Computer Graphics

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Lecture 11
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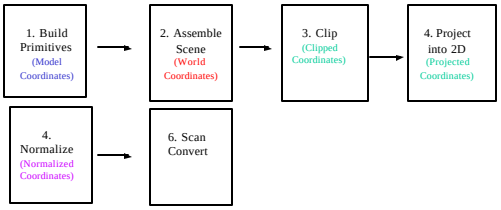
Graphics Pipeline – What does the user do?



User Defines:

- Objects in the scene and how they are positioned
- Viewing system
- Lighting
- State Variables
- I/O

Defining the Objects: GL Primitives

- GL_POINTS
- GL_LINES
- GL_TRIANGLES
- GL_POLYGON
- Etc. (see WNDS pp 44-45)

GL Primitives: Example 1

```
glColor3f(.5,.5,.5);
glBegin(GL_POLYGON);
    glVertex2f(0.0,0.0);
    glVertex2f(10.0,0.0);
    glVertex2f(10.0,10.0);
    glVertex2f(0.0,10.0):
glEnd();
```

GL Primitives: Example 2

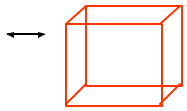
```
glColor3f(.5,.5,.5);
glRectf(0.0,0.0,10.0,10.0);
```

GL Primitives: Example 3

```
glBegin(GL_POINTS);
    glColor3f(1.0,0.0,0.0);
    glVertex2f(0.0,0.0);
    glVertex2f(10.0,0.0);
    glColor3f(0.0,0.0,1.0);
    glVertex2f(10.0,10.0);
    glVertex2f(0.0,10.0):
glEnd();
```

GL Primitives: Example 4

```
glColor3f(1.0,0.0,0.0);
glutWireCube(10.0);
```



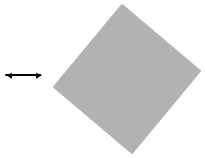
Positioning the Object: GL Transformations

- glTranslate
- glRotate
- glScale

For details see WNDS pp 110-112

Putting It Together

```
glColor3f(.5,.5,.5);
glRotatef(45.0,0.0,0.0,1.0);
glRectf(0.0,0.0,10.0,10.0);
```



Exercise 1

Build a 5x10x1 box with a blue top/bottom, red left/right, and green front/back. The box should be centered at the origin. You can use the following

- glRect(0.0,0.0,1.0,1.0)
- glRotatef(angle,vx,vy,vz)
- glScalef(sx,sy,sz)
- glTranslatef(dx,dy,dz)
- glLoadIdentity()
- glColor3f(red,green,blue)

Matrix Stack

- glPushMatrix()
- glPopMatrix()

Exercise 2

Now rotate your box:

45 degrees about the x axis

then 45 degrees about the y axis

Defining the Viewing System: Viewpoint

Default:

- Eye Position: (0,1,0)
- Viewing Direction: (0,0,-1)
- Up: (0,1,0)

Viewpoint

- Is it part of the viewing system?
- Is it part of the model?

gluLookAt (GLdouble *eyex*, GLdouble *eyey*, GLdouble *eyez*, GLdouble *centerx*, GLdouble *centery*, GLdouble *centerz*, GLdouble *upx*, GLdouble *upy*, GLdouble *upz*,);

Defining the Viewing System: Projection Mode/Viewing Volume

1. glOrtho(GLdouble *left*, GLdouble *right*, GLdouble *bottom*, GLdouble *top*, GLdouble *near*, GLdouble *far*);
2. glFrustum(GLdouble *left*, GLdouble *right*, GLdouble *bottom*, GLdouble *top*, GLdouble *near*, GLdouble *far*);

Example

```
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
glOrtho(-10.0,10.0,-10.0,10.0,1.0,21.0);
glMatrixMode(GL_TRANSFORMATION);
glLoadIdentity();
glColor3f(1.0,0.0,0.0);
glTranslatef(0.0,0.0,-10.0);
glutSolidCube(5.0);
```


Exercise

Establish a viewing system with perspective projection to view your rotated box.

Defining the Viewing System: Viewports

- Default: projection plane maps to window
- glViewport: see WNDS pp 130

Lighting

- Define lights
- Define material properties
- Enable lighting/lights

See WNDS ch 5 for details