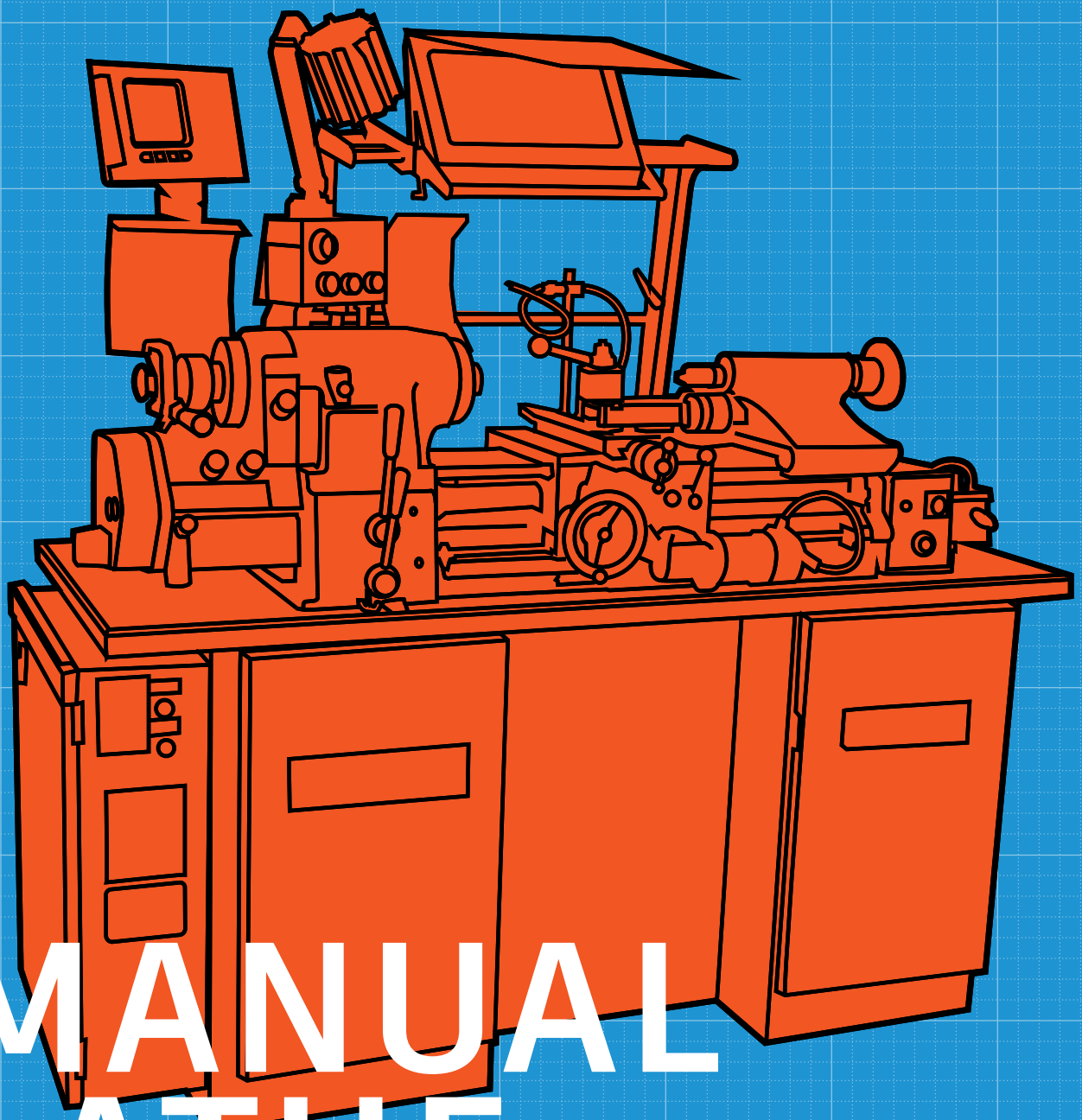
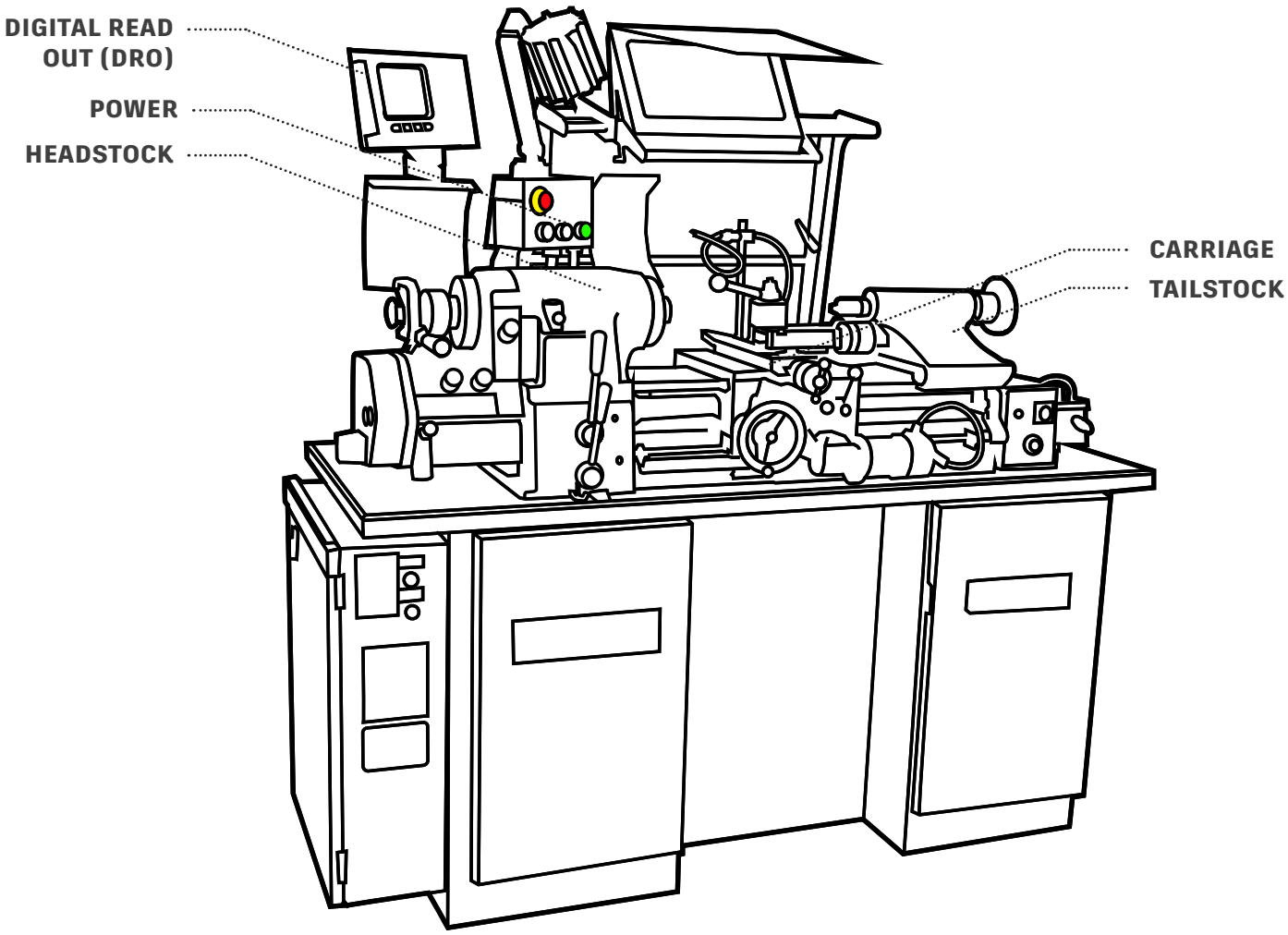


MANUAL LATHE

VERSION 3.1

AUTODESK
PIER 9



MATERIALS

ALLOWED MATERIALS

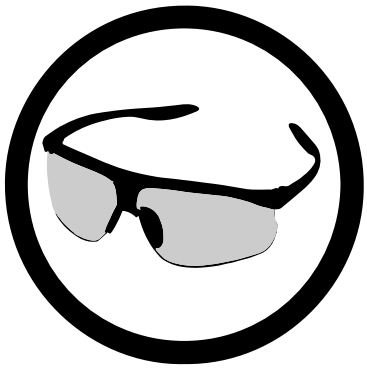
+ Most metal
+ Most plastics

BANNED MATERIALS

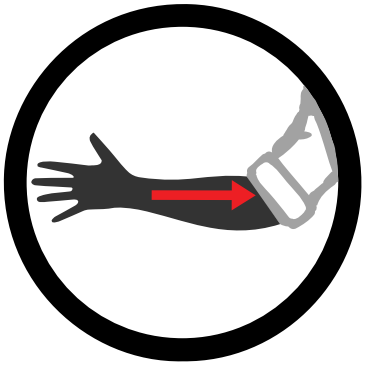
+ Wood
+ Carbon fiber and composites

SEE SHOP STAFF FIRST

+ All other materials

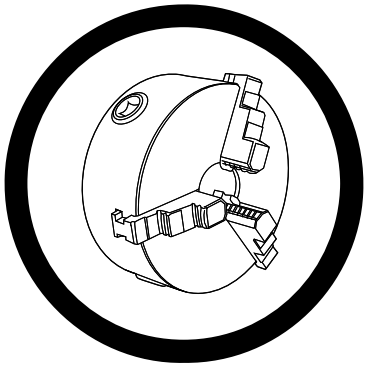


Always
wear safety
glasses.



Always wear short
sleeves, or rolled
sleeves, pull back
and tuck in long hair,
remove jewelry and
lanyards, etc.

Do not wear gloves.



Using a chuck or collet
is required for all work.

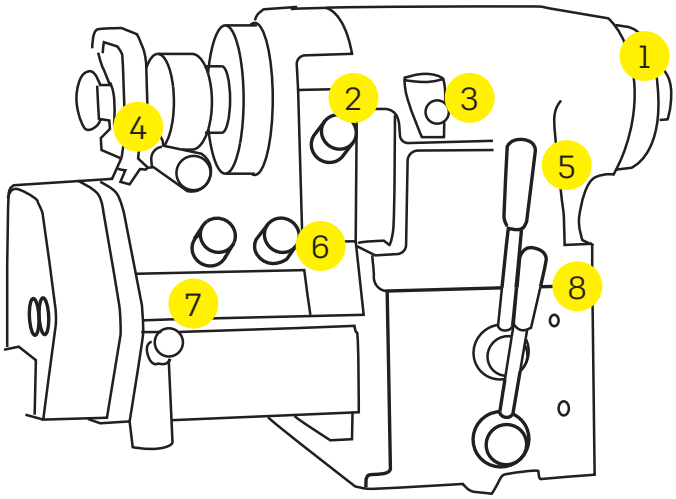
LATHE BASICS

The lathe is different from other shop tools, because it rotates the workpiece rather than the cutting tool. As the workpiece is rotating, the tool is moved in one of two axes.

The lathe is used to cut cylinders, tapers and threads on the inside or outside of the workpiece.

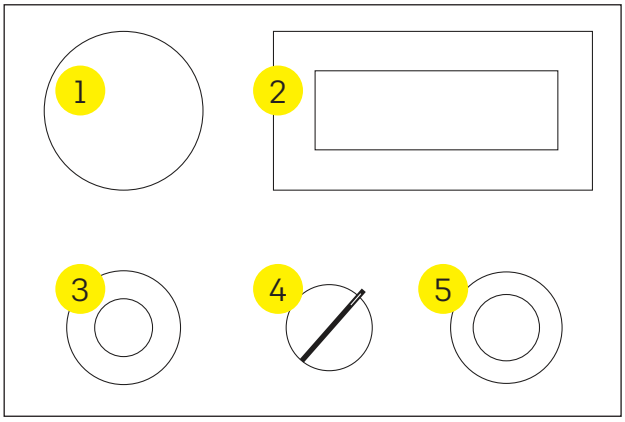
The **headstock** holds the parts that control the speed of the lathe, as well as the threading controls. It also holds the chuck and collet, which are used for workholding.

Note: Only #5 and #8 may be moved while the lathe is in motion.



1. Spindle nose
   - Chucks and collets attach to the spindle nose.
2. Feed/thread selector
   - Selects either feeding or threading.
3. Spindle lock
   - Ensure that the spindle is unlocked before operating.
4. Collet closer
5. Threading feed direction lever
6. SAE/metric threading selector
7. Thread pitch controls
8. Spindle speed range (hi/low) and brake lever

The **control panel** sets the spindle speed and rotation direction. The panel is located just under the tailstock.



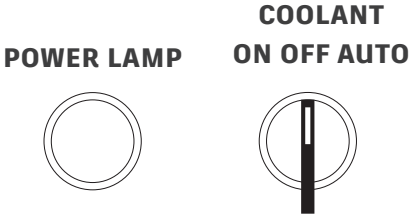
1. E-Stop
2. Speed (RPM) display
3. Speed (RPM) control
4. Spindle direction
5. Start button

Below the headstock are a light and switch.

The **Power Lamp** lights up green when the power switch is on.

The **Coolant** switch has three positions

+ Leave the coolant switch off.
+ Use a brush or dropper for coolant.

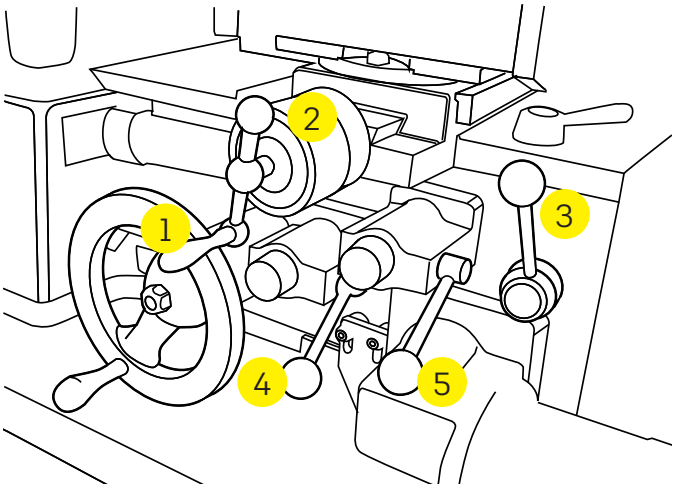


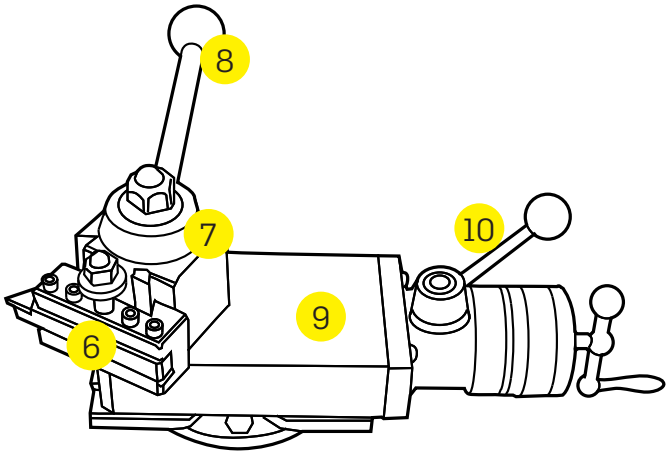
The **bedway** (also called the **ways**) are the rails that the carriage rides on. They must always be protected from damage.

+ Never use any kind of tool (hammer, file, scraper, etc) on the ways.
+ Do not use sandpaper on the lathe, because the grit will damage the ways.

The **carriage** rides on the ways and holds many of the frequently used controls.

1. Z axis handwheel
   - ▸ Moves the carriage along the long axis (Z).
2. Cross slide handwheel
   - ▸ Moves the cross slide on the short axis (X).
3. Threading lever
   - ▸ See Shop Staff for cutting threads.
4. Power feed (carriage)
   - ▸ Engage the lever to move the carriage at a steady rate for a precise cut.
5. Power feed (cross slide)
6. Cutting tool (installed in a tool holder)
7. Tool post
   - ▸ Holds the tool holder and cutting tool.
   - ▸ Can be rotated independently of the compound.
8. Tool holder lock handle
   - ▸ Locks the tool holder into place.
9. Compound slide
   - ▸ Can be rotated in order to change the angle of the tool or to cut short tapers.
10. Quick lever
    - ▸ Move the lever forward before starting a cut.
    - ▸ When reaching the end of a cut, pull the lever back to move the cutting tool away from the workpiece.
    - ▸ This allows you to clear the workpiece without adjusting the cross slide or compound slide.

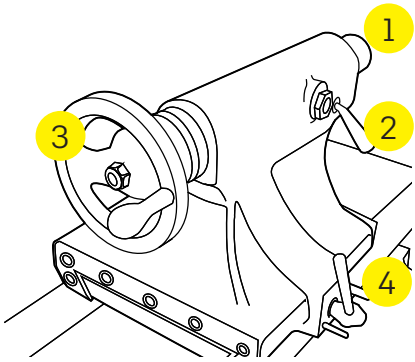




The **tailstock** is commonly used to hold a **drill chuck** or a **live center**.

+ The drill chuck is used to hold drill bits for drilling into the end of the workpiece.
+ The live center is used for supporting long workpieces.

1. Quill
   - ▸ Located inside the tailstock, and can be extended or retracted.
   - ▸ Inside the quill is a tapered hole that holds the accessories.
2. Quill lock
3. Quill handwheel
   - ▸ Extends and retracts the quill along the long axis (Z).
4. Tailstock lock
   - ▸ Locks the tailstock to keep it from sliding along the ways.



Shown from the back side, for clarity

USING THE TAILSTOCK

Be aware that sliding the tailstock too far down the ways can cause the tailstock to fall off the lathe.

+ Do not slide the tailstock all the way to the end of the lathe.

Installing a tapered accessory

The two tapers must be exactly the same (on this lathe, it's a size 2 Morse Taper). See Shop Staff for assistance if needed.

1. Unlock the quill lock.
2. Lock the tailstock.
3. Adjust the quill so it is sticking out 1/2" to 1".
4. Clean the inside of the taper on the quill.
5. Clean the outside of the taper on the accessory.
6. Slide the tapered accessory into the taper of the quill.
7. Ensure that the tang on the taper is vertical.
   - ▸ If the tang does not line up with the vertical slot inside the taper, it will not go in.
8. Gently slide (but with some force) the accessory into the taper to seat it.
   - ▸ It is OK to give the drill chuck a soft hit with a deadblow hammer to help seat it.
   - ▸ Retract the jaws of the drill chuck before striking it.
   - ▸ Never use a metal hammer.

Removing the accessory

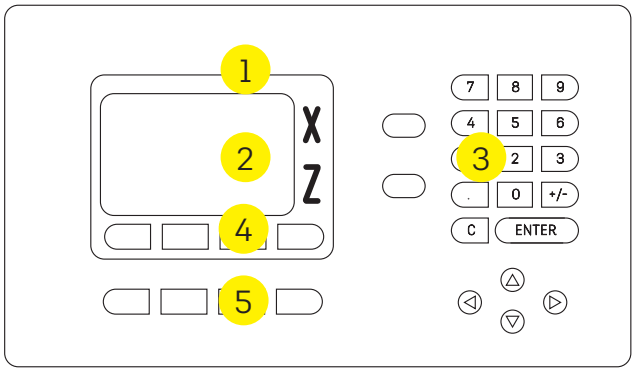
1. Loosen the quill lock.
2. Fully retract the quill, and remove the accessory by hand.

The **Digital Readout** (DRO) displays the location of the tool tip as the carriage or cross slide moves. It is not connected to the compound slide or to the tool holder.

If needed, turn on the DRO with the power switch on the back.

+ Press the NO REF button after the DRO boots up.

1. Status indicator
   - ▸ Inch/metric, ABS/INC, Diameter/Radius, etc.
2. Main Display screen
   - ▸ X & Z values are displayed here.
3. Keypad
4. Function display
   - ▸ Displays functions that can be changed with the function buttons
5. Function buttons



Inch/metric

Measurements are displayed in decimal inches (in increments of 0.0002") or millimeters (in increments of 0.005mm). Switch between the two systems with the function buttons.

ABS/INC (absolute/incremental)

The DRO can be in ABS or INC mode. Best practice is to set the DRO when in ABS mode, then use INC mode for making small changes.

+ For example, if the DRO displays 3.125" in ABS mode, and you want to move .5" you can calculate (3.125 - .5) or go to INC mode, set 0 and move .5" without losing the ABS value.

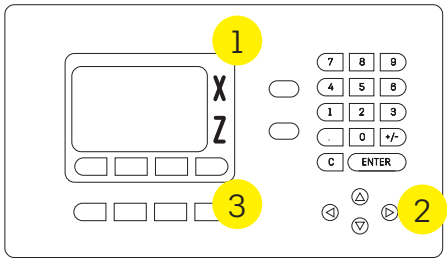
Diameter/Radius

This changes the display to show the tool movement or twice the tool movement. This is a very important distinction.

+ For example, if you have a 2" diameter workpiece and move the tool 0.5" in X, the new diameter will be 1", because 0.5" is being removed from both sides of the part.
  - ▸ In Diameter mode, the X display would show that the tool moved 1".
  - ▸ In Radius mode, the X display would show that the tool moved 0.5"

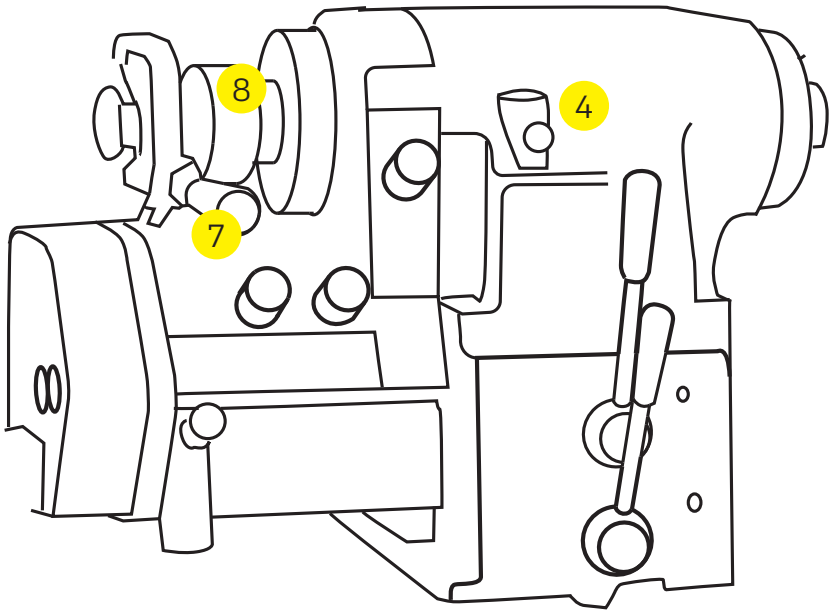
Setting a value for an axis

1. Check the SET/ZERO status (displays SET or ZERO).
2. If the SET/ZERO button (#3) does not say SET/ZERO, press the right or left arrow key until it does.
3. Press the SET/ZERO button to change the status if needed.
   - ▸ ZERO Mode: Press the axis button to set it to 0.
   - ▸ SET Mode: Select the axis with the X or Z button and enter a value on the kreypad.



A collet is an easy method for holding small diameter parts. Each collet is sized to fit a specific diameter, and must fit snugly. The collet is threaded into the end of the spindle, after the chuck is removed and the collet clamps down on the workpiece.

1. Press the E-stop.
2. Select a collet that is the correct size for the workpiece.
3. Ensure that the outside of the collet and the inside of the spindle are clean.
   - ▸ Wipe with a clean shop towel.
4. Engage the spindle lock.
5. Slide the collet into the spindle.
6. Slide the material into the collet.
   - ▸ Never close an empty collet.
7. Push the collet closer handle towards the tailstock (to the right).
8. Rotate the collet closer ring to pull the collet deeper into the spindle.
   - ▸ Stop when you feel a bit of resistance.
9. Flip the tab on the collet closer ring to keep the ring from rotating.
10. Release the spindle lock.
11. Move the collet closer lever to the left to secure the material.
    - ▸ When closing, you should feel a "click" as the mechanism engages.
    - ▸ If you don't feel the click, tighten the ring and try again.
    - ▸ If the mechanism is too tight, loosen the ring and try again.
12. Rotate the workpiece by hand to ensure the spindle is unlocked.



There are several common ways to hold materials on the lathe. Usually, the 3 jaw chuck is installed on the lathe. It is a self centering chuck, meaning that all the jaws move together, and keep the workpiece centered. The 3 jaw chuck only works on round material, or materials with a number of sides divisible by 3.

+ A 6 jaw chuck works the same way, with the same rules.

For holding square, rectangular or odd shapes, a 4 jaw chuck can sometimes be used.

+ See Shop Staff for 4 jaw chuck use.

Using the 3 or 6 jaw chuck

1. Press the E-stop to ensure safety.
2. Use the chuck key to open the jaws.

NEVER LEAVE THE CHUCK KEY IN THE CHUCK, EVEN FOR A MOMENT. THE ONLY SAFE LOCATION FOR THE KEY IS IN THE KEY HOLDER ON THE LATHE, OR IN YOUR HAND.

NEVER OPEN THE CHUCK JAWS SO THEY EXTEND MORE THAN HALFWAY BEYOND THE CHUCK BODY.

3. Place your part in the jaws.
   - The workpiece must be inserted into the jaws deep enough for a secure grip.
   - If more than 3x the workpiece diameter is sticking out of the chuck, you must use a center to hold the end. For example, if the material is 1" in diameter, and 4" is sticking out of the chuck, use a center.
   - To help center the workpiece in the chuck, wiggle it when tightening the jaws.
   - Ensure that there is enough material sticking out of the chuck to keep the tool from hitting the chuck.
4. Tighten the jaws with the key.
   - Remove the key.
5. Rotate the chuck by hand to ensure that the material is centered and that there is no interference between the chuck and any other part of the lathe.

USING A LIVE CENTER

1. Insert a drill chuck and center drill in the tailstock.
2. Slide the tailstock 1" from the workpiece and lock it.
3. Turn on the lathe.
4. Set the correct RPM.
5. Extend the quill until you drill into the workpiece about 1/4".
6. Turn off the lathe and replace the drill chuck with a live center.
7. Move the tailstock close to the workpiece and lock it.
8. Extend the quill until the center is snug in the workpiece.
9. Lock the quill.

SPEEDS AND FEEDS CHART

Use the wall chart to determine the correct RPM, cutting speed and maximum depth of cut.

If desired, you can use the following information to determine a suggested RPM.

CALCULATING THE LATHE RPM

Setting the lathe to use the correct speed (spindle RPM) for the operation is important. Determining the correct RPM takes a combination of research, observation and common sense.

Common materials have a calculated value, called **surface feet per minute** or **SFM,** for the maximum speed that a tool can move through the material, without excessive wear or damage.

The SFM is used to calculate the RPM of the spindle and workpiece. RPM is based on the material being cut, the material of the cutting tool and the diameter of the material being cut.

SFM of common materials cut in the Pier 9 workshop using the available cutting tools.

MATERIAL	SFM
Hard Steel (stainless, tool steel, etc)	50-60
Mild Steel (regular steel)	100-125
Brass	150-200
Aluminum	250-350

For plastics, check with the manufacturer or shop staff.

RPM = 4 X SFM / MATERIAL DIAMETER

To convert the SFM to RPM, use the following formula.

Example: 2" diameter stainless steel

4 x 50 / 2 = 200 / 2 = 100 RPM

Example: 1/2" diameter aluminum

4 x 300 / 0.5 = 1,200 / 0.5 = 2,400 RPM

Note: Observation and common sense will also help determine the correct speed. For example, if the tool is chattering and making lots of noise, something is wrong. Stop, look at the cutting tool, recalculate the speeds, and ask Shop Staff for help if needed. If the formula calculates an extremely high RPM, perhaps your math isn't correct. If you have questions about the RPM, see Shop Staff for help.

When it is time to start cutting, turn the spindle speed to a low number and start the spindle. Slowly turn up the speed until the readout is close to the calculated RPM.

PARTING AND DRILLING

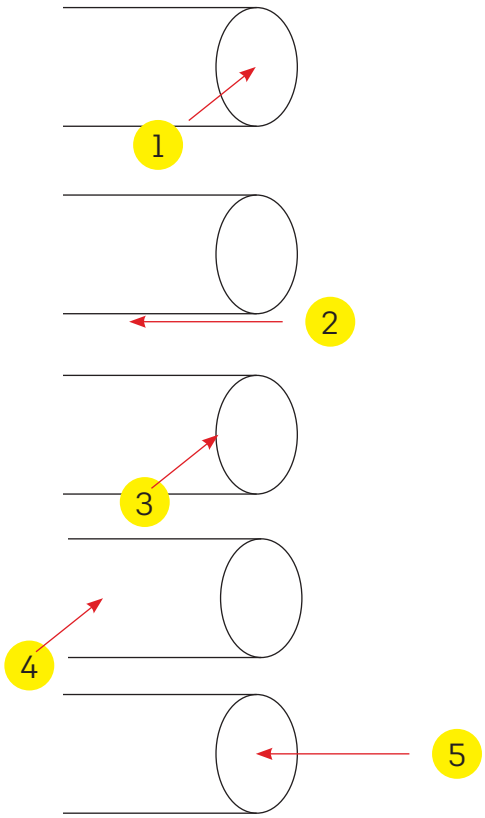
When using the parting off tool, set the RPM to about 1/4 of the calculated value.

When drilling, calculate the RPM based on the drill bit diameter, rather than the workpiece size.

+ Using a small drill bit will calculate a high RPM. If the workpiece is large, you may need to reduce the RPM for safety. See Shop Staff if you have any questions about RPM.

There are 5 commonly used types of cutting operations.

1. Facing
   - Removing the end of the workpiece, to make it flat as well as perpendicular to the length.
   - After facing, but before moving the carriage along the Z axis is a good time to set the Z axis to ABS 0.
2. Turning
   - Removing material along the Z axis of the workpiece.
   - The remaining material can be cylindrical or tapered.
3. Profiling
   - Using a shaped cutting tool to create a feature, usually a radius or chamfer, on the part.
4. Parting
   - Cutting straight into the workpiece along the X axis, in order to cut it to length.
   - Reduce the RPM to 25% and use lots of cutting fluid when parting.
5. Drilling
   - Using a drill bit to drill into the end of the workpiece.



Other lathe operations are possible, but not covered in this class.

+ Boring
   - Using a cutter to create a hole in the end of the workpiece.
   - Similar to drilling, but it's more accurate and the hole can be made any diameter, or even conical.
+ Threading
   - Cutting threads on the inside of a hole, or the outside of a shaft.

AREA AND MACHINE PREPARATION

1. Press the E-stop.
2. Clean and clear the lathe.
3. Secure the workpiece.
4. Select and install the cutting tool.
5. Calculate the RPM (speed) for your cutter and material.
6. Use the handwheel to rotate the chuck to check for collisions.
7. Turn the speed control to a low number.
8. Lock the Quick lever into the forward position.

ALL WORK MUST BE SECURED AT ALL TIMES.

MAKING THE CUT

1. Start the lathe.
   - Release the E-Stop.
   - Press start.
   - Move the spindle speed range lever to high or low.
2. Change the RPM to the calculated value.
3. Move the cutting tool close to the desired starting point.
4. Gently engage the cutting tool.
5. Make the first cutting pass.
   - This may be a good time to 0 the X or Z axis.
6. Move the spindle speed range lever to the center to stop the spindle.

AVOID ACCUMULATING LONG STRINGY CHIPS. STOP AND CLEAN THE LATHE IF NEEDED.

CLEANUP

1. Press the E-stop.
2. Remove the workpiece.
3. Clean the lathe and the area nearby.
   - Use brushes and a vacuum, not compressed air.
   - Chips may be sharp; use a tool to remove them.
4. Clean up any coolant spills.
5. Put away tooling, drill bits and tools.
6. Recycle scraps and put reusable pieces in the storage bin in the metal shop.

NEVER CLEAN OFF CHIPS WHILE THE WORKPIECE IS SPINNING.