NX CAM 10.0.2: Robotic Machining

Output NX milling tool paths to robotic machines.
About NX CAM

NX™ CAM software has helped many of the world’s leading manufacturers and job shops produce better parts faster. You can also achieve similar benefits by making use of the unique advantages NX CAM offers.

This is one of many hands-on demonstrations designed to introduce you to the powerful capabilities in NX CAM 10.0.2. In order to run this demonstration, you will need access to NX CAM 10.0.2.

Visit the NX Manufacturing Forum to learn more, ask questions, and share comments about NX CAM.
Hands-on Demonstration: Robotic Machining

NX can now simulate robotic machines. Robotic machines are useful for milling, polishing, finishing, deburring, and laser, plasma, and water jet cutting. In this example, you will polish both sides of a turbine blade.

In this self-demo, you will:

- Specify the robotic machine tool
- Simulate the robotic machine tool
- Examine the kinematics chain
- Check for collisions and make corrections
- Edit robotic machining rules
- Polish the opposite side of the blade
- Postprocess
Prerequisites:
1. You will need access to NX CAM 10.0.2 in order to run this demonstration.
2. You will need the appropriate licenses.
3. If you haven’t done so already, download and unzip robotic_machining.7z.

Demo:

You will need to specify the Assembly Load Options to access the part assembly components in the mach library.

1. Click **Assembly Load Options** in the Ribbon Bar.
2. Select **From Search Folders** from the **Load** list.
3. Type the location of the mach directory for your local install in the **Add Folder to Search** box (ex: C:\Program Files\Siemens\NX 10.0.2\mach...) and press the Enter key.
4. Click **OK**.
5. Open **robotic_polishing.prt** in NX.

4. Select the **Operation Navigator** tab in the Resource Bar.
5. In the Program Order View, right-click **ROUGH1_SIDE1** and select **Replay**.

The tool path was created by a Variable Streamline milling operation.

6. Click **Verify Tool Path** in the Ribbon Bar.
7. Select the **Replay** tab and select **Tool** from the **Tool** list.
   The milling tool used to create the tool path is displayed.
Display the polishing tool

1. Select **Assembly** from the **Tool** list.
   
The polishing disk that will be used by the robotic machine is displayed.

2. Set the **Animation Speed** to 5.
3. Click **Play**.
4. Click **OK** in the **Tool Path Visualization** dialog box.
5. Display the **Machine Tool View** of the **Operation Navigator**.
   
The robotic machine will use the head and polishing tool defined in this view.

Specify the robotic machine tool

You will select a robotic machine tool from the library.

1. Double-click **GENERIC_MACHINE**.
2. Click **Retrieve Machine from Library**.
3. Select **ROBOT** from the **Class to Search** list.
4. Click **OK**.
5. Select **ABB_IRB_6640_235_255** from the **Matching Items** list.
6. Click **OK**.
7. Select **Use Part Mount Junction** from the **Positioning** list.
8. Select **Entire Assembly** from the **Selection Scope** list in the Border Bar.
9. Select the center point on the face of the mounting bracket.

10. Click **OK** in the Part Mounting dialog box.
11. Click **OK** in the 6-Ax Robot dialog box.
12. Close the Information window.
13. Display the machine tool in an isometric view.

You can also display the entire robotics work station.

14. Select the **Assembly Navigator** tab in the Resource Bar.
15. Select the **ABB_ex01_PolishingStation_noRobot** check box to display the station.

16. Select the **ABB_ex01_PolishingStation_noRobot** check box again to remove the station display.

**Simulate the robotic machine tool**

1. Select the **Operation Navigator** tab in the Resource Bar.
2. In the Machine Tool View, click **ROUGH1_SIDE1**.
3. Click **Simulate Machine** in the Ribbon Bar.
4. Select the **Show Tool Path** and **Show Tool Trace** check boxes if they are not already selected.
5. Set the **Animation Speed** to 8.
6. Click **Play**.

Notice the excessive head rotation as the tool changes direction along the zig-zag tool path. You will eventually correct this by editing the robotic machining rules to control the head orientation.
7. Click **Close** when the simulation is complete.

**Examine the kinematics chain**

1. Select the **Machine Tool Navigator** tab in the Resource Bar.
2. On the background of the Machine Tool Navigator, right-click and select **Expand All** to see all of the objects.
3. Click each one of the objects (J1-J6) to highlight the various components of the machine tool.

4. On the background of the Machine Tool Navigator, right-click and select **Preview Motion**.

5. Click **Show Machine Axis Positions**.

You can use the sliders to manually control each joint of the robotic arm and observe the rotational limits. The blue dot for J5 indicates a singularity, or excessive joint rotation of J4 and J6 caused by J5 approaching its allowable 120 degree limit. You will correct this singularity by editing the robotic machining rules to control the joint rotation.

6. In the Preview Motion dialog box, select the **Move Spindle About Part** check box.

This allows you to observe the robotic arm movement by dragging the graphic handles.

7. Drag the handles to move and rotate the arm.
8. Click **Close** in the Preview Motion dialog box.

**Define the part component in the setup configurator**

You will specify the blade and clamps as the part component in the kinematics chain. This will allow you to check for collisions between the robotic arm and the part and fixture.

1. In the Machine Tool Navigator, double-click **PART** to edit the object.

![Machine Tool Navigator](image)

2. Select the blade and the three fixture bodies indicated below to define the part component.

![Fixture Bodies](image)

These three fixture bodies are the ones most likely to collide with the arm.

3. Click **OK**.

**Check for collisions**

You will specify two objects with which to detect collisions. J4 on the robotic arm will be the first object and the part component you just defined will be the second object. You will then perform a collision check using machine simulation.

1. Select the **Operation Navigator** tab in the Resource Bar.
2. In the Machine Tool View, click **ROUGH1_SIDE1**.
3. Click **Simulate Machine** in the Ribbon Bar.
4. Click **Simulation Settings**.
5. Select **On** from the **Collision Detection** list.
6. Click **Specify Collision Pairs**.
7. In the First Object section of the dialog box, select **J4** from the **Name** list.
8. In the Second Object section of the dialog box, select **PART** from the **Name** list.

![Specify Collision Pairs dialog box](image)

9. Type **5.000** in the **Collision Clearance** box.
10. Click **OK** in the Specify Collision Pairs dialog box.
11. Click **OK** in the Simulation Settings dialog box.
12. Click **Play**.

The J4 and PART objects collide due to the excessive 180 degree head rotation. You will edit the head orientation rules to prevent this collision.
13. Click **Continue until Reset**.
14. Click **Close** when the simulation has finished.

**Edit the head orientation**

You will eliminate the collision by editing the robotic machining rule that controls the head orientation.

1. With **ROUGH1_SIDE1** still selected in the Operation Navigator, click **Edit Rules** in the Ribbon Bar.

   ![New!](image)

   **New!**

   - **Edit**
   - **Apply**
   - **Rules**
   - **Rules**

2. In the Events Used section of the dialog box, double-click **Robot Tool Orientation/Orientation Mode=Tangent** to edit the event.

3. Select **Fixed** from the **Orientation Mode** list.
4. Select **Inferred Vector** from the **Fixed Tool Direction** list.
5. Select the edge of the clamp at the end shown below to define the fixed orientation of the head.

![Diagram](image)

   This orientation will prevent the arm from swinging too far to the right so that it avoids colliding with the fixture.

6. Click **OK** in the Robot Tool Orientation dialog box.
7. Click **OK** in the User Defined Events dialog box.
8. Click **Apply Rules**.

9. Click **OK** in the Tool Path Processing dialog box.

10. Click **Simulate Machine** in the Ribbon Bar.
11. Click **Play**.

   The 180 degree head rotation has been eliminated and the head no longer collides with the fixture, but the J5 singularity still needs to be corrected.

12. Click **Continue until Reset**.
13. Click **Close**.

**Correct the J5 singularity**

You will eliminate the singularity by editing the robotic machining rule that controls the joint rotation at J5.

1. Click **Edit Rules**.
2. In the Events Used section of the dialog box, double-click **Positioner/Positioner Mode=Constant Joint Value** to edit the event.

   ![Events Used](image)

3. Select **Constant Surface Normal** from the **Positioner Mode** list.
4. Select **ZC** from the **Target Normal Direction** list.
5. Click **OK** in the Positioner dialog box.
6. Click **OK** in the User Defined Events dialog box.

7. Click **Apply Rules**.
8. Click **OK**.

9. Click **Simulate Machine** in the Ribbon Bar.
10. Click **Play**.

The positioner tilts the blade, allowing the head to remain vertical as specified. Collisions and singularities have been removed.

11. Click **Close**.

**Specify Non-Cutting Moves and Motion Output Type**

You will complete the tool path by specifying non-cutting moves that will allow you to safely rotate the blade and polish the opposite side. For robotics, it is also essential that you specify a linear motion output type because circular moves, spline motions, and drill cycles are not currently handled. Once this has been done, you will be able to copy and edit the operation to polish the other side of the blade.

1. Double-click **ROUGH1_SIDE_1** to edit the operation.
2. Click **Non Cutting Moves**.
3. Select the **Engage** tab.
4. In the Initial section of the dialog box, select **Arc-Normal to Part** from the **Engage Type** list.
5. Select the **Retract** tab.
6. In the Final section of the dialog box, select **Same as Initial Engage** from the **Retract Type** list.
7. Select the **Transfer/Rapid** tab.
8. In the Initial and Final section of the dialog box, select **Along Tool Axis** from the **Approach Method** list.
9. Type **200.000** in the **Distance** box and select **mm** from the list.
10. In the Initial and Final section of the dialog box, select **Along Tool Axis** from the **Departure Method** list.
11. Type **200.000** (mm) in the **Distance** box.
12. Click **OK**.
13. In the Machine Control section of the dialog box, select Line from the Motion Output Type list.
14. Click Generate.
15. Click Overwrite Path.

16. Click OK to complete the operation.

Note: You must always Apply Rules after generating a tool path.

17. Click Apply Rules.
18. Click OK.

Polish the opposite side of the blade

You will copy and edit the existing operation to polish the opposite side of the blade. You will also edit the robotic machining rule to specify an appropriate head orientation.

1. In the Program Order View of the Operation Navigator, right-click ROUGH1_SIDE1 and select Copy.
2. Right-click POLISH_BLADE_ROUGH_1 and select Paste Inside.
3. Right-click ROUGH1_SIDE1_COPY and select Rename.
4. Type ROUGH1_SIDE2.
5. Double-click ROUGH1_SIDE2 to edit the operation.
6. In the Drive Method section of the dialog box, click Edit.
7. In the Material Side section of the dialog box, click Flip Material.
8. Click OK.
9. Click Generate.
10. Click OK to complete the operation.
11. Click Edit Rules.
12. In the Events Used section of the dialog box, double-click Robot Tool Orientation/Orientation Mode=Fixed to edit the event.
13. Click Reverse Direction.

14. Click OK in the Robot Tool Orientation dialog box.
15. Click OK in the User Defined Events dialog box.
16. Click Apply Rules.
17. Click OK.

**Simulate the machine tool**

1. Click POLISH_BLADE_ROUGH_1 in the Operation Navigator.

2. Click Simulate Machine in the Ribbon Bar.
3. Click Play.

Both sides of the blade are polished with no collisions or singularities occurring.

4. Click Close.
Postprocess

1. Be sure tool paths have been generated and rules have been applied to each of the operations.

2. In the Program Order View, click **POLISH_BLADE_ROUGH_1**.

3. Click **Post Process** in the Ribbon Bar.

4. In the Postprocess dialog box, select **ABB RAPID** from the **Postprocessor** list.

5. Click **Browse for an Output File** and specify a directory you can write to.

6. Click **OK** to postprocess.

7. Close the Information window.

8. Close the part without saving.
Siemens Industry Software

Headquarters
Granite Park One
5800 Granite Parkway
Suite 600
Plano, TX 75024
USA
+1 972 987 3000

Americas
Granite Park One
5800 Granite Parkway
Suite 600
Plano, TX 75024
USA
+1 314 264 8499

Europe
Stephenson House
Sir William Siemens Square
Frimley, Camberley
Surrey, GU16 8QD
+44 (0) 1276 413200

Asia-Pacific
Suites 4301-4302, 43/F
AIA Kowloon Tower, Landmark East
100 How Ming Street
Kwun Tong, Kowloon
Hong Kong
+852 2230 3308

About Siemens PLM Software
Siemens PLM Software, a business unit of the Siemens Industry Automation Division, is a leading global provider of product lifecycle management (PLM) software and services with seven million licensed seats and more than 71,000 customers worldwide. Headquartered in Plano, Texas, Siemens PLM Software works collaboratively with companies to deliver open solutions that help them turn more ideas into successful products. For more information on Siemens PLM Software products and services, visit www.siemens.com/plm.

© 2015 Siemens Product Lifecycle Management Software Inc. Siemens and the Siemens logo are registered trademarks of Siemens AG. D-Cubed, Femap, Geolus, GO PLM, I-deas, Insight, JT, NX, Parasolid, Solid Edge, Teamcenter, Tecnomatix and Velocity Series are trademarks or registered trademarks of Siemens Product Lifecycle Management Software Inc. or its subsidiaries in the United States and in other countries. All other logos, trademarks, registered trademarks or service marks used herein are the property of their respective holders.