contexts, so in order to use these drawing functions on a bitmap, you need to create a Memory DC, and then select the HBITMAP into it with SelectObject(). The effect is that the "device" that the HDC refers to is the bitmap in memory, and when you operate on the HDC, the resulting graphic operations are applied to the bitmap. As I mentioned, this is actually a very conveiniant way of doing things, as you can write code that draws to an HDC and you can use it on a Window DC or a Memory DC without any checks or changes.

You do have the option of manipulating the bitmap data in memory yourself. You can do this with Device Independant Bitmaps (DIB), and you can even combine GDI and manual operations on the DIB. However for the time being, this is beyond the scope of the basic tutorial and for now we're just cover the simpler GDI operations on their own.

### GDI Leaks

Once you're finished with an HDC, it's very important to release it (just how you do that depends on how you got it, which we'll talk about in a bit). GDI objects are limited in number. In versions of windows prior to Windows 95, they were not only incredably limited but also shared system wide, so that if one program used up too many, none of the rest would be able to draw anything! Fortunately this isn't the case any longer, and you could get away with using up quite a lot of resources in Windows 2000 or XP before anything too bad happened... but it's easy to forget to free GDI objects and they can quickly run your program out of GDI resources under Windows 9x. Theorhetically you shouldn't be able to drain the system of GDI resources in NT systems (NT/2K/XP) but it still happens in extreme cases, or if you hit the right bug on the nose.

If your program runs fine for a few minutes and then starts drawing strangely or not at all, it's a good sign that you're leaking GDI resources. HDCs aren't the only GDI objects you need to be careful about releasing, but generally it's ok to keep things like bitmaps and fonts around for the entire lifetime of your program, since it's much more efficient than reloading them each time you need them.

Also, an HDC can only contain one of each type of object (bitmap, font, pen...) at a time, and when you select a new one in it will return the last one. It's very important that you deal with this object properly. If you ignore it completely, it might be lost and pile up in memory as a GDI leak. When an HDC is created, it's also created with some default objects selected into it... it's a good idea to store these when they are returned to you, and then when you are completed drawing with the HDC select them back into it.

This is particularly important as you can't delete a GDI object while it is selected into an HDC. To clean up properly, you should reselect the default object back into the HDC releasing the object you had selected into it, which you can then DeleteObject() successfully. Trying to delete a bitmap you created while that bitmap is selected into an HDC will fail, and probably leak the bitmap if you assume it has been cleaned up from that point on.

Even Microsoft engineers get caught by this, there was a bug in one of the Windows screensavers and it turns out it was because the default bitmap wasn't getting replaced causing a leak and eventually the screensaver ran out of GDI resources. Be warned! It's an easy mistake to make.

## Displaying Bitmaps

Ok, down to business. The simplest drawing operations on a window occur by handling WM\_PAINT. When your window is first displayed, restored from being minimised, or uncovered from having another window on top of it, Windows sends the WM\_PAINT message to the window to let it know that it needs to redraw it's contents. When you draw something on the screen it is NOT permanent, it's only there untill something else draws over it, and you will need to redraw it when that part of your window becomes visible to the user again.

HBITMAP g\_hbmBall = NULL;

case WM\_CREATE:

g\_hbmBall = LoadBitmap(GetModuleHandle(NULL), MAKEINTRESOURCE(IDB\_BALL));

if(g\_hbmBall == NULL)

MessageBox(hwnd, "Could not load IDB\_BALL!", "Error", MB\_OK | MB\_ICONEXCLAMATION);

break;

The first step is of course loading the bitmap, this is quite simple with a bitmap resource, there are no significant differences from loading other resource types. Then we can get down to drawing...

case WM\_PAINT:

{

BITMAP bm;

PAINTSTRUCT ps;

HDC hdc = BeginPaint(hwnd, &ps);

HDC hdcMem = CreateCompatibleDC(hdc);

HBITMAP hbmOld = SelectObject(hdcMem, g\_hbmBall);

GetObject(g\_hbmBall, sizeof(bm), &bm);

BitBlt(hdc, 0, 0, bm.bmWidth, bm.bmHeight, hdcMem, 0, 0, SRCCOPY);

SelectObject(hdcMem, hbmOld);

DeleteDC(hdcMem);

EndPaint(hwnd, &ps);

}

break;

### Getting the Window DC

To start off we declare a couple of variables we need. Notice that the first one is a BITMAP, not an HBITMAP. BITMAP is a struct that holds information about an HBITMAP which is the actual GDI object. We need a way to get the height and width of the HBITMAP so we use GetObject() which contrary to it's name doesn't really get an object, but rather information about an existing one. "GetObjectInfo" would have been a more appropriate label. GetObject() works for various GDI object types which it can distinguish based on the value of the second parameter, the size of the structure.

The PAINTSTRUCT is a structure that contains information about the window being painted and what exactly is going on with the paint message. For most simple tasks, you can simply ignore the information it contains, but it's required for the call to BeginPaint(). BeginPaint() as it's name suggests is designed specifically for handling the WM\_PAINT message. When not handling a WM\_PAINT message you would use GetDC() which we will see in the timer animation examples in a while... but in WM\_PAINT, it's important to use BeginPaint() and EndPaint().

BeginPaint() returns us an HDC that represents the HWND that we pass to it, the one that WM\_PAINT is being handled for. Any drawing operation we perform on this HDC will immediately display on the screen.

### Setting up a Memory DC for the Bitmap

As I mention above, in order to draw on or with bitmaps, we need to create a DC in memory... the easiest way to do that here is to CreateCompatibleDC() with the one we already have. This gives us a Memory DC that is compatible with the color depth and display properties of the HDC for the window.

Now we call SelectObject() to select the bitmap into the DC being careful to store the default bitmap so that we can replace it later on and not leak GDI objects.

### Drawing

Once we've gotten the dimentions of the bitmap filled into the BITMAP struct, we can call BitBlt() to copy the image from our Memory DC to the Window DC, thus displaying on the screen. As always, you can look up each parameter in MSDN, but in short they are: The destination, the position and size, the source and source position, and finally the Raster Operation (ROP code), which specifies how to do the copy. In this case, we want a simple exact copy of the source made, no fancy stuff.

BitBlt() is probably the all time happiest function in all of the Win32 API and is the staple diet of anyone learning to write games or other graphics applications in windows. It was probably the first API that I memorised all the parameters to.

### Cleanup

At this point the bitmap should be on the screen, and we need to clean up after ourselves. The first thing to do is restore the Memory DC to the state it was when we got it, which means replacing our bitmap with the default one that we saved. Next we can delete it altogether with DeleteDC().

Finally we release the Window DC we got from BeginPaint() using EndPaint().

Destroying an HDC is a little confusing sometimes because there are at least 3 ways to do it depending on how you got it in the first place. Here's a list of the common methods of gaining an HDC, and how to release it when you're done.

* GetDC() - ReleaseDC()
* BeginPaint() - EndPaint()
* CreateCompatibleDC() - DeleteDC()

And finally, at the termination of our program, we want to free any resources that we allocated. Technically speaking this isn't absolutely required, since modern Windows platforms are pretty good at freeing everything when your program exists, but it's always a good idea to keep track of your own objects because if get lazy and don't delete them they have a habit of getting loose. And no doubt, there are still bugs in windows especially older versions that won't clean up all of your GDI objects if you don't do a thorough job.

case WM\_DESTROY:

DeleteObject(g\_hbmBall);

PostQuitMessage(0);

break;

# Transparent Bitmaps

Example: bmp\_two

## Transparency

Giving bitmaps the appearance of having transparent sections is quite simple, and involves the use of a black and white *Mask* image in addition to the colour image that we want to look transparent.

The following conditions need to be met for the effect to work correctly: First off, **the colour image must be black in all areas that we want to display as transparent**. And second, **the mask image must be white in the areas we want transparent**, and black elsewhere. The colour and mask images are displayed as the two left most images in the example picture on this page.

### BitBlt operations

How does this get us transparency? First we BitBlt() the mask image using the SRCAND operation as the last parameter, and then on top of that we BitBlt() the colour image using the SRCPAINT operation. The result is that the areas we wanted transparent don't change on the destination HDC while the rest of the image is drawn as usual.

SelectObject(hdcMem, g\_hbmMask);

BitBlt(hdc, 0, 0, bm.bmWidth, bm.bmHeight, hdcMem, 0, 0, SRCAND);

SelectObject(hdcMem, g\_hbmBall);

BitBlt(hdc, 0, bm.bmHeight, bm.bmWidth, bm.bmHeight, hdcMem, 0, 0, SRCPAINT);

Pretty simple eh? Fortunately it is, but one question remains... where does the mask come from? There are basically two ways to get the mask...

* Make it yourself in whatever graphics program you made the colour bitmap in, and this is a reasonable solution if you are using a limited number of graphics in your program. This way you can just add the mask resource to your program and load it with LoadBitmap().
* Generate it when your program runs, by selecting one colour in your original image to be your "transparent" colour, and create a mask that is white everywhere that colour exists, and black everywhere else.

Since the first one is nothing new, you should be able to do things that way yourself if you want to. The second way involves from BitBlt() trickery, and so I will show one way of accomplishing this.

### Mask Creation

The simplest way to do it, would be to loop through every pixel on the colour image, check it's value and then set the corresponding pixel on the mask to black or white... SetPixel() is a *very* slow way to draw images however, and it's not really practical.

A much more efficient way involves using the way BitBlt() converts from colour images to black and white. If you BitBlt() (using SRCCOPY) from an HDC holding a colour image into an HDC holding a black and white image, it will check what colour is set as the *Background Colour* on the colour image, and set all of those pixels to **White**, any pixel that is not the background colour will end up **Black**.

This works perfectly to our advantage, since all we need to do is set the background colour to the colour we want transparent, and BitBlt() from the colour image to the mask image. Note that **this only works with a mask bitmap that is monochrome** (black and white)... that is bitmaps with a bit depth of 1 bit per pixel. If you try it with a colour image that only has black and white pixels, but the bitmap itself is greater than 1 bit (say 16 or 24 bit) then it won't work.

Remember the first condition for succesful masking above? It was that the colour image needs to be black everywhere we want transparent. Since the bitmap I used in this example already meets that condition it doesn't really need anything special done, but if you're going to use this code for another image that has a different colour that you want transparent (hot pink is a common choice) then we need to take a second step, and that is use the mask we just created to alter the original image, so that everywhere we want transparent is black. It's ok if other places are black too, because they aren't white on the mask, they won't end up transparent. We can accomplish this by BitBlt()ing from the new mask to the original colour image, using the SRCINVERT operation, which sets all the areas that are white in the mask to black in the colour image.

This is all a bit of a complex process, and so it's nice to have a handy utility function that does this all for us, and here it is:

HBITMAP CreateBitmapMask(HBITMAP hbmColour, COLORREF crTransparent)

{

HDC hdcMem, hdcMem2;

HBITMAP hbmMask;

BITMAP bm;

// Create monochrome (1 bit) mask bitmap.

GetObject(hbmColour, sizeof(BITMAP), &bm);

hbmMask = CreateBitmap(bm.bmWidth, bm.bmHeight, 1, 1, NULL);

// Get some HDCs that are compatible with the display driver

hdcMem = CreateCompatibleDC(0);

hdcMem2 = CreateCompatibleDC(0);

SelectBitmap(hdcMem, hbmColour);

SelectBitmap(hdcMem2, hbmMask);

// Set the background colour of the colour image to the colour

// you want to be transparent.

SetBkColor(hdcMem, crTransparent);

// Copy the bits from the colour image to the B+W mask... everything

// with the background colour ends up white while everythig else ends up

// black...Just what we wanted.

BitBlt(hdcMem2, 0, 0, bm.bmWidth, bm.bmHeight, hdcMem, 0, 0, SRCCOPY);

// Take our new mask and use it to turn the transparent colour in our

// original colour image to black so the transparency effect will

// work right.

BitBlt(hdcMem, 0, 0, bm.bmWidth, bm.bmHeight, hdcMem2, 0, 0, SRCINVERT);

// Clean up.

DeleteDC(hdcMem);

DeleteDC(hdcMem2);

return hbmMask;

}

NOTE: This function call SelectObject() to temporarily select the colour bitmap we pass it into an HDC. A bitmap can't be selected into more than one HDC at a time, so **make sure the bitmap isn't selected in to another HDC** when you call this function or it will fail. Now that we have our handy dandy function, we can create a mask from the original picture as soon as we load it:

case WM\_CREATE:

g\_hbmBall = LoadBitmap(GetModuleHandle(NULL), MAKEINTRESOURCE(IDB\_BALL));

if(g\_hbmBall == NULL)

MessageBox(hwnd, "Could not load IDB\_BALL!", "Error", MB\_OK | MB\_ICONEXCLAMATION);

g\_hbmMask = CreateBitmapMask(g\_hbmBall, RGB(0, 0, 0));

if(g\_hbmMask == NULL)

MessageBox(hwnd, "Could not create mask!", "Error", MB\_OK | MB\_ICONEXCLAMATION);

break;

The second parameter is of course the colour from the original image that we want to be transparent, in this case black.

## How does all this work?

.. you may be asking. Well hopefully your experience with C or C++ means that you understand binary operations such as OR, XOR, AND, NOT and so on. I'm not going to explain this process completely, but I will try to show how I used it for this example. If my explanation isn't clear enough (which it's bound to not be), reading up on binary operations should help you understand it. Understanding it isn't critical for using it right now, and you can just get away with trusting that it works if you want.

### SRCAND

The SRCAND raster operation, or ROP code for BitBlt() means to combine the bits using AND. That is: only bits that are set both in the source AND the destination get set in the final result. We use this with our mask to set to black all the pixels that will eventually have colour on them from the colour image. The mask image has black (which in binary is all 0's) where we want colour, and white (all 1's) where we want transparency. Any value combined with 0 using AND is 0, and therefor all the pixels that are black in the mask are set to 0 in the result and end up black as well. Any value that is combined with 1 using AND is left unaffected, so if it was 1 to begin with it stays 1, and if it was 0 to begin with it stays 0... therefor all the pixels that are white in our mask, are completely unaffected after the BitBlt() call. The result is the top right image in the example picture.

### SRCPAINT

SRCPAINT uses the OR operation, so if either (or both) of the bits are set, then they will be set in the result. We use this on the colour image. When the black (transparent) part of our colour image is combined with the data on the destination using OR, the result is that the data is untouched, because any value combined with 0 using the OR operation is left unaffected.

However, the rest of our colour image isn't black, and if the destination also isn't black, then we get a combination of the source and destination colours, the result you can see in the second ball on the second row in the example picture. This is the whole reason for using the mask to set the pixels we want to colour to black first, so that when we use OR with the colour image, the coloured pixels don't get mixed up with whatever is underneath them.

### SRCINVERT

This is the XOR operation used to set the transparent colour in our original image to black (if it isn't black already). Combining a black pixel from the mask with a non-background colour pixel in the destination leaves it untouched, while combining a white pixel from the mask (which remember we generated by setting a particular colour as the "background") with the background colour pixel on the destination cancels it out, and sets it to black.

This is all a little GDI mojo that depends on it's colour vs. monochrome handling, and it hurts my head to think about it too much, but it really makes sense... honest.

## Example

The example code in the project bmp\_two that goes along with this section contains the code for the example picture on this page. It consists of first drawing the mask and the colour image exactly as they are using SRCCOPY, then using each one alone with the SRCAND and SRCPAINT operations respectively, and finally combining them to produce the final product.

The background in this example is set to gray to make the transparency more obvious, as using these operations on a white or black background makes it hard to tell if they're actually working or not.

# Timers and Animation

Example: anim\_one

## Setting up

Before we get things animated, we need to set up a structure to store the position of the ball between updates. This struct will store the current position and size of the ball, as well as the delta values, how much we want it to move each frame.

Once we have the structure type declared, we also declare a global instance of the struct. This is ok since we only have one ball, if were were going to animate a bunch of them, you'd probably want to use an array or other container (such as a linked list in C++) to store them in a more convenient way.

const int BALL\_MOVE\_DELTA = 2;

typedef struct \_BALLINFO

{

int width;

int height;

int x;

int y;

int dx;

int dy;

}BALLINFO;

BALLINFO g\_ballInfo;

We've also defined a constant BALL\_MOVE\_DELTA which is how far we want the ball to move on each update. The reason we store deltas in the BALLINFO structure as well is that we want to be able to move the ball left or right and up and down independantly, BALL\_MOVE\_DELTA is just a handy name to give the value so we can change it later if we want.

Now we need to initialize this structure after we load our bitmaps:

BITMAP bm;

GetObject(g\_hbmBall, sizeof(bm), &bm);

ZeroMemory(&g\_ballInfo, sizeof(g\_ballInfo));

g\_ballInfo.width = bm.bmWidth;

g\_ballInfo.height = bm.bmHeight;

g\_ballInfo.dx = BALL\_MOVE\_DELTA;

g\_ballInfo.dy = BALL\_MOVE\_DELTA;

The ball starts off in the top left corner, moving to the right and down according to the dx and dy members of BALLINFO.

## Setting the Timer

The easiest way to add a simple timer into a window program is with SetTimer(), it's not the best, and it's not recommended for real multimedia or full games, however it's good enough for simple animations like this. When you need something better take a look at timeSetEvent() in MSDN; it's more accurate.

const int ID\_TIMER = 1;

ret = SetTimer(hwnd, ID\_TIMER, 50, NULL);

if(ret == 0)

MessageBox(hwnd, "Could not SetTimer()!", "Error", MB\_OK | MB\_ICONEXCLAMATION);

Here we've declared a timer id so that we can refer to it later (to kill it) and then set the timer in the WM\_CREATE handler of our main window. Each time the timer elapses, it will send a WM\_TIMER message to the window, and pass us back the ID in wParam. Since we only have one timer we don't need the ID, but it's useful if you set more than one timer and need to tell them apart.

We've set the timer to elapse every 50 milliseconds, which results in approximately 20 frames per second. Approximately because like I said, SetTimer() is a little inaccurate, but this isn't critical code, and a few milliseconds here or there won't kill us.

## Animating in WM\_TIMER

Now when we get WM\_TIMER we want to calculate the new position for the ball and draw it's updated position.

case WM\_TIMER:

{

RECT rcClient;

HDC hdc = GetDC(hwnd);

GetClientRect(hwnd, &rcClient);

UpdateBall(&rcClient);

DrawBall(hdc, &rcClient);

ReleaseDC(hwnd, hdc);

}

break;

I've put the code for updating and drawing the ball in their own functions. This is good practice, and it lets us draw the ball from either WM\_TIMER or WM\_PAINT without duplicating code, note that the method we use to get the HDC in each case is different, so it's best to leave this code in the message handlers and pass the result into the DrawBall() function.

void UpdateBall(RECT\* prc)

{

g\_ballInfo.x += g\_ballInfo.dx;

g\_ballInfo.y += g\_ballInfo.dy;

if(g\_ballInfo.x < 0)

{

g\_ballInfo.x = 0;

g\_ballInfo.dx = BALL\_MOVE\_DELTA;

}

else if(g\_ballInfo.x + g\_ballInfo.width > prc->right)

{

g\_ballInfo.x = prc->right - g\_ballInfo.width;

g\_ballInfo.dx = -BALL\_MOVE\_DELTA;

}

if(g\_ballInfo.y < 0)

{

g\_ballInfo.y = 0;

g\_ballInfo.dy = BALL\_MOVE\_DELTA;

}

else if(g\_ballInfo.y + g\_ballInfo.height > prc->bottom)

{

g\_ballInfo.y = prc->bottom - g\_ballInfo.height;

g\_ballInfo.dy = -BALL\_MOVE\_DELTA;

}

}

All this does is some basic math, we add the delta value to the x position to move the ball. If the ball goes outside the client area, move it back in range and change the delta value to the opposite direction so that the ball "bounces" off the sides.

void DrawBall(HDC hdc, RECT\* prc)

{

HDC hdcBuffer = CreateCompatibleDC(hdc);

HBITMAP hbmBuffer = CreateCompatibleBitmap(hdc, prc->right, prc->bottom);

HBITMAP hbmOldBuffer = SelectObject(hdcBuffer, hbmBuffer);

HDC hdcMem = CreateCompatibleDC(hdc);

HBITMAP hbmOld = SelectObject(hdcMem, g\_hbmMask);

FillRect(hdcBuffer, prc, GetStockObject(WHITE\_BRUSH));

BitBlt(hdcBuffer, g\_ballInfo.x, g\_ballInfo.y, g\_ballInfo.width, g\_ballInfo.height, hdcMem, 0, 0, SRCAND);

SelectObject(hdcMem, g\_hbmBall);

BitBlt(hdcBuffer, g\_ballInfo.x, g\_ballInfo.y, g\_ballInfo.width, g\_ballInfo.height, hdcMem, 0, 0, SRCPAINT);

BitBlt(hdc, 0, 0, prc->right, prc->bottom, hdcBuffer, 0, 0, SRCCOPY);

SelectObject(hdcMem, hbmOld);

DeleteDC(hdcMem);

SelectObject(hdcBuffer, hbmOldBuffer);

DeleteDC(hdcBuffer);

DeleteObject(hbmBuffer);

}

This is essentially the same drawing code as the past few examples, with the exception that it gets the position and dimentions of the ball from the BALLINFO structure. There is however one important difference...

## Double Buffering

When doing your drawing directly to the HDC of the window, it's entirely possible that the screen will get updated before you're done... for example after you draw the mask and before you draw the colour image over top, the user might see a flicker of the back background before your program has a chance to draw over it in colour. The slower your computer and the more drawing operations that you do, the more flicker will be apparent and eventually it will look like a big jumbled mess.

This is terribly distracting, and we can solve it simply by doing all the drawing in memory first, and then copying the completed masterpiece to the screen in a single BitBlt() so that the screen is updated directly from the old image, to the complete new image with none of the individual operations visible.

To do this, we create a temporary HBITMAP in memory that is the exact size of the area we are going to draw to on the screen. We also need an HDC so that we can BitBlt() to the bitmap.

HDC hdcBuffer = CreateCompatibleDC(hdc);

HBITMAP hbmBuffer = CreateCompatibleBitmap(hdc, prc->right, prc->bottom);

HBITMAP hbmOldBuffer = SelectObject(hdcBuffer, hbmBuffer);

Now that we have a place to draw to in memory, all of the drawing operations use hdcBuffer instead of hdc (the window) and the results are stored on the bitmap in memory untill we are complete. We can now copy the whole thing over to the window in one shot.

BitBlt(hdc, 0, 0, prc->right, prc->bottom, hdcBuffer, 0, 0, SRCCOPY);

That's it, and we clean up our HDCs and HBITMAPs as usual.

### Faster Double Buffering

In this example I am creating and destroying the bitmap used for double buffering each frame, I did this basically because I wanted to be able to size the window so it's easier to just always create a new buffer than to track when the window position changes and resize the buffer. It would be more efficient to create a global double buffer bitmap and either not allow the window to resize or only resize the bitmap when the window resized, instead of creating it and destroying it all the time. It's up to you to implement this if you want to optimize the drawing for a game or something.

## Killing the Timer

When our window is destroyed, it's a good idea to release all resources we used, and in this case that includes the timer we set. To stop it, we simply call KillTimer() and pass in the ID that we used when we created it.

KillTimer(hwnd, ID\_TIMER);

# Text and Fonts

Example: font\_one

## Loading Fonts

The Win32 GDI has some remarkable capabilites for dealing with vastly different typefaces, styles, languages and characters sets. One of the drawbacks of this is that dealing with fonts can look rather intimidating to the newcomer. CreateFont(), the primary API when it comes to fonts, has 14 parameters for specifying height, style, weight, family, and various other attributes.

Fortunately, it's not really has hard as it might appear, and a large portion of the work involved is taken care of my sensible default values. All but 2 of the parameters to CreateFont() can be set to 0 or NULL, and the system will simply use a default value giving you a plain ordinary font.

CreateFont() creates an HFONT, a handle to a *Logical Font* in memory. The data held by this handle can be retreived into a LOGFONT structure using GetObject() just as a BITMAP struct can be filled from an HBITMAP.

The members of the LOGFONT are identical to the parameters to CreateFont() and for convenience you can create a font directly from an existing LOGFONT structure using CreateFontIndirect(). This is very handy, since it makes it simple to create a new font from an existing font handle when you only want to alter certain aspects of it. Use GetObject() to fill a LOGFONT, alter the members that you wish, and create a new font with CreateFontIndirect().

HFONT hf;

HDC hdc;

long lfHeight;

hdc = GetDC(NULL);

lfHeight = -MulDiv(12, GetDeviceCaps(hdc, LOGPIXELSY), 72);

ReleaseDC(NULL, hdc);

hf = CreateFont(lfHeight, 0, 0, 0, 0, TRUE, 0, 0, 0, 0, 0, 0, 0, "Times New Roman");

if(hf)

{

DeleteObject(g\_hfFont);

g\_hfFont = hf;

}

else

{

MessageBox(hwnd, "Font creation failed!", "Error", MB\_OK | MB\_ICONEXCLAMATION);

}

This is the code used to create the font in the example image. This is *Times New Roman* at *12 Point* with the *Italics* style set. The italics flag is the 6th parameter to CreateFont() which you can see we have set to TRUE. The name of the font we want to use is the last parameter.

The one bit of trickery in this code is the value used for the size of the font, the lfHeight parameter to CreateFont(). Usually people are used to working with *Point* sizes, Size 10, Size 12, etc... when dealing with fonts. CreateFont() however doesn't accept point sizes, it wants Logical Units which are different on your screen than they are on your Printer, and even between Printers and screens.

The reason this situation exists is because the resolution of different devices is so vastly different... Printers can easily display 600 to 1200 pixels per inch, while a screen is lucky to get 200... if you used the same sized font on a printer as on a screen, you likely wouldn't even be able to see individual letters.

All we have to do is convert from the point size we want, into the appropriate logical size for the device. In this case the device is the screen, so we get the HDC to the screen, and get the number of logical pixels per inch using GetDeviceCaps() and slap this into the formula so generously provided in MSDN which uses MulDiv() to convert from our pointsize of 12 to the correct logical size that CreateFont() expects. We store this in lfHeight and pass it as the first parameter to CreateFont().

### Default Fonts

When you first call GetDC() to get the HDC to your window, the default font that is selected into it is *System*, which to be honest isn't all that attractive. The simplest way to get a reasonable looking font to work with (without going through the CreateFont() hassle) is to call GetStockObject() and ask for the DEFAULT\_GUI\_FONT.

This is a system object and you can get it as many times as you want without leaking memory, and you can call DeleteObject() on it which won't do anything, which is good because now you don't need to keep track of whether your font is one from CreateFont() or GetStockObject() before trying to free it.

## Drawing Text

Now that we have a handy-dandy font, how do we get some text on the screen? This is assuming that we don't just want to use an Edit or Static control.

Your basic options are TextOut() and DrawText(). TextOut() is simpler, but has less options and doesn't do word wrapping or alignment for you.

char szSize[100];

char szTitle[] = "These are the dimensions of your client area:";

HFONT hfOld = SelectObject(hdc, hf);

SetBkColor(hdc, g\_rgbBackground);

SetTextColor(hdc, g\_rgbText);

if(g\_bOpaque)

{

SetBkMode(hdc, OPAQUE);

}

else

{

SetBkMode(hdc, TRANSPARENT);

}

DrawText(hdc, szTitle, -1, prc, DT\_WORDBREAK);

wsprintf(szSize, "{%d, %d, %d, %d}", prc->left, prc->top, prc->right, prc->bottom);

DrawText(hdc, szSize, -1, prc, DT\_SINGLELINE | DT\_CENTER | DT\_VCENTER);

SelectObject(hdc, hfOld);

First thing we do is use SelectObject() to get the font we want to use into our HDC and ready for drawing. All future text operations will use this font untill another one is selected in.

Next we set the Text and Background colours. Setting the background colour doesn't actually make the *whole* background this colour, it only affects certain operations (text being one of them) that use the background colour to draw with. This is also dependant on the current *Background Mode*. If it is set to OPAQUE (the default) then any text drawn is filled in behing with the background colour. If it is set to TRANSPARENT then text is drawn without a background and whatever is behind will show through and in this case the background colour has no effect.

Now we actually draw the text using DrawText(), we pass in the HDC to use and the string to draw. The 3rd parameter is the length of the string, but we've passed -1 because DrawText() is smart enough that it will figure out how long the text is itself. In the 4th parameter we pass in prc, the pointer to the client RECT. DrawText() will draw inside this rectangle based on the other flags that you give it.

In the first call, we specify DT\_WORDBREAK, which defaults to aligned to the top left, and will wrap the text it draws automatically at the edge of the rectangle... very useful.

For the second call, we're only printing a single line without wrapping, and we want it to be centered horizontally as well as vertically (which DrawText() will do only when drawing a single line).

#### Client Redraw

Just a note about the example program... when the WNDCLASS is registered I have set the CS\_VREDRAW and CS\_HREDRAW class styles. This causes the entire client area to be redrawn if the window is resized, whereas the default is to only redraw the parts that have changed. That looks really bad since the centered text moves around when you resize and it doesn't update like you'd expect.

## Choosing Fonts

In general, any program that deals with fonts will want to let the user choose their own font, as well as the colour and style attribute to use when displaying it.

Like the common dialogs for getting open and save file names, there is a common dialog for choosing a font. This is, oddly enough, called ChooseFont() and it works with the CHOOSEFONT structure for you to set the defaults it should start with as well as returning the final result of the users selection.

HFONT g\_hfFont = GetStockObject(DEFAULT\_GUI\_FONT);

COLORREF g\_rgbText = RGB(0, 0, 0);

void DoSelectFont(HWND hwnd)

{

CHOOSEFONT cf = {sizeof(CHOOSEFONT)};

LOGFONT lf;

GetObject(g\_hfFont, sizeof(LOGFONT), &lf);

cf.Flags = CF\_EFFECTS | CF\_INITTOLOGFONTSTRUCT | CF\_SCREENFONTS;

cf.hwndOwner = hwnd;

cf.lpLogFont = &lf;

cf.rgbColors = g\_rgbText;

if(ChooseFont(&cf))

{

HFONT hf = CreateFontIndirect(&lf);

if(hf)

{

g\_hfFont = hf;

}

else

{

MessageBox(hwnd, "Font creation failed!", "Error", MB\_OK | MB\_ICONEXCLAMATION);

}

g\_rgbText = cf.rgbColors;

}

}

The hwnd in this call is simply the window you want to use as the parent for the font dialog.

The easiest way to use this dialog is in conjunction with an existing LOGFONT structure, which is most likely from whichever HFONT you are currently using. We set the lpLogFont member of the structure to point to the LOGFONT that we just filled with our current information and also added the CF\_INITTOLOGFONTSTRUCT flag so that ChooseFont() knows to use this member. The flag CF\_EFFECTS tells ChooseFont() to allow the user to select a colour, as well as Underline and Strikeout attributes.

Oddly enough, the Bold and Italics styles don't count as effects, they are considered part of the font itself and in fact some fonts only come in Bold or Italics. If you want to check or prevent the user from selecting a bold or italic font you can check the lfWeight and lfItalic members of the LOGFONT respectively, after the user has made their selection. You can then prompt the user to make another selection or something change the members before calling CreateFontIndirect().

The colour of a font is not associated with an HFONT, and therefor must be stored seperately, the rgbColors member of the CHOOSEFONT struct is used both to pass in the initial colour and retreive the new colour afterward.

CF\_SCREENFONTS indicates that we want fonts designed to work on the screen, as opposed to fonts that are designed for printers. Some support both, some only one or the other. Depending on what you're going to be using the font for, this and many other flags can be found in MSDN to limit exactly which fonts you want the user to be able to select.

## Choosing Colours

In order to allow the user to change just the colour of the font, or to let them pick a new colour for anything at all, there is the ChooseColor() common dialog. This is the code used to allow the user to select the background colour in the example program.

COLORREF g\_rgbBackground = RGB(255, 255, 255);

COLORREF g\_rgbCustom[16] = {0};

void DoSelectColour(HWND hwnd)

{

CHOOSECOLOR cc = {sizeof(CHOOSECOLOR)};

cc.Flags = CC\_RGBINIT | CC\_FULLOPEN | CC\_ANYCOLOR;

cc.hwndOwner = hwnd;

cc.rgbResult = g\_rgbBackground;

cc.lpCustColors = g\_rgbCustom;

if(ChooseColor(&cc))

{

g\_rgbBackground = cc.rgbResult;

}

}

This is fairly straightforward, again we're using the hwnd parameter as the parent to the dialog. The CC\_RGBINIT parameter says to start off with the colour we pass in through the rgbResult member, which is also where we get the colour the user selected when the dialog closes.

The g\_rgbCustom array of 16 COLORREFs is required to store any values the user decides to put into the custom colour table on the dialog. You could potentially store these values somewhere like the registry, otherwise they will simply be lost when your program is closed. This parameter is not optional.

## Control Fonts

Something else you might want to do at some point is change the font on the controls on your dialog or window. This is usually the case when using CreateWindow() to create controls as we've done in previous examples. Controls like windows use System by default, so we used WM\_SETFONT to set a new font handle (from GetStockObject()) for the control to use. You can use this method with fonts you create from CreateFont() as well. Simply pass the font handle as wParam and set lParam to TRUE to make the control redraw.

I've done this in previous examples, but it makes sense to mention it here because it's relevant and very short:

SendDlgItemMessage(hwnd, IDC\_OF\_YOUR\_CONTROL, WM\_SETFONT, (WPARAM)hfFont, TRUE);

Where hfFont is of course the HFONT you want to use, and IDC\_OF\_YOUR\_CONTROL is the ID of whichever control you want to change the font of.

# Solutions to Common Errors

* [Error LNK2001: unresolved external symbol \_main](http://www.winprog.org/tutorial/errors.html#_main)
* [Error C2440: cannot convert from 'void\*' to 'HICON\_\_ \*'](http://www.winprog.org/tutorial/errors.html#C2440) (or similar)
* [Fatal error RC1015: cannot open include file 'afxres.h'](http://www.winprog.org/tutorial/errors.html#RC1015)
* [Error LNK2001: unresolved external symbol InitCommonControls](http://www.winprog.org/tutorial/errors.html#LNK2001)
* [Dialog does not display when certain controls are added](http://www.winprog.org/tutorial/errors.html#Dialog)

## Error LNK2001: unresolved external symbol \_main

An unresolved external occurs when some code has a call to a function in another module and the linker can't find that function in any of the modules or libraries that you are currently linking to.

In this specific case, it means one of two things. Either you are trying to write a Win32 GUI application (or non-console application) and accidently compiled it as a Console application... or you really are trying to compile a console application and didn't write or properly compile in a main() function.

Generally the first is the most common, if you specify Win32 Console as the project type in VC++ when you create your project you will get this error. You will also likely get it if you try to compile from the command line using BC++ but you neglect to specify the correct parameters to tell it to make a Win32 GUI application instead of a console app which is the default.

### Fixing

If you're using VC++ re-create your project and select the Win32 Application project type (NOT "Console").

If you're using BC++ command line compiler, use -tW to specify a windows application.

## Error C2440: cannot convert from 'void\*' to 'HICON\_\_ \*' (or similar)

If you're compiling the code from this tutorial, it means that you are trying to compile it as C++ code. The code is written for the bcc32 and VC++ C compilers, and as such may not compile exactly the same under C++ since C++ has much stricter rules about converting types. C will just let it happen, C++ wants to you to make it explicit.

VC++ (and most compilers) will automatically compile a file with a .cpp extension as C++ code, and a file with a .c extension as C code. If you have added the tutorial code to a .cpp file, this is the most likely reason of getting this error.

If you're compiling code not from this tutorial, I can't guarantee that it's correct and therefor it may actually be an error that needs resolving. You'll have to use your own judgement to determine if it's safe to cast the value and remove the error, or if you are actually trying to make a variable be something it's not.

### Fixing

If you want to use C, simply rename your file from .cpp to .c. Otherwise, simply add a cast, all of the code in the tutorial will work without any other changes when compiled as C++.

For example, in C this will work:

HBITMAP hbmOldBuffer = SelectObject(hdcBuffer, hbmBuffer);

But in C++ requires a cast:

HBITMAP hbmOldBuffer = (HBITMAP)SelectObject(hdcBuffer, hbmBuffer);

## Fatal error RC1015: cannot open include file 'afxres.h'.

Oddly enough, VC++ adds afxres.h to resource files even when you aren't using an MFC project, and yet the file may only be installed if you install MFC. This perticular file isn't actually required, so to fix the error you can edit the .rc file in notepad and replace both occurances of "afxres.h" with "winres.h" (note that there should be two of them, and you need to change both).

## Error LNK2001: unresolved external symbol InitCommonControls

You aren't linking to comctl32.lib which this API is defined in. This library is not included by default so you will either need to add it to the libraries on your command line, or add it in your VC++ project settings on the Link tab.

## Dialog does not display when certain controls are added

Controls such as the ListView, TreeView, Hotkey, Progress Bar, and others are classified as Common Controls, as they were added to windows in comctl32.dll and were not available prior to Windows 95. Controls such as BUTTON, EDIT, LISTBOX, etc... while no doubt being common, are not "Common Controls" and I generally refer to them as "Standard Controls".

If you add a Common Control to a dialog and it fails to display, you most likely failed to call InitCommonControls() before running your dialog, or perhaps at all. The best place to call it is first thing in WinMain(). Calling it in WM\_INITDIALOG is too late, since the dialog will fail before it reaches this point and it will never get called.

Some people and documentation may tell you that InitCommonControls() is deprecated and you should use InitCommonControlsEx(). Feel free to do this if you want, InitCommonControls() is just simpler and there's nothing wrong with using it.

# Resource file notes

## Argh!

The one thing I really hated when I switched my primary development environment from Borland C++ to MS Visual C++ was the way VC++ handles resource scripts (.rc files).

In BC++ was free to control the layout and content of the .rc files, and when using the resource editor, only the things that I specifically changed in the editor got changed in the resource file. Much to my dismay, the VC++ resource editor will completely rewrite your .rc file, and possibly destroy or ignore any changes that you personally make.

This was terribly frustrating at first, but I basically learned to deal with it and it's not SO bad after a while, since in general I don't write any amount of my resources by hand, but reserve that for minor changes that perhaps I can't quite accomplish in the editor.

## Compatibility

One small challange for this tutorial was to make the resource files compile properly under VC++ and BC++ without changes. In the original tutorial I used the Borland naming convention for the resource header, which was project\_name.rh. However by default in VC++ this header is ALWAYS called resource.h, so for simplicity I've adopted this for the current tutorial revision, as it doesn't impact BC++ at all.

For the curious, it is possible to change the name of the resource that VC++ uses by editing the .rc file manually and changing the name in two places, once where it is #included, and second where it is contained in a TEXTINCLUDE resource.

The next problem is that by default VC++ requires the file afxres.h to be included in it's .rc files, whereas BC++ has all the necessary preprocessor macros defined automatically and requires no such include. Another dumb thing about this is that afxres.h is only installed when you insall MFC which not everyone does, even when you are creating an API application which only requires winres.h which is always installed.

Since I work in VC++ and use it's resource editor I've solved this problem by slightly altering each .rc file that is generated to include the following:

#ifndef \_\_BORLANDC\_\_

#include "winres.h"

#endif

Which under default circumstances would usually read:

#include "afxres.h"

For those of you that are using VC++ you can find the option to change this text within the IDE under "View > Resource Includes". There is generally no need to ever use this in normal practice, it's simply a way I used to work around the problem of making things work with BC++ and VC++.

To those of you using BC++, I'm sorry about the extra mess in the .rc files that are generate by the VC++ editor, but it shouldn't interfere with anything.

## Compiling resources under BC++

Try as I might I couldn't find a simple way to compile a program with BC++ that included RC files, and ultimately had to settle on the non-optimal configuration that you will find in the makefiles included with the source for this tutorial. You can find the notes for the BC++ compiler in [Free Borland C++ Command Line Tools](http://www.winprog.org/tutorial/bcpp.html).