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/

You don't actually have to go out here. We will give you some libraries that are ready-to-use.

Using GLUT to Setup the Window

All the GLUT_XXX constants are #defined in **glut.h**

GLUT_RGBA	I want to display colors
GLUT_DOUBLE	I want to do double-buffering
GLUT_DEPTH	I want to use a depth-buffer while rendering

```
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 **GL_** or **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 whenever 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 ever return
			break;			// keep the compiler happy

		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

Assign new display parameter values depending on what key was hit

Good programming practice

glutPostRedisplay( ) forces your Display( ) function to be called to redraw the scene with the new display parameter values

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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
	}
}
```

Where the mouse was when the button was hit

GLUT_DOWN or GLUT_UP

Which button was hit

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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;            // change in mouse coords

        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( );
}
```

Where the mouse moved to

If the mouse moved with the left button down, do a rotate

If the mouse moved with the middle button down, do a scale

glutPostRedisplay( ) forces your Display( ) function to be called to redraw the scene with the new display parameter values

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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 in InitGraphics( )

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

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

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

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

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

glutPostRedisplay( ) forces your Display( ) function to be called to redraw the scene with the new display parameter values

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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

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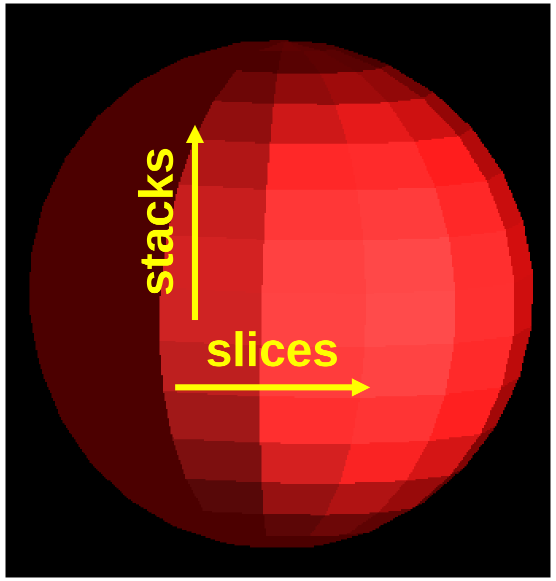
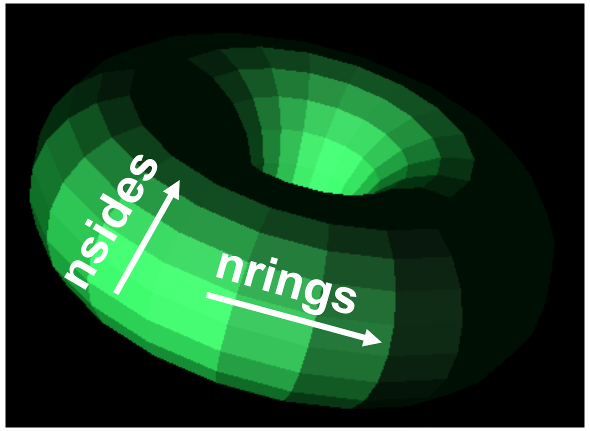
The GLUT 3D Objects

```
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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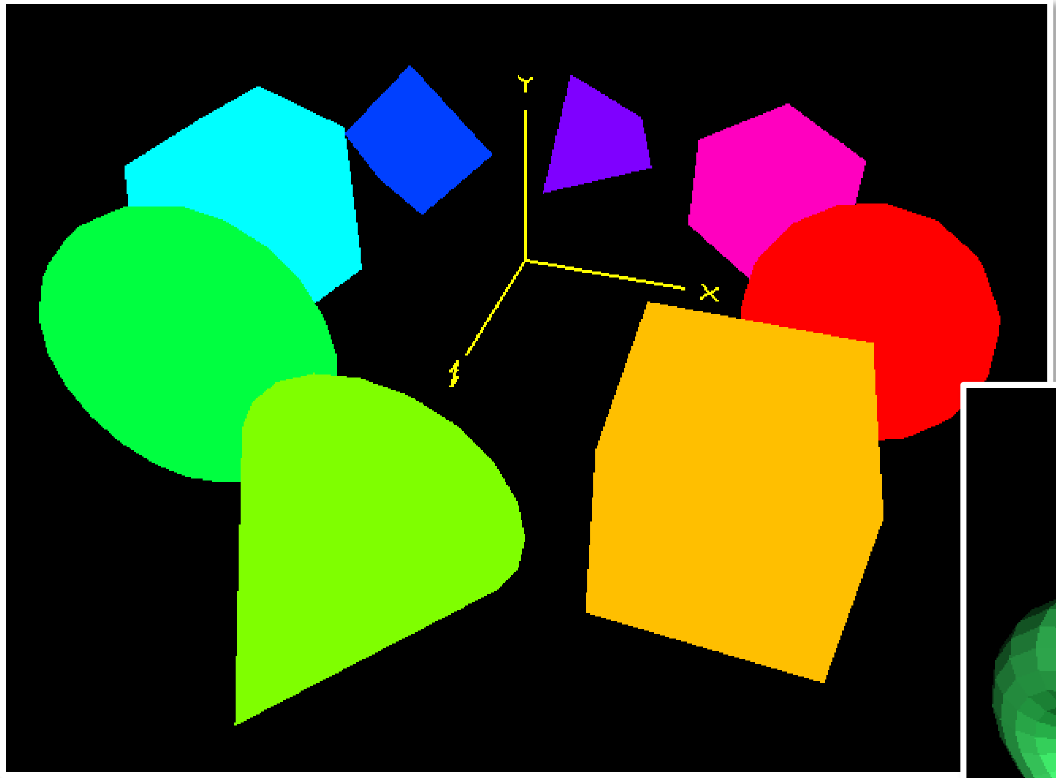
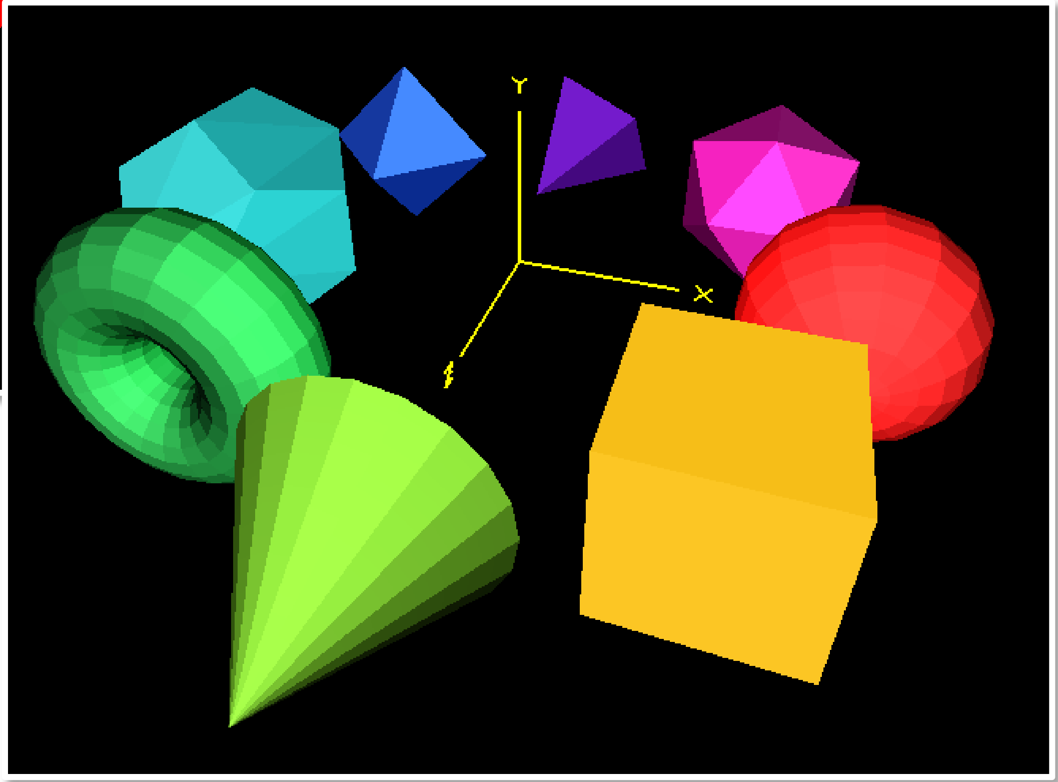
The GLUT 3D Objects

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



Without lighting



With lighting