Forward Kinematics:
You Start with Separate Pieces, all Defined in their Own Local Coordinate System

You Hook the Pieces Together, Change Parameters, Things Move
(All Children Understand This)

Ground

Forward Kinematics: Where do the Pieces Move To?
Locations?

Positioning Part #1 With Respect to Ground

1. Rotate by \( \theta_1 \)
2. Translate by \( T_{VG} \)

Write it

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

Say it

Why Do We Say it Right-to-Left?

It's because in the matrix notes, we adopted the convention that the coordinates are multiplied on the right side of the matrix:

So the right-most transformation in the sequence multiplies the (x,y,z,1) first and the left-most transformation multiplies it last.
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 $T_{1/G}$

\[
[M_{2/G}] = [T_{1/G}] \cdot [R_{\Theta_1}] \cdot [T_{2/G}] \cdot [R_{\Theta_2}]
\]
\[
[M_{2/G}] = [I_{1/G}] \cdot [M_{1/G}] \cdot [M_{2/G}]
\]

Say it

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 $T_{1/G}$

\[
[M_{3/G}] = [T_{1/G}] \cdot [R_{\Theta_1}] \cdot [T_{2/G}] \cdot [R_{\Theta_2}] \cdot [T_{3/G}] \cdot [R_{\Theta_3}]
\]
\[
[M_{3/G}] = [I_{1/G}] \cdot [M_{1/G}] \cdot [M_{2/G}] \cdot [M_{3/G}]
\]

Say it

Sample Program

```c
Sample Program

```

Sample Program, using OpenGL's Automatic Transformation Concatenation

```
Sample Program

```
In Project #4, you won't be able to do this. You will need to create each full matrix separately using your own Matrix class methods.