

TA Outline (CNC Drilling & Threading on TM-2)

Students have had NO introduction to CNC machines yet, so you will have to provide the background information for them [5min]:

- A. Ask if students know what CNC stands for? *Computer Numerical Control*
- B. Advantages of CNC:
 - 1. can simultaneously move multiple axes to cut complex 2D and 3D contours; not just limited to 1D cutting motion like on manual machines (*explain cutting circular profile*)
 - 2. great for producing large quantities of identical parts
 - 3. can change between multiple tools automatically
 - 4. uses high pressure air or coolant to flush away chips and keep cutting tools cooler
- C. Disadvantages of CNC:
 - 1. more expensive capital investment (\$60k vs \$15k for manual mills in lab)
 - 2. requires programming & debugging skillset, so more expensive operator
 - 3. slower or more expensive for making just one simple part
 - 4. requires more space, electricity and maintenance than manual machine

Turn on Machine [3min] (students don't have to see this part; you can do it a few minutes before each lab starts or while the students clean up the lathe):

- 1. Press the green POWER ON button and wait for machine to boot (~60 seconds)
- 2. Press the orange RESET button **twice** to clear alarm codes (3+ times doesn't hurt anything)
- 3. Press the blue POWER UP / RESTART button to initialize servos; **NOTE THE MACHINE WILL HOME ITSELF AND CHANGE TO TOOL NUMBER ONE, SO TELL EVERYONE TO STAND BACK**

Load the Part [2min]:

- 4. Press the Y button on the alphanumeric keyboard and then press the HOME button; **THIS WILL MOVE THE Y-AXIS ALL THE WAY TOWARDS THE DOOR FOR EASY PART LOADING**
- 5. Load part into the rotary vise; **ALIGN THE TOP OF THE PART WITH THE TOP OF THE CHUCK JAWS** by feel with your fingers (within $\pm 0.050''$)

Load the Program [3min]:

- 6. Press LIST PROGRAM button, scroll to the MEMORY tab, and **select program O10007 (7 HOLE LAB HUB – ON G57)** by pressing the right arrow, scrolling and pressing the SELECT PROGRAM button; if it already has an "A" next to it, move on to the next step
- 7. Explain some of the G & M codes so the students can see the language used to program CNC machines [~ 2 min]

8. Press the orange RESET button to move the program pointer to the beginning of the program; **this is VITAL so you don't begin in the middle of the program and crash the machine**
9. Press the MEMORY mode button

Run the Program [10min]:

10. Set SPINDLE SPEED and FEEDRATE to 100%
11. Set RAPID to 100% (it's much slower on the TM-2 than the VF-2)
12. Press the green CYCLE START button, **expecting the machine to change tools, load the tool probe and rapid the probe to 5" above the top of the workpiece**
13. **IF THE PROBE RAPIDS CLOSER THAN 5" ABOVE THE WORKPIECE, press the red FEED HOLD button to pause the machine** and grab Mike or a senior TA to investigate the problem. **This occurs about once a year, so stay alert.**
14. Explain to the students the purpose of the probe; just like on the manual machines, we have to find part zeros; the 3-axis touch probe just speeds up the process
15. The probe will probe the Z-height of the part; when it is retracting you can set the RAPID speed to 50% for the rest of the program
16. Next the machine will change to the 0.157" screw machine drill to make the tap drill holes for the 10-24 tap. **Use the oil brush to place oil on the part or tool;** the center drill is not needed because the more expensive *screw machine drills* are shorter and have special *split points* that function as center drills
17. Explain to the students the CNC still has to peck drill like they did on the manual machine because the chips will otherwise pack in the hole and cause the drill bit to break
18. Next the CNC will load the 10-24 tap and use it to automatically thread the holes using a process called **rigid tapping**; this process synchronizes the spindle speed and feedrate to match the thread pitch of the tap; the CNC essentially screws the tap in and out of the tap drilled hole, leaving threads behind. **Use the oil brush to place oil on the part or tap**
19. Explain to the students the CNC still has to **peck tap** the threads, just like we would on the manual machines to allow the chips to evacuate without breaking the tap
20. Allow the program to finish, and the tap to retract
21. If you're lucky, your part will now have several 10-24 threaded holes in it; if you're not, ask Mike to order a replacement tap or two, lol

Unload the Part [1min]:

22. At the end of the program the CNC will bring the Y-axis of the machine all the way towards the operator for easy part unloading
23. Now you can wipe off the part, remove it from the vise and check that a 10-24 fastener threads into the holes nicely **(be careful not to drop the part into the center of the vise)**
24. Ask the students if they have any questions and move them onto a manual mill to tap the side holes on the wheel hub or begin the milling machine part

TA Outline (TM-2 SPINDLE WARMUP)

The spindle warmup program should be run if the machine sits idle for more than 24 hours. Below are the instructions for doing so:

1. **TEMPORARILY DISABLE THE SAFETY SWITCH:** Press the gray SETNG | GRAPH button (on the DISPLAY menu); type “51”; change the setting to YES to turn the **SAFETY SWITCH OVERRIDE ON**; you **MUST** turn it OFF when you are finished!
2. Load any tool other than the electronic probe into the spindle by pressing the MDI button and typing TXX (where XX is the desired carousel location of the tool you desire to load) and the ATC FWD button. **THIS WILL LOAD THE DESIRED TOOL INTO THE SPINDLE, SO MAKE SURE YOUR HANDS OR BODY ARE NOT IN THE WAY OF A TOOL CHANGE.**
3. Press LIST PROGRAM button, scroll to the MEMORY tab, and **select program O00001 (SPINDLE WARM-UP)** by pressing the right arrow, scrolling and pressing the SELECT PROGRAM button; if it already has an “A” next to it, move on to the next step
4. Press the MEMORY mode button
5. Press the orange RESET button to move the program pointer to the start of the program
6. Press the green CYCLE START button
7. **RE-ENABLE THE SAFETY SWITCH:** Press the gray SETNG | GRAPH button (on the DISPLAY menu); type “51”; change the setting to NO to turn the **SAFETY SWITCH OVERRIDE OFF**; you **MUST** turn it OFF when you are finished!
8. Continue by following the instructions earlier this document on loading the **LAB HUB** program (Step 7 on page 1)