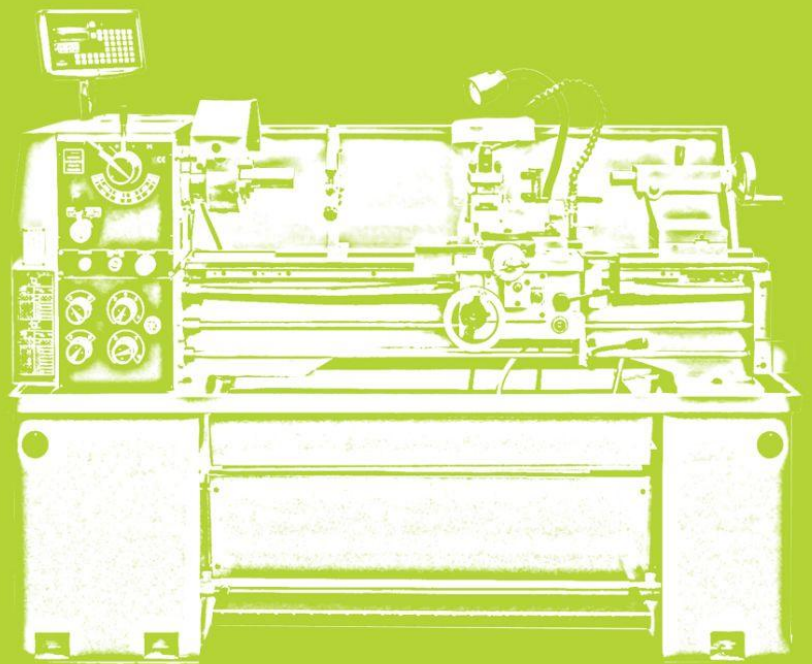


METAL LATHE CERTIFICATION TUTORIAL



MAKER WEB

TUTORIAL OVERVIEW

This tutorial will give you a basic understanding on how to operate the Metal Lathe in the Make Lab.

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Part 1:

Tutorial Description

DESCRIPTION

A Lathe is used to remove metal in the form of chips from a piece of stock material (generally cylindrical) by mounting the stock material on a machine spindle and revolving at the required speed. A fixed cutting tool mounted on a tool post which is positioned by three different slides that each move in different directions. The tool is fed against the stock material either longitudinally or crosswise to reduce the stock material to the required shape and size. Lathes generally produce symmetrical objects about a singular axis of rotation. Opposite of the headstock and spindle is a support device called a tailstock. The tailstock can be slid along the lathe bed and locked in place to perform precise drilling operations or to firmly support the end of a work piece. Typical lathe operations include facing, turning, parting and drilling.

This process of separating the work piece (the part you want to produce) from the “chips” (the unwanted material surrounding the part you want to produce) requires 5 things.

- A securely held, sharp tool
- A securely held workpiece
- Sufficient force applied to the tool to produce chip separation
- The continuous removal of newly formed chips (allowing the formation of subsequent chips)
- The prevention of overheating of the tool and / or work piece

The goal of this document and the accompanying training is not to make you an expert lathe operator or machinist, but to make sure you can safely do certain basic tasks specifically on the on the Timeway T-1440B lathe. It applies to all students, staff, faculty and others who wish to use the lathe. This document should be read, fully understood, and reviewed at the machine with a Maker Web employee as part of the certification process.

Certification is required to use the Lathe. In order to get certified you must:

- Review this document at the machine with a Maker Web Employee.
- Demonstrate “hands-on” proficiency with a Maker Web Employee by performing lathe operations on a piece of aluminum bar stock.
- Sign the BASIC USER CLEARANCE FORM, WAIVER and SUPERVISED EXPERIENCE LOG.

The allowable machining tasks will be limited to those covered in this document. There is much more to using a Lathe than what is covered in this document so always ask a Maker Web employee before doing any task not mentioned in this document.

Part 2: Learning Objectives

HOW TO USE THIS DOCUMENT

As stated, the goal of this document is to give you a basic ability to safely operate the Timeway T-1440B lathe. There are several parts to the document and several learning objectives. It is recommended that you start by reading the document on your own in or out of the Lab. It is then mandatory to go through the document again, step by step, while actually engaging the machine with a Maker Web employee.

LEARNING OBJECTIVES

While reviewing this document at the machine it is required that you go through the following steps and complete the following tasks that correspond with the sequential “Parts” of the tutorial.

- REVIEW DOCUMENTATION
- IDENTIFY ALL PARTS OF THE MACHINE
- CLAMPING AND FIXTURING THE STOCK MATERIAL
- SETTING RPM VALUES
- USING THE CLUTCH TO ENGAGE THE SPINDLE
- MOVING THE VARIOUS AXIS
- MOVING AND LOCKING THE TAILSTOCK
- REVIEW CUTTING TOOL BASICS
- REVIEW LATHE OPERATIONS AND CUT TYPES
- INSTALLING AND REMOVING CUTTING TOOLS
- USING THE D.R.O. TO ZERO A STOCK MATERIAL
- USING CUTTING FLUID
- UNDERSTANDING DEPTH OF CUT
- UNDERSTANDING CUTTING SPEED

Part 3:

General Rules

- You must wear safety glasses AT ALL TIMES while in the Make Lab. You must wear safety goggles over prescription glasses. A full face shield may be recommended for some operations. Hearing protection is recommended.
- You will remove all loose rings, watches, necklaces, bracelets, and dangling earrings before operating any equipment in the Make Lab. Loose or dangling objects can easily become caught in rotating machinery.
- Long pants are recommended. Keep hair, clothes, hands, and loose tools away from moving machinery. Loose hair and clothing are extremely dangerous. You must tuck in your shirt, roll up long sleeves, secure drawstrings, tie back hair, etc...
- No open toe shoes allowed in the Lab. Shoes must be fully enclosed. Inappropriate footwear includes: open toe shoes, sandals, crocks, high heels, etc...
- Know the location and proper use of the nearest fire extinguisher, first aid kit, eyewash station, and other emergency supplies.
- Nonemployees using the Lathe should be accompanied by another person who can assist, render first aid, or contact emergency services in the event of an emergency.
- Do not wear gloves while operating the Lathe. Like jewelry, they can easily be caught in rotating machinery.
- Every tool in the Lab has the potential to cause serious injury or death. Horseplay, pranks, and improper use of equipment are forbidden without exception. Anyone who witnesses another person using equipment in an unsafe or improper manner has the right to give advice on safe and proper usage. Refer to this document if necessary.
- Refrain from any action that may surprise someone who is currently operating equipment, including shouting, dropping heavy objects, touching the member, or standing too close to them. Surprising people may cause serious or fatal injury.
- Only one person may operate a tool at a time. Do not interfere with anyone else's operation. Do not distract anyone who is operating equipment. Avoid talking with anyone while operating a machine tool. Keep your mind on the job and be ready for any emergency!
- Become thoroughly familiar with the milling machine before attempting to operate it. When in doubt, obtain additional instructions.

Part 3:

General Rules (continued)

-Check equipment for mechanical issues or pressing maintenance needs before turning it on. If you notice an issue with the equipment, report it to an employee immediately. If the machine makes an unusual noise or acts in any suspicious manner, you must stop the machine and inform the instructor immediately.

-Turn off equipment when you are done using it. Do not leave unattended machines running!

-Before leaving the shop area, you must assist in cleaning any mess (metal chips, splashed coolant) that you produce. You must clean any spilled liquids immediately. Leave the machine and surrounding area at least as clean as you found it.

-Use a vacuum cleaner or a brush and dustpan to clean up. Do not attempt to clear swarf with your bare hands or compressed air. Most metal cuttings will be sharp or hot. STOP the machine before trying to remove accumulated chips.

-You will return any tools, instruments, bits, etc. to their proper location after using them.

-You must immediately report ANY injury to an employee. If an injury requires medical attention, call 911 immediately.

Part 3A:

Lathe Specific Rules

-Speed rates. Operating the lathe at the wrong speed can cause nearby parts to break or the work piece to come loose, which will result in dangerous projectiles that could cause severe impact injuries.

-Chuck Key safety. A chuck key left in the chuck can become a deadly projectile when the spindle is started. Always remove the chuck key after using it. Develop a habit of not taking your hand off of a chuck key unless it is away from the chuck.

-Safe clearances. Work pieces that crash into other components on the lathe may throw dangerous projectiles in all directions, leading to impact injury and damaged equipment. Before starting the spindle, make sure the workpiece has adequate clearance by hand-rotating it through its entire range of motion. Also, check the tool and tool post clearance, chuck clearance, and saddle clearance.

-Long stock safety. Long stock can whip violently if not properly supported, causing serious impact injury and damage to the lathe. Reduce this risk by supporting any stock that extends from the chuck more than three times its own diameter. Always turn long stock at slow speeds.

-Securing Workpiece. An improperly secured workpiece can fly off the lathe spindle with deadly force; which can result in a severe impact injury. Make sure the work piece is properly secured in the chuck or faceplate before starting the lathe.

-Clearing chips. Metal chips can easily cut bare skin—even through a piece of cloth. Avoid clearing chips by hand or with a rag. Use a brush or vacuum to clear metal chips.

-Crashes. Aggressively driving the cutting tool or other lathe components into the chuck may cause an explosion of metal fragments, which can result in severe impact injuries and major damage to the lathe. Always check clearances before starting the lathe. Make sure no part of the tool, tool holder, compound rest, cross slide, or carriage will contact the chuck during operation.

-Tool selection. Cutting with an incorrect or dull tool increases the risk of accidental injury due to the extra force required for the operation, which increases the risk of breaking or dislodging components that can cause small shards of metal to become dangerous projectiles. Always check that the tool is sharp and free from imperfections and damages before use and ask a Maker Web employee if you are unsure about the tool.

COMPETENCY:

General Rules



ACTION ITEM:

ASK THE STUDENT QUESTIONS

QUESTIONS:

- Have you read the rules thoroughly?
- Do you understand the rules completely?
- Do you have any questions regarding safety?

COMPETENCY:

Safety Check



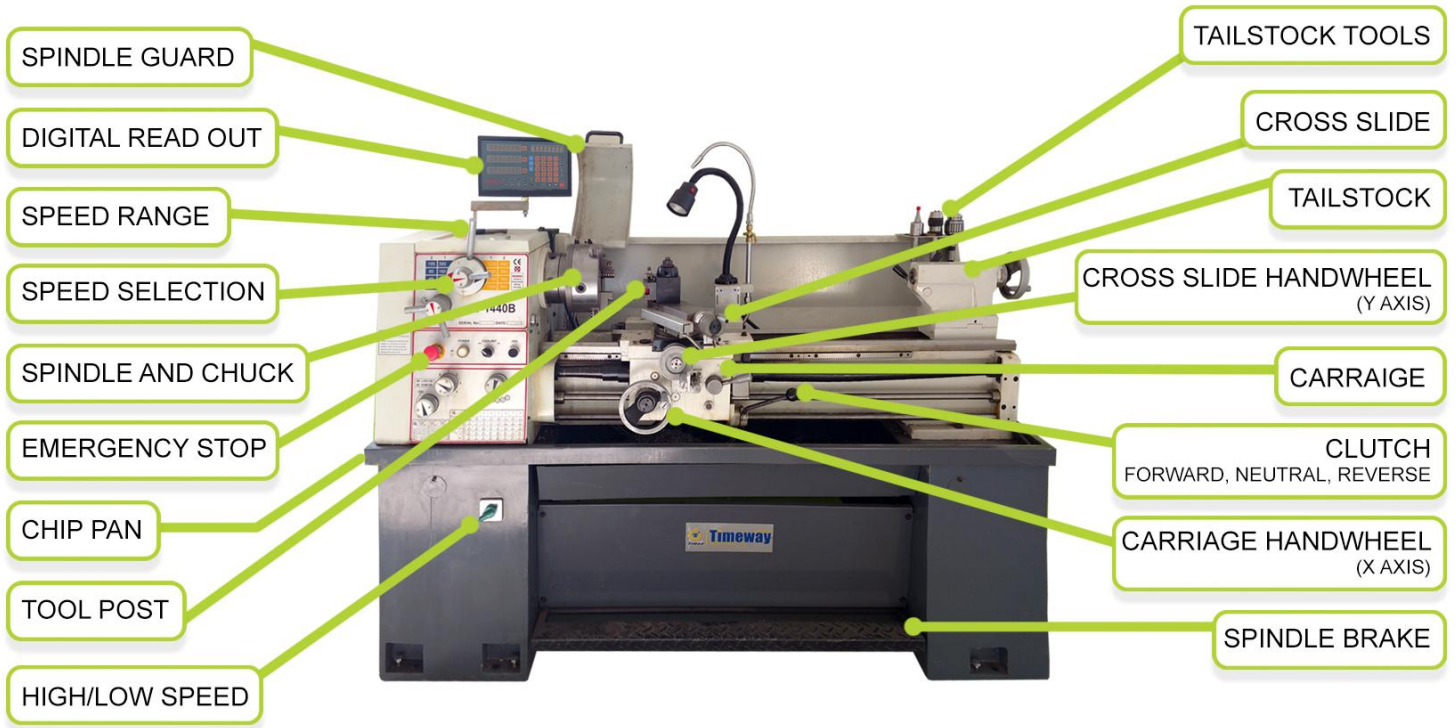
ACTION ITEM:

SAFETY WARNING!

THIS IS A POTENTIALLY LIFE THREATENING MACHINE AND MUST BE OPERATED CORRECTLY IN ACCORDANCE WITH THIS TUTORIAL AND ALL SAFETY GUIDELINES. REITERATE THESE SPECIFIC HAZARDS

- **ENTANGLEMENT**
- **PROJECTILES**
- **CRASHES**
- HAIR MUST BE TIED BACK AND NO LOOSE CLOTHING!
- SAFETY GOGGLES MUST BE WORN IF THE MACHINE IS ON!
 - NEVER TOUCH SPINNING OR MOVING THINGS!

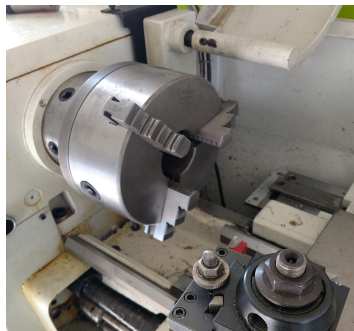
Part 4: Basic Machine Parts



DETAIL IMAGES OF PARTS



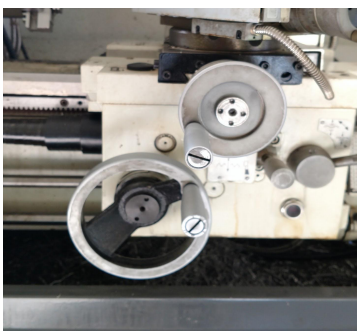
SPEED DIALS



3 JAW CHUCK



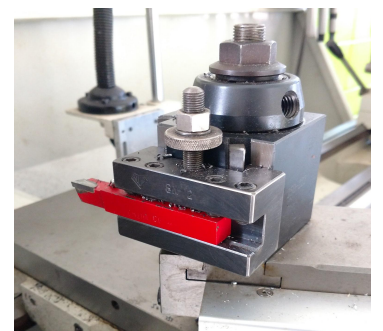
CROSS SLIDE



XY AXIS HANDWHEELS



TAILSTOCK



TOOL POST

Part 4:

Basic Machine Parts Description

Spindle Guard-A safety guard that must be in a Down/Closed position to operate the machine

Digital Read Out-A digital measuring device that locates the tool in the X and Y axis.

Speed Range-Selects High or Low range speeds.

Speed Selection-Sets desired speeds within the Low or High range.

Spindle and Chuck-The spindle is the rotating part that holds the Chuck which holds the workpiece or stock material.

Emergency Stop-Quick machine shut down in case of emergency.

Chip Pan-Sits on the base for collecting chips.

Tool Post-To mount tool holders in which the cutting bits are clamped.

High/Low Speed-Changes the gear range to control the speed of the spindle

Tailstock Tools-Tools with a Morse taper that can be inserted in the Tailstock, Includes Live Center, Chuck,

Cross Slide-Mounted on the transverse slide of the carriage, and uses a handwheel to feed tools into the workpiece.

Tailstock-The tailstock can be slid along the lathe bed and locked in place to perform precise drilling operations or to firmly support the end of a workpiece.

Cross Slide Handwheel-Moves the cutting tool in the Y Axis (side to side).

Carriage-Moves on the outer ways. Used for mounting and moving most the cutting tools and carries the Cross Slide and Tool Post.

Clutch-Starts and stops the machine by shifting it into and out of gear. Positions are Forward, Neutral and Reverse.

Carriage Handwheel-Moves the cutting tool in the X Axis (front to back).

Spindle Break-A foot brake to slow and stop the spindle once it's out of gear.

COMPETENCY:
Machine Description



ACTION ITEM:

ASK THE STUDENT QUESTIONS

QUESTIONS:

- Does the student have any questions about the critical parts of the machine?
- Can the student identify the Emergency Stop?

Part 5:

The 3 Jaw Chuck and Loading a Workpiece



GENERAL FIXTURING TIPS

- A. MAKE SURE THE EMERGENCY STOP IS ENGAGED BEFORE LOADING/UNLOADING STOCK.
- B. The 3 jaw chuck is self centering but always check that your piece is firmly held evenly by all 3 jaws
- C. Always wipe off the chuck jaws and fixtures when fixturing a new part.
- D. It is recommended to use the tailstock and live center to support longer pieces.
- E. Always hold as much material length as possible within the chuck while maintaining clearances.
- F. Confirm that you have all the clearances necessary in all of the axis once material is loaded.
- G. Get instruction or supervision if you are unsure if you are fixturing the workpiece correctly.
- H. Turn the chuck key clockwise to tighten and counterclockwise to loosen. **ALWAYS REMOVE CHUCK KEY IMMEDIATELY AFTER USE.**



NEVER LEAVE THE CHUCK KEY IN THE CHUCK!!

COMPETENCY:

The 3 Jaw Chuck and Loading a Workpiece



ACTION ITEM:

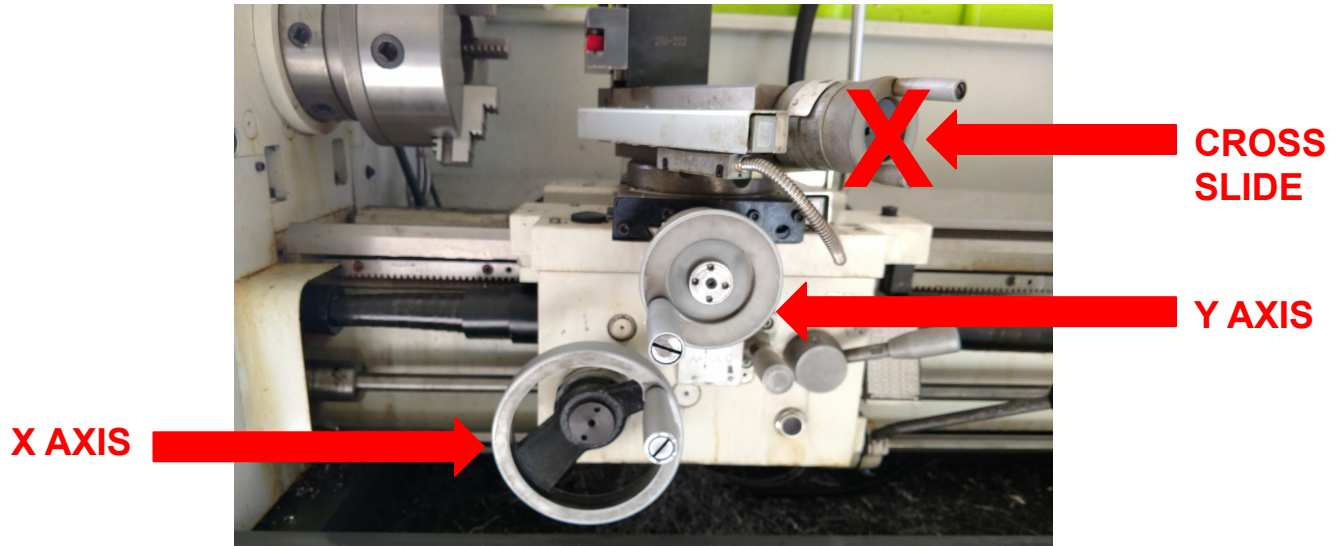
HAVE THE STUDENT USE THE CHUCK TO HOLD A PIECE OF ALUMINUM BAR STOCK

QUESTIONS:

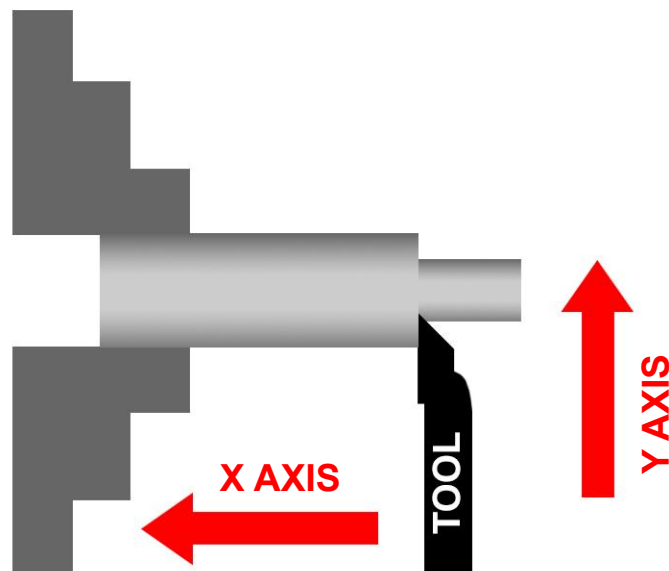
- Did the student clean the chuck and jaws before use?
- Did the student remove the chuck key immediately after use?
- Is the workpiece placed in the center of the chuck?
- Is the workpiece sufficiently deep in the chuck?
- Is the workpiece held in place firmly so that it will NOT MOVE?

Part 6:

Moving the X and Y Axis



To move the X Axis (right and Left) turn the knob on the bottom left of the carriage. To move the Y Axis (forward and backward) turn the knob on the upper right of the carriage. The Cross Slide also has a knob control but **using the cross slide is beyond the scope of this tutorial**. All of the knobs have measurement dials that can be used in addition to the DRO. The dials increments are .001”.



This image describes tool movement based on X and Y axis movement. Counter clockwise moves the X axis to the Left and clockwise moves it to the right. Counter clockwise moves the Y axis backward away from the workpiece and clockwise moves it forward into the workpiece.

COMPETENCY:

Moving the X and Y Axis



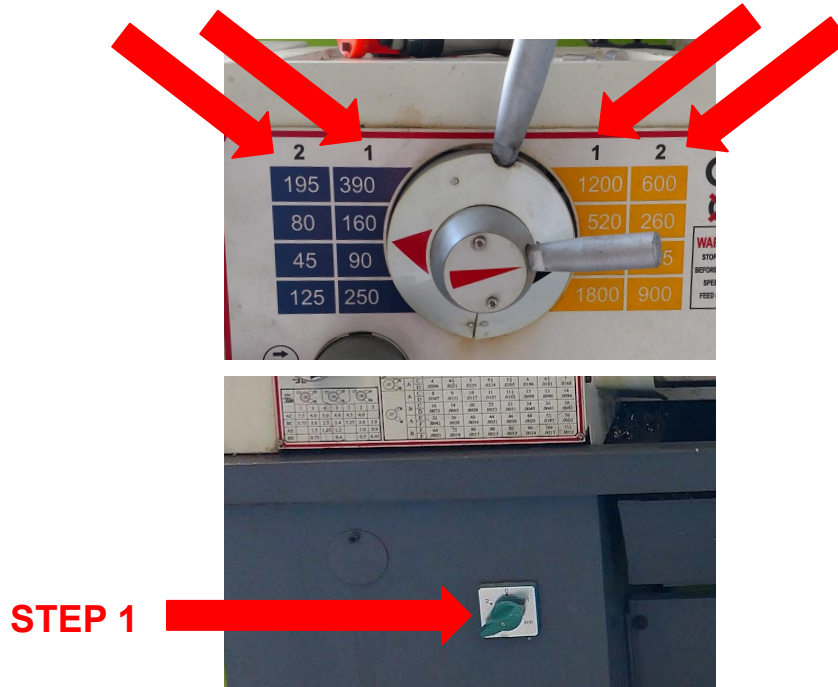
ACTION ITEM:

HAVE THE STUDENT JOG THE X and Y AXIS

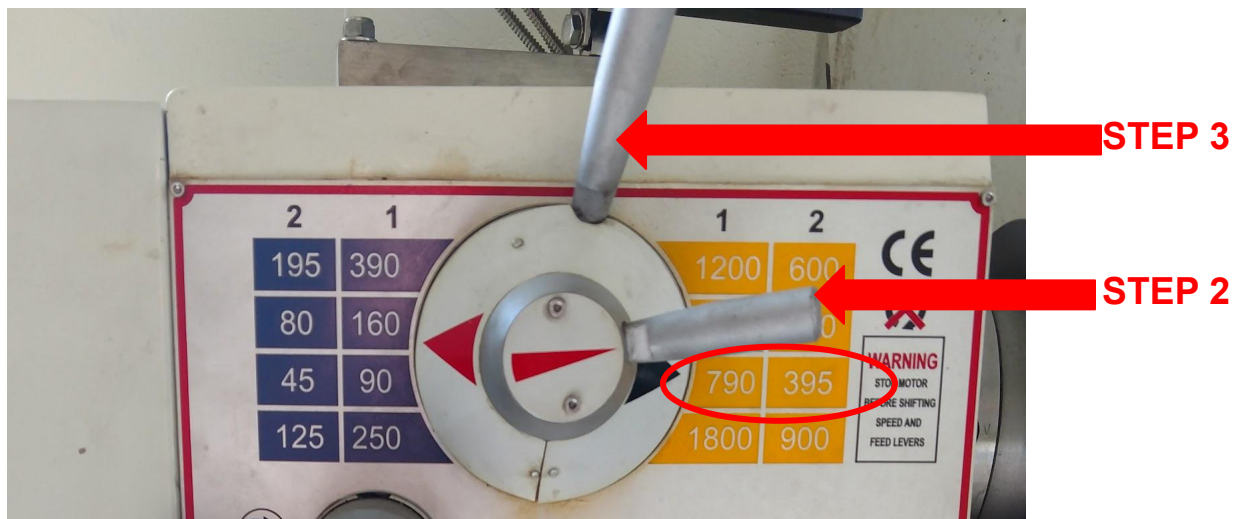
QUESTIONS:

- Does the student understand how to move the X and Y Axis?
- Did the student move the X axis to the right and the left?
- Did the student move the Y axis forward and backward?

Part 7: Setting RPM Values for the Chuck



Adjustments to RPM speed CAN NOT happen if the machine spinning. Be sure the machine is at a full stop and push in the emergency stop. Decide which speed you would like to use from the options provided around the speed dial indicator. The range is 45 to 1800 RPMs. Once you note the speed you want, notice which column it is in (1 or 2). Now turn the green High/Low knob below to the appropriate setting (1 or 2).



Now return to the speed dials on the headstock. First rotate the outer dial, which has two positions (right or left) to the correct side for your selected speed. Next rotate the inner dial which has 4 positions to the correct speed. You may need to jiggle the chuck to get the gears to mesh. Always rotate the chuck a few times to be sure it's in gear before starting the machine. In the image above the outer dial is set to the right and the inner dial is set to the 3rd speed down. This means the RPMs would be 790 or 395 depending on the High/Low dial below.

COMPETENCY:

Setting RPM Values for the Chuck



ACTION ITEM:

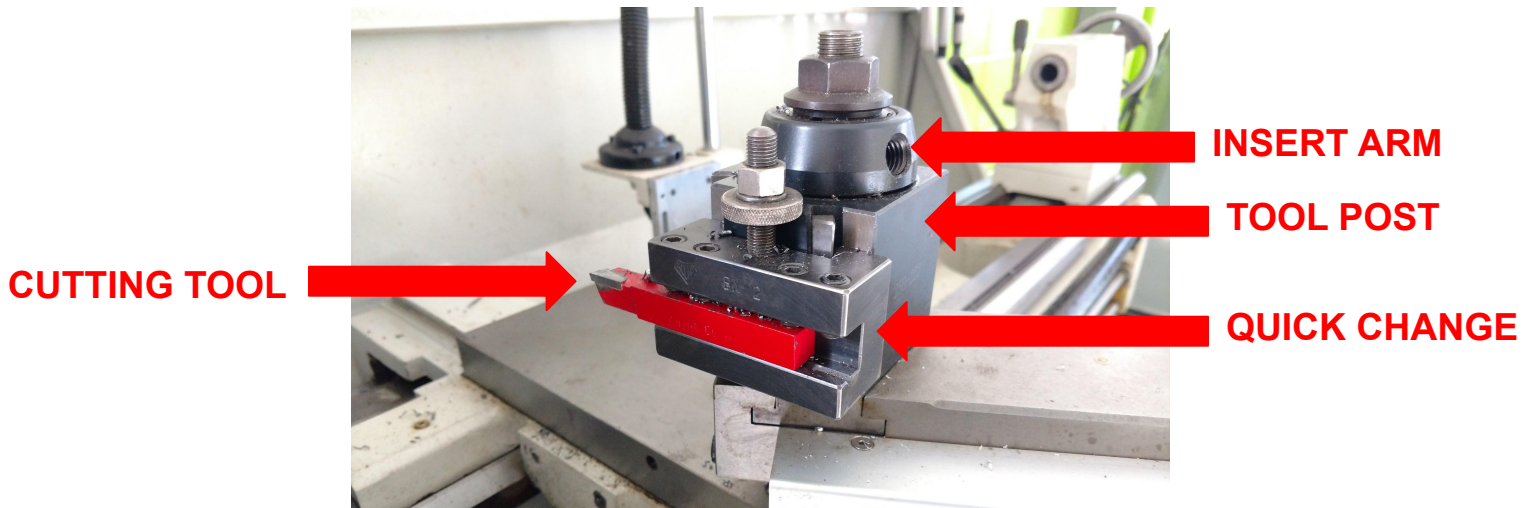
**SELECT A SPINDLE SPEED AND HAVE THE STUDENT SET IT
USING THE DIALS**

QUESTIONS:

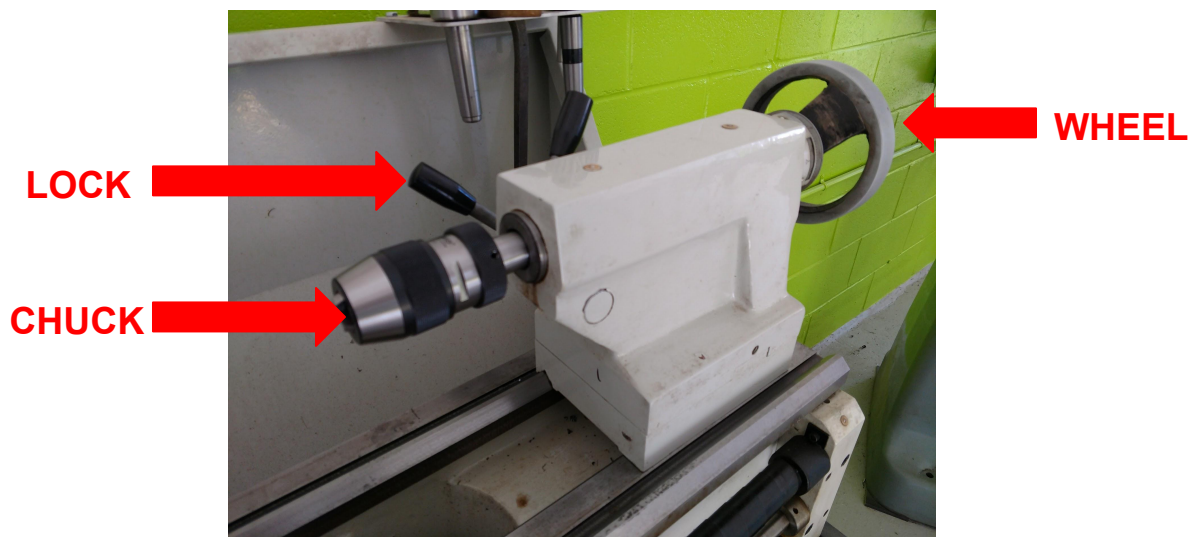
- What speed did you choose?
- Did you check to be sure you selected the proper Hi/Low range?
- Did you set the two speed dials on the headstock correctly for the speed you chose?
- Did you jiggle the spindle and chuck by hand as necessary while adjusting the speed range to be sure the spindle is engaging the gears.

Part 8: Installing and Removing Cutting Tools

STUDENTS ARE ONLY ALLOWED TO USE 2 CUTTING TOOLS SO THIS TUTORIAL DOES NOT COVER A BREADTH AND DEPTH OF INFORMATION ON LATHE CUTTING TOOLS.



The Lathe in the Lab is equipped with 2 cutting tools and these are all that may be used on the Lathe. One tool is a universal cutting tool for facing and turning and the second is a cut off parting tool. **Both of these tools are carefully calibrated and should not be adjusted.** They can only be swapped out. Please consult with an employee if you feel you need another tool. Each cutting tool is mounted on a quick change coupler that is mounted on the tool post. A threaded arm can be inserted at the top of the tool post which can be toggled to engage a locking cam to lock the quick change and tool in place or release it for a swap out. Do not take the tools out of the couplers and do not change tools on your own. Before using a tool make sure it doesn't have any damages or defects.



The other way to use tools on the Lathe is with the Tailstock. You can insert a tapered chuck into the tailstock which can hold drill bits. It is possible to move the Tailstock along the rails and lock it in place near your workpiece. You can advance the chuck using the wheel at the end of the Tailstock. Take special caution not to move the tailstock too close to your workpiece which might collide with the spinning Lathe chuck. Also note that some of the inserts for the Tailstock have a key in the back so they must be oriented correctly to fit the taper.

COMPETENCY:

Installing and Removing Cutting Tools



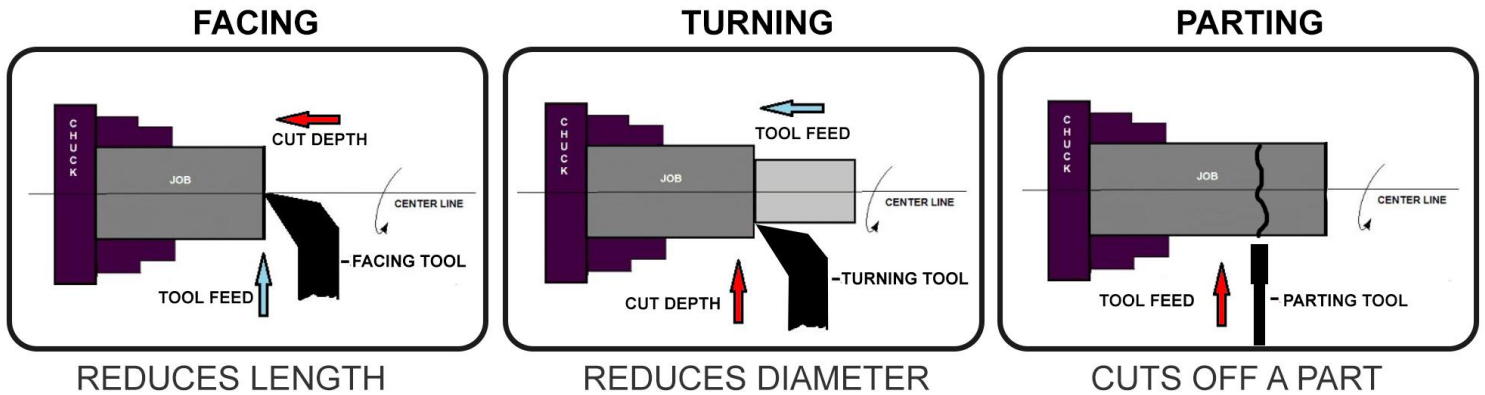
ACTION ITEM:

SWAP THE CUTTING TOOL AND INSERT A CHUCK AND BIT IN THE TAILSTOCK

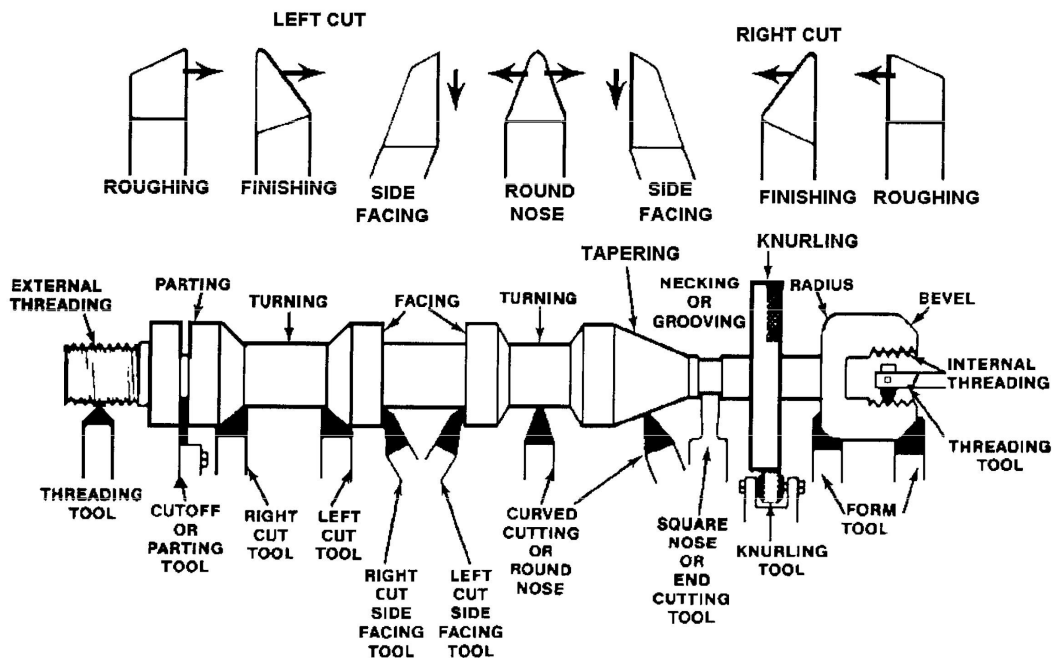
QUESTIONS:

- Did the student check that the tool post was clean before inserting a new tool?
- Did the student tighten the tool holder sufficiently with the quick change arm?
- Did the student insert the chuck in the Tailstock correctly?
- Do the student load the bit correctly into the chuck?
- Did the student remove the chuck correctly using the wheel if necessary?

Part 9: Lathe Operations and Cut Types



These are the most common lathe operations and will and will be the majority of the work done on the machine. They are Facing, Turning and Parting



Of course there are a variety of other operations that can be performed on a lathe but you must consult with an employee before attempting anything besides Facing, Turning and Parting. Most of these operations require different cutting tools or different setups.

COMPETENCY:

Lathe Operations and Cut Types



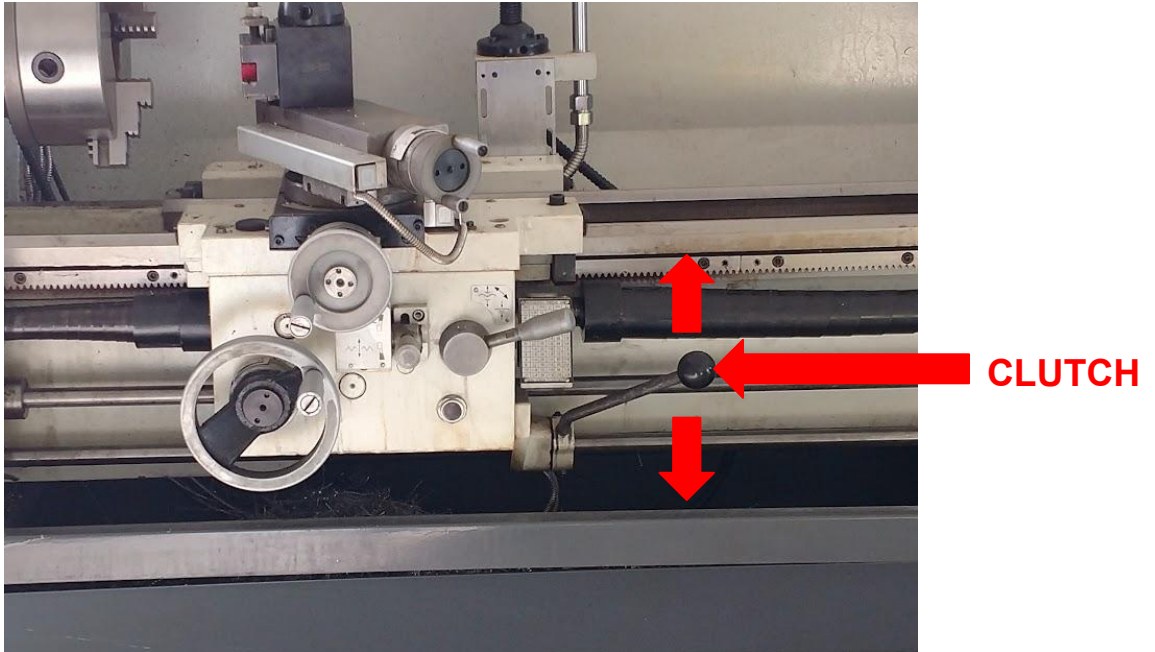
ACTION ITEM:

ASK THE STUDENT QUESTIONS

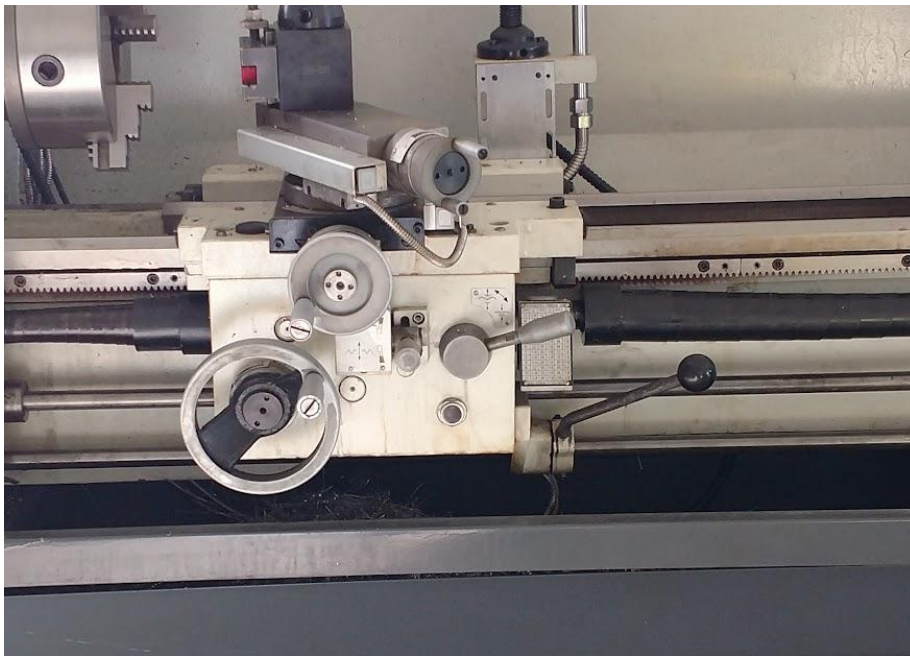
QUESTIONS:

- Do the student understand the 3 basic LATHE operations allowed on the machine?

Part 10: Using the Clutch to Activate the Lathe



Once the machine is powered up and the Emergency Stop has been pulled out you can use the clutch to put the machine in gear, engage the motors and get the chuck spinning. The clutch locks into 3 positions (forward, reverse and neutral).



By default you should leave the clutch in the Neutral (middle position). Moving it down makes it spin counterclockwise (correct) and moving it upwards will make it spin clockwise (WRONG)

COMPETENCY:

Using the Clutch to Activate the Lathe



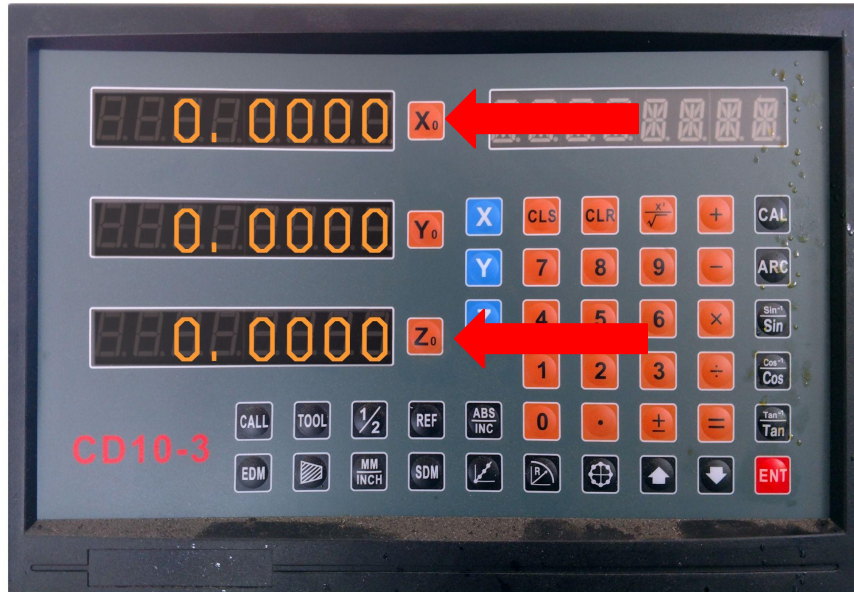
ACTION ITEM:

USE THE CLUTCH TO PUT THE MACHINE IN GEAR AND SPIN THE CHUCK FORWARD, REVERSE AND NEUTRAL.

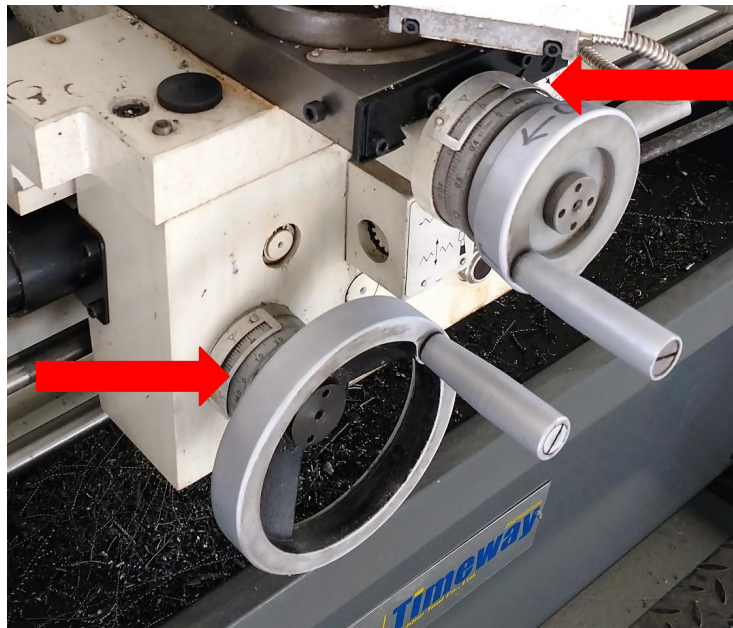
QUESTIONS:

- Did the student check the clearances around the chuck and that there would be no collisions before putting it in gear?
- Did the student properly use the clutch to put it into gear?
- Does the student understand the difference between forward and reverse?

Part 11: Using the Digital Read Out (DRO)



On the left side of the machine is a Digital Read Out screen or DRO. The screen measures and indicates movement in the X and Y axis. Each Axis can be set to zero or to a desired value. Note that the DRO measures to the 4th decimal place.



As an alternative to the DRO you can use the dial indicators located on each of the Axis Handles. These can be used to track movements. The increments on the dials are .001”.

COMPETENCY:

Using the Digital Read Out (DRO)



ACTION ITEM:

ZERO THE DRO IN ONE AXIS AND ENTER A VALUE FOR THE OTHER AXIS

QUESTIONS:

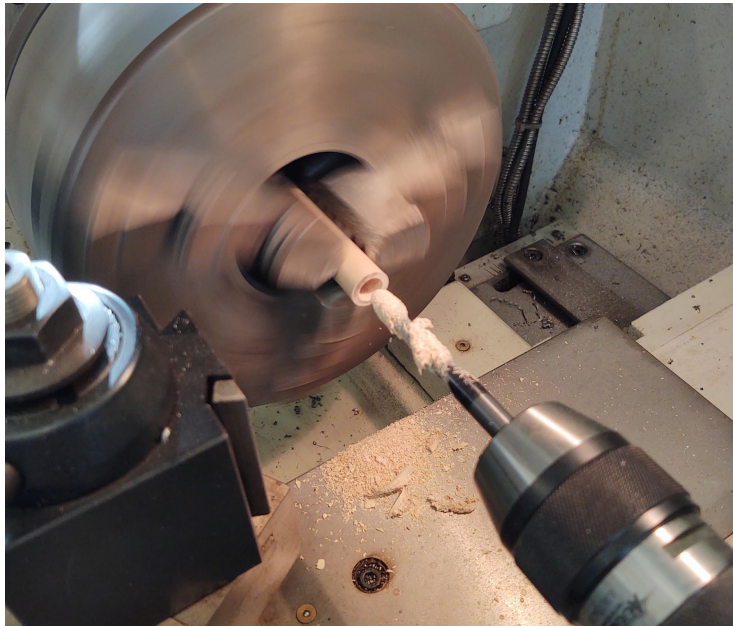
- Do you understand how to “zero” the X and Z axis?
- Do you understand how to enter a desired value?

Part 12:

Lubrication and Cutting Fluid



Cutting tools and work pieces will heat up during machining. Coolants reduce heat build-up by flowing over the surface of the cutting tool and work piece, picking up some of their heat, and carrying it away. There are many types of coolants, lubricants and cutting fluids. You can use WD-40 as a decent general lubricant that can be applied by spraying it on the tool and workpiece or using a brush. Never get near a rotating tool.



Lubricants also reduce friction and clear space for the formation of new chips. They do so by lubricating newly formed chips, allowing them to slide away more efficiently and by flushing out chips that tend to stick in confined spaces. Use of coolants and lubricants prolongs tool life, improves results, and allows faster cutting speeds.

COMPETENCY:

Lubrication and Cutting Fluid



ACTION ITEM:

ASK THE STUDENT QUESTIONS

QUESTIONS:

- Do you understand what cutting fluid to use and how to apply it?
- Do you understand the importance of chip removal and how to do it safely while the spindle is off?



REVIEW

ACTION ITEM:

ASK THE STUDENT QUESTIONS

QUESTIONS:

- Does the student have any questions about the tutorial?
- Is the student ready to watch you use the machine and begin the hands-on component of the tutorial?



ACTION ITEM:

1. HAVE THE STUDENT OBSERVE YOU:
2. LOAD A STOCK PIECE AND CUTTING TOOL.
3. SELECT AN APPROPRIATE RPM SPEED
4. WITH THE SPINDLE ON-SET THE X AXIS TO ZERO AND USE A CUT DEPTH OF .050" TO DO FACING CUTS
5. WITH THE SPINDLE ON-SET THE Y AXIS TO ZERO AND USE A CUT DEPTH OF .050" TO DO TURNING CUTS.
6. TAKE OUT THE STOCK MATERIAL AND THE CUTTING TOOL AND SET THE RPM TO 1200 SO THE STUDENT HAS TO ADJUST IT.
7. HAVE THE STUDENT PERFORM THE EXACT SAME OPERATIONS YOU JUST DID TO MAKE THEIR OWN CHIPS

QUESTIONS:

- Did the student competently and safely make chips?
- Are you satisfied that the student can competently and SAFELY use the machine?



REVIEW

ACTION ITEM:

- IF THE STUDENT HAS COMPLETED THE CERTIFICATION TUTORIAL AND YOU ARE SATISFIED WITH THEIR PERFORMANCE: GO TO THE CERTIFICATION SPREADSHEET AND CONFIRM THAT THEY HAVE COMPLETED THE HANDS-ON PART OF THE CERTIFICATION AND INFORM THEM THEY CAN NOW USE THE MACHINE DURING OUR OPEN HOURS.

HANDS-ON LATHE CERTIFICATION CHECKLIST:

To be completed by certification administrator during certification

- THE STUDENT HAS READ AND UNDERSTANDS ALL RULES, HAZARDS AND SAFETY GUIDELINES IN THE TUTORIAL
 - THE STUDENT USED THE CHUCK TO SUCCESSFULLY HOLD A PIECE OF STOCK MATERIAL IN PLACE.
 - THE STUDENT HAS TURNED ON THE MACHINE AND TURNED IT OFF USING THE EMERGENCY STOP.
 - THE STUDENT HAS ADJUSTED THE RPM SPEED AND CHANGED FROM LOW TO HIGH RANGE.
 - THE STUDENT HAS MOVED THE X AND Y AXIS..
 - THE STUDENT HAS LOADED AND UNLOADED A CUTTING TOOL.
 - THE STUDENT UNDERSTANDS THE ALLOWED CUTTING OPERATIONS ON THE LATHE.
 - THE STUDENT UNDERSTANDS THE BASIC RELATIONSHIP BETWEEN FEEDS, SPEEDS AND CUT DEPTH.
 - THE STUDENT UNDERSTANDS HOW TO USE CUTTING FLUID AND CLEAR CHIPS FROM A WORKPIECE.
-

HANDS ON LATHE ACTIONS:

- THE STUDENT LOADED A PIECE OF STOCK MATERIAL
 - THE STUDENT LOADED A CUTTING TOOL
 - THE STUDENT SELECTED AN APPROPRIATE SPEED
 - THE STUDENT ZEROED THE X/Y AXIS AND SELECTED A PROPER CUT DEPTH
 - THE STUDENT STARTED AND STOPPED THE MACHINE WITH THE CLUTCH
 - THE STUDENT DID FACING AND TURNING OPERATIONS
-

Student name

Administrator name

Student signature

Date

Administrator signature

Date