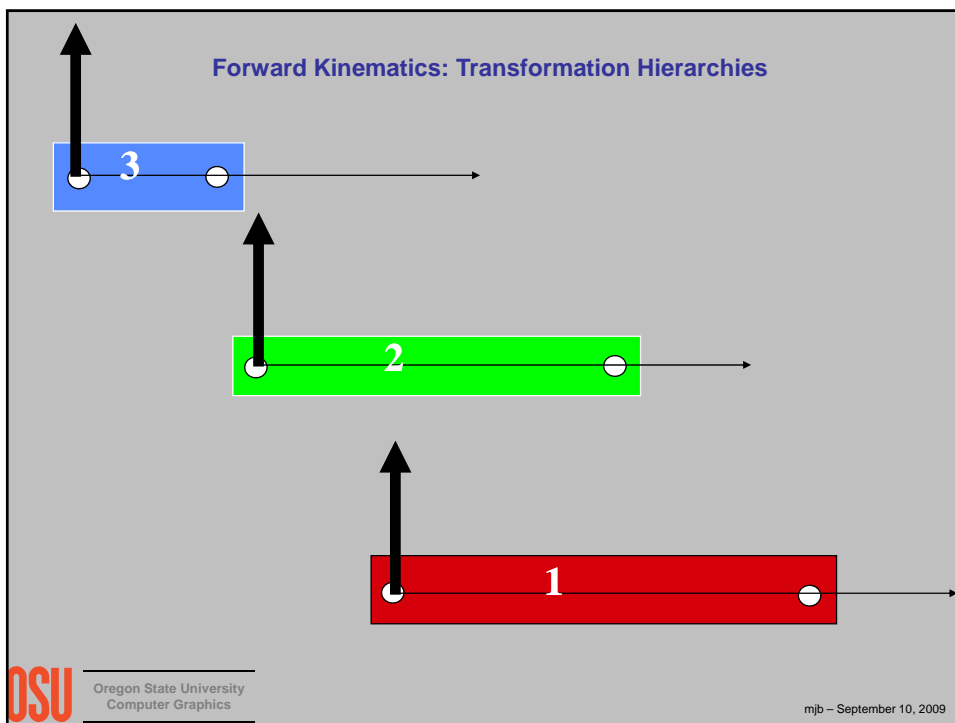


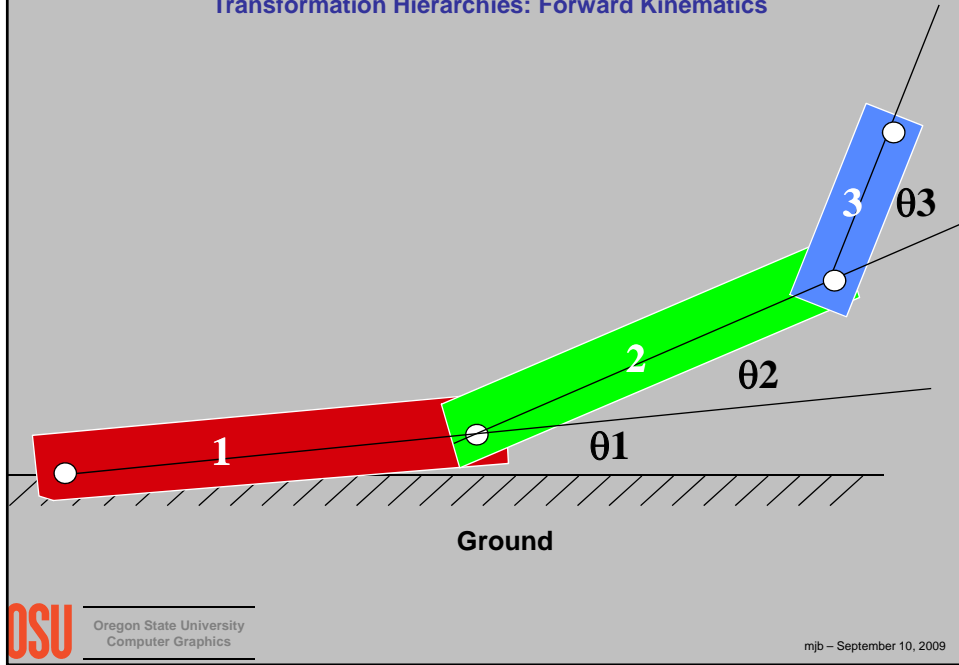
# Forward Kinematics

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### Transformation Hierarchies: Forward Kinematics



### Positioning Part #1 With Respect to Ground

1. Rotate by  $\theta_1$
2. Translate by  $\Delta_{1/G}$

Write it



$$[M_{1/G}] = [T_{1/G}] * [R_{\theta_1}]$$

Say it



### Positioning Part #2 With Respect to Ground

1. Rotate by  $\theta_2$
2. Translate the length of part 1
3. Rotate by  $\theta_1$
4. Translate by  $\Delta_{1/G}$

Write it

$$\begin{aligned} [M_{2/G}] &= [T_{1/G}] * [R_{\theta_1}] * [T_{2/1}] * [R_{\theta_2}] \\ &= [M_{1/G}] * [M_{2/1}] \end{aligned}$$

Say it



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### Positioning Part #3 With Respect to Ground

1. Rotate by  $\theta_3$
2. Translate the length of part 2
3. Rotate by  $\theta_2$
4. Translate the length of part 1
5. Rotate by  $\theta_1$
6. Translate by  $\Delta_{1/G}$

Write it

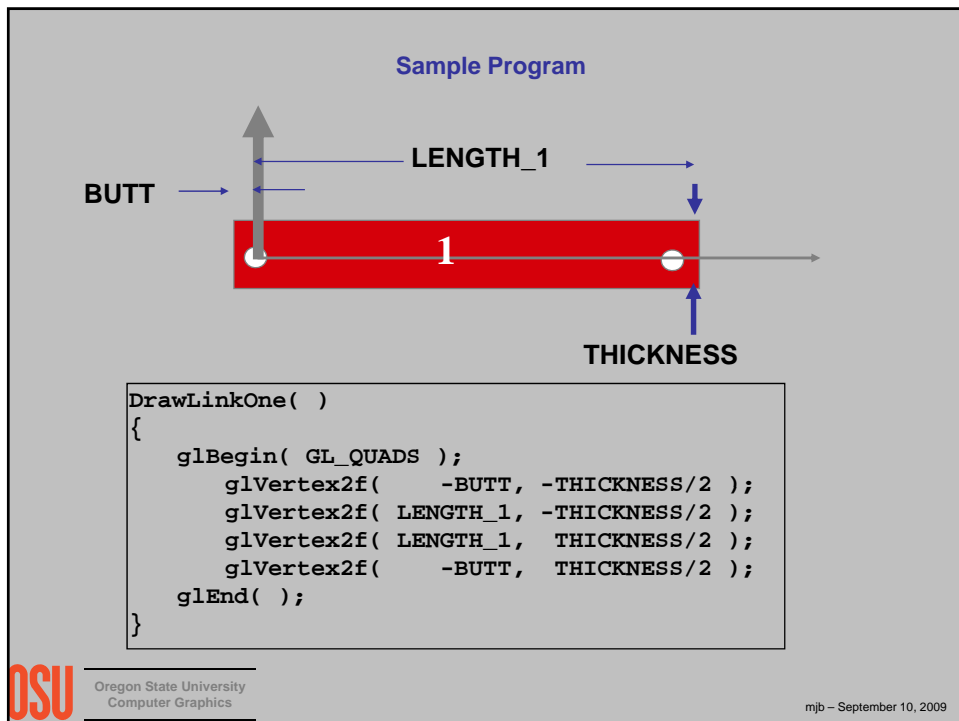
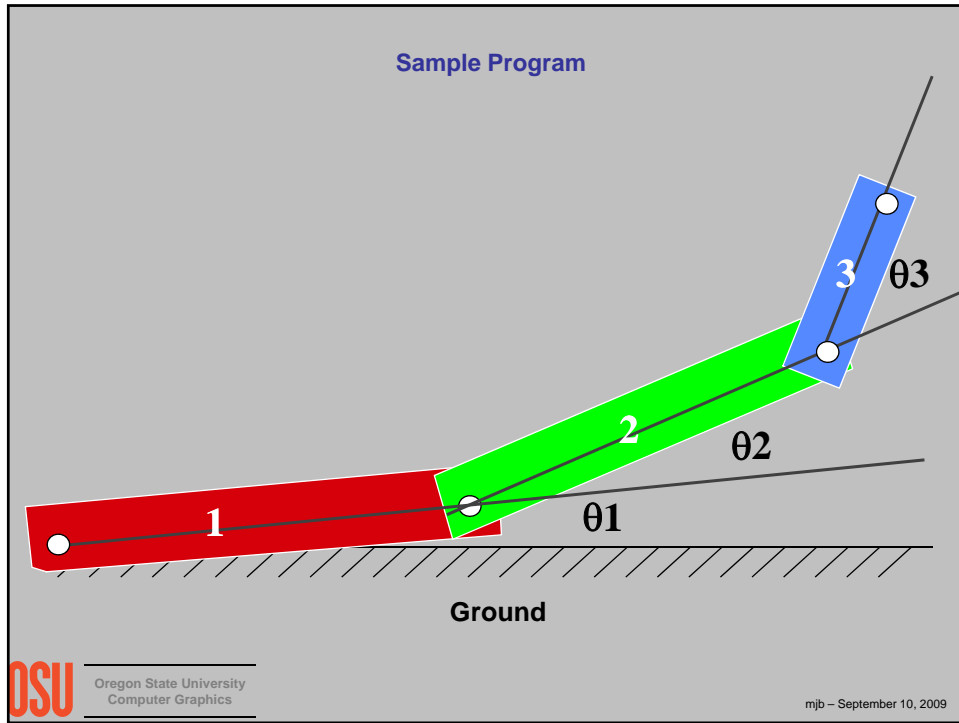
$$\begin{aligned} [M_{3/G}] &= [T_{1/G}] * [R_{\theta_1}] * [T_{2/1}] * [R_{\theta_2}] * [T_{3/2}] * [R_{\theta_3}] \\ &= [M_{1/G}] * [M_{2/1}] * [M_{3/2}] \end{aligned}$$

Say it



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### Sample Program

```
DrawMechanism( float  $\theta$ 1, float  $\theta$ 2, float  $\theta$ 3 )
{
    glPushMatrix( );
    glRotatef(  $\theta$ 1, 0., 0., 1. );
    glColor3f( 1., 0., 0. );
    DrawLinkOne( );

    glTranslatef( LENGTH_1, 0., 0. );
    glRotatef(  $\theta$ 2, 0., 0., 1. );
    glColor3f( 0., 1., 0. );
    DrawLinkTwo( );

    glTranslatef( LENGTH_2, 0., 0. );
    glRotatef(  $\theta$ 3, 0., 0., 1. );
    glColor3f( 0., 0., 1. );
    DrawLinkThree( );
    glPopMatrix( );
}
```



### Sample Program

Where in the window to display (pixels)

Viewing Info: field of view angle, x:y aspect ratio, near, far

Whatever interaction is being used to get the eye position

Set the eye position

```
glViewport( 100, 100, 500, 500 );

glMatrixMode( GL_PROJECTION );
glLoadIdentity( );
gluPerspective( 90., 1.0, 1., 10. );

glMatrixMode( GL_MODELVIEW );
glLoadIdentity( );

done = FALSE;
while( ! done )
{
    << Determine  $\theta$ 1,  $\theta$ 2,  $\theta$ 3 >>
    glPushMatrix();
    gluLookAt( eyex, eyey, eyez,
              centerx, centery, centerz,
              upx, upy, upz );
    DrawMechanism(  $\theta$ 1,  $\theta$ 2,  $\theta$ 3 );
    glPopMatrix();
}
```

