Lab 03: Manual Milling and Turning Operations

I. Purpose

A.) Provide an overview of safety considerations for the CNC Mill
B.) Provide manual experience using the laboratory's CNC Mill
C.) Provide an overview of safety considerations for the CNC Lathe
D.) Provide manual experience using the laboratory's CNC Lathe

II. Practice

Your lab team will be divided into two sub-teams to perform both the lathe and the milling operations, each person will rotate through both workstations. Your team is to produce raw material for your project of sufficient dimensional quality for automated production. The lab instructor will lead your group through this exercise, but class participation is expected. You are to document the process in your engineering notes.

Lathe Operations:

A.) Obtain your supply of raw stock materials, and deburr the ends with the flat mill file.
B.) Observe and take notes as the lab instructor explains the computer display and operation of the lathe. Team members will help you to follow the process and watch for hazards.
C.) For each machine, you will perform the following operations:
   a. **Set Up** of both machine & stock
   b. **Homing** of the machine (also called ***Hard Homing***)
   c. **Touch-Off** on the stock (also called ***Soft Homing***)
   d. **Production** operations
   e. **Tool Change** operations
   f. **Change-Over** & **5 S** activities

Follow the steps (below) to produce your stock piece:

Set Up:

1. Turn on the CNC Controller.
2. Turn on the Computer.
3. Double Click on the icon "Shortcut to WPLT3000" in the lower right corner.
4. Set up your stock on the computer:
   a. Set Up>Verify Settings
   b. Click the Stock Tab then enter your stock length in the Dimension window:
      i. Length (Z): 4.45 in
      ii. Diameter (X): 0.5 in
   c. Enter your coordinate system information in the Origin window:
      i. Z Axis: 4.45 in
      ii. X Axis: 0 in
   d. Enter your tool starting position information in the Initial Tool Position window:
      i. Z Axis: 5 in
      ii. X Axis: 0.5 in
   e. Click the OK button

5. Verify the tools on the tool turret:
    a. Tools>Configure Turret
    b. Verify the tools in the odd turret locations, then
    c. Click the OK button
6. Open the guard and insert your workpiece into the air chuck by toggling the lower electric socket icon on the left toolbar (to open/close the chuck). Make sure your workpiece is held securely and seems square in the chuck. Close the guard.

Hard Home:

7. Home the lathe:
    a. Set Up>Check Home>Home (or click the Home Button on the top tool bar>Home)
8. Home the turret:
    a. Tools>Operate Turret>Home … wait for indication …>Done

Touch-Off (Soft Home):

9. Select Tool 1 (right hand profiling tool) from the tool bar
10. Jog the tool (Fast) until the tool tip is about ¼" from the end of the workpiece in X and Z.
11. Set the (feed) Speed and the Step size as necessary to move to the top, right corner of the workpiece (carefully, so as to just touch, but NOT move into the part)
12. Set the workpiece Zero Position:
    a. Set Up>Set Position Z = +0.0 X = +0.25
    b. Click the OK button

    Now all moves within the part envelope will have negative Z coordinates, and all points outside the part envelope will have positive Z coordinates. All the X coordinates will be measured radially from the central axis of the part.

Production Operations: Facing

13. Jog the tool (Fast) along the positive X axis to the position Z = 0.0 X = +0.35
14. Select Tool 3 (parting tool) from the tool bar
15. Jog the tool (Fast) to the position Z = – 0.05 X = +0.35
16. Set the Spindle Speed:
    a. Set Up>Spindle
    b. 1500 RPM
17. Start the Spindle by clicking the Spindle Icon button on the top of the left toolbar.
18. Setup>Go To Position: Z = – 0.05 X = – 0.1
    a. Insert a Feed of 1
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button

    This facing cut will give you a pretty smooth end to accurately locate within the chuck. (You may need to remove the nub on the end with a utility knife.)
19. Step the tool along the positive X axis until: X = + 0.5
20. Stop the Spindle by clicking on the Spindle Icon button on the top of the left button bar.
21. Open the guard, and un-chuck the workpiece by clicking on the lower Outlet button on the left toolbar. Remove the workpiece.
22. Insert the faced end of the workpiece within the chuck, and click on the lower Outlet button (again) to close the jaws.
23. Jog the tool down the negative Z and X axes until: Z = – 0.1 X = +0.35
24. Start the Spindle rotating again from the top button on the left toolbar.

25. Setup>Go To Position: Z = – 0.1 X = – 0.1
    a. Insert a Feed of 1
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button

    This facing cut will give you a pretty smooth end to accurately locate within the chuck. (You may need to remove the nub on the end with a utility knife.)

Tool Change:

26. Step the tool along the positive X axis until: X = + 0.5
27. Select Tool 7 (grooving tool) from the tool bar
28. Jog the tool (Fast) to the position Z = – 1.000 X = + 0.35

Production Operations: Grooving

29. Setup>Go To Position: Z = – 1.000 X = + 0.2
    a. Insert a Feed of 1
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button

    This grooving cut will give you a warning mark to locate the end of the first part on your workpiece. (You will program the lathe to make the pieces later.)
30. Step the tool along the positive X axis until: X = + 0.35
31. Setup>Go To Position: Z = – 2.000 X = + 0.35
    a. Insert a Feed of 10
    b. Press the ENTER button
32. Setup>Go To Position: Z = – 2.000 X = + 0.2
    a. Insert a Feed of 1
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button

    This grooving cut will give you a warning mark to locate the end of the second part on your workpiece. (You will program the lathe to make the pieces later.)

Change-Over & 5S:

33. Step the tool along the positive X axis until: X = + 0.35
34. Setup>Go To Position: Z = + 1.000 X = + 0.35
    a. Insert a Feed of 10
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button
35. Stop the Spindle by clicking the Spindle button on the top of the left toolbar.
36. Click on the Home button on the top toolbar, then click the Home button that appears.
37. Select Tool 1 (right hand profiling tool) from the tool bar
38. Open the guard, and un-chuck the workpiece by clicking on the lower Outlet button on the left toolbar. Remove the workpiece.
39. Use the small chip brush and the small vacuum to clean up excess debris. Sort and replace tooling, gauges, and aids for the next use.

Mark your initials on your workpiece in pencil, then store your workpiece in your Team's storage bin for future use.

Milling Operations:

A.) Obtain your supply of raw stock materials, and remove any splinters on the ends with the flat mill file

B.) Observe and take notes as the lab instructor explains the computer display and operation of the mill. The lab instructor will help you to follow the process and watch for hazards. Your team members should also do the same.

C.) NOTE: The operation of the mill is similar to the lathe, BUT NOT EXACTLY THE SAME! In particular, the axes on the mill jog panel operate as if you were moving the tool in a particular direction (but it is really the table of the mill that moves). Be careful not to get confused, or you may ruin your workpiece. Also, there is no readout for spindle speed on the machine, and the override is only enabled when a toggle switch is set to Manual (instead of CNC).

CAREFULLY follow the steps (below) to produce the base for your product:

40. Open the vise and insert your workpiece onto the spacer fixture within the air vise by pushing the pneumatics valve on the bench and venting the air out of the vise. To close the vise, twist the pneumatics valve on the bench to allow air to enter the vise, pressurizing it. Make sure your workpiece is held securely and seems square in the vise.
41. **Home the mill**:
    a. Set Up>Check Home>Home
42. Select Tool 4 (1/16" Flat End Mill):
    a. Tools>Select Tool
    b. Choose tool T04, >Insert Tool
    c. Remove the 1/16" Flat End Mill from the tool magazine, and insert the tool holder into the Quick-Change tool collar. Align the slot in the tool holder with the square "dog" protrusion in the collar, and gently push the tool holder up until the collar clicks (locking the tool holder in place).
    d. Rotate the guard back into position, enabling the Mill, and click on the green button.
    e. Click on the Green Button to continue
43. **Set the Zero Position (Touch-Off):**
    a. Set Up>Zero Position > OK
44. Set the (feed) Speed to Fast, and click Continuous step
45. Jog the tool to the a position just above the top, left corner of the front of the workpiece.
46. Adjusting the Speed and Step sizes as appropriate, move to the top, left, front corner of the workpiece (carefully, so as to just touch, but NOT move into the part)
47. Set the Zero Position (as before):
    a. Set Up>Zero Position > OK

    Now all moves within the part envelope will have a negative Z coordinate, and all points outside the part envelope will have positive Z coordinates. (Moves in the X and Y directions will *generally* be positive when inside the part edges.)
48. Set the step size to C (.10), and the Speed (feed) to Fast
49. Step the tool along the positive Z axis until: Z= +.10
50. Select Tool 1 (1/4" Ball End Mill):
    a. Tools>Select Tool

   b. Choose tool T01, >Insert Tool

51. Lower the guard, and change the tool to the 1/4" Ball End Mill:
    a. Rotate the spindle until the hole on the column head shows. Put the tool change pin into the hole to stop the spindle from rotating
    b. Support the 1/16" Flat End Mill tool holder with your left hand. With your right hand, press the button on the Quick-Change tool collar, and rotate the collar counter-clockwise (left) and jiggle the holder side to side (DO NOT PULL DOWN!) until the tool holder is released and the collar stays in position.
    c. Set the 1/16" Flat End Mill tool holder into the # 04 tool bin in the tool magazine with the cutter pointing up.
    d. Remove the 1/4" Ball End Mill from the tool magazine, and insert the tool holder into the Quick-Change tool collar. Align the slot in the tool holder with the square "dog" protrusion in the collar, and gently push the tool holder up until the collar clicks (locking the tool holder in place).
    e. Rotate the guard back into position, enabling the Mill, and click on the green button.
52. Setup>Go To Position: X = – 0.30 Y = + 0.0 Z = + 0.15
    a. Insert a Feed of 20
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button

    This will set up to begin the contouring cut on your workpiece. (Later, you will be programming a similar operation for the other side.)
53. Step the tool along the negative Z axis until: Z = – 0.15
54. Set the Spindle Speed:
    a. Set Up>Spindle
    b. 1500 RPM
55. Start the Spindle rotating counter clockwise from the top button on the left toolbar
56. Setup>Go To Position: X = + 5.70 Y = + 0.0 Z = – 0.15
    a. Insert a Feed of 10
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button

    Make sure that the workpiece does not move in the air vise, and that the vacuum is sucking up the produced chips.
57. Step the tool along the positive Z axis until: Z = + 0.15
58. Setup>Go To Position: X = + 5.45 Y = – 0.20 Z = + 0.15
    a. Keep a Feed of 10
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button

    This will set up to begin the next contouring cut on your workpiece.
59. Step the tool along the negative Z axis until: Z = – 0.15
60. Setup>Go To Position: X = + 5.45 Y = +5.70 Z = – 0.15
    a. Keep a Feed of 10
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button

    Make sure that the workpiece does not move in the air vise, and that the vacuum is still sucking up the produced chips.

61. Step the tool along the positive Z axis until: Z = + 0.15
62. Setup>Go To Position: X = + 5.70 Y = + 5.45 Z = + 0.15
    a. Keep a Feed of 10
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button

    This will set up to begin the next contouring cut on your workpiece.
63. Step the tool along the negative Z axis until: Z = – 0.15
64. Setup>Go To Position: X = – 0.3 Y = + 5.45 Z = – 0.15
    a. Keep a Feed of 10
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button
65. Step the tool along the positive Z axis until: Z = + 0.15
66. Setup>Go To Position: X = + 0.0 Y = + 5.70 Z = + 0.15
    a. Keep a Feed of 10
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button

    This will set up to begin the last contouring cut on your workpiece.
67. Step the tool along the negative Z axis until: Z = – 0.15
68. Setup>Go To Position: X = + 0.0 Y = – 0.20 Z = – 0.15
    a. Keep a Feed of 10
    b. Move your mouse over the red STOP button as a precaution, then
    c. Press the ENTER button
69. Step the tool along the positive Z axis until: Z = + 0.15
70. Stop the Spindle with the top button on the left toolbar
71. Select Tool 4 (1/16" Flat End Mill):
    a. Tools>Select Tool
    b. Choose tool T04, >Insert Tool
    c. Click on the Green Button to continue
72. Lower the guard, and remove the 1/4" Ball End Mill:
    a. Rotate the spindle until the hole on the column head shows. Put the tool change pin into the hole to stop the spindle from rotating
    b. Support the 1/4" Ball End Mill tool holder with your left hand. With your right hand, press the button on the Quick-Change tool collar, and rotate the collar counter-clockwise (left) and jiggle the holder side to side (DO NOT PULL DOWN!) until the tool holder is released and the collar stays in position.
    c. Set the 1/4" Ball End Mill tool holder into the # 01 tool bin in the tool magazine with the cutter pointing up. LEAVE NO TOOL HOLDER IN THE MILL SPINDLE.
73. Click on the Home button (and once again on the Home button that appears)
74. Carefully release the pressure to the air-vise by closing the Mill Pneumatics Shut-Off valve on the front of the Mill Table. The vise jaws can now be opened by hand, and your workpiece removed.

Mark your initials on the side of your workpiece in pencil, then store your part in your Team's storage bin for future use. Help your remaining team members to safely and correctly complete this lab, then 5S the laboratory before you leave. There is no lab write-up required for this lab.