The GL Utility Toolkit (GLUT)

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What is GLUT?

The **GL Utility Toolkit** (GLUT) serves two major purposes:

1. It interfaces with your operating system and window system

2. It provides various application utilities, such as drawing 3D shapes for you

You can find GLUT (actually freeGLUT) at:

http://freeglut.sourceforge.net/

although we will give you some binaries that are ready-to-use.

Using GLUT to Setup the Window

All the GLUT_XXX constants are #defined in glut.h

```
 glutInitDisplayMode( GLUT_RGBA | GLUT_DOUBLE | GLUT_DEPTH );

// set the initial window configuration:

glutInitWindowPosition( 0, 0 );
glutInitWindowSize( INIT_WINDOW_SIZE, INIT_WINDOW_SIZE );

// open the window and set its title:

MainWindow = glutCreateWindow( WINDOWTITLE );
glutSetWindowTitle( WINDOWTITLE );
```

Constants not beginning with GLUT_ are user-defined

Using GLUT to Specify Event-driven Callback Functions

```
glutSetWindow( MainWindow );
glutDisplayFunc( Display );
glutReshapeFunc( Resize );
glutKeyboardFunc( Keyboard );
glutMouseFunc( MouseButton );
glutMotionFunc( MouseMotion );

glutPassiveMotionFunc( NULL );
glutVisibilityFunc( Visibility );
glutEntryFunc( NULL );
glutSpecialFunc( NULL );
glutSpaceballMotionFunc( NULL );
glutSpaceballRotateFunc( NULL );
glutSpaceballButtonFunc( NULL );
glutButtonBoxFunc( NULL );
glutDialsFunc( NULL );
glutTabletMotionFunc( NULL );
glutTabletButtonFunc( NULL );
glutMenuStateFunc( NULL );
glutTimerFunc( -1, NULL, 0 );
glutIdleFunc( NULL );
```

For example, the **Keyboard( )** function gets called when a keyboard key is hit

A NULL callback function means that this event will be ignored

The *Keyboard* Callback Function

```
void
Keyboard( unsigned char c, int x, int y )
{
	if( DebugOn != 0 )
		fprintf( stderr, "Keyboard: '%c' (0x%0x)\n", c, c );

	switch( c )
	{
		case 'o':  case 'O':
			WhichProjection = ORTHO;
			break;

		case 'p':  case 'P':
			WhichProjection = PERSP;
			break;

		case 'q':  case 'Q':
		case ESCAPE:
			DoMainMenu( QUIT );	// will not return here
			break;			// happy compiler

		default:
			fprintf( stderr, "Don't know what to do with keyboard hit: '%c' (0x%0x)\n", c, c );
	}

	// force a call to Display( ):

	glutSetWindow( MainWindow );
	glutPostRedisplay( );
}
```

Where the mouse was when the key was hit

The key that was hit

The *MouseButton* Callback Function

```
void
MouseButton( int button, int state, int x, int y )
{
	int b = 0;			// LEFT, MIDDLE, or RIGHT
	if( DebugOn != 0 )
		fprintf( stderr, "MouseButton: %d, %d, %d, %d\n", button, state, x, y );

	// get the proper button bit mask:
	switch( button )
	{
		case GLUT_LEFT_BUTTON:
			b = LEFT;		break;

		case GLUT_MIDDLE_BUTTON:
			b = MIDDLE;		break;

		case GLUT_RIGHT_BUTTON:
			b = RIGHT;		break;

		default:
			b = 0;
			fprintf( stderr, "Unknown mouse button: %d\n", button );
	}

	// button down sets the bit, up clears the bit:
	if( state == GLUT_DOWN )
	{
		Xmouse = x;
		Ymouse = y;
		ActiveButton |= b;		// set the proper bit
	}
	else
	{
		ActiveButton &= ~b;		// clear the proper bit
	}
}
```

The *MouseMotion* Callback Function

```
void
MouseMotion( int x, int y )
{
	if( DebugOn != 0 )
		fprintf( stderr, "MouseMotion: %d, %d\n", x, y );

	int dx = x - Xmouse;		// change in mouse coords
	int dy = y - Ymouse;

	if( ( ActiveButton & LEFT ) != 0 )
	{
		Xrot += ( ANGFACT*dy );
		Yrot += ( ANGFACT*dx );
	}

	if( ( ActiveButton & MIDDLE ) != 0 )
	{
		Scale += SCLFACT * (float) ( dx - dy );

		// keep object from turning inside-out or disappearing:
		if( Scale < MINSCALE )
			Scale = MINSCALE;
	}

	Xmouse = x;			// new current position
	Ymouse = y;

	glutSetWindow( MainWindow );
	glutPostRedisplay( );
}
```

The *Animate* Idle Callback Function

The Idle Function gets called when the GLUT event handler has nothing else to do

```
glutSetWindow( MainWindow );

glutIdleFunc( Animate );
```

Setting it up

We'll talk about this later. This is a good way to control your animations!

```
void
Animate( )
{
        int ms = glutGet( GLUT_ELAPSED_TIME );          // milliseconds
        ms  %=  MS_IN_THE_ANIMATION_CYCLE;
        Time = (float)ms  /  (float)MS_IN_THE_ANIMATION_CYCLE;       // [ 0., 1. )

        // put animation stuff in here -- change some global variables
        // for Display( ) to find:

        // force a call to Display( ) next time it is convenient:

        glutSetWindow( MainWindow );
        glutPostRedisplay( );
}
```

Pop-up Menus are easy to Create with GLUT

```
void
InitMenus( )
{
        glutSetWindow( MainWindow );

        int numColors = sizeof( Colors ) / ( 3*sizeof(int) );
        int colormenu = glutCreateMenu( DoColorMenu );
        for( int i = 0; i < numColors; i++ )
        {
                glutAddMenuEntry( ColorNames[i], i );
        }

        int axesmenu = glutCreateMenu( DoAxesMenu );
        glutAddMenuEntry( "Off",   0 ) ;
        glutAddMenuEntry( "On",    1 );

        int depthcuemenu = glutCreateMenu( DoDepthMenu );
        glutAddMenuEntry( "Off",   0 );
        glutAddMenuEntry( "On",    1 );

        int debugmenu = glutCreateMenu( DoDebugMenu );
        glutAddMenuEntry( "Off",   0 );
        glutAddMenuEntry( "On",    1 );

        int projmenu = glutCreateMenu( DoProjectMenu );
        glutAddMenuEntry( "Orthographic",  ORTHO );
        glutAddMenuEntry( "Perspective",    PERSP );

        int mainmenu = glutCreateMenu( DoMainMenu );
        glutAddSubMenu(   "Axes",  axesmenu);
        glutAddSubMenu(   "Colors",          colormenu);
        glutAddSubMenu(   "Depth Cue",     depthcuemenu);
        glutAddSubMenu(   "Projection",     projmenu );
        glutAddMenuEntry( "Reset",          RESET );
        glutAddSubMenu(   "Debug",          debugmenu);
        glutAddMenuEntry( "Quit",            QUIT );

        // attach the pop-up menu to the right mouse button:
        glutAttachMenu( GLUT_RIGHT_BUTTON );
}
```

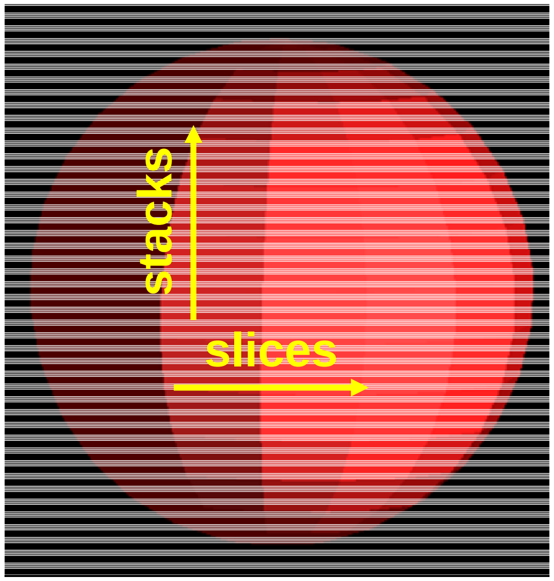
This is the color menu's callback function. When the user selects from this pop-up menu, its callback function gets executed. Its argument is the integer ID of the menu item that was selected. You specify that integer ID in **glutAddMenuEntry( ).**

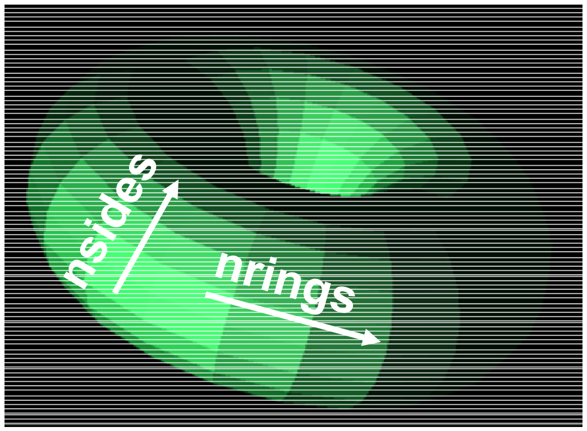
This is how you create hierarchical sub-menus

Finally, tell GLUT which mouse button activates the entire menu hierarchy

The GLUT 3D Objects

```
glutSolidSphere( radius, slices, stacks );
glutWireSphere( radius, slices, stacks ) ;
glutSolidCube( size );
glutWireCube( size );
glutSolidCone( base height, slices, stacks );
glutWireCone ( base height, slices, stacks );
glutSolidTorus( innerRadius, outerRadius, nsides, nrings );
glutWireTorus( innerRadius, outerRadius, nsides, nrings );
glutSolidDodecahedron( );
glutWireDodecahedron( );
glutSolidOctahedron( );
glutWireOctahedron( );
glutSolidTetrahedron( );
glutWireTetrahedron( );
glutSolidIcosahedron( );
glutWireIcosahedron( );
glutSolidTeapot( size );
glutWireTeapot( size );
```





In case you have a hard time remembering which direction "slices" are, think of this:

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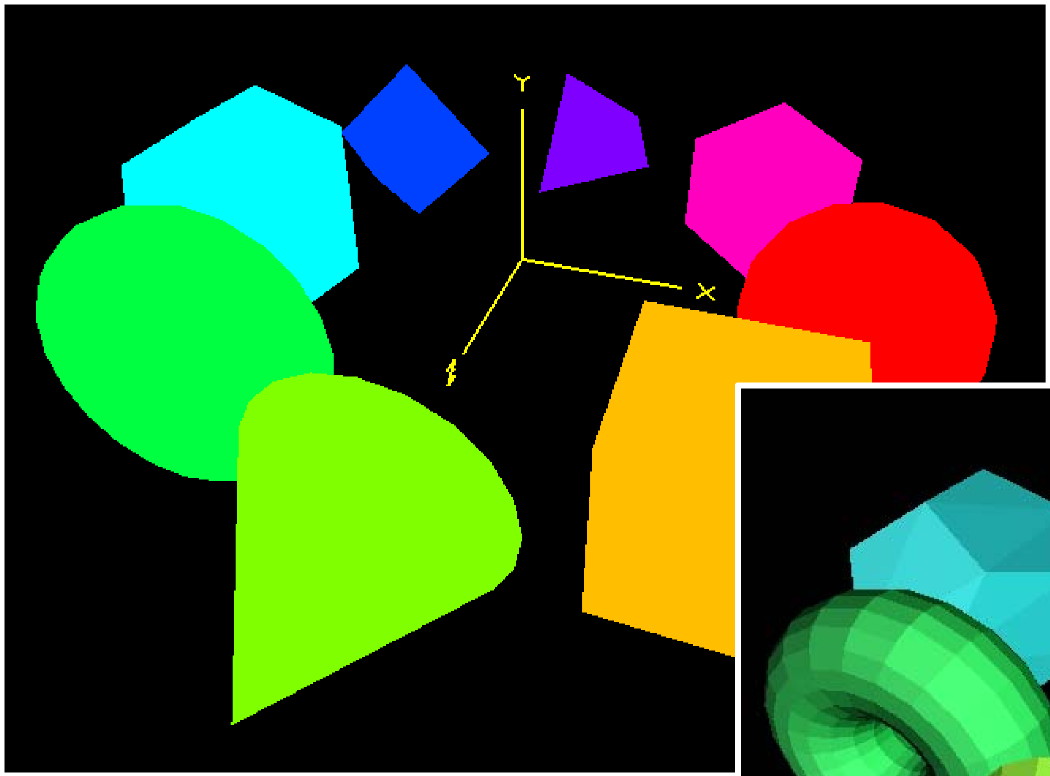
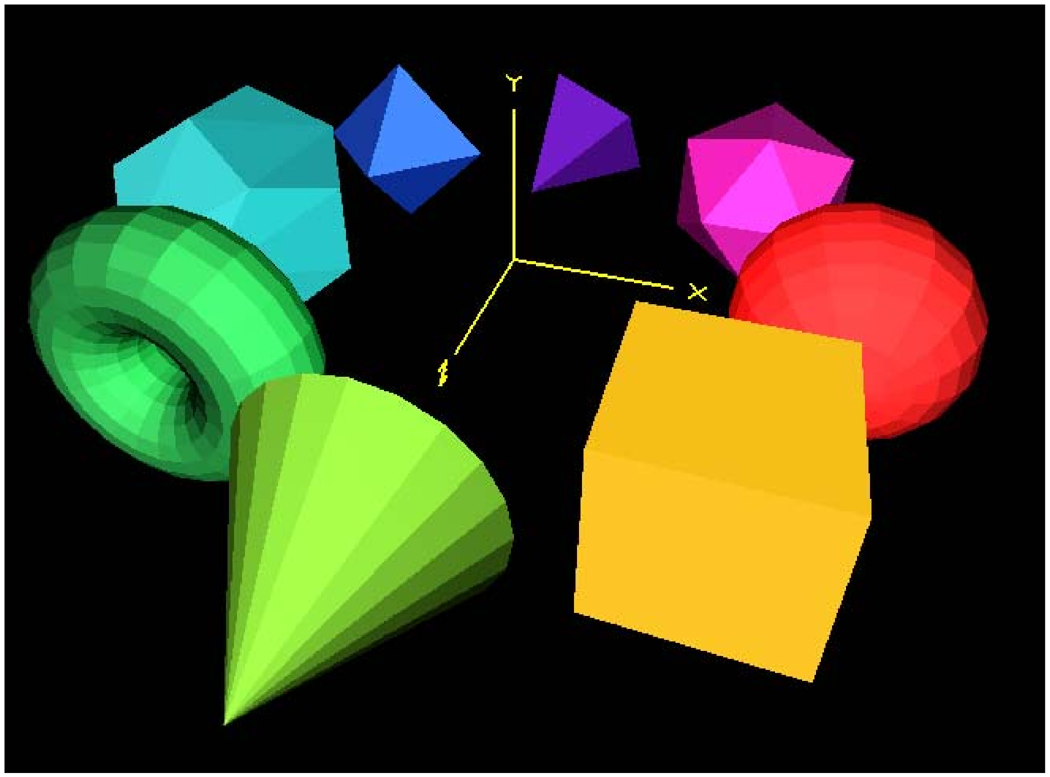
The GLUT 3D Objects



Without lighting

Without *lighting*, the GLUT solids don't look very cool. I'd recommend you stick with the wireframe versions of the GLUT 3D Objects for now!



With lighting