Engineering Innovation Center
Fabrication Shop
Basic Lathe Training
The Engineering Innovation Center Fabrication Shop was established for support of undergraduate student course work. Every effort will be made to make the shop available for these projects. Students of Engineering who desire to use this equipment for educationally-related activities are required to attend training.
Lathe Safety

- **Safety Glasses** must be worn at all times when using the lathe
- Full length pants, sleeved shirts, closed toe shoes, and safety glasses are required all times
  - Full sleeved shirts **must** be rolled up and cuffed
  - Tank tops are not permitted
- Long hair must be tied up and not dangling
  - Ponytails tucked into collar of shirt are permitted
- Watches and rings should be removed and put away
- **Dangling necklaces or lanyards** must be removed and put away
- No jackets or hoodies can be worn, even with sleeves rolled up
- **Do not wear gloves** while using the lathe
Lathe Safety

• **ALWAYS REMOVE THE CHUCK KEY FROM CHUCK IMMEDIATELY AFTER USING**

• **Students are not allowed to teach other students in the use of the lathe**
  – If you have a question, ask a technician on duty or the fabrication shop manager for assistance

• Keep all rags away from machine while it is in motion

• Always check the chuck or collet will clear the tool post before you start

• Make sure part is securely tightened in the chuck or collet

• Do not grasp or touch chips or turnings with your fingers
  – It is safer to turn off the lathe before clearing chips with a brush or soft air blasts

• Stop the machine before taking any measurements

• Leave the entire machine CLEANER than when you found it!
Lathe Capabilities

The lathe is a versatile machine and is capable of many operations. The lathe is used to modify or create parts that are cylindrical or have a standard profile across a length, such as hexagonal or square stock. The operations covered are as follows:

- **Turning** - Reducing the outer diameter of the work piece
- **Facing** - Taking material off face of the work piece
- **Bore** - Increasing the inner diameter of the work piece.
- **Thread** - Cutting threads on the outer diameter of the work piece.
- **Drill** - Drilling a hole into the face of the work piece with the tailstock
- **Groove** - Cutting grooves into the outer diameter profile of the work piece
Lathe Description

- **Headstock**- supports the lathe spindle and houses the gearing mechanism
- **Variable Speed Lever**- changes spindle speed
- **Compound Slide**- Allows for making angled cuts on the work piece
- **Cross Slide**- Allows for making cuts perpendicular to work piece
- **Carriage**- Moves the tool post and cross slide toward or away from the chuck on the ways. Moves along the Z-axis
- **Tail Stock**- centered with the spindle, holds tools and attachments to assist with machining
- **Bed**- attaches to base, supports carriage and tail stock
- **Tool Post**- attached to carriage, quick release tool post allows tools to be exchanges easily and fastened securely
- **Ways**- Machined onto the bed, allows the carriage and tailstock to slide toward and away from the chuck
- **Base**- Supports the entire machine

NOTE: The Clausing lathe is belt driven, and the spindle speed must be adjusted only when the motor is on. The DoALL and Turnmaster Lathes are gear driven and thus the spindle speed must be set before the machine is turned on.
Carriage Description

- **Tool holder** - slides into tool post and holds the tool securely and can be adjusted to cut on center
- **Cross Slide Hand Wheel** - for manually feeding the tool into the work piece on the X-axis
- **Carriage Hand Wheel** - for manually moving the carriage toward or away from the chuck on the Z-axis
- **Compound Hand Wheel** - for manually feeding the tool in at an angle
- **Split Nut Lever** - presses split nut into lead screw, for cutting external threads on work piece
- **Spindle Engage Lever (Clutch)** - engages the spindle to rotate the part in the chuck
- **Feed Lever** - engages the power feed for the carriage or cross slide
- **Thread Dial** - used when cutting threads with lead screw
Headstock Description

- **Motor Power Lever**: Turns motor on and determines spindle rotation direction.
- **Spindle Gear Select Knob**: Changes spindle speed range.
- **Feed Direction Lever**: Changes the feed direction for the cross slide and carriage feeds.
- **Feed and Thread Select Lever**: Used to feed specified rate on chart.
- **Feed and Thread Select Knob**: Used to feed specified rate on chart.
- **Feed and Thread Select Chart**: Will feed the carriage and cross slide at the specified rate depending on the feed and thread select knob and lever and the slide gear shaft.
- **Slide Gear Shaft**: Changes the range of feeds and thread pitches the machine will access when the feed or split nut is engaged.
Lathe Accessories-Work Holding

- **Lathe Centers** - used to support work pieces
  - Live centers used in tail stocks, rotate with work piece
- **Chuck** - directly attached to spindle, uses jaws to hold work pieces securely
  - 3 and 6 jaw chucks are self centering and used to hold cylindrical parts
  - 4 jaw chucks have independently moving jaws and can hold irregular shaped work pieces and cylindrical parts
- **Faceplates** - attaches to spindle, has T-slots for fastening work pieces and to drive lathe dogs
- **Mandrels** - used to hold work from the inside diameter of the work piece in a standard size range, and allows to work to be machined between centers
Lathe Accessories-Work Holding

- **Steady and Following Rest**- used to stabilize very long work pieces
  - Steady rests do not move and attach to the lathe bed, follow rests are attached to the carriage and move with it
- **Lathe Dogs**- clamps onto work piece and transmits lathe spindle motion to work piece, used when turning between centers
- **Drive Plates**- attaches to the lathe faceplate and drives the lathe dog
Carriage and Cross Slide Movement

- The carriage moves along the ways toward and away from the chuck, the **Z-Axis**
- The cross slide moves toward and away from the center of the part, the **X-Axis**
- The cross slide moves diametrical distances - that is, each graduation of the hand wheel indicates .001” of diameter movement of your tool
  - DO NOT think of the work piece in terms of its radius. You can only physically measure the diameter of the work piece
Power Feeds

- Two levers on the carriage control the Carriage power feed and the Cross Slide power feed
- To engage the Carriage power feed, pull the lever to the right and pull up (L stands for Longitudinal Feed)
- To engage the Cross slide power feed, push the lever to the left and pull down (C stands for Cross Feed)
- When the lever is pulled to the center position, no feed is engaged regardless if the lever is pushed right or left
A compound slide is a smaller version of the cross feed with one major difference, it can be set at any angle. It offers a way to turn tapers and cut angles on a lathe. Most commonly it is used to cut tapered holes and other conical shapes using a boring bar or lathe bits. There is a degree wheel directly underneath the compound slide that can be set to the specific angle that is needed. Two nuts on the degree wheel must be loosened so the compound angle can be set. There is no power feed option and it must be operated manually.
Tailstock

• The tailstock is located on the opposite end of the lathe from the chuck. It is mounted on the ways of the machine and shares a centerline with the chuck.

• The tail-stock’s most common use is to drill out the centers of work pieces.

• Into the tailstock you can insert a drill chuck that has a compatible Jacob’ taper.

• The tailstock is slid toward the work piece and locked down, leaving about 1 in of room between the drill and the work piece. The tailstock hand wheel is then used to feed the drill into the work piece.
Tailstock

• The other common use is to support long work pieces (shafts / tubes / rods) with the use of a live center.
  – A live center is a cone shaped object with a Morse taper adapter that is inserted into the tailstock.
  – The cone portion spins on an internal ball bearing mechanism. This is used to fit into a center hole of the work piece to hold it firmly between the tailstock and chuck.

• It is very important to lock down the tailstock and set correct tension with the tailstock hand wheel whenever using the live center.

• If the length of piece is sticking out more than 5 times the diameter, a live center should be used.

• Live centers should not be used when the work piece will be parted with a cut-off tool.
Three important Elements

• **Rotation Speed** - Number of RPM of the chuck or collet
  – High RPM achieves higher MRR (Material Removal Rate)
  – Too fast causes too much friction, work hardens tool, poor cutting, higher risk
  – It is better to start at low RPM then increase rotation speed as needed

• **Cutting Depth** - The cutting depth of the tool affects the processing speed and surface finish (roughness).
  – When the cutting depth is big, the processing speed becomes quick but the surface temperature becomes high and leaves a rough finish.
  – Taking off too much material can break the tool or work piece
  – If uncertain, start off with small depth of cut.
  – Always remove a very small amount of material on your final pass to achieve good surface finish

• **Feed Rate** - how quickly the tool is fed into the part, affects processing speed and surface finish
  – High feed can remove material quickly, low feeds give better surface finish
  – Use the power feeds to achieve consistent and good surface finish
  – **BE CAUTIOUS USING POWER FEEDS TO MAKE CUTS, SERIOUS DAMAGE OR INJURY CAN RESULT IF THE TOOL POST OR CARRIAGE HITS THE ROTATING CHUCK**
Lathe Tooling

• **Turning Tool**- used to cut outside surfaces and edges
  – Some bits are carbide brazed onto a steel bar
  – More common are indexable insert lathe tooling which have a carbide bit that is fastened into the steel bar and can be rotated or swapped for a new bit when the edge becomes dull

• **Parting Tool**- used to cut off (part off) the work piece and for making outside grooves
  – This tool can only cut across the work piece in one direction (along the x-axis of the cross slide)

• **Boring Bar**-This tool is used to make diametrical holes of nearly any size and depth.
  – Makes holes more accurately and larger than standard drill bits and with flat bottoms
Lathe Tooling

- **External Thread Inserts** - used for cutting external threads on a work piece
  - Indexable inserts are also available for this type of tool
- **Knurling tool** - presses knurl tool pattern into work piece
  - Desirable for parts that require better gripping
Tool Post Setup

- The tool post is where the cutting tool and its holder will be located. It uses a dovetail design to enable the operator to pre-set a number of tools for easy and accurate changes between cutting tools.
- The tool post is permanently mounted to the machine but can be moved and rotated. The tool holders have knobs on top to quickly adjust tool height.
- For safe and efficient cutting, the tip of the tool must be located directly on the center of the part in the chuck.
  - Too high and the base of the tool will push on the part, which may damage your work piece or break the cutting tool.
  - Too low and the tool will gouge the work piece or cut too deep. When facing a part, a nub will be left when you reach the center of the work piece.
• The chuck is directly attached to the spindle
• The operator uses the jaws of the chuck to hold the work piece.
• 3-jaw and 6 jaw chucks are self centering
  – If precision is important, use a dial indicator to check the true concentricity of the part.
  – Place the dial indicator on the carriage and lock it with the magnet. Then touch the work piece with the indicator. Sweep the indicator across the work piece by rotating the chuck. Adjust as needed to minimize the run-out of the part
• NEVER LEAVE THE CHUCK KEY IN THE CHUCK
  – SERIOUS INJURY AND/OR DAMAGE TO THE MACHINE WILL OCCUR IF THE MACHINE TURNS ON WITH THE CHUCK KEY IN THE CHUCK
Yale Machine Shop Accident

- Read the following articles, details from the articles will be in the quiz
- Yale Machine Shop Accident
- Yale Machine Shop Accident Response
Unsafe practice or obvious abuse of equipment constitutes a danger to people and damages equipment. Therefore the Fabrication Shop Manager or any person observing an unsafe act should stop unsafe practices in the Fabrication Shop. Students violating any of these rules will have their Fabrication Shop privileges revoked for a period of at least two weeks. Longer periods may be assessed, depending upon the judgment of the Fabrication Shop Manager and the Engineering Innovation Center Facility Manager.