# Model an Articulated Robot

A quick guide for modeling a 6 DOF robot

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# ATTENTION

- Requires Visual Components Professional or Premium
- Tutorial made with Visual Components Premium 4.1.0
- Date of creation is 13 March, 2018
- Special thanks to Jamal Muhammed for collecting and developing tutorial material

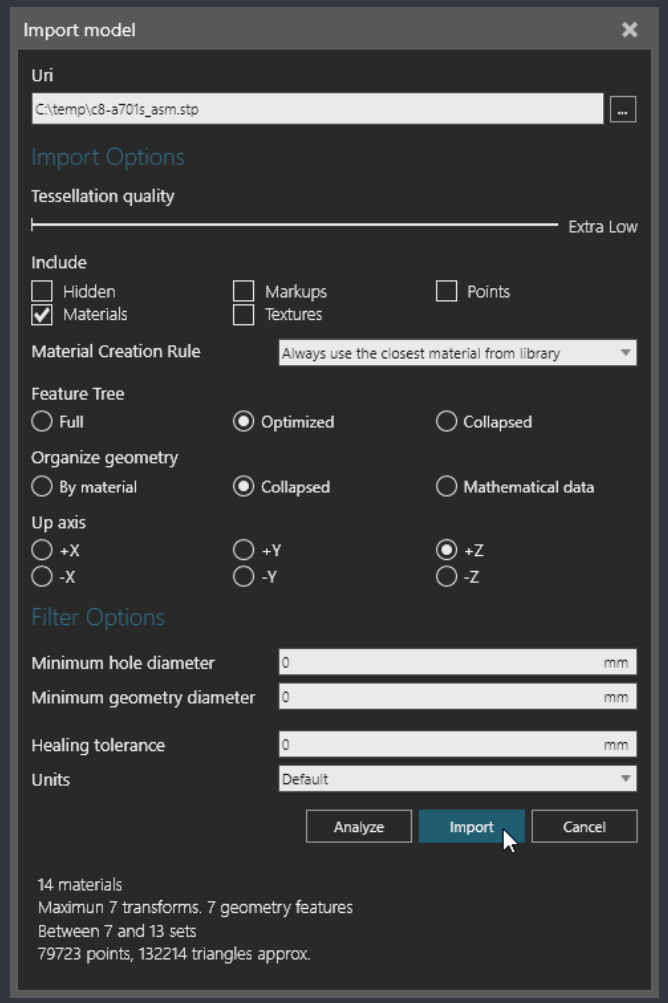
# YOU NEED

- Data Sheet for Robot
  It contains the specifications of robot:
  - Link lengths
  - Joint limits and speeds
  - Joint rotation direction (+ve, -ve)
  - Robot world frame (RWF) position and orientation
  - Robot tool center point (TCP) position and orientation

- CAD File for Robot
  It should be a supported file type
  - Tutorial uses a STEP file

  It should be simplified for simulation
  - Try to make data count/number of triangle sets around 100,000 since motion and appearance of robot is suitable for most cases at this level of detail

# STEP 1. IMPORT GEOMETRY




→ Tessellation of Extra Low is used to reduce data count of robot

→ Materials are imported but mapped to closest match in system library

→ Feature tree is optimized to avoid too many or too few Geometry features

→ Geometry is collapsed to simplify geometry sets

→ Up axis is at default of +Z

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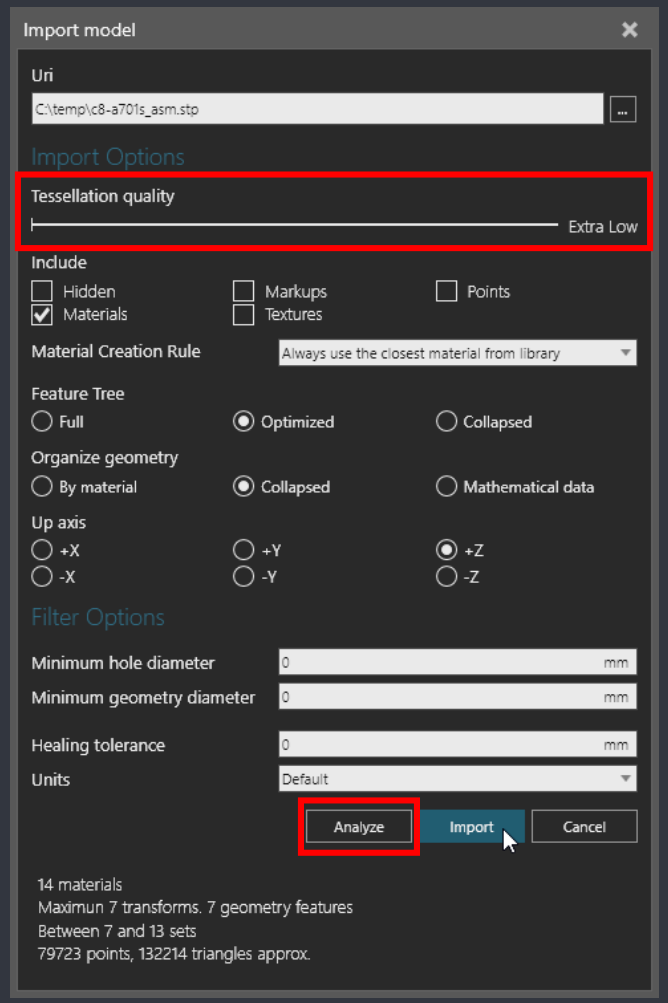
# TESSELLATION QUALITY




Tessellation of Extra Low is used to reduce data count of robot.

- Try to get as close to 100,000 triangles as possible
- Analyze can be used to evaluate data count based on tessellation quality
- If you are importing mathematical data, you can change the tessellation quality at feature level after importing the geometry

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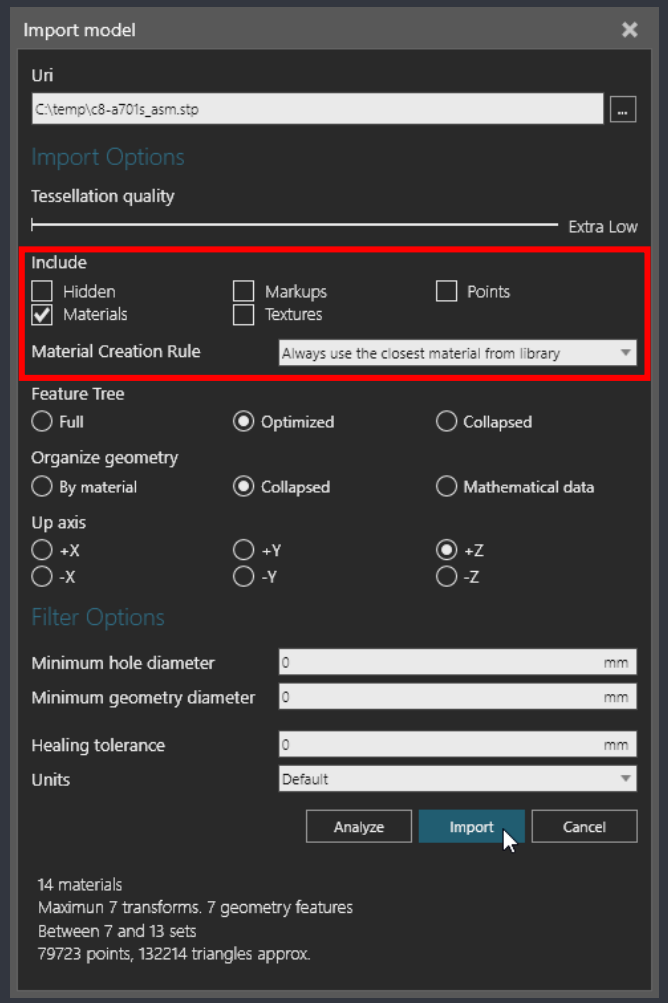
# MATERIALS




Materials are imported but mapped to closest match in system library.

- System/native materials are better in terms of performance
- Sometimes you may want to import and create new materials as well as include textures
- Do not import what you do not need
- Points, for example reference points, are imported as Frame features

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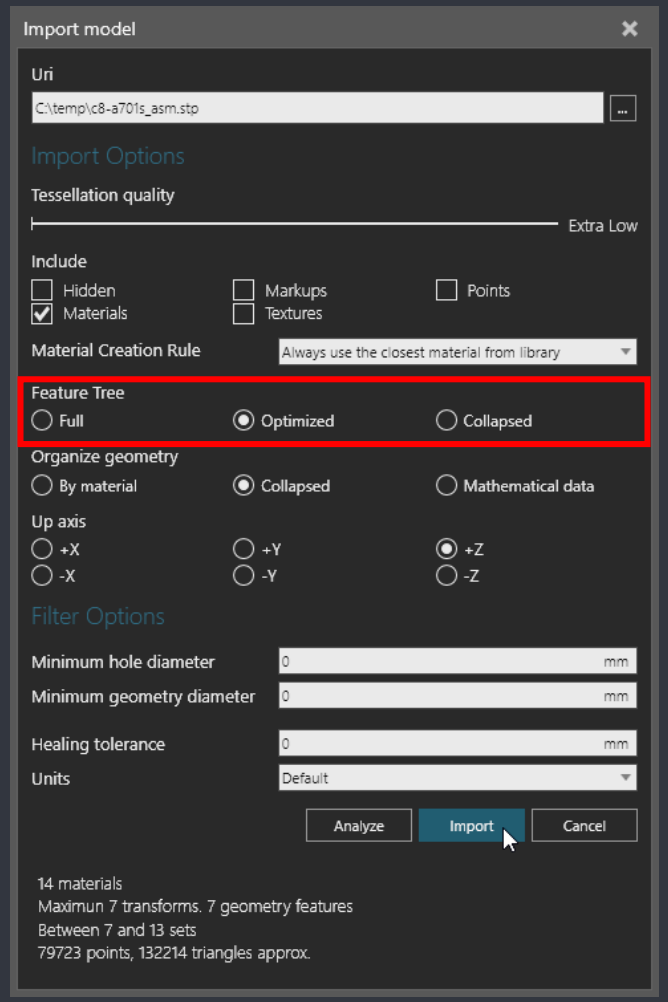
# FEATURE TREE




Feature tree is optimized to avoid too many or too few Geometry features.

- The Split tool can always be used later on to split up geometry into different features
- Collapsed will likely put all geometry into one feature, thereby more work
- Full might create too many features and potentially lead to mistakes
- Structure of CAD file may dictate the Feature Tree option

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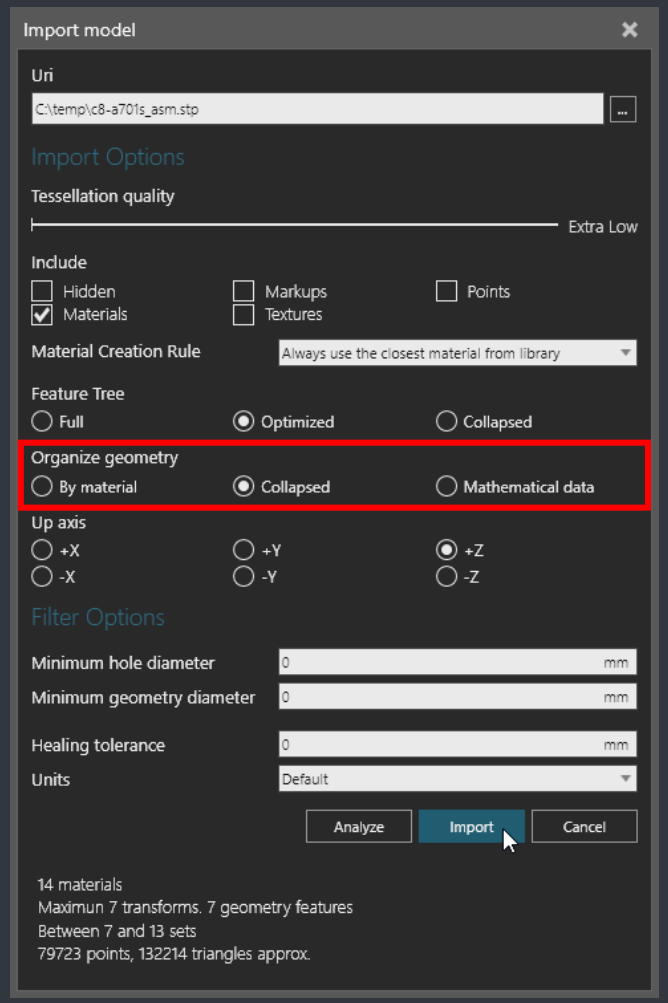
# GEOMETRY




Geometry is collapsed to simplify geometry sets.

- Do not import mathematical data such as BREP if you are not going to use it
- By material might create a large set of geometry depending on how many materials you use in the model
- Generally, you work at geometry set level when you need to fix something

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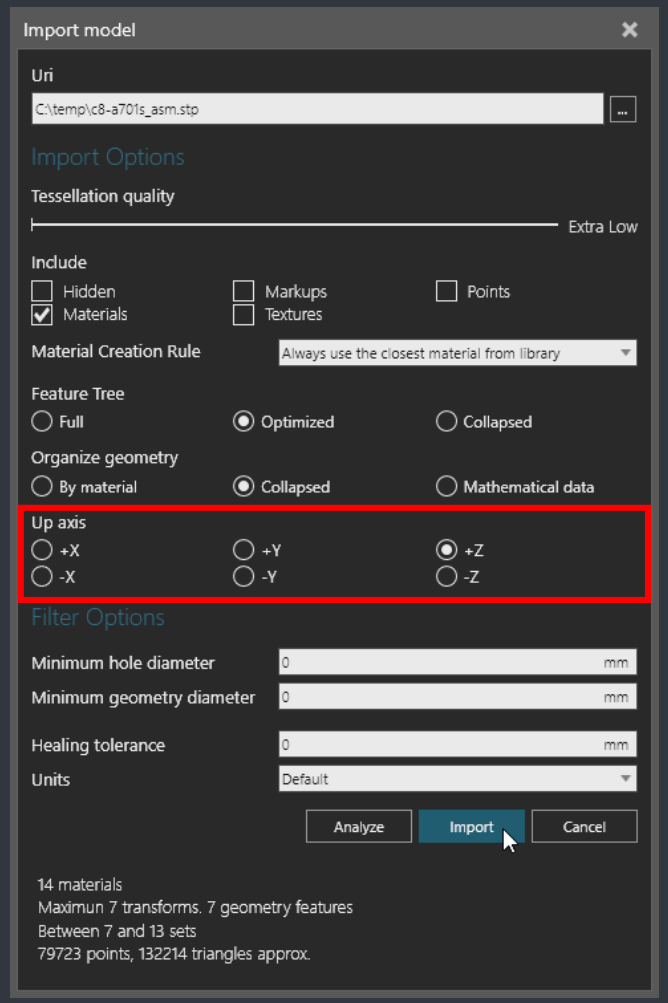
# UP AXIS




Up axis is at default of +Z.

- Generally, you would correct the orientation of component after importing the geometry
- If you know which axis defines the up orientation of model then you can use it

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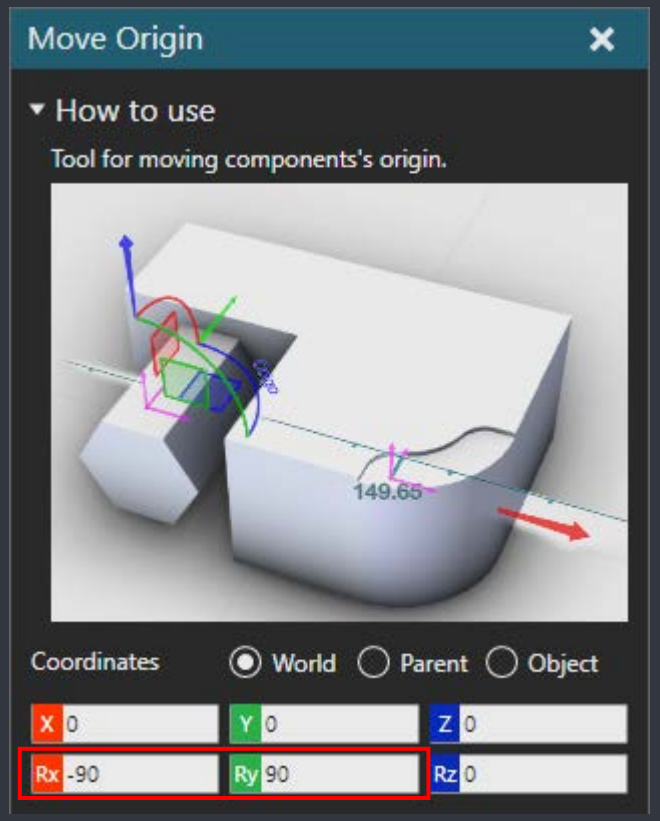
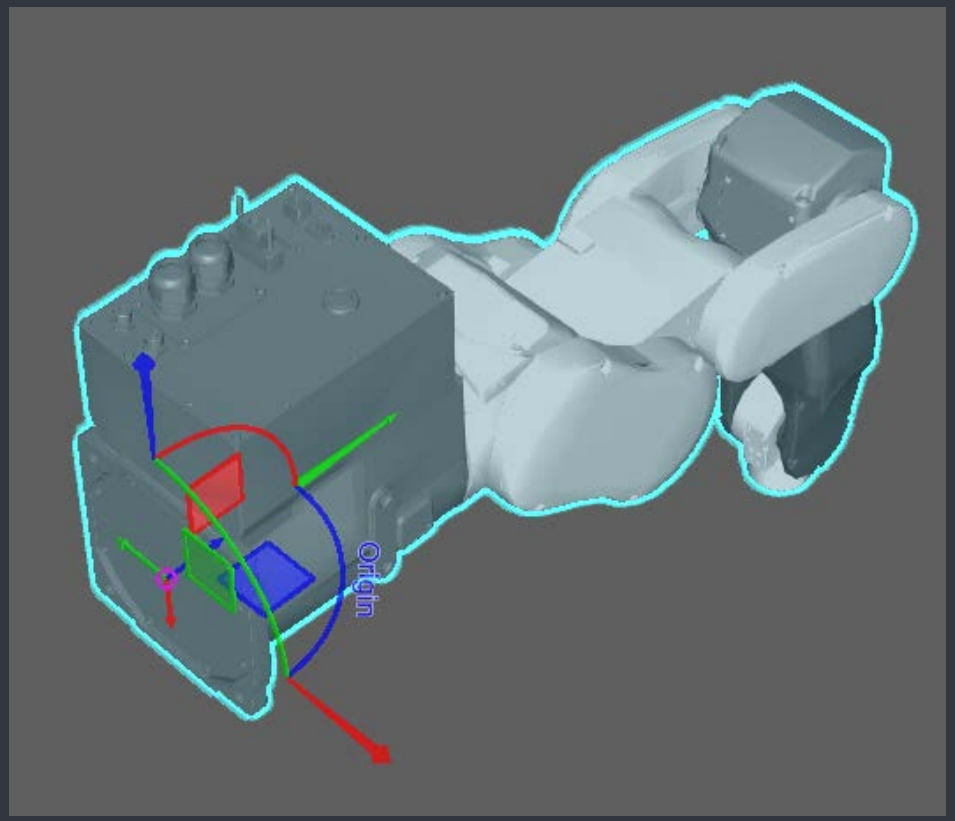
# STEP 2. MODIFY COMPONENT ORIGIN




The smaller coordinate system shows the component (object) coordinate system.
The goal is to align robot geometry in XZ plane of component.

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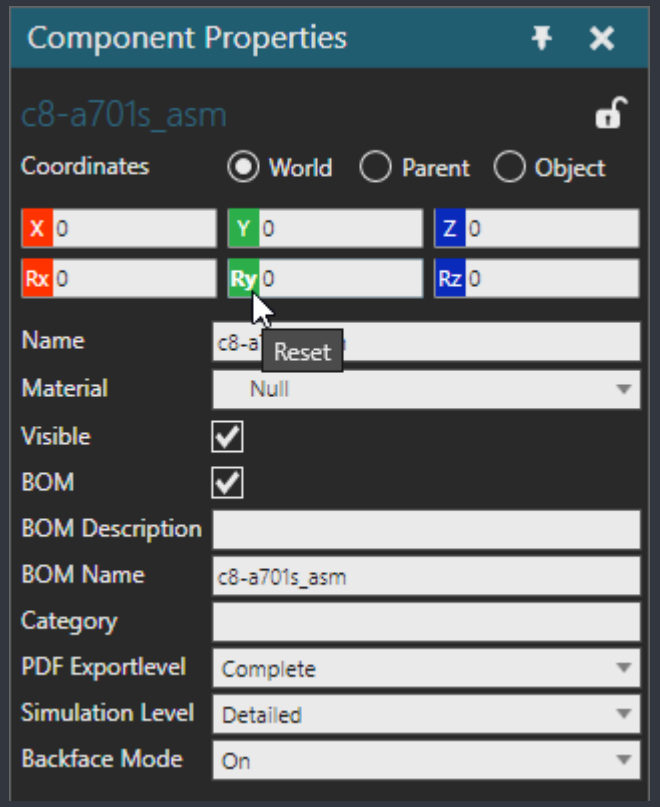
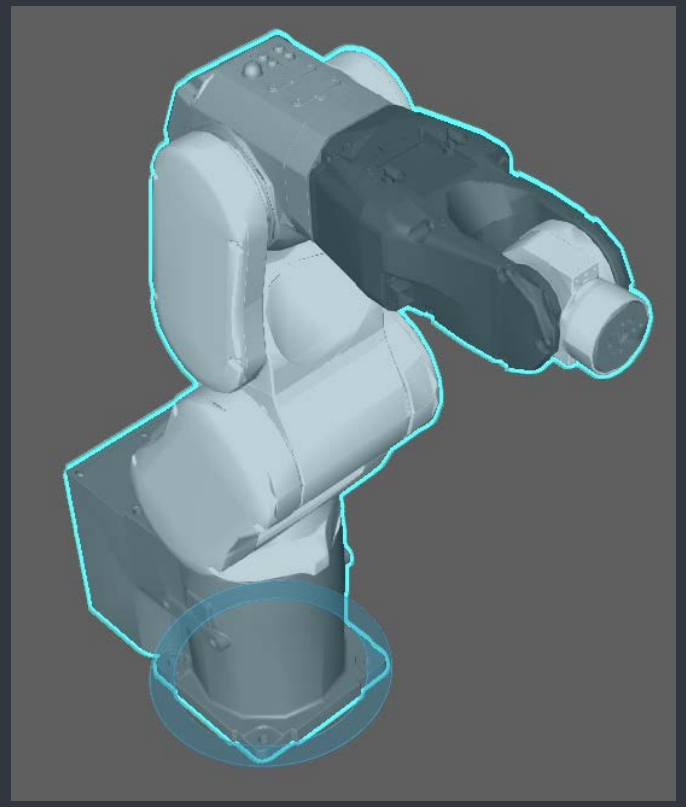
# COMPONENT LEVEL



Resetting all World coordinates to zero will now properly align and orient robot component.

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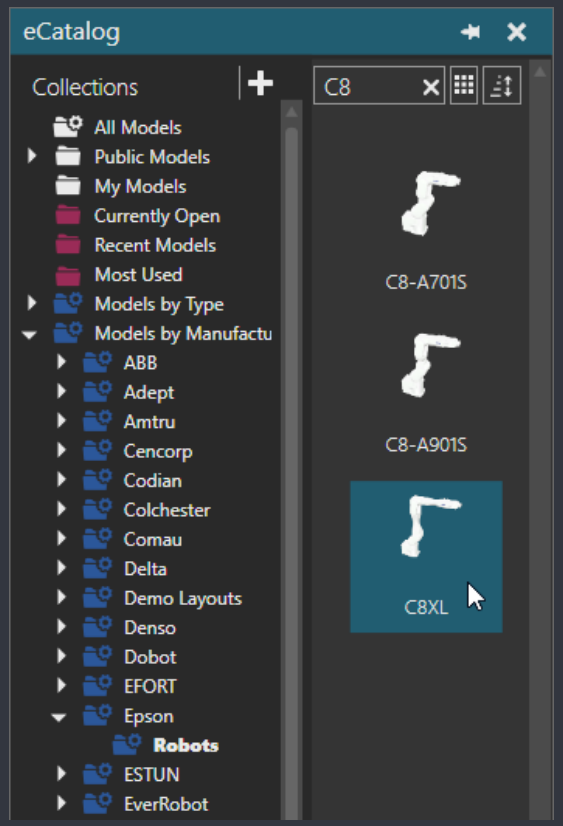
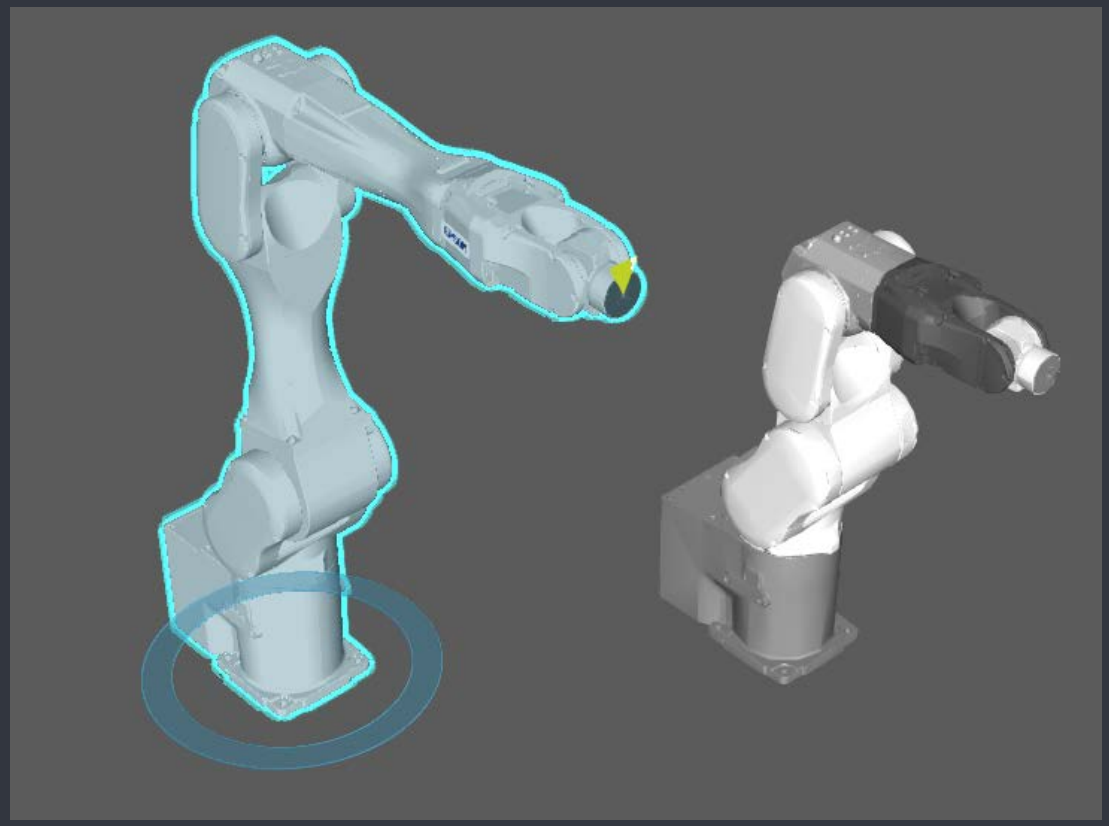
# STEP 3. ADD TEMPLATE ROBOT



A ready-made robot from the eCatalog panel can be used to make a new robot.
In this case, use an Epson C8XL robot.

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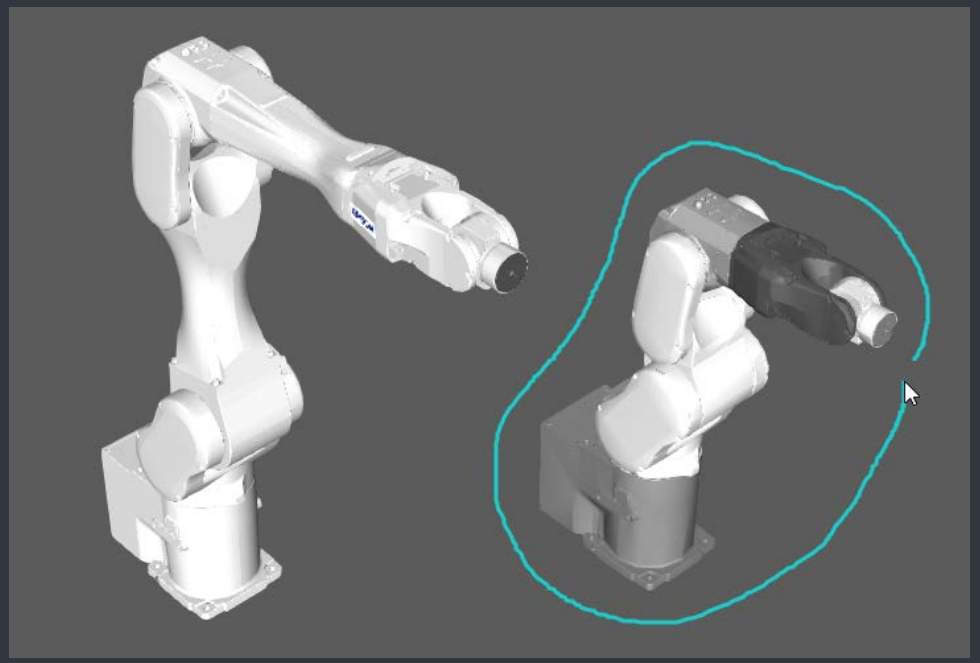
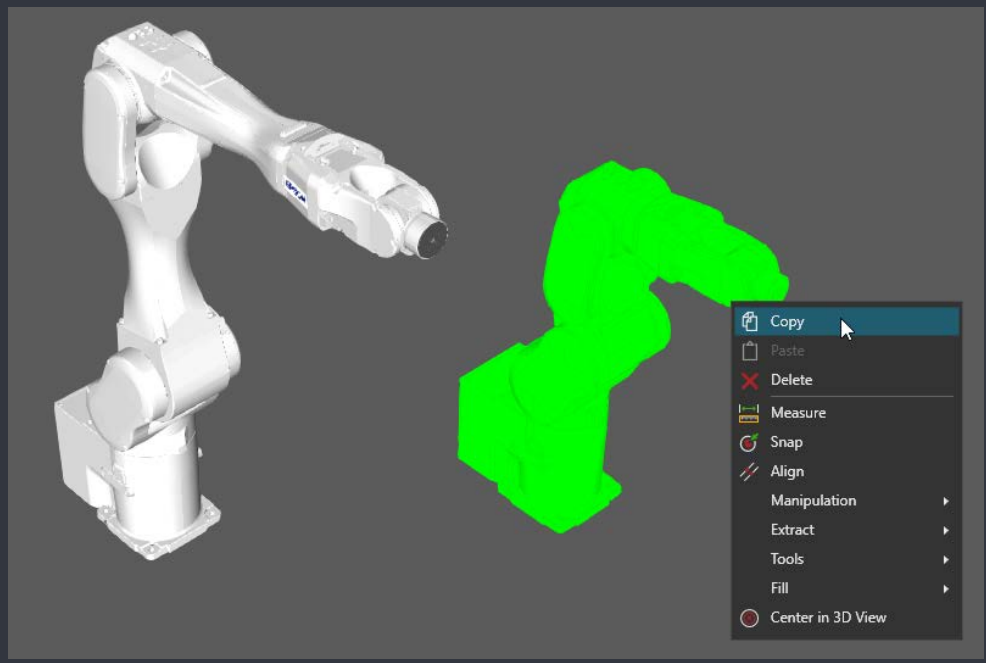
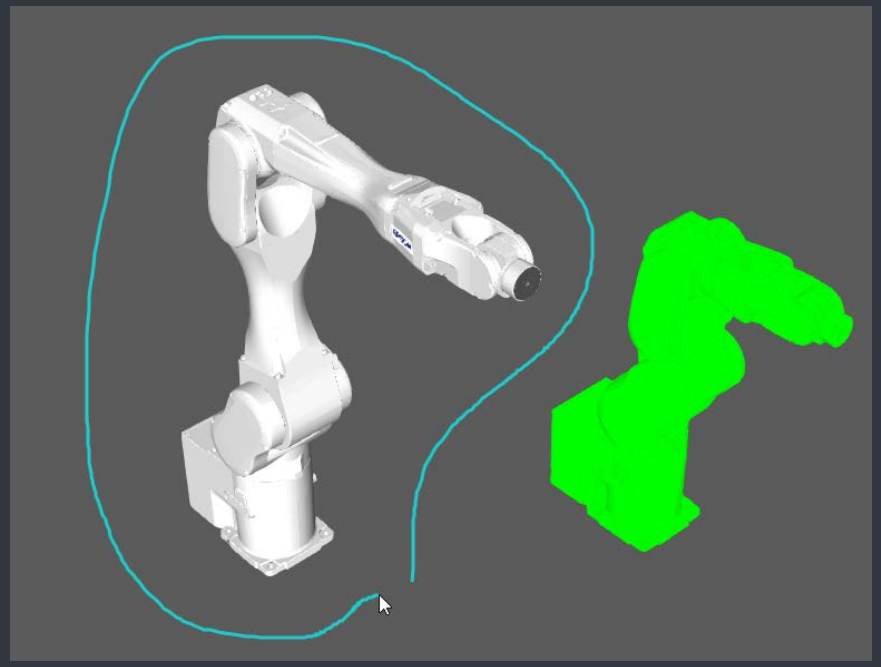
# STEP 4. MOVE GEOMETRY TO TEMPLATE

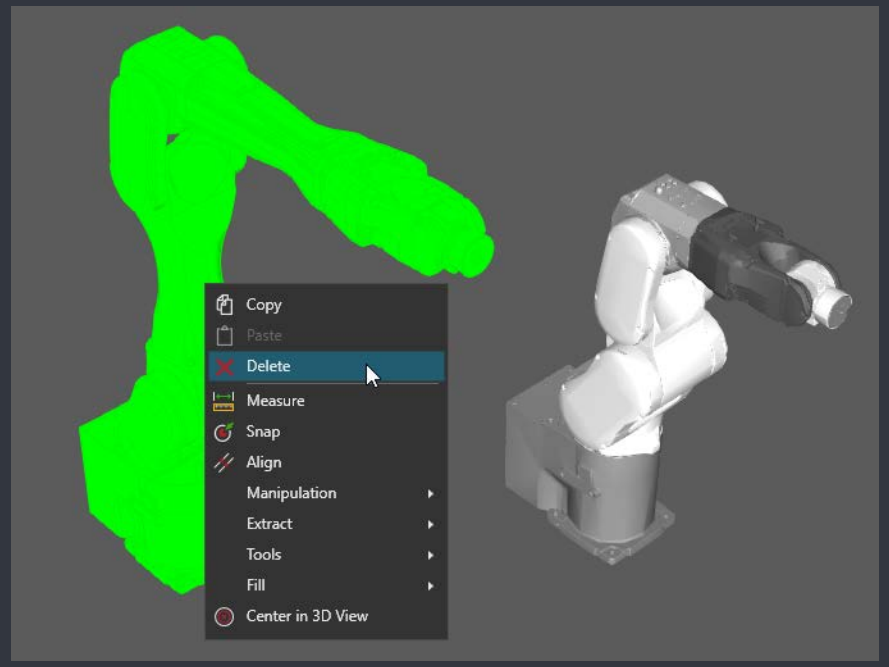





First, select and copy of the geometry from new robot.
Remember, the Modeling tab allows you to select features in the 3D world.

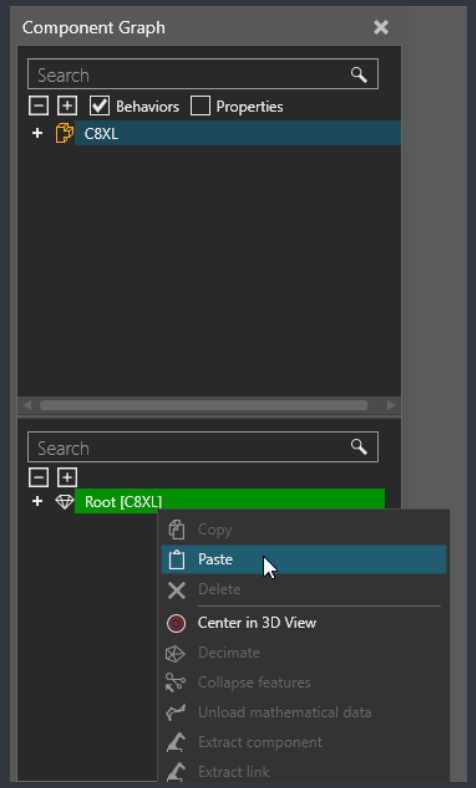
# OLD SHELL

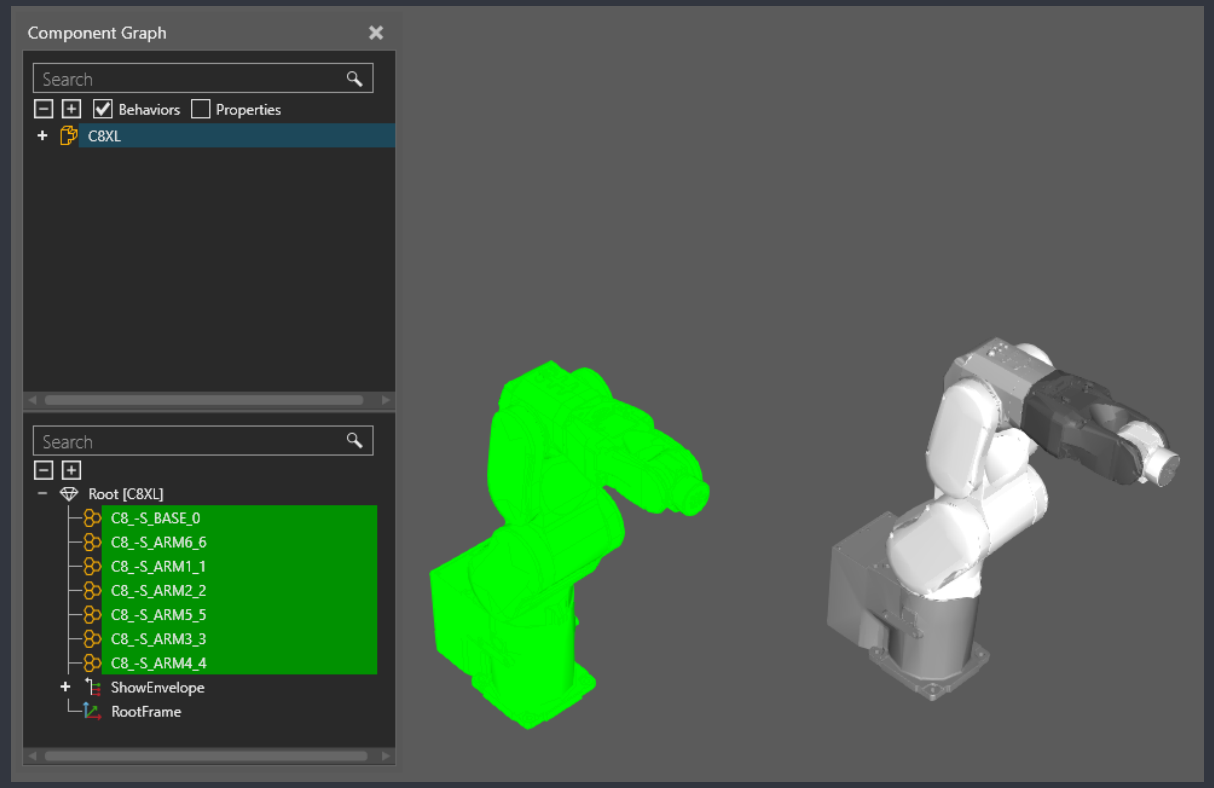





Now, select and delete all geometry from the template robot.

# NEW SHELL




Finally, in the Component Graph panel, select the root node of template robot followed by its root feature. Next, right-click and paste the copied geometry from the new robot.

Tip: If you need to select the C8XL, use the Cell Graph panel.

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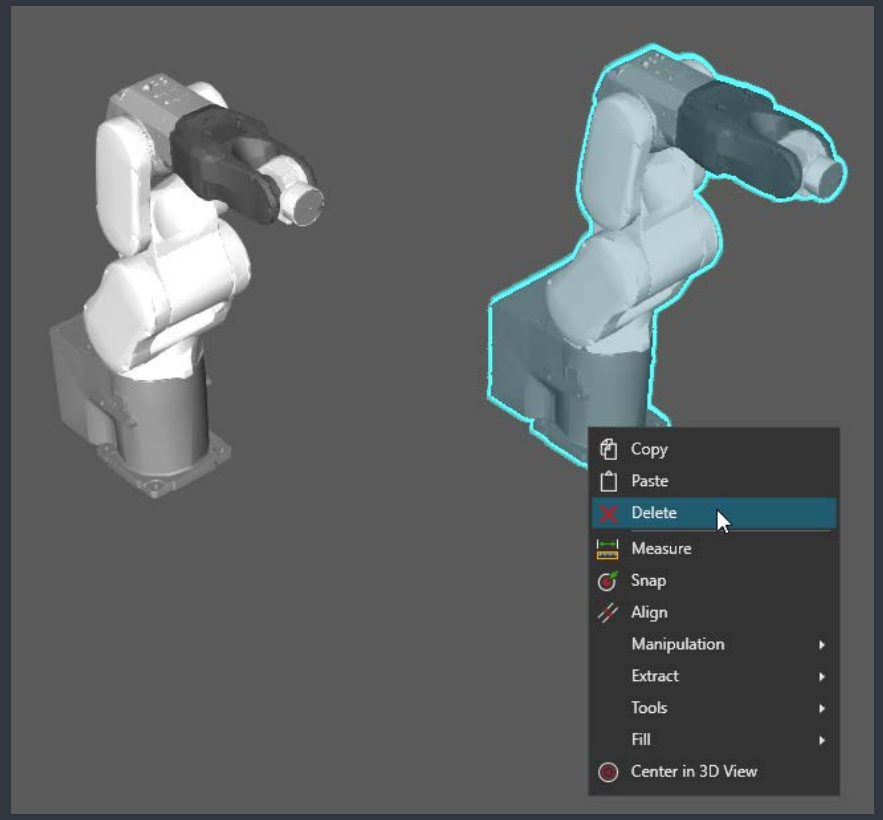
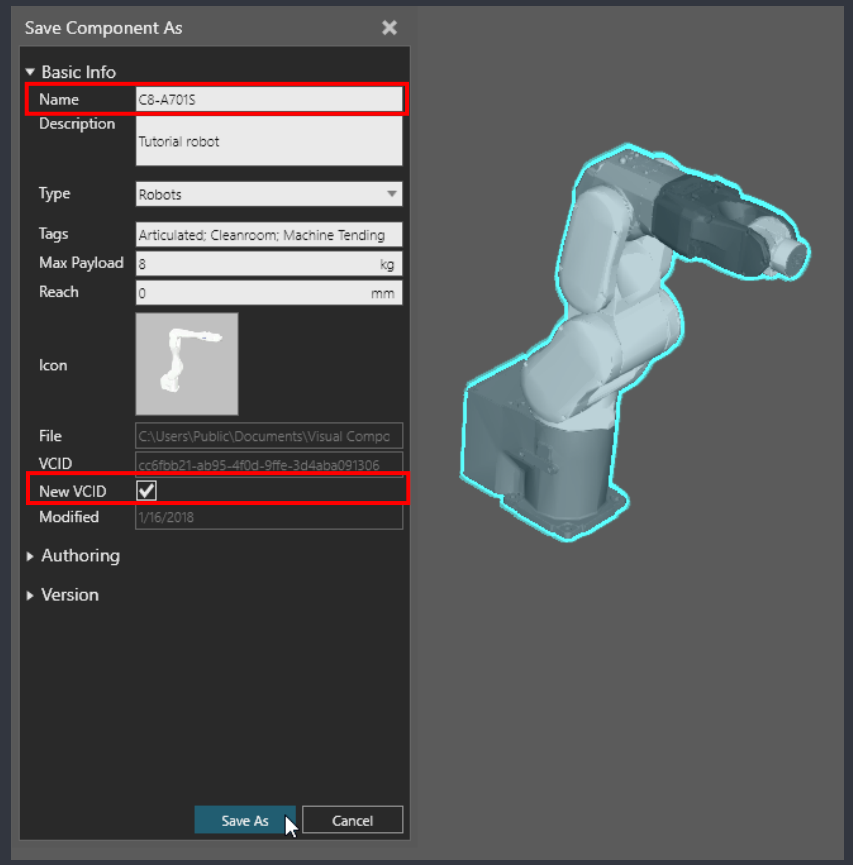
# STEP 5. SAVE AS NEW COMPONENT




Delete the component that only contains imported geometry.

- You want to keep the template robot because it contains all the logic and behaviors for robot.

# SAVE YOUR WORK




Rename the C8XL component to C8-A701S and then save it as a new component.

IMPORTANT! Make sure the New VCID option is active.

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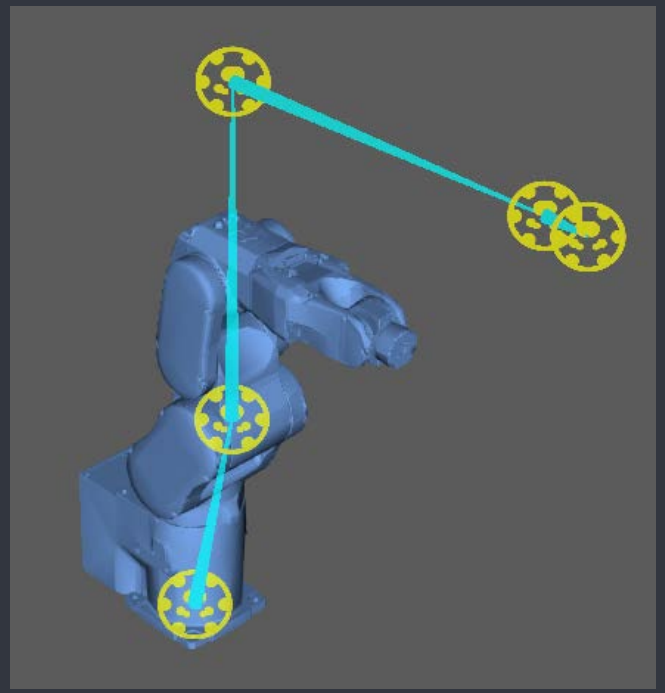
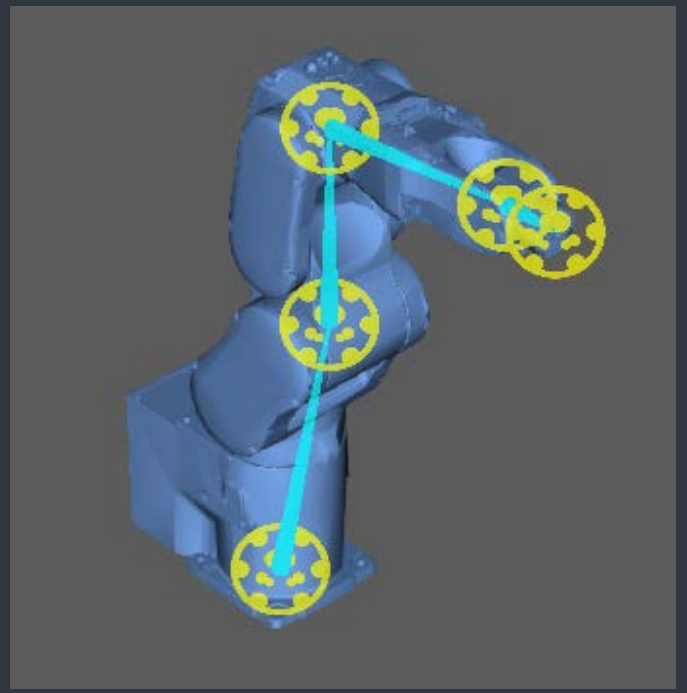
# STEP 6. UPDATE KINEMATICS

Enable the Show Structure option.

Next, select the Kinematics behavior in robot, and then update its link length properties based on data sheet (page 17). That is, you need to define the distance between each link in robot.

- L01Z +472
- L12X +100
- L23Z +300
- L34X -30
- L34Z +310
- L56Z +80





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# STEP 7. UPDATE JOINTS

Update the Min Limit, Max Limit, Max Speed, Max Acceleration and Max Deceleration joint properties for each of the **six joints** in the robot. Refer to the data sheet (page 23). In this case, a link is a degree of freedom (DOF) object which contains its own set of joint properties. For example, you only need to update J1 through J6 nodes in the robot component.

| Item | | Specification | | |
|---|---|---|---|---|
| Model Number | | C8-A701** | C8-A901** | C8-A1401** |
| Model Name | | C8 | C8L | C8XL |
| Mounting type | | Table Top mounting (Ceiling mounting) *1 | | |
| Weight (not include the weight of cables or shipping jigs) | Standard m, Cleanroom & ESD | 49 kg (108 lb.) | 52 kg (115 lb.) | 62 kg (137 lb.) |
| | Protection | 53 kg (117 lb.) | 56 kg (123 lb.) | 66 kg (146 lb.) |
| Driving method | All joints | AC servo motor | | |
| Max. operating speed *2 | Joint #1 | 331 deg./s | 294 deg./s | 200 deg./s |
| | Joint #2 | 332 deg./s | 300 deg./s | 167 deg./s |
| | Joint #3 | 450 deg./s | 360 deg./s | 200 deg./s |
| | Joint #4 | 450 deg./s | | |
| | Joint #5 | 450 deg./s | | |
| | Joint #6 | 720 deg./s | | |
| Maximum synthetic speed | | 8958 mm/sec | 9679 mm/sec | 8858 mm/sec |
| Repeatability | Joint #1 ~ #6 | ± 0.02 mm | ± 0.03 mm | ±0.05 mm |
| Max. motion range | Joint #1 | ±240 deg. | | |
| | Joint #2 | -158 deg. ~ +65 deg. | -158 deg. ~ +65 deg. | –135 deg. to +55 deg. |
| | Joint #3 | –61 deg. to +202 deg. | | |
| | Joint #4 | ± 200 deg. | | |
| | Joint #5 | ± 135 deg. | | |
| | Joint #6 | ± 360 deg. | | |

Note:
Max Acceleration is 4 times Max Speed
Max Deceleration is 4 times Max Speed

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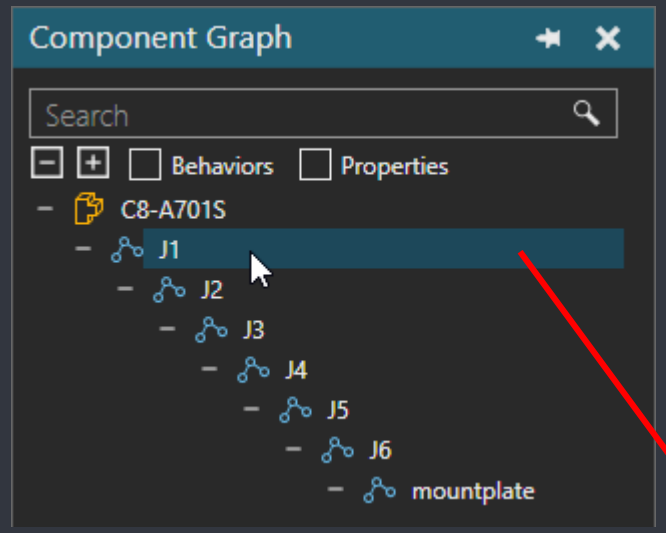
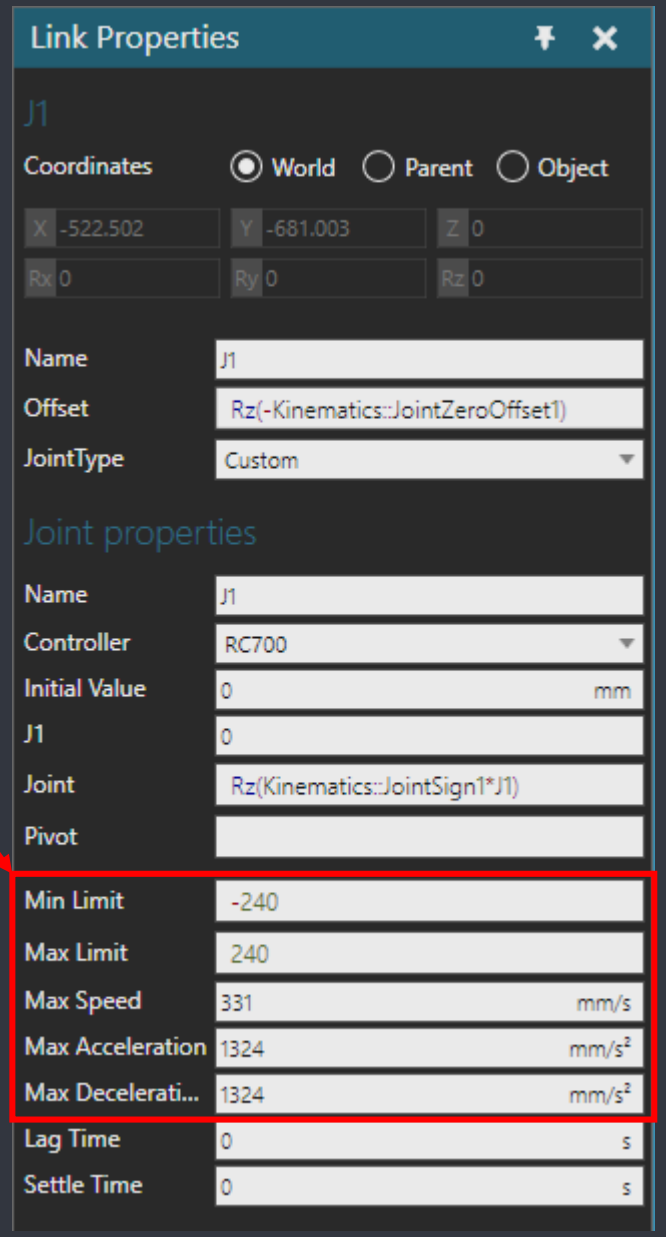
# J1




Remember to update J2, J3, J4, J5 and J6 joint properties as well.

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# STEP 8. MOVE GEOMETRY TO LINKS

Save the component, and then move the Geometry features into the correct links/nodes in component.

IMPORTANT!
You need to hold down **SHIFT** and then drag and drop a Geometry feature so it retains its position. Otherwise, the feature will inherit the offset of the link.

ARM1_1 goes to J1

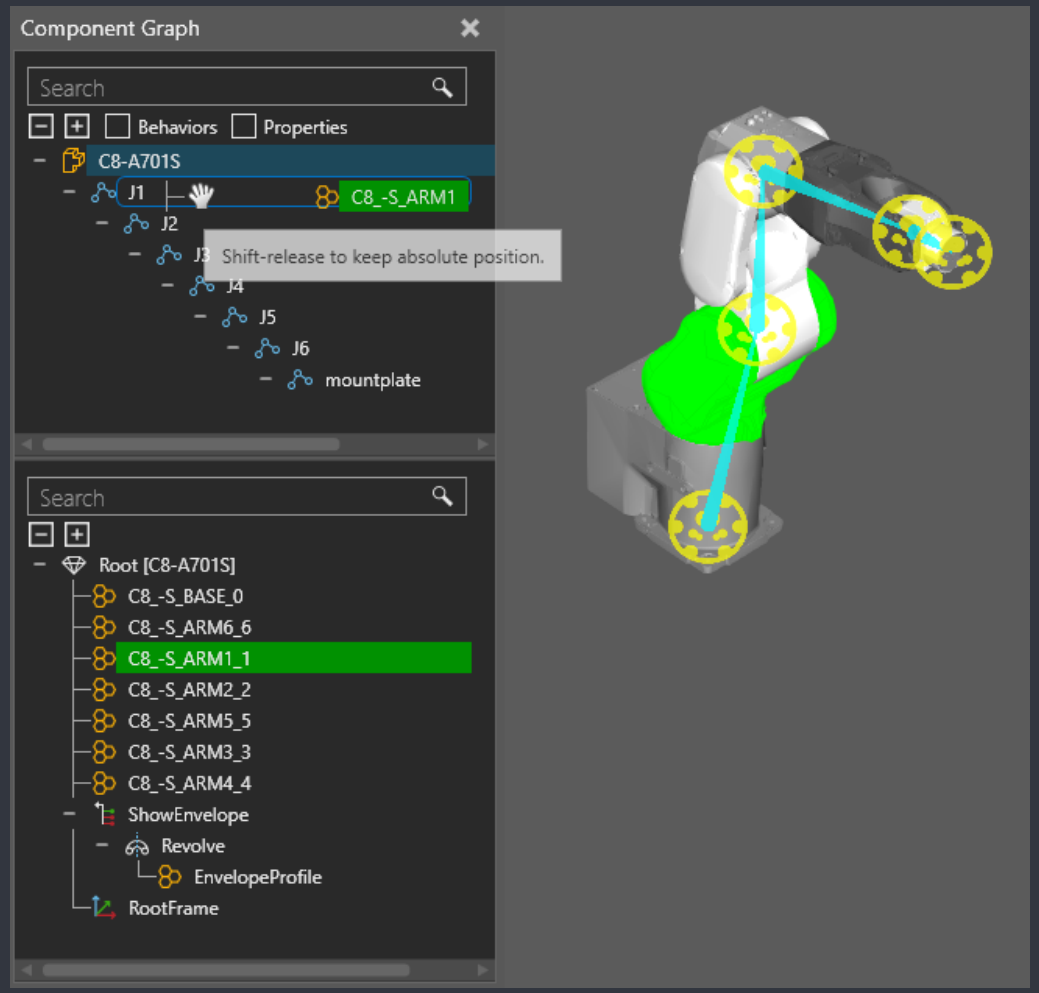
ARM2_2 goes to J2

ARM3_3 goes to J3

ARM4_4 goes to J4

ARM5_5 goes to J5

ARM6_6 goes to J6

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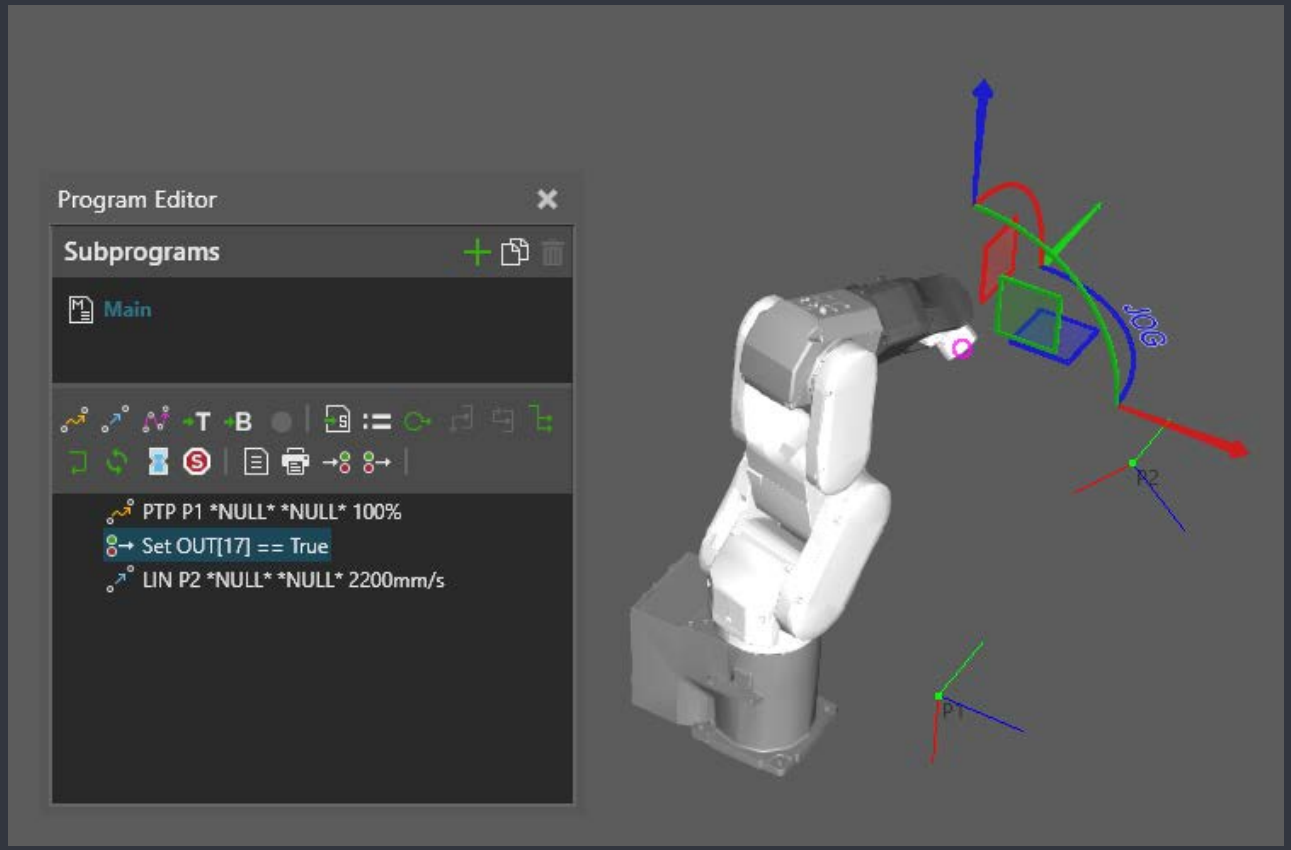
# STEP 9. SAVE AND TEST ROBOT

Save the component.

At this point, the robot is ready to be tested, so run it through several use cases.

For example, teach the robot a few motion statements and simulate that program.

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# REVIEW

- Modeling a robot requires a data sheet and source geometry
  - You can try to model it on your own, but best to adhere to robot manufacturer specs and try to get source geometry instead of making it yourself.
- Always try to use a template robot
  - The process is considerably longer and prone to errors when you start from scratch.
- Moving geometry is not always easy
  - Sometimes you need to simplify and split up geometry.
- Save your work on a regular basis
  - Each save creates a backup, so it is a good practice.
- Test your work
  - Always run the robot through a series of tests, e.g. mount/dismount tools, limit and reachability checks, I/O connections, external axis connections, etc.

# FOR FEEDBACK OR QUESTIONS

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