

CNC Milling

WORKING WITH THE 4TH AXIS (VIRTUAL)

Name	Class/Period	Date

1. Overview

In this tutorial, you will equip your virtual machine with a rotary axis and use the axis to machine a cylindrical part.

2. Performance Objectives

After completing these hardware tasks, you will be able to:

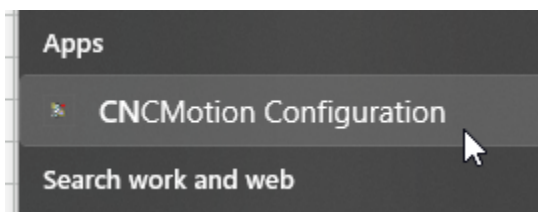
- Configure the 4th axis on a virtual milling machine.
- Jog the machine about the 4th axis.
- Touch off a cylindrical part to define the machine origin.
- Run a program that machines a cylindrical part.

3. Working with the ATC in CNCMotion

3.1. Installing the Rotary Axis

Your machine's default configuration does not have a 4th (rotary) axis. Perform the following steps to install the axis onto the virtual machine:

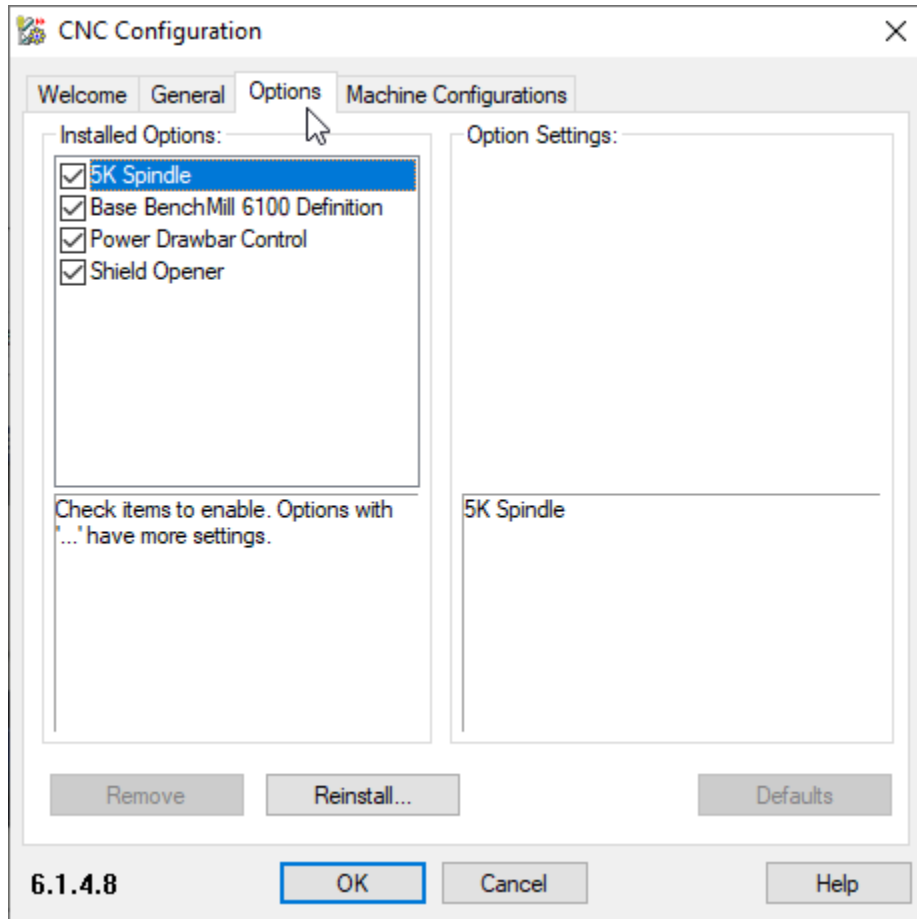
1. Close CNCMotion if it is running.
2. In your computer's Start or program menu, open the **CNCMotion Configuration** app.



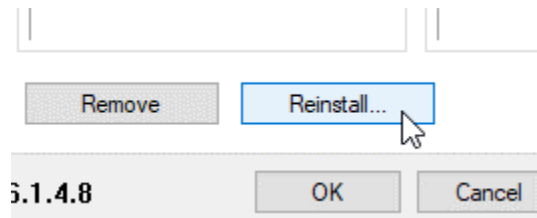
The CNC Configuration window for your machine is displayed.



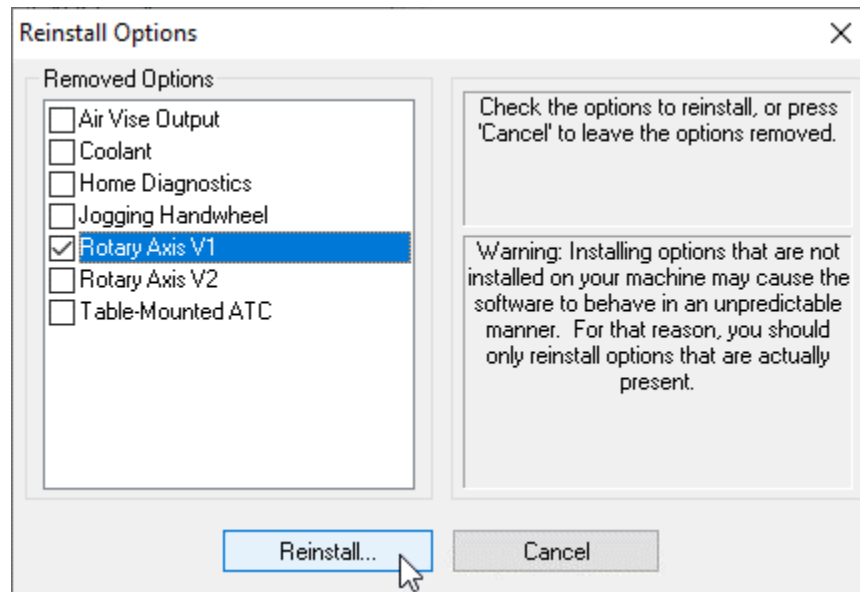
3. Select the **Options** tab.



4. Click **Reinstall**.

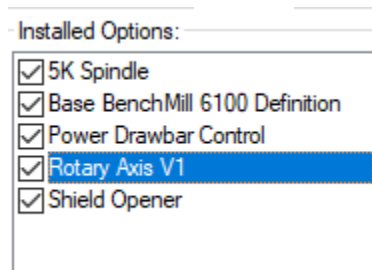


- The Reinstall Options window opens. Check one of the **Rotary Axis** options and then click **OK**.

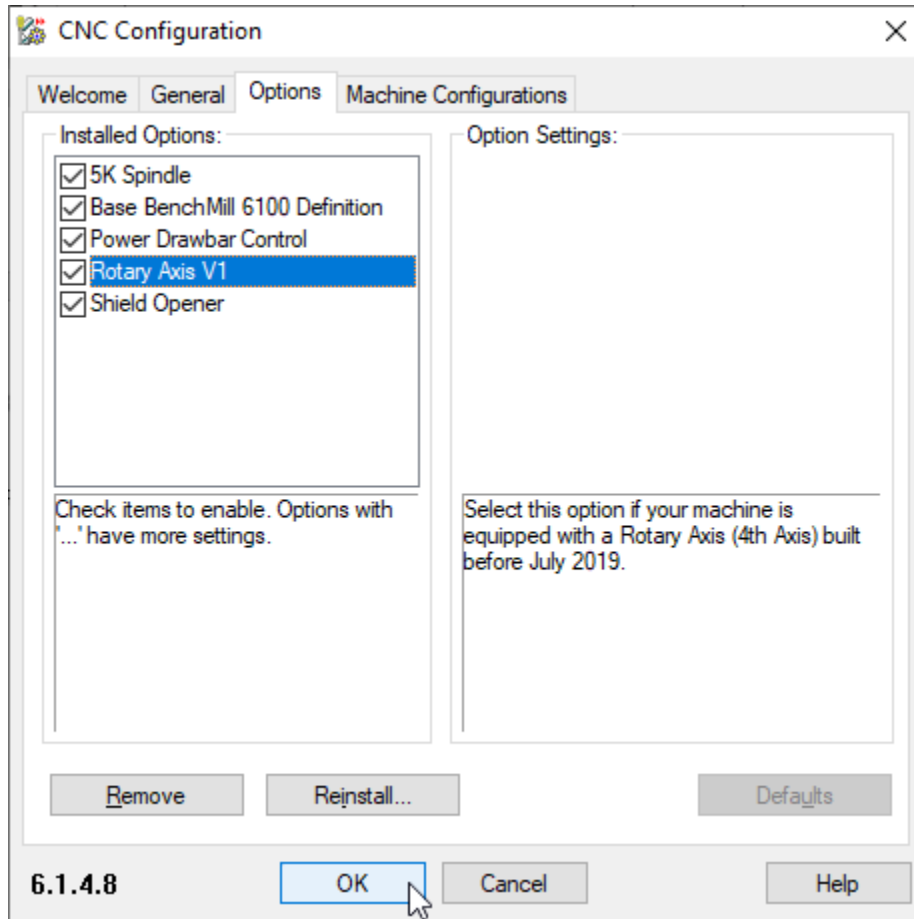


- Note:** When installing the axis on a physical machine, select **Rotary Axis V2**.

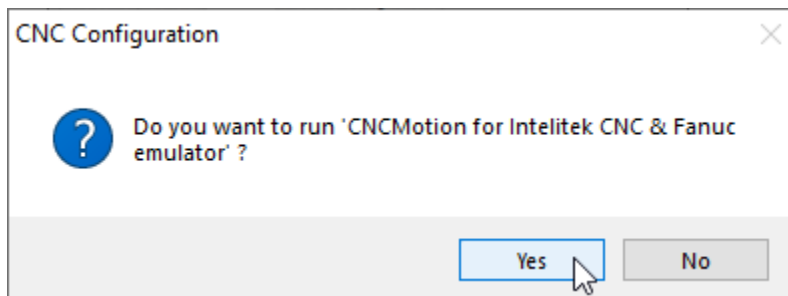
The Rotary axis is added to the Installed Options.



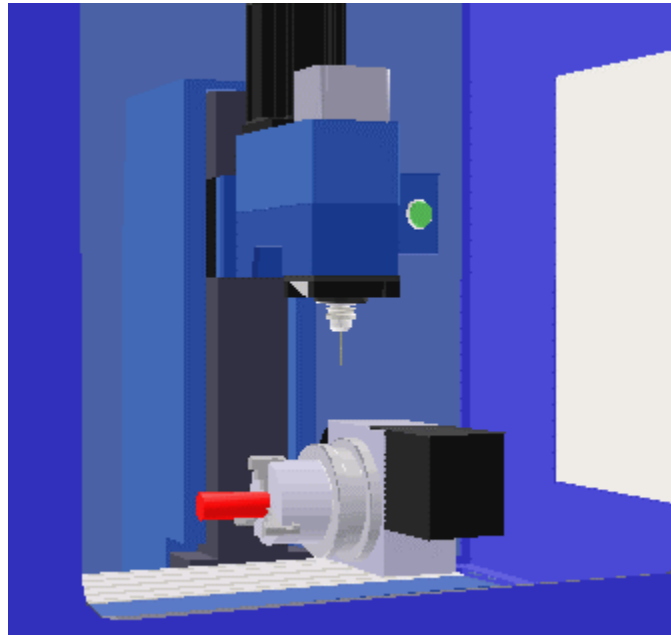
6. Click **OK** to confirm and exit.



7. In the popup window, click **Yes** to run CNCMotion.



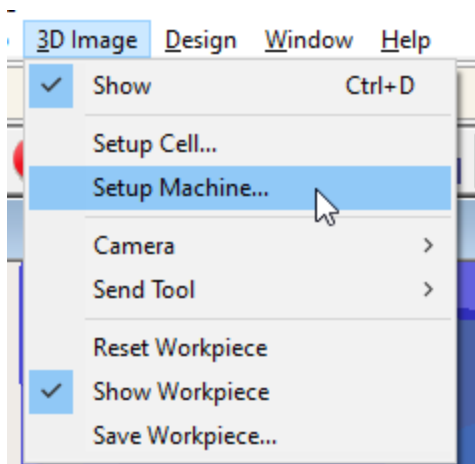
The rotary axis is installed in the machine. Note that the workpiece is cylindrical and is installed in the rotary axis' chuck (which is similar to a vise).



ⓘ **Note:** When the machine is equipped with a 4th axis, Send Tool to Corner and Send Tool to Point options are unavailable.

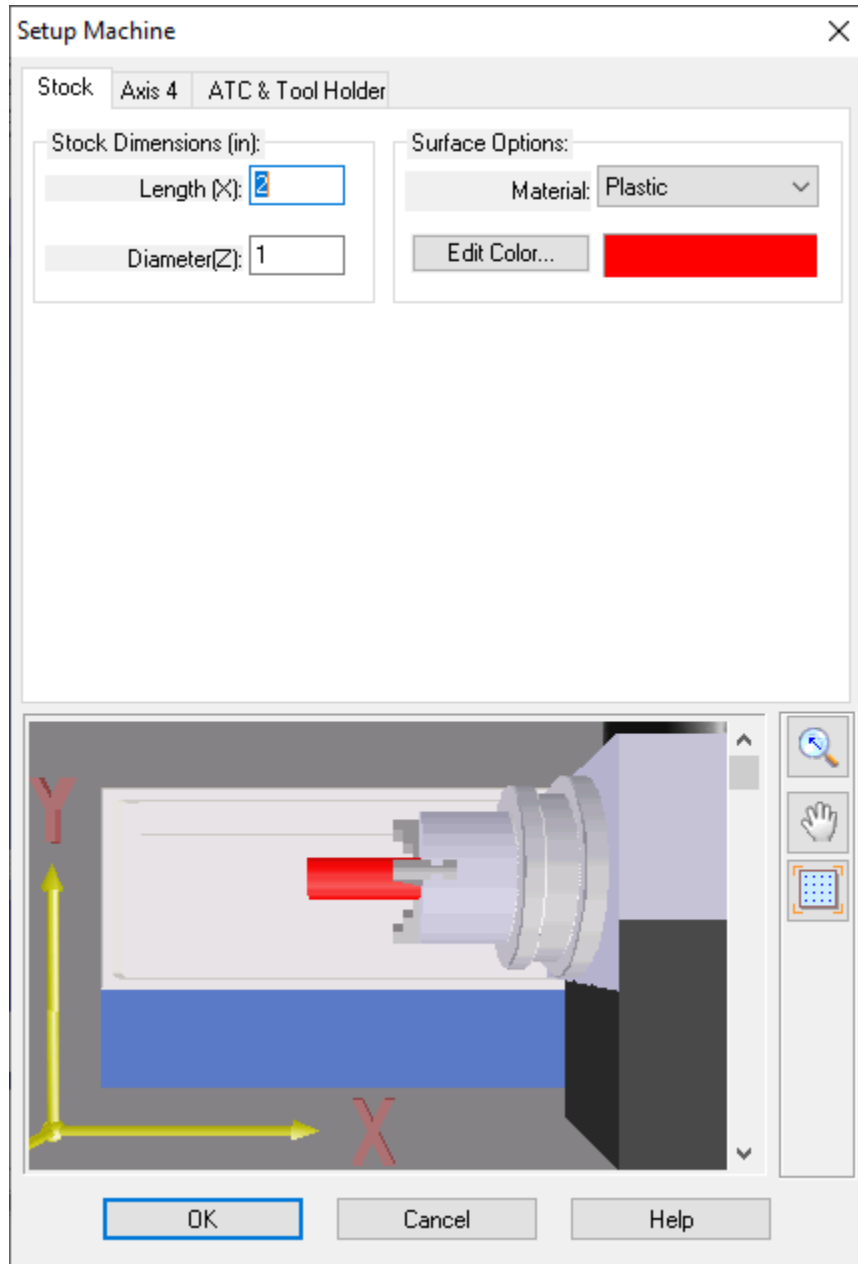


8. Close the safety shield.
9. Home the machine.
10. From the menu, select **3D Image > Setup Machine**.

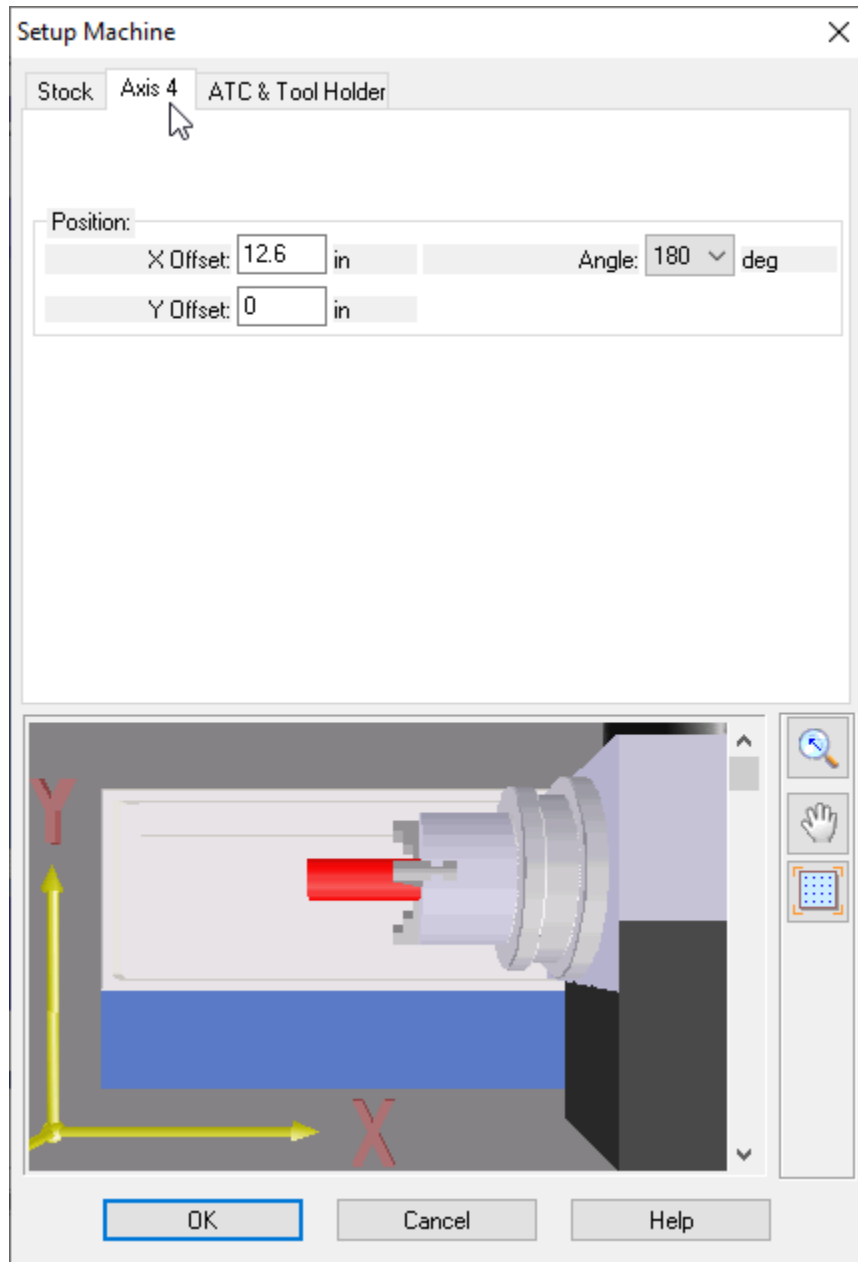


The Setup Machine window is displayed. Note that the workpiece has two dimensions: X, the length and Z, the diameter. Ensure that the dimensions are as follows:

- For imperial: X = 2, Z = 1
- For metric: X = 50, Z = 25

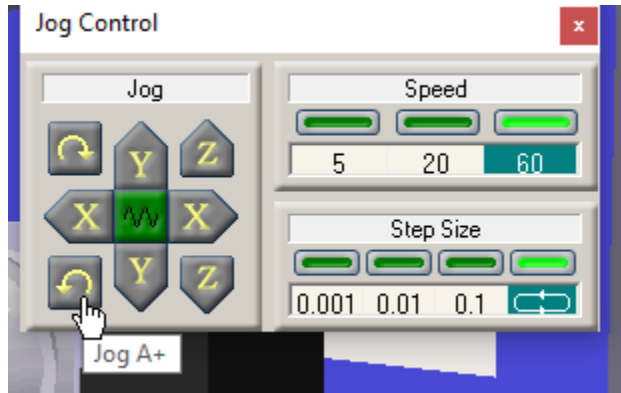


11. Select the **Axis 4** tab. In this tab, you can set the position and the angle of the chuck and workpiece.



12. Change the values and observe how the position of the axis changes. Return the axis to its original position and then click **OK** to confirm any changes and to close the window.

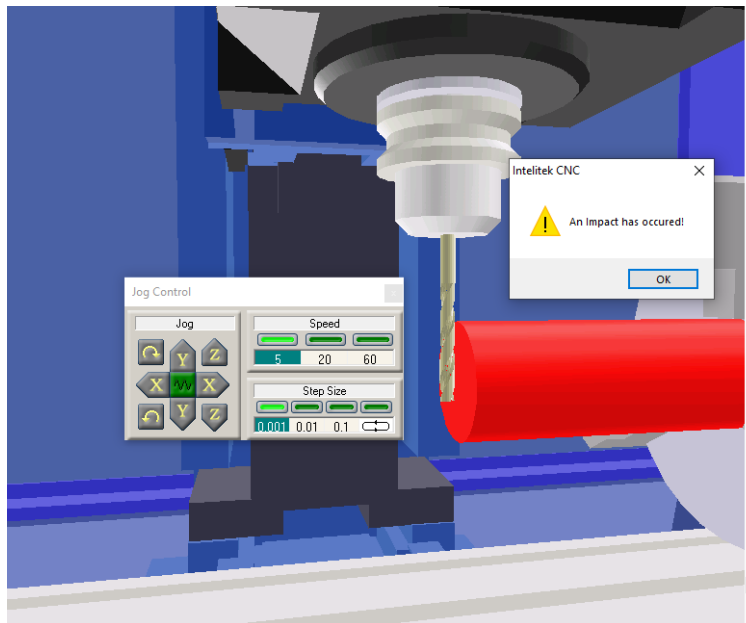
- Open the Jog Control window. Note the addition of the new axis (A). You can jog the workpiece about the A axis by clicking the clockwise (A-) and counterclockwise (A+) buttons. Click these buttons and observe the movement of the workpiece.



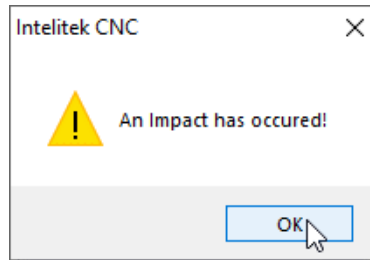
3.2. Touching off the Workpiece

In this task, you will touch off the workpiece to define the origin (0,0,0). The origin should be just above the face of the workpiece. Perform the following steps:

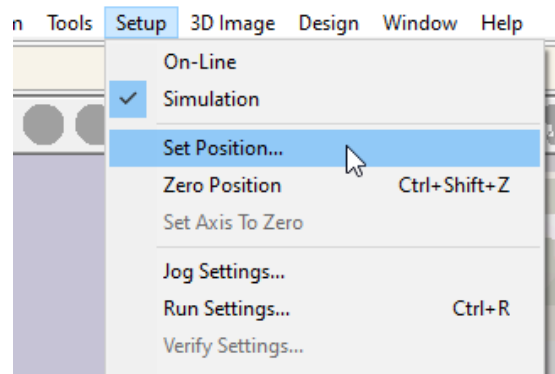
- Ensure that tool #1, a 0.125 inch / 3 mm end mill is inserted in the spindle.
- Jog the tool to the face of the workpiece. Using the lowest speed and step size, jog the tool into the face of the workpiece until an impact occurs.



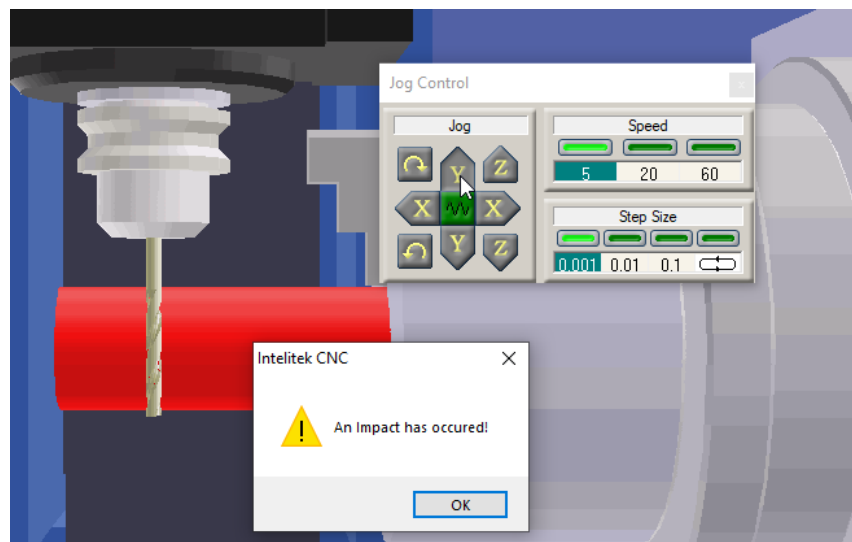
- In the popup window, click **OK** to close the window.



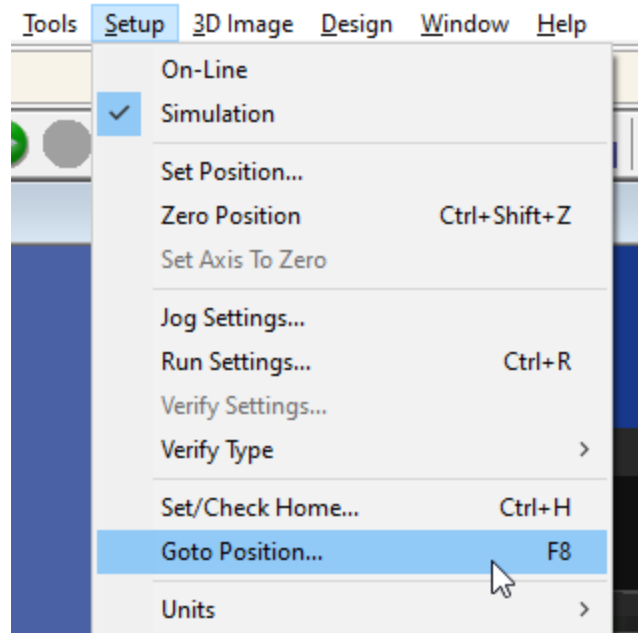
- Select **Setup > Set Position**.



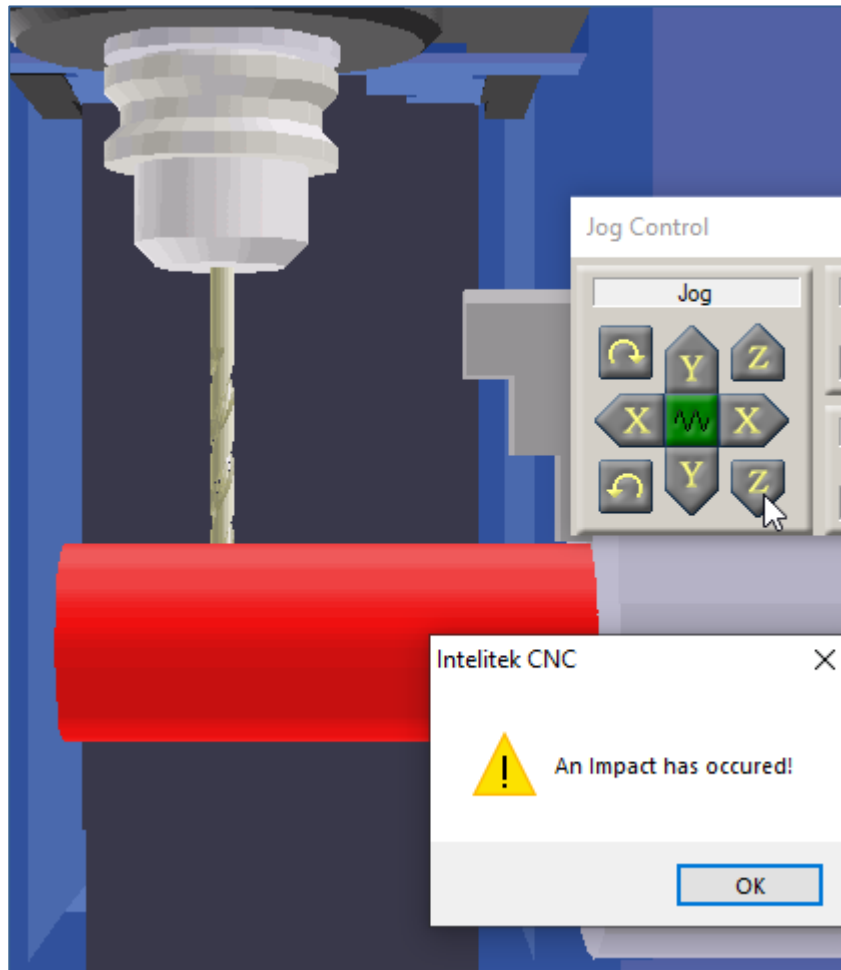
- Change the X position to 0 minus half the diameter of the tool.
 - For Imperial, this position is: -0.0625 in
 - For metric, this position is: -1.5 mm
- Click **OK** to close the window.
- Jog the tool until it is in front of the workpiece (between the workpiece and the safety shield as shown in the image below). Using the lowest speed and step size, jog the tool backwards into the workpiece until there is an impact.



8. Select **Setup > Set Position**. Set the Y position to 0 minus (half the diameter of the tool plus half the diameter of the workpiece). The diameter of the default workpiece is 1 inch / 25 mm.
 - For Imperial, the Y position is: -0.5625 in
 - For metric, the Y position is: -13 mm
9. Jog the tool so that it is entirely above the workpiece.
10. Select **Setup > Goto Position**.

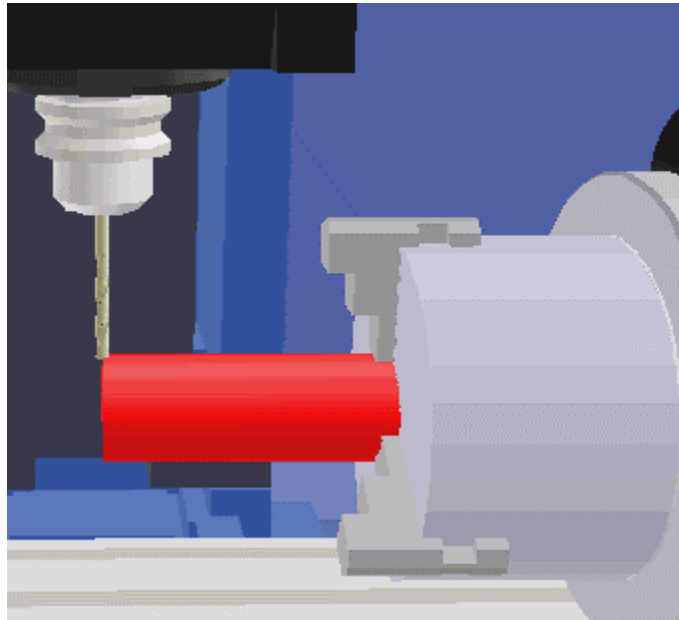


11. In the Goto Position window, set the Y position to **0** and then click **GO**. The tool moves above the center of the workpiece.
12. Using the lowest speed and step size, jog the tool downwards into the workpiece until there is an impact.

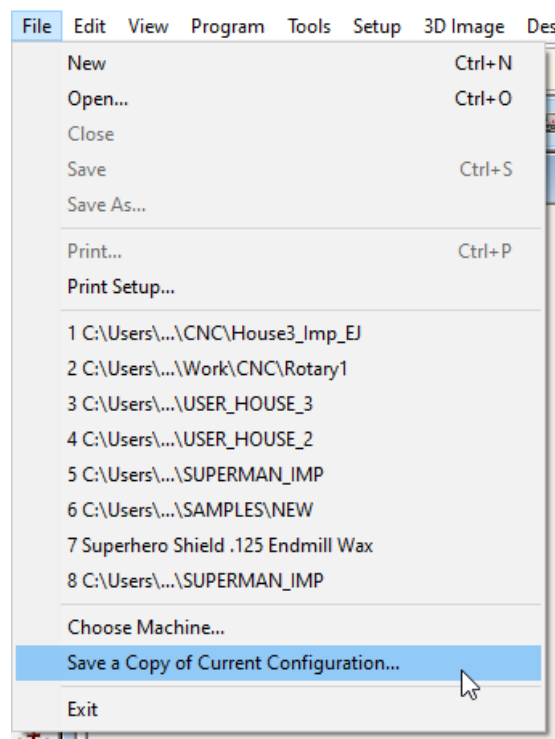


13. Select **Setup > Set Position**. Set the Z coordinate to **0** and then click **OK**.

14. Select **Setup > Goto Position**. Set all coordinates to **0** and then click **GO**. The tooltip should move to the intended origin.



15. Save your machine configuration by selecting **File > Save a Copy of Current Configuration**. Include your name or initials in the configuration file name.

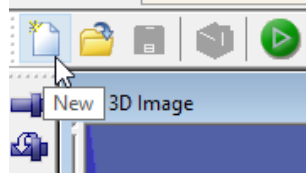


3.3. Running a Simple Program

In this task, you will run a program that will make linear cuts along the length of the workpiece at 45° increments.

Perform the following:

1. Open a new program.



2. Copy the relevant program below and paste it into the Program window.

Imperial	Metric
N1 ; G-code program with 4th axis (rotary axis) movement	N1 ; G-code program with 4th axis (rotary axis) movement
N11 ; Rotate workpiece in 45-degree increments	N11 ; Rotate workpiece in 45-degree increments
N21 ; Make linear cuts along the length of the workpiece	N21 ; Make linear cuts along the length of the workpiece
N31 G20 ; Set units to inches	N31 G21 ; Set units to mm
N41 G90 ; Absolute positioning	N41 G90 ; Absolute positioning
N51 M06 T01 ; Insert tool #1	N51 M06 T01 ; Insert tool #1
N61 M03 S2000 ; Spindle on (clockwise)	N61 M03 S2000 ; Spindle on (clockwise)
N71 F10 ; Set feed rate	N71 F250 ; Set feed rate
N81 G00 X0 Y0 Z1 A0 ; Initial position (above workpiece)	N81 G00 X0 Y0 Z25 A0 ; Initial position (above workpiece)
N91 G01 Z-0.1 ; 1st Plunge into workpiece	N91 G01 Z-2.5 ; 1st Plunge into workpiece
N101 X1.5 ; First cut (0 degrees)	N101 X40 ; First cut (0 degrees)
N111 X0	N111 X0
N121 Z0.1 ; Retract	N121 Z2.5 ; Retract
N131 A45	N131 A45
N141 Z-0.1 ; Plunge	N141 Z-2.5 ; Plunge
N151 X1.5 ; Second cut (45 degrees)	N151 X40 ; Second cut (45 degrees)
N161 X0	N161 X0
N171 Z0.1	N171 Z2.5
N181 A90	N181 A90
N191 Z-0.1	N191 Z-2.5
N201 X1.5 ; Third cut (90 degrees)	N201 X40 ; Third cut (90 degrees)
N211 X0	N211 X0
N221 Z0.1	N221 Z2.5
N231 A135	N231 A135
N241 Z-0.1	N241 Z-2.5
N251 X1.5 ; Fourth cut (135 degrees)	N251 X40 ; Fourth cut (135 degrees)
N261 X0	N261 X0
N271 Z0.1	N271 Z2.5
N281 A180	N281 A180
N291 Z-0.1	N291 Z-2.5
N301 X1.5 ; Fifth cut (180 degrees)	N301 X40 ; Fifth cut (180 degrees)
N311 X0	N311 X0
N321 G00 Z1 ; Retract spindle	N321 G00 Z25 ; Retract spindle
N331 M05 ; Spindle off	N331 M05 ; Spindle off
N341 M30 ; End of program.	N341 M30 ; End of program.

Note: The A coordinate is not in inches or mm, but in degrees.

- 3. Save the program with an appropriate name.
- 4. Run the program.



- 5. Observe the tool and the 4th axis as the program is run. Note the movement of the workpiece.
- ④ **Note:** *There is no verification or simulation of the machined workpiece when the 4th axis is present.*
- 6. *Bonus task:* If time remains, create and run your own unique NC program for machining the workpiece.
- 7. Exit CNCMotion.

4. Authentic Skills Assessment

Have your instructor verify that your work meets the requirements in the Performance Objectives and sign below. Keep this sheet for future reference.

Instructor Signature	Date