# Aligning Coordinate Systems between Solidworks/Simscape/Unreal

When going from a Solidworks assembly to Simscape and Unreal, a critical point is to align the coordinate systems of the individual parts. If coordinate systems are not aligned, the user needs to somehow figure out what the offsets in position and rotation are between parts in Unreal and Simscape, which is a manual step and introduces a huge source of human error. The idea is that Solidworks should act as the **single source of truth** for defining the coordinate system.

**Example of coordinate system mismatch:**

The following image compares the configuration of the excavator arm when the rotation angles of the boom, stick and bucket are set to 0.

**A yellow excavator on a brown box

Description automatically generatedA yellow construction equipment on a construction site

Description automatically generated**

## Configuring the model in Solidworks

Solidworks will act as the single source of truth, and defines the corresponding configuration of the zero-position.

**Solidworks Part Origin:**

**A black object with white text

Description automatically generated**

Move the origins of each part to align with the desired center of rotation of the part in Unreal.

# Studying Export from Solidworks to Simscape

For this study, in Solidworks:

* the Top Plane of the boom was mated in parallel with the Front Plane of the assembly
* The Top Plane of the stick was mated in parallel with the Top Plane of the boom
* The Top Plane of the bucket was mated in parallel with the Top Plane of the stick

This ensures that the local coordinate systems of the parts align with the global coordinate system. Before exporting to Simscape, the mates were disabled to allow Simscape to automatically insert the joints.

A computer screen shot of a machine

Description automatically generated

When exporting to Simscape, we get the following configuration:

A screenshot of a computer

Description automatically generated

The source of the 180 degree offset has not been investigated. Assumption: some coordinate system may to have been flipped in Solidworks.

The parts were then unmated, and rotated as follows:

A machine with green lines

Description automatically generated

A screenshot of a computer program

Description automatically generated

A mechanical arm with a green line

Description automatically generated with medium confidence

A screenshot of a computer

Description automatically generated

Conclusion: Simscape joint angles correspond to the angles between the local coordinate systems of the connected parts (source of the 180 degree offset has not been investigated).

# Studying Export from Solidworks to Unreal

The flat Solidworks assembly (no hierarchies) was exported to Unreal via Datasmith. The conclusion appears to be similar to Simscape: the relative rotation angles of the manipulator parts correspond to the angles between the local coordinate systems in Solidworks.

However, there are some 90 degree rotations in Unreal where the source is not obvious. Also, some parts rotate around the y-axis, while others rotate around the z-axis.

Furthermore, in Unreal we want to put the parts in a hierarchy in order to move the arm accordingly, and childing an object can create some additional offsets, like here:

**A screenshot of a computer

Description automatically generated**