# ME Machine Shop General Shop Policy/Rules (MEMS)

EVERYONE MUST SIGN IN ON TABLET

1. Safety glasses, cover goggles, or face shields are required when in any shop area, whether working or not!!
2. Closed-toe shoes and long pants must be worn in any shop area. No one wearing sandals or shorts will be allowed to enter any shop area. The minimum footwear must cover the entire foot.
3. Do not operate any item of equipment unless you have been authorized to operate it. If you have any questions regarding the use of equipment, ask the shop manager or personnel.
4. No work may be performed using power tools unless at least two people are in the shop area and can see each other.
5. Machines must be shut off when cleaning, repairing, or oiling.
6. Do not wear ties, loose clothing, jewelry, gloves, etc. around moving or rotating machinery. Long hair must be tied back or covered to keep it away from moving machinery. Hand protection in the form of suitable gloves should be used for handling hot objects, glass, or sharp-edged items.
7. Never indulge in horseplay in the shop areas.
8. Keep fingers clear of the point of operation of machines by using special tools or devices, such as push sticks, hooks, pliers, etc. Never use a rag near moving machinery.
9. Practice cleanliness and orderliness in the shop areas. Put everything back & clean up your area. Leave the areas better than you found it.
10. Keep the floor around machines clean, dry, and free from trip hazards. Do not allow chips to accumulate. Machines are to be cleaned with a brush & dustpan. Shop vacs can be used for small cleaning but no liquids.
11. Before starting a machine, always check it for correct setup and always check to see if the machine is clear by operating it manually, when possible.
12. Safe procedures for most shop operations are described in the Health and Safety manual located by the shop manager's office. READ THEM!

# Shop Users Agreement

I have read the shop Safety Policy and Rules and understand them as they apply to my work in the Mechanical Engineering machine shop areas. Specifically:

1. I agree to abide by the published and posted regulations and accept personal responsibility for my work and actions in the shop. I will abide by all additional shop rules. I understand that my failure to do so may result in my loss of privileges in the shop areas.
2. I understand the shop access rules, supervision requirements, and shop hours.
3. I will always wear safety glasses while in the shop.
4. I understand that the minimum Personal Protection Equipment (PPE) required to work in the shop is safety glasses, closed-toed shoes, long pants, tied up hair, and no jewelry or loose clothing.
5. After use, I will thoroughly clean and maintain all equipment, floors, and workbench space I use. I will begin clean-up 30 minutes before closing or before my lab session ends.
6. I will not attempt to use any machine, tool, or equipment that I do not have written permission to use. I will ask for instruction and/or training before using any machine, tool, or equipment with which I am not familiar.
7. For any equipment or tooling I damage, I will promptly notify a shop staff member, and I will leave my name and contact information (phone number or email address) where I can be reached.
8. I understand that it is a privilege and learning opportunity to use the shop facilities and agree to abide by all University regulations and stipulations placed upon me as conditions for working in these areas.
9. I understand that breaking the terms and conditions of the policy as outlined in this document will result in a 14 to 30-day suspension, depending on the infraction, from the UCR Mechanical Engineering Machine Shop and hereby agree to comply with the shop rules outlined in this document.

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| MEMS User | Date |
| ME Machine Shop | Date |

# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for HORIZONTAL BANDSAW
## REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.

IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

### PRE-OPERATIONAL SAFETY CHECKS

- ✓ Locate and ensure you are familiar with all machine operations and controls.
- ✓ Ensure all guards are fitted, secure and functional. Do not operate if guards are missing or faulty.
- ✓ Check workspaces and walkways to ensure no slip/trip hazards are present.
- ✓ Ensure dust catch tray is secured under fly wheel behind bottom door.
- ✓ Close bottom door.
- ✓ Recheck for any loose clothing, jewelry, or any hazards.
- ✓ Make sure all compulsory PPE is fitted – fit earmuffs and ensure PVC apron, face shield, nitrile gloves and closed-in shoes (preferably gum boots) are being worn.

### Operating bandsaw

- Ensure blade guard is correctly set in position. Never operate the bandsaw without the blade guard in position.
- Move the moveable guide into position. This will be different for each specimen – always keep the guide assembly as close to the point of cutting as possible.
- Plug in and turn on at wall.
- Rotate red safety stop button until it clicks out.
- Press green button to start. Machine will take approximately two seconds to reach full speed.
- Begin to guide cadavers into the bandsaw after it has reached full speed. Ensure the flattest side of the specimen is face-down – it should be as stable as possible.
- Do not force specimens through the blade. The cutting action should be smooth and rhythmical.
- Remain focused and take care whilst operating the bandsaw.
- The operator’s fingers may be close to the blade particularly with smaller cuts. If this is the case, guide the specimen through by gently pulling or use another cut to push the portion through.

Stopping bandsaw

- Push the red stop button on the machine. Machine will stop within a few seconds.
- Further isolate the machine by turning off at the wall and removing the plug.

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for VERTICAL BANDSAW
## REVISION: V6 DATE: 02-14-2024

**CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.**

**IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.**

### PRE-OPERATIONAL SAFETY CHECKS

- ✓ Ensure the guard doors are closed and the blade is properly adjusted prior to turning on the machine.
- ✓ Adjust the upper guard assembly to within 1/4 inch of the stock prior to starting the machine. Set the band saw at the appropriate speed for the type of stock being machined.
- ✓ Check to ensure the band saw blade is sharp.
- ✓ Check to ensure the blade is correct for the type of stock and correct speed being used.

### OPERATIONAL SAFETY CHECKS

- ✓ Allow the saw to reach full set speed prior to cutting stock.
- ✓ Do not force stock into the saw blade. Let the speed of the blade cut stock appropriately.
- ✓ Plan your cuts to avoid backing out of curves in the stock.
- ✓ Never push a piece of stock with hands in front of the saw blade. Use a push stick & keep hands at a safe distance on either side of the stock being cut.
- ✓ Use a push stick or board to push small or irregular sized stock. Small work pieces can also be secured with a tabletop vise or clamp.
- ✓ All round stock must be secured in a tabletop vise or clamp prior to starting the cut.
- ✓ Hold the stock flat on the table prior to starting the cut.
- ✓ If the saw blade binds on a piece of stock, turn the saw off and wait until it comes to a complete stop before attempting to remove the blade from the stock.
- ✓ Do not allow large quantities of chips to accumulate around the work piece table. **After** stopping the machine, use a brush or rag to remove all excess chips from saw with brush & dustpan. Leave it better than you found it.

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for BELT & DISC SANDERS
## REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.

IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

### PRE-OPERATIONAL SAFETY CHECKS

- ✓ All appropriate PPE must be worn, safety glasses, shield and/or glove when necessary.
- ✓ No loose garments are to be worn; hair tied back.
- ✓ Ensure the machine and area is clean and free from obstacles.
- ✓ Ensure all guards and adjustable table on disc sander are secured and correctly fitted.
- ✓ Never use without extraction and appropriate dusk mask.
- ✓ Never attempt an operation if you are unsure of what you are doing.
- ✓ Never use for more than one operation at any one time- belt sanding or disc sanding.
- ✓ Ensure the on – off switch works correctly.
- ✓ Check that the sanding belt & disc are installed correctly.

### OPERATIONAL SAFETY CHECKS

- ✓ Be sure to use the downward rotation side of disc.
- ✓ Ensure work is held correctly.
- ✓ Use firm, forward pressure without overloading the machine.
- ✓ When you finish, clean machine of all debris with a brush & dustpan.
- ✓ Be sure area is left in a clean condition and any waste is removed.

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for BENCH/PEDESTAL GRINDER
## REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.

IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

### PRE-OPERATIONAL SAFETY CHECKS

- ✓ Check workspaces and walkways to ensure no slip/ trip hazards are present.
- ✓ Ensure all guards and safety shields (spark deflectors) are in position before starting the grinder.
- ✓ Check that electrical cords are not damaged.
- ✓ Ensure that the grinding wheels are properly 'dressed' and that wheels do not touch the tool rest and that the gap between wheel and rest is no greater than 1.5 mm.
- ✓ Check that grinding wheels are running true (regularly dressed) and are not glazed or loaded.
- ✓ Locate and ensure you are familiar with the operation of the ON/OFF start switch and the
- ✓ Emergency Stop button (where fitted).
- ✓ Faulty equipment must not be used. Immediately report and repair any damaged machinery.
- ✓ All PPE must be worn. Safety glasses, shield and/or glove if necessary.

### OPERATIONAL SAFETY CHECKS

- ✓ Stand to the side of the wheels when starting up.
- ✓ Let the wheels gain maximum speed before starting to grind.
- ✓ Do not grind on the side of the wheel.
- ✓ Small objects must not be held by hand.
- ✓ Workpiece must never be held with gloves, cloth, apron, or pliers.
- ✓ Never leave the machine running unattended.
- ✓ Do not bend down near the machine whilst it is running.
- ✓ Never force the workpiece against a wheel.
- ✓ Slowly move the workpiece across the face of the wheel uniformly. Do not use the side of the
- ✓ grinding wheel to grind workpieces.
- ✓ Coolant spilt on the floor should be immediately cleaned up with absorbent material.

HOUSEKEEPING

- Switch off the grinder at the end of work and switch off at power point.
- Check that power leads have not been damaged during use.
- Clean swarf and leave the machine in a safe, clean, and tidy state.
- Clean area with brush & dustpan. Leave it better than you found it.

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for BENCH ROUTER
## REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.
IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

Potential Hazards:

Material kickback,
Flying chips and airborne dust,
Noise,
Eye injuries,
Hair/clothing getting caught in moving machine parts.
Cuts.

PRE-OPERATIONAL SAFETY CHECKS

- ✓ Locate and ensure you are familiar with all machine operations and
- ✓ controls.
- ✓ Ensure all guards are fitted, secure and functional. Do not operate if guards are missing or faulty.
- ✓ Faulty equipment must not be used. Immediately report suspicious machinery.
- ✓ Use only materials free from defects.
- ✓ Ensure cutter size conforms to machine specification.
- ✓ Ensure the machine power is off while cutters are being installed.
- ✓ Ensure all cutters are sharp and free of resin build up.
- ✓ Check cutter for clearance of rotation before starting machine.
- ✓ Adjust fence, guards and extraction for maximum protection and efficiency.

PPE REQUIREMENTS

- Safety glasses must be always worn in work areas.
- Long and loose hair must be contained.
- Closed toe footwear must be always worn in work areas.
- Close fitting/protective clothing must be worn.
- Rings and jewelry must not be worn.
- Hearing protection IS required.

## OPERATIONAL SAFETY CHECKS

- ✓ Before making any adjustments, switch off and bring the machine to a complete standstill.
- ✓ Feeding must be against the direction of rotation.
- ✓ Feed work slowly into the cutter.
- ✓ Any available jigs, fixtures or templates should be used wherever possible and available.

## HOUSEKEEPING

- Clean table and router of all debris with brush & dustpan. Leave it better than you found it.
- Return all accessories to storage racks.
- Leave the work area in a safe, clean, and tidy state.
- Unplug any unused cords and other equipment.

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for DRILL PRESS
# REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.
IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

TASK HAZARDS CONTROLS

1. Clean the table and area with brush & dustpan. Leave it better than you found it.
Eye injury from metal debris Wear eye protection.
*Do not use compressed air.*

2. Load the vise. Foot injury if the vise falls Secure the vise on the table with T-pins.
Finger pinching while sliding the vise. Don't let your fingers get under the vise unless you are lifting it from the table.
*Keep your eyes on the task.*

3. Lock the table in place. Back strain Don't lean over the table to twist the lock handle.

4. Load the bit. Hand injury from the bit. Wear gloves.
Don't hold on the end of the bit.

5. Start the drill.

6. Feed the drill with the feed. Feed with the appropriate pressure.
   - Use the appropriate bit for the type of metal.
   - Wear eye protection.
   - Eye or skin damage from cutting oil.
   - Use the lowest RPM.
   - Wear eye protection.
   - Wear a long-sleeved shirt.
   - Hand injury from the exposed pulley near the feed handle
   - Make sure a pulley guard is in place.
   - Don't push the feed handle toward the pulley.

7. Unload the vise. Foot injury if the vise falls Leave the vise secure on the table with T-pins until it is unloaded. Finger pinching while sliding the vise. Don't let your fingers get under the vise unless you're lifting it from the table.
*Keep your eyes on the task.*

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for HAAS TL LATHE
# REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine

IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and instructions

CAUTION: All CNC machines present hazards from rotating cutting tools, belts and pulleys, high voltage electricity, noise, and compressed air. When you use CNC machines and their components, you must always follow basic safety precautions to reduce the risk of personal injury and mechanical damage.

The work area must be adequately illuminated to allow clear view and safe operation of the machine.

This includes the operator work area and all areas of the machine that might be accessed during maintenance or cleaning. Adequate lighting is the responsibility of the user.

Cutting tools, work holding, workpiece and coolant are beyond the scope and control of Haas Automation, Inc. Each of these potential hazards associated with it (sharp edges, heavy lifting considerations, chemical composition, etc.) and it is the responsibility of the user to take appropriate action (PPE, training, etc.).

Cleaning of the machine is required during normal use and prior to maintenance or repair. Optional equipment is available to aid cleaning such as washdown hoses, chip conveyors and chip augers. Safe use of this equipment requires training and might require appropriate PPE and is the responsibility of the user.

This operator’s manual is intended as a reference guide and is not to be the sole source of training.

Complete operator training is available from the authorized Haas distributor.

## Summary of Types of Operation for Haas Automation

### Machine Tools

Haas CNC Lathes are intended for cutting and shaping of metals and other hard materials. They are general purpose in nature and a list of all of those materials and types of cutting would never be complete. Almost all cutting and shaping is performed by a rotating part clamped in a chuck. The tools are held on a turret. Some cutting operations require liquid coolant. That coolant is also an option depending on the type of cutting.

Operations of Haas Lathes are separated into three areas. They are: Operations, Maintenance, and Service. Operations and Maintenance are intended to be performed by a trained and

qualified machine operator. This Operator's Manual contains some of the information necessary to operate the machine. All other machine operations are to be considered Service. Service is only to be performed by specially trained service personnel.

Operation of this machine consists of the following:
1. Machine Setup: Machine setup is done to initially set up the tools, offsets, and fixtures required to perform a repetitive function that later is called machine operation. Some machine setup functions can be done with the door open but are limited to “hold to run”.
2. Machine operating in Automatic Mode: Automatic operation is initiated with Cycle-Start and can only be done with the doors closed.
3. Operator loading and unloading of materials (parts): Parts loading and unloading is what precedes and follows an automatic operation. This must be done with the doors open and all machine automatic motion is stopped when the door is open.
4. Operator loading and unloading of cutting tools: Tool loading and unloading is done less often than setup. It is often required when a tool has become worn and must be replaced.

Maintenance only consists of the following:
1. Adding and maintaining condition of coolant: Adding coolant and maintaining coolant concentration is required at regular intervals. This is a normal operator function and is either done from a safe location outside of the work enclosure or with the doors open and the machine stopped.
2. Adding lubricants: Adding lubricants for spindle and axes is required at regular intervals. These are often months or years in length. This is a normal operator function and is always done from a safe location outside of the work enclosure.
3. Cleaning chips out of the machine: Cleaning out of chips is required at intervals dictated by the type of machining performed. This is a normal operator function. It is performed with the doors open and all the machine operation is stopped. Clean area with brush & dustpan and leave it better than you found it.

Read Before Operating

DANGER: Do not enter the machining area any time the machine is in motion, or at any time that machine motion is possible. Severe injury or death may result. Motion is possible when the power is on and the machine is not in [EMERGENCY STOP].

BASIC SAFETY
- This machine can cause severe bodily injury.
- This machine is automatically controlled and may start at any time.
- Consult your local safety codes and regulations before you operate the machine. Contact your dealer if you have questions about safety issues.
- It is the machine owner’s responsibility to make sure that everyone who is involved in installing and operating the machine is fully acquainted with the operation and safety instructions provided with the machine BEFORE they work with the machine. The

ultimate responsibility for safety rests with the machine owner and the individuals who work with the machine.

- Use appropriate eye and ear protection when you operate the machine.
- Use appropriate gloves to remove processed material and to clean the machine.
- Replace windows immediately if they are damaged or severely scratched.
- Keep the side windows locked during operation (if available).

DANGER: To avoid injury, verify that the spindle has stopped turning before opening the doors. In the event of a loss of power the spindle will take much longer to coast to a stop.

OPERATIONAL SAFETY CHECKS

- ✓ Do not operate the machine unless the doors are closed and the door interlocks are functioning correctly.
- ✓ Check for damaged parts and tools before you operate the machine. Any part or tool that is damaged should be properly repaired or replaced by authorized personnel. Do not operate the machine if any component does not appear to be functioning correctly.
- ✓ When a program runs, the tool turret can move rapidly at any time.
- ✓ Improperly clamped parts machined at high speeds/feeds may be ejected and puncture the enclosure. It is not safe to machine oversized or marginally clamped parts.

CAUTION: Manual or Automatic closing of the enclosure doors is a potential pinch point. With Auto Door, the door may be programmed to close automatically, or by pressing the door open/close button on the operator's pendant. Avoid putting hands or appendages in the door while closing either manually or automatically.
Follow these guidelines when you work with the machine:

Normal operation - Keep the door closed and guards in place (for non-enclosed machines) while the machine operates.
Part loading and unloading - An operator opens the door, completes the task, closes the door, and then presses [CYCLE START] (starting automatic motion).
Machining job set-up - When set-up is complete, turn the set-up key to lock out set-mode and remove the key.
Maintenance / Machine Cleaner - Press [EMERGENCY STOP] or [POWER OFF] on the machine before you enter the enclosure.
Tool loading or unloading - A machinist enters the machining area to load or unload tools. Exit the area completely before automatic movement is commanded (for example, [NEXT TOOL], [TURRET FWD], [TURRET REV] ).

DANGER: Improperly clamped parts or oversized parts may be ejected with deadly force.

CHUCK SAFETY

- Do not exceed the chuck's rated speed. Higher speeds reduce chuck clamping force.
- Unsupported bar stock must not extend outside the drawtube.

- Grease the chuck weekly. Follow the chuck manufacturer's instructions for regular service.
- Chuck jaws must not protrude beyond the diameter of the chuck.
- Do not machine parts larger than the chuck.
- Follow all the chuck manufacturer's warnings regarding the chuck and work holding procedures.
- Hydraulic pressure must be set correctly to securely hold the work piece without distortion.
- Improperly clamped parts at high velocity may puncture the safety door. You must reduce the spindle speed to protect the operator when performing dangerous operations (e.g. turning oversized or marginally clamped parts).

Periodic inspection of machine safety features:

- Inspect door interlock mechanism for proper fit and function.
- Inspect safety windows and enclosure for damage or leaks.
- Verify all enclosure panels are in place.

Door Safety Interlock inspection:

- Inspect the door interlock, verify the door interlock key is not bent, misaligned, and that all fasteners are installed.
- Inspect the door interlock itself for any signs of obstruction or misalignment.
- Immediately replace any components of the Door Safety Interlock system that do not operate properly.
- With the machine in run mode, close the machine door, run the spindle at 100 RPM, pull the door and verify the door does not open.

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| MEMS User | Date |
| ME Machine Shop | Date |

# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for HAAS VF MILL
## REVISION: V6 DATE: 02-14-2024

**CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine**
**IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and instructions**

**CAUTION:** All CNC machines present hazards from rotating cutting tools, belts and pulleys, high voltage electricity, noise, and compressed air. When you use CNC machines and their components, you must always follow basic safety precautions to reduce the risk of personal injury and mechanical damage.
The work area must be adequately illuminated to allow clear view and safe operation of the machine. This includes the operator work area and all areas of the machine that might be accessed during maintenance or cleaning. Adequate lighting is the responsibility of the user.
Cutting tools, work holding, workpiece and coolant are beyond the scope and control of Haas Automation, Inc. Each of these potential hazards associated with it (sharp edges, heavy lifting considerations, chemical composition, etc.) and it is the responsibility of the user to take appropriate action (PPE, training, etc.).
Cleaning of the machine is required during normal use and prior to maintenance or repair. Optional equipment is available to aid cleaning such as washdown hoses, chip conveyors and chip augers. Safe use of this equipment requires training and might require appropriate PPE and is the responsibility of the user.
This operator’s manual is intended as a reference guide and is not to be the sole source of training. Complete operator training is available from the authorized Haas distributor.

### Summary of Types of Operation for Haas Automation
### Machine Tools
Haas CNC Mills are intended for cutting and shaping of metals and other hard materials. They are general purpose in nature and a list of all those materials and types of cutting would never be complete. Almost all cutting and shaping is performed by a rotating tool mounted in a spindle. Rotation of the mill is not required. Some cutting operations require liquid coolant. That coolant is also an option depending on the type of cutting.
Operations of Haas Mills are separated into three areas. They are Operations, Maintenance, and Service. Operations and Maintenance are intended to be performed by a

trained and qualified machine operator. This Operator's Manual contains some of the information necessary to operate the machine. All other machine operations are to be considered Service. Service is only to be performed by specially trained service personnel.

Operation of this machine consists of the following:
1. Machine Setup: Machine setup is done to initially set up the tools, offsets, and fixtures required to perform a repetitive function that later is called machine operation. Some machine setup functions can be done with the door open but are limited to “hold to run”.
2. Machine operating in Automatic Mode: Automatic operation is initiated with Cycle-Start and can only be done with the doors closed.
3. Operator loading and unloading of materials (parts): Parts loading and unloading is what precedes and follows an automatic operation. This must be done with the doors open and all machine automatic motion is stopped when the door is open.
4. Operator loading and unloading of cutting tools: Tool loading and unloading is done less often than setup. It is often required when a tool has become worn and must be replaced.

Maintenance only consists of the following:
1. Adding and maintaining condition of coolant: Adding coolant and maintaining coolant concentration is required at regular intervals. This is a normal operator function and is either done from a safe location outside of the work enclosure or with the doors open and the machine stopped.
2. Adding lubricants: Adding lubricants for spindle and axes is required at regular intervals. These are often months or years in length. This is a normal operator function and is always done from a safe location outside of the work enclosure.
3. Cleaning chips out of the machine: Cleaning out of chips is required at intervals dictated by the type of machining performed. This is a normal operator function. It is performed with the doors open and all the machine operation is stopped. Clean area with brush & dustpan and leave it better than you found it.

Read Before Operating

DANGER: Do not enter the machining area any time the machine is in motion, or at any time that machine motion is possible. Severe injury or death may result. Motion is possible when the power is on and the machine is not in [EMERGENCY STOP].

BASIC SAFETY
- This machine can cause severe bodily injury.
- This machine is automatically controlled and may start at any time.
- Consult your local safety codes and regulations before you operate the machine. Contact your dealer if you have questions about safety issues.
- It is the machine owner’s responsibility to make sure that everyone who is involved in installing and operating the machine is fully acquainted with the operation and safety instructions provided with the machine BEFORE they work with the machine. The

ultimate responsibility for safety rests with the machine owner and the individuals who work with the machine.

- Use appropriate eye and ear protection when you operate the machine.
- Use appropriate gloves to remove processed material and to clean the machine.
- Replace windows immediately if they are damaged or severely scratched.
- Keep the side windows locked during operation (if available).

DANGER: To avoid injury, verify that the spindle has stopped turning before opening the doors. In the event of a loss of power the spindle will take much longer to coast to a stop.

OPERATIONAL SAFETY CHECKS

- ✓ Do not operate the machine unless the doors are closed and the door interlocks are functioning correctly.
- ✓ Check for damaged parts and tools before you operate the machine. Any part or tool that is damaged should be properly repaired or replaced by authorized personnel. Do not operate the machine if any component does not appear to be functioning correctly.
- ✓ Rotating cutting tools can cause severe injury. When a program runs, the mill table and spindle head can move rapidly at any time.
- ✓ Improperly clamped parts machined at high speeds/feeds may be ejected and puncture the enclosure. It is not safe to machine oversized or marginally clamped parts.

CAUTION: Manual or Automatic closing of the enclosure doors is a potential pinch point. With Auto Door, the door may be programmed to close automatically, or by pressing the door open/close button on the operator's pendant. Avoid putting hands or appendages in the door while closing either manually or automatically.
Follow these guidelines when you work with the machine:

- Normal operation - Keep the door closed and guards in place (for non-enclosed machines) while the machine operates.
- Part loading and unloading – An operator opens the door, completes the task, closes the door, and then presses [CYCLE START] (starting automatic motion).
- Machining job set-up – When set-up is complete, turn the set-up key to lock out set-mode and remove the key.
- Maintenance / Machine Cleaner– Press [EMERGENCY STOP] or [POWER OFF] on the machine before you enter the enclosure.

Periodic inspection of machine safety features:

- Inspect door interlock mechanism for proper fit and function.
- Inspect safety windows and enclosure for damage or leaks.
- Verify all enclosure panels are in place.

Door Safety Interlock inspection:

- Inspect the door interlock, verify the door interlock key is not bent, misaligned, and that all fasteners are installed.

- Inspect the door interlock itself for any signs of obstruction or misalignment.
- Immediately replace any components of the Door Safety Interlock system that do not meet this requirement. With the machine in run mode, close the machine door, run the spindle at 100 RPM, pull the door and verify the door does not open.

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| MEMS User | Date |
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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for TENNSMITH HAND NOTCHER
# REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.
IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

- Know the safety and operating instructions prior to operation of this notcher. Become familiar with and understand the hazards and limitations of this notcher. Always practice safety.
- Wear approved eye safety protection, such as safety glasses or goggles, etc., when operating the notcher to protect your eyes.
- Protective type footwear should be worn, and jewelry such as rings, watches, necklaces, etc., should be removed prior to operation of this notcher.
- Do not remove the front safety guard (Index # 12). This is a protective device. If the hold-down is inoperable, immediately disconnect the handle (index #35) to the machine, and contact Tennsmith or your authorized distributor for a replacement part.
- Keep the safety guard (Index #12) at the minimum gap required to feed the material into the notcher. The gap should never be higher than 3/16” from the table. If you have questions regarding the safety guard, ask the shop personnel.
- Always keep hands clear of the blade.
- Do not misuse the notcher by using it for other than its intended purpose.
- Never exceed the rated capacity of this machine.
- Keep the work area clear and clean to hazards. Use brush & dustpan. Leave it better than you found it.
- Any malfunction or abnormality pertaining to this machine should be reported to the maintenance supervisor immediately.

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for SHEET METAL BRAKE
# REVISION: V6 DATE: 02-14-2024

## PPE REQUIREMENTS:

- Safety glasses MUST be always worn.
- Closed toe shoes must be worn in the shop.
- No jewelry to be worn.
- Do not wear gloves when using the surface grinder.
- Secure all loose hair and clothing.
- Hearing protection should be considered.

## OPERATIONAL SAFETY CHECKS

- ✓ Guards or safety devices shall never be removed or adjusted, except by an authorized person for maintenance purposes.
- ✓ Working parts should be well lubricated and the jaws and fingers free of rust and dirt.
- ✓ Ensure no slip/trip hazards are present in workspaces and walkways.
- ✓ Be aware of other personnel in the immediate vicinity and ensure the area is clear before using equipment.
- ✓ Familiarize yourself with and check all machine operations and controls.
- ✓ Never use pan brakes for bending metal that is beyond the machine's capacity with respect to thickness, shape, or type.
- ✓ Never attempt to bend rod, wire, strap, or spring steel sheets in a pan brake.
- ✓ Remove the pan brake fingers that are in the way - use only the pan brake fingers required to make the bend.
- ✓ Ensure the pan brake fingers that are not removed for an operation are securely seated and firmly tightened before the machine is used.
- ✓ Ensure fingers and limbs are clear before operating the pan brake.
- ✓ Lower finger clamps to work - gently.
- ✓ Check that the material is secure.
- ✓ Keep clear of moving counterweight (if equipped).

## POTENTIAL HAZARDS

Sharp edges and burrs
Squash/crush and pinch points
Impact from counterweight

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for SHEET METAL SHEAR
## REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.
IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

PPE REQUIREMENTS:

- Safety glasses MUST be always worn.
- Closed toe shoes must be worn in the shop.
- No jewelry to be worn.
- Do not wear gloves when using the surface grinder.
- Secure all loose hair and clothing.
- Hearing protection should be considered.

PRE-OPERATIONAL SAFETY CHECKS:

- ✓ Check workspaces and walkways to ensure no slip/trip hazards are present.
- ✓ Always keep hands clear of moveable knife and holding fingers.
- ✓ Never overload the shear. Do not exceed the manufacturer’s capacity recommendations.
- ✓ Always keep blades sharp. Replace or sharpen when blades become dull.
- ✓ Keep blades properly adjusted. The ideal adjustment is to keep the greatest clearance possible between the blades and still obtain a clean burr free cut.
- ✓ Never reach behind or around the shear and do not allow someone to do so while equipment is in operation.
- ✓ Keep all moving parts lubricated.
- ✓ Do not store tools and parts on top of the machine.
- ✓ Faulty equipment must not be used. Immediately report such hazards to shop manager or personnel.
- ✓ Clean machine and area with a brush & dustpan. Leave it better than you found it.

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for SURFACE GRINDER
## REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.
IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

PPE REQUIREMENTS:

- Safety glasses MUST be always worn.
- Closed toe shoes must be worn in the shop.
- No jewelry to be worn.
- Do not wear gloves when using the surface grinder.
- Secure all loose hair and clothing.
- Hearing protection should be considered.

OPERATIONAL SAFETY CHECKS:

- ✓ Check workspace and walkways to ensure no slip-hazards are present.
- ✓ Check that all guards are in position.
- ✓ Inspect both sides of the grind wheel carefully. Rotate the wheel manually and visually inspect for chips and cracks.
- ✓ Ensure that the workpiece and the magnetic chuck are clean and smooth. Stone surface if needed.
- ✓ Be sure you know where the on/off and e-stop buttons are located.
- ✓ Re-check the magnetic chuck status before engaging power feeds. With the power on, try to move the workpiece to be sure the chuck is working.
- ✓ Don’t operate if spindle vibration is present.
- ✓ Do not grind NON-FERROUS METALS. These metals can/will plug up the wheel causing an unsafe condition.
- ✓ Never leave rags or tools on the grinder or chuck.
- ✓ Check the grind wheel location before engaging the automatic feed.
- ✓ Ensure that the coolant supply lines clear the workpiece and is secured out of the way.
- ✓ NEVER attempt any grinding operation with the magnetic chuck disengaged.
- ✓ Never allow coolant to run onto a grinding wheel that is not running. This causes the grind wheel to absorb coolant causing an out of balance condition.

- ✓ Do not touch off the wheel to the workpiece unless the wheel is turning. Contact with the workpiece can cause damage to the wheel, workpiece, or the arbor.
- ✓ When finished, shut off the coolant flow. Allow the wheel to wind down to flush excess fluid from the wheel. Clean machine and surrounding areas with brush & dustpan. Leave it better than you found it.

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for TABLE SAW
# REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.
IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

Pre-Check Precautions:

- ✓ Do not use this machine unless you are trained and qualified to use it safely.
- ✓ Inspect the saw for damage or missing parts. Be sure all shields and guards are securely in place. If the saw fails the pre-check inspection, notify the shop supervisor immediately.

Operating Precautions:

- ✓ Wear proper personal protection equipment when using a table saw, including safety glasses or goggles and hearing protection.
- ✓ Ensure saw fences, blade guards, spreaders, and anti-kick devices are in place and functioning properly.
- ✓ Assure saw blades are clean, sharp, and correctly set so that they will cut freely without forcing the work piece against the blade.
- ✓ Keep the body and face to one side of the saw blade out of the line of a possible kickback.
- ✓ Check stock for nails, screws, or other foreign objects prior to sawing.
- ✓ Use a guard high enough to cover the part of the blade rising above the stock and wide enough to cover the blade when it is tilted.
- ✓ Use guard with a spreader and anti-kickback fingers for all ripping or cross cutting operations.
- ✓ The blade height should be set so it does not extend more than about an 1/8 in above the height of the material.
- ✓ Never feed the work piece faster than the saw can accept.
- ✓ Use a push stick to cut short or thin pieces of stock on a table saw.
- ✓ Never make free-hand cuts with a table saw; guide stock using a rip fence or miter gauge.
- ✓ Never reach behind, over, or under a saw blade unless it has stopped turning and the power has been disconnected.
- ✓ Disconnect the power source before changing or adjusting the saw blade.
- ✓ Do not leave a saw running unattended. Turn off the power and make sure the machine has stopped running before leaving the area.

- ✓ When you finish, clean machine of all debris with a brush & dustpan. Leave it better than you found it.
- ✓ Be sure surrounding area is left in a clean condition and any waste is removed.

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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for MIG/TIG WELDER
# REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.
IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

## OPERATIONAL SAFETY CHECKS

1. Ensure the welder is used in a suitable safe work area.
2. Ensure all cables are correctly fastened, free of cracks and splits and unwound before work.
3. Keep the area clean & free of grease, oils & flammables.
4. Ensure other workers are protected from any UV flash.
5. Ensure the area is well ventilated (with fume extraction as required).
6. Ensure the welder is correctly set up for current, voltage and good earth.
7. Ensure that other workers in this locality are protected from any UV & IR radiation flash. Always close the UV curtain to the welding bay or erect a UV screen.
8. Ensure the welding return cable (earth) makes firm contact to provide a good electrical contact.
9. Ensure your workpiece has been prepared to be free of any paint, oxides or other surface finishes ensuring a good electrical contact.
10. Take particular care to avoid accidental UV welding flash to the skin or eyes.
11. Never leave the welder running unattended.
12. Regularly inspect the welding tip and shield for damage.
13. When welding is finished or interrupted, turn off the welder and secure the handpiece safely.
14. Ensure the work area can isolate hot areas from workers to avoid hot surfaces until job is cool.

## HOUSEKEEPING

1. Ensure the welder is switched off (and fume extraction if used).
2. Check for any damage to welder and cables at the end of job. Wind up cables.
3. Hang up the welding handpiece and cables securely.
4. Check contact points for damage or corrosion.

5. Leave the work area and welding bench in a safe, clean, and tidy condition with a brush & dustpan.
6. Leave it better than you found it.

## POTENTIAL HAZARDS

1. Welding flash eye injury - correct use of PPE, maintain or replace bad or worn items
2. Eye injury, hot slag - protective glasses or face shield when removing weld slag
3. Fire and explosion - clean work area and correct use of hot mats
4. Burns - Correct use of protective clothing / PPE and hot work mats

**DO NOT** proceed with this equipment unless appropriately instructed in its safe use and operation and permission to operate has been given.

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| MEMS User | Date |
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# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for MANUAL MILLING MACHINES
# REVISION: V6 DATE: 02-14-2024

CAUTION: Only authorized and trained personnel may operate this equipment. You must always act in accordance with the Operator's manual, safety decals, safety procedures, and instructions for safe machine operation. Untrained personnel present a hazard to themselves and the machine.
IMPORTANT: Do not operate this machine until you have read all warnings, cautions, and Instructions.

## BASIC CAPABILITIES

Milling machines are very versatile. They are usually used to machine flat surfaces on square or rectangular parts but can also produce many unique and irregular surfaces. They can also be used to drill, bore, produce slots, pockets, and many other shapes. The type of milling machine in the UCR Mechanical Engineering Machine Shop is a variable speed vertical spindle, knee-mill with a swiveling head (also known as a "Bridgeport"). Although there are several other types of milling machines, this document will focus only on the vertical milling machine.
A milling machine removes metal by rotating a multi-toothed cutter that is fed into the moving workpiece. The spindle can be fed up and down with a quill handle on the head.
The goal of this SOP and the accompanying "training" is not to make you a mill operator/machinist, but to make sure you can safely do certain tasks. It applies to all students, staff, faculty, and others who wish to use the machine shop!
This SOP should be read, fully understood, and reviewed at the machine with the Shop Manager. Every machine user will have to take the "Basic User Safety Test", demonstrate "hands-on" proficiency, and then sign the "BASIC USER CLEARANCE FORM & SUPERVISED EXPERIENCE LOG" before being approved to operate the machine. The allowable machining tasks will be limited to those covered in this SOP.
There is much more to using a mill than what is covered in this SOP. Always ask before doing a new operation!

## BASIC MACHINE PARTS

ON / OFF SWITCH For turning the spindle ON or OFF and for changing the direction of spindle rotation.
BRAKE For manually stopping the rotation of the spindle after turning the spindle off.
SPEED KNOB For adjusting the spindle rotation speed.
(RPM) POWER DRAWBAR For inserting or removing of collets / cutters from the machine spindle.

QUILL LOCK For locking the machine's quill at a preset height or location.
QUILL HANDLE For moving the quill up and down in the Z-axis direction.
VICE For clamping work pieces onto the milling machine table.
X- AXIS HANDLE For moving the machine table in the X+ or X- direction (left or right)
Y-AXIS HANDLE For moving the machine table in the Y+ or Y- direction (front to back)
Z-AXIS HANDLE For moving the machine table in the Z+ or Z- direction (up and down)

## SAFETY RULES

### For everyone using the milling machines, without exceptions!

1. Safety glasses always worn, by everyone in the shop!
2. No long sleeves, no gloves, no open toe shoes, and no jewelry or watches.
3. Long hair must be secured behind your head!
4. Become thoroughly familiar with the machine before operating it!
5. When in doubt, always ask a supervisor or shop manager!
6. Never use the mill (or any other equipment) when tired or rushed for time!
7. Only attempt work that you have been approved to do and are comfortable doing!
8. Get additional training, refresher courses and approval as necessary! ASK FOR HELP!
9. Never reach anywhere over, around or near any rotating cutter(s)!
10. Stop the machine every time the cutter is not cutting, not being used, or you are changing tools/parts!
11. Only remove chips using gentle air blasts or chip brushes, be aware of cutting tools!
12. Use a chip shield to keep chips from hitting you and/or others in the area!
13. Keep ALL rags and tools away from the machine and off machine table(s) during use!
14. Be sure the holding device and workpiece are both securely clamped!
15. Always make sure that the cutting tool is sharp, at the correct height and has the proper clearance.
16. Do not be distracted or talk to others when operating the machine.
17. Do not walk away from running machines. Turn them off every time!
18. Report ALL broken tools, cutters and/or malfunctioning equipment to a supervisor or the Shop Manager!
19. Keep your work area clean (including the floor), free of chips and any oils!
20. Students are NOT ALLOWED to teach other students in the use of the mill!
21. Leave the entire machine CLEANER than when you found it!

Be safe, ask if unsure, use your common sense, and look out for the safety of others.

## USING THE MACHINE

### 1. Tramming the Head with the help of a supervisor or Shop Manager.

The head of a vertical milling machine can be tilted from side to side and from front to back. This allows for versatility of the machine, but these adjustments can drift. Occasionally, one should check and adjust the head so that the spindle will be normal to the plane of the table. To check, install a dial indicator into the tramming bar, and install the dial indicator on the other end of the bar. The indicator face should be facing up and the probe at 45 degrees to the table. Lower the spindle until the dial indicator contacts the table then registers about one half of a revolution.

Set the dial indicator is toward you and set the bezel to zero. Rotate the spindle by hand 180 degrees. If the dial indicator still reads zero, the spindle is aligned front to back. If not, adjust the head until the dial reads half of the original reading and iterate the entire process until the error falls within acceptable limits. Repeat the process with the dial displaced left and right to alight the head side to side.

2. Squaring the Vise. *Check before every job, don't assume it's aligned or tightened!*
Work on a milling machine is most often held in a vise clamped onto the bed. To make sure the parts we make are square and parallel, the vice must be aligned with the X travels of the machine. To do this, mount the vise on the bed and secure it with T-bolts, but only lightly to permit adjustment of the orientation of the vise. Mount a dial indicator in the spindle of the machine with the probe facing away from you. Lower the spindle and run the bed of the table back until the fixed (back) jaw of the vise is in contact with the indicator and further until the indicator registers one half of a revolution. Set the bezel to zero. Use the manual cross feed to run the indicator across the face of the vise.
If the vise is squared, the indictor will remain at zero. If the dial indicator does not read zero, tap lightly with a soft hammer to realign the vise. Repeat this procedure until the dial indicator reads zero through the full travel across the face of the vise jaw. Tighten down the T-bolts be careful not to change the vise orientation. Recheck the alignment of the vise.

3. Setting Spindle Speed & High/Low Gearing.
Spindle speed is set by turning the speed crank on the right side of the spindle. The spindle must be on and rotating to adjust the speed. There is a manual display (dial) on the head of the machine that shows the speed in rpm. The spindle speed dial has two scales, one for low range, and one for high range. The machine is switched between ranges with "SPEED RANGE" lever on the right side of the machine head. Switching this lever must be done with the spindle not running! Sometimes, the spindle must be rotated slightly (by hand) to allow the gears to mate properly and allow the lever to "click" into gear.

4. Using an Edge Finder.
Before doing precise work on a milling machine, one must locate the edges of a part accurately. An edge finder is designed to do this on edges with flat vertical surfaces. An edge finder is composed of two concentric cylinders, spring loaded together. To use it you must first insert it into the machine with the appropriate collet. The big end of the edge finder is held in the collet at least ½ way in. Start the spindle and set the speed to approximately 1,000rpm. Flick the bottom of the edge finder to induce a wobble in the smaller diameter. The smaller diameter is usually .200" diameter. Then, move the part into the tool very slowly. The edge finder will center up, then break out of concentricity suddenly. At that point, reset the dial indicator or digital readout for that axis of the machine to a value equal the radius of the edge finder. Repeat the process at least twice to make sure your edge finding was correct.

5. Using the Digital Read-outs, commonly known as DROs.

The mills are equipped with electronic display for accurate positioning. These DROs have a 4-place display (.0002" accuracy) for the X and Y axes. The Z axes is still read off the mechanical dial on the Z-axis handle with a .001" accuracy.
There are two systems of measurement that the DROs can supply, Incremental and Absolute. Absolute should be used for the "zero" corner of your part and not be changed during the job. The incremental setting can be "zeroed" as necessary for use between any two locations, features, holes, etc….

6. Cutting Fluids and their applications.
Different applications and/or materials require slightly different cutting fluids. These fluids are designed to provide the correct amount of lubricity, cooling, better surface finish, increased tool life and more. All cutting fluids (especially WS11) should be thoroughly cleaned / removed from the machine when finished! The machine should be dry and a light "misting" of WD40 applied to the entire vice, tables, and machine ways to prevent corrosion.

Fluids:
- WS11 – Water soluble oil. A combination of 5% WS11 oil + 95% water. Resembles "milk"
- A9 Cutting Fluid. Specially designed for aluminum and other soft metals. Green in color.
- Moly Dee. A thick, black, heavy cutting fluid for steels and other tough to machine materials.
- WD40. Not a cutting fluid, only use to protect for corrosion on cleaned machines.

Applications:
Aluminum & other soft materials tapping: Use A9 cutting fluid. Applied with a drip from the nozzle or brushed onto the tap.
Aluminum & other soft materials drilling/milling/boring/etc.: Apply liberal amounts of WS11 with an acid brush or spray bottle.
Steel tapping & heavy cutting: Use Moly Dee, applied with a drip or acid brush directly to the tap.
Steel drilling/milling/boring/etc.: Apply liberal amounts of WS11 with an acid brush or spray bottle.
Plastics: Most do not need any cutting fluids. Correct speeds & feeds are more critical.

7. Cutting Tool Holders. *You must match the correct ones!*
The only types of tools that are permitted to be used in the manual mills are listed below. The machine operator should review and learn the information given in the separate [MILL CUTTING TOOLS SOP] to determine when to use what type of cutting tools.

Mill cutting tools can only be held in the machine with a collet or Drill chuck:
In an R8 mill collet, you can hold: End Mills, boring heads, fly cutters, shell mills, counterbores.
- Diameter of tool MUST match the size of the collet.

In a precision drill chuck, you can hold: Drill bits, reamers, countersinks, center drills.
- Do not use keyed or tapered drill chucks in the mill.

8. Removing and Installing Cutting Tools. *Easy if done correctly.*
REMOVNG OR INSTALLING CUTTING TOOLS IS ALWAYS DONE WITH THE MACHINE OFF!!! Make sure that there is enough room between the quill and workpiece/vice/table (8" -12") to easily remove/insert the cutting tool and collet.
To remove a tool from a machine WITH a power drawbar installed, move the quill to the highest position and lock it in place with the quill lock. Hold whatever is in the collet (endmill, drill chuck, etc.) then press and hold the green button and the red "OUT" button simultaneously (for 3 seconds) on the power drawbar box. This will release the collet and cutter from the spindle. Hold on to both as you remove them. If you do not hold on to the collet and cutter, they will fall out and can be damaged.
To install a collet and cutter, move the quill to the highest position and lock it in place with the quill lock. Place the desired milling cutter (or drill chuck) in a collet of the correct diameter. Insert the collet into the spindle. Ensure that the keyway on the collet mates properly with the key in the spindle and is fully inserted. While holding the tool with one hand, press and hold the green button and the red "IN" button simultaneously (for 3 seconds) on the power drawbar box.
9. Cleaning the Machine proper procedures for care and feeding the machine must be cleaned after every use. If another user needs the machine, immediately after you, make sure you discuss who will leave the machine clean. The process is simple and should not take more than 10 minutes.

Make sure you are aware of clock to leave enough time to finish clean-up. The procedure is:
A. Turn off the machine and remove the cutter and collet from the spindle.
B. Put away all your hand, set-up and cutting tools. If not sure where they go, ask a supervisor.
C. Use a brush or light blasts of air to remove the chips from the vice, table, and ways.
D. Do not blast the chips and fluids across the shop, use enough force to get the chips to the ground.
E. Brush or vacuum the difficult to reach spots. Wipe the spindle, table, ways, covers, vice, etc…
F. Wipe off ALL cutting fluids and oils from the ENTIRE machine. Top to bottom, machine must be dry.
G. Gently mist the table, ways, vices, or chuck(s) with WD40. Pump the central lubrication handle 4x.
H. Sweep the floor and surrounding areas. Chips are to be placed in chip buckets, not regular trash cans.
I. There should be NO visible chips of any size on the machine. Leave it cleaner than when you found it.

10. Unfinished Work and leaving your machine.
A machine may be left set-up with your job ONLY if you will be returning at the next available opportunity. If it is less than a 2-hour gap, the machine may be left as is, just sweep the floor. If it is to be more than two hours or you are unsure, the machine must be cleaned (as above) and all tools/cutters/supplies must be put away. Machine set-ups will be broken down after 4 hours or if there is an urgent need unless other arrangements are made with a supervisor or shop manager. Make sure you leave a sign with your name, phone number and a time/date when you will be returning to use the machine.

11. Climb vs. Conventional Milling. *The wrong choice can do damage!*
This section refers to using end mills (or similar tools) and cutting away at the side/wall of a workpiece. When milling, one should be aware of the difference between conventional and climb milling. In conventional milling, the workpiece is fed against the rotation of the cutter. The material is being scooped away. This type of cut has lower forces and is preferred for roughing or heavy cuts. It should be used in most cases. In climb milling, the work moves with the rotation of the cutter, as if it is "climbing up" the material. Using a climb cut for a "last pass" or a "finish pass" to remove only .002" - .015" is OK. Using a climb cut for heavy material removal could lead to tool breakage and damaged parts. The machine operator should review and learn the information given in the separate [MILL CUTTING TOOLS SOP] to determine what type of end mills to use and when to use them.

12. Drilling and use of drill chucks.
Drilling is the process normally described as cutting round holes in a material. Keyless drill chucks are the most common way to hold drill bits. Bigger drill bits (over .500" dia.) can be held in R8 collets ONLY if the drill shank (aka, body) is the EXACT SAME SIZE as the collet being used. The machine operator should review and learn the information given in the separate [MILL CUTTING TOOLS SOP] to determine what type of drill bits to use and when to use them. Be aware of the range capability of the drill chuck, most are .063" to .520" The best way to tighten a "keyless" drill chuck is (with the machine OFF) hold the machine's spindle brake and turn the chuck body counterclockwise. Reverse this to release the drill bit, but make sure you don't allow the drill bit to fall out!

13. Calculating Speeds and Feeds *"A happy machine is a quiet machine!"*
*"Speed"* refers to the spindle RPM (Revolutions Per Minute). *"Feed or feedrate"* refers to the amount you make the cutting tool move across or into your workpiece (aka, feedrate). Feeds and speeds affect the time to finish a cut, tool life, finish of the machined surface and power required of the machine. The cutting speed is mostly determined by the material to be cut and the material of the cutter. Lubricant plays a critical role in cutting. Make sure you use plenty of the correct type! Broken or abused tools are the responsibility of the user and will have to be replaced at your cost.
To find the right speed for any task, first ask a shop supervisor. If unavailable, use the *"Speed vs. Feed" guidelines* as a starting point. The feed rate depends on the width and depth of cut, finish desired and many other variables. THE *most* common mistake is to run the feeds or spindle speed too fast!

SPEED VS. FEED - BASIC GUIDELINES
IF THEN
You INCREASE the FEEDRATE too much… You risk taking too big a "bite" and will break the cutter.
You DECREASE the FEEDRATE too much… You risk "rubbing" (not cutting) and will wear out the cutter.

You INCREASE the SPINDLE SPEED too much… You will not cut, but instead burn up the tool with friction.
You DECREASE the SPINDLE SPEED too much Your cut will be very slow.
You find the right balance… The machine will be quiet (not screaming or shaking)
You find the right balance… You will be making (nice, not discolored) chips.
You find the right balance… You will be removing material, and the cutter will last!

14. USING A VICE for clamping parts.
A precision vice (KURT model 675) is the most common way to hold parts in a milling machine. There are several considerations that must be taken into account to make sure the part is secure. At first, you should seek guidance from a supervisor for every setup in a vice and learn by example. Vice stops will enable you to accurately take parts in and out of the vice, learn how to use them. Most importantly, always get a supervisor's advice for unusually shaped parts or setups.

Some general guidelines:
A. ALWAYS SHUT OFF THE MACHINE BEFORE DOING ANYTHING IN OR NEAR A VICE.
B. Don't assume the vice is aligned or tightened down! Always check with an indicator.
C. Always wipe off the vice jaws, parallels and other fixtures when clamping a new part.
D. Always grip at least 50% of the part and in the center of the jaws.
E. Never grip a part at just one end of the vice unless an identical part is at the other end.
F. Get instruction or supervision!

15. USING PARALLELS in a Kurt vice.
Parallels are used to raise the work above the vice jaws for machining, drilling, or other operations. They can set the part height so the vice jaws will not be hit by your cutting tools and that any drilling operations will not cut into the bottom of the vice. Make sure you use a matching (height) set. Also be aware of running into the parallels, and constantly check to see that they have not moved unintentionally. It is a good idea to always check that no chips have fallen on top of or underneath the parallels, as this will greatly affect the accuracy of your parts!

16. SQUARING STOCK & FACE MILLING
First step in accurate parts is to create a square corner on a part, first orient an already finished edge vertically in the vise and clamp lightly onto the part. Set a machinist's square against the finished edge and the bottom of the vise. Lightly tap the part with a plastic hammer to align it with the square. Clamp the vise down securely. Now the top edge of the part is ready to be milled horizontally.
It is often necessary to create a flat face on a large part. This is called face milling. Select a sharp, flat bottom, end mill cutter a little wider than the workpiece so that the facing can be accomplished in one pass. This can work for end mills up to .750" diameter in size. Beyond that size, you will have to make multiple passes or use a fly cutter.
Fly cutting, which is also called single point milling, is one of the most versatile milling operations. It is done with a single point cutting tool shaped like a lathe tool bit. It is held and rotated by a fly cutter arbor. You can grind this cutter to almost any form that you need. It is more economical to

grind the desired form on a lathe-type tool bit than to buy a pre-ground form cutter, which is very expensive and usually suitable only for one job.
For milling slots, end mills are an idea tool. They will produce a slot to within two one-thousandths of an inch in one pass. If greater accuracy is required, use an end mill a little smaller than the desired slot. Measure the slot you produced and then open it to the desired dimension with a second pass. Note that the depth of cut should not exceed three times the diameter of the cutter.

## 17. DRILLING, BORING & REAMING

Much more accurate than a drill press, the milling machine may be used effectively for drilling, since accurate location of the hole may be secured by means of
table positioning. Spacing holes in a circular path, such as the holes in an index plate, may be accomplished by indexing with the index head positioned vertically.
Twist drills may be supported in drill chucks fastened in the milling machine spindle or mounted directly in milling machine collets or adapters. The workpiece to be drilled is fastened to the milling machine table by clamps, vises, or angle plates.
For boring, there are various types of boring tool holders may be used for boring on the milling machine, the boring tools being provided with either straight shanks to be held in chucks and holders or taper shanks to fit collets and adapters. The two attachments most commonly used for boring is the offset boring head, also known as the "Criterion Boring Head."
The single edge cutting tool used for boring on the milling machine is the same as a lathe cutter bit. Cutting speeds, feeds, and depth of cut should be the same as that prescribed for lathe operations.
Boring is usually used for holes bigger than .500" diameter. The most accurate way to finish a hole smaller than .500" diameter is the process of reaming. Reaming is a process which slightly enlarges a pre-existing hole to a tightly toleranced diameter. A reamer is like a mill bit in that it has several cutting edges arranged around a central shaft.
Reaming is always done after hole drilling. If the hole is drill crooked, the reamer will follow the crooked hole. Reaming should not be relied upon to correct the location or alignment of a hole. Reamed holes should not intersect with drilled holes. Its primary purpose is to fine-tune the diameter of the hole. Reaming is most accurate for axially symmetric parts produced and reamed on a mill. Reamers come in a multitude of sizes.

## 18. OTHER CONSIDERATIONS to be aware of.

- Never be afraid to ask for help and guidance, that is why the shop supervisor is there! When in doubt, always ask!
- These are very capable machines but must be used correctly to avoid damage and accidents. Learn how to use them correctly, there are no shortcuts in quality and safety!
- Come prepared. Have your material/parts, complete (accurate) drawing(s), a plan of action and list of tools you will need.
- Cutting tools are VERY expensive and easy to break or dull. You are responsible if they are broken or damaged.
- Don't leave rags, measuring or other precision tools on the table of the machine. They will get damaged,

- contaminated or fall off.
- Double check your set-up before starting any operation. Check for tightness/rigidity, correct speeds/feeds, obstructions, clamps, etc.
- Re-read the safety rules, your life and health depend on it!

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| MEMS User | Date |
| ME Machine Shop | Date |

# UC RIVERSIDE – MECHANICAL ENGINEERING DEPARTMENT – MACHINE SHOP
# STANDARD OPERATING PROCEDURES
# for MANUAL TOOL ROOM LATHES
# REVISION: V6 DATE: 02-14-2024

## BASIC CAPABILITIES

Lathes are very versatile. They are usually used to machine (turn) round (cylindrical) parts, but can also produce many unique and irregular shapes. A lathe can drill, ream, turn, knurl, cut and shape cylindrical parts. The type of machine in
the UCR Mechanical Engineering Machine Shop is a manual lathe, also known as a tool room lathe. Although there are several other types of LATHES, this document will focus only on the manual lathe. They are also known as tool room lathes and/or engine lathes.
Normally, a part is held in a collet or lathe chuck and a cutting tool is held in a tool post. The lathe is switched on and the part begins to rotate. The cutting tool is then brought to the rotating part and removes material.
The goal of this SOP and the accompanying "training" is not to make you a lathe operator/machinist, but to make sure you can safely do certain tasks. It applies to all students, staff, faculty, and others who wish to use the machine shop!
This SOP should be read, fully understood, and reviewed at the machine with the Shop Manager. Every machine user will have to take the *"Basic User Safety Test",* demonstrate *"hands-on"* proficiency, and then sign the *"BASIC USER CLEARANCE FORM & SUPERVISED EXPERIENCE LOG"* before being approved to operate the machine. The allowable
machining tasks will be limited to those covered in this SOP.
There is much more to using a lathe than what is covered in this SOP. Always ask before doing a new operation!

## BASIC MACHINE PARTS

SPINDLE LOCK KNOB For keeping the spindle from rotation when tightening or loosening collets.
TAILSTOCK For accurately holding the tailstock spindle.
TAILSTOCK HAND WHEEL For moving the tailstock spindle toward or away from the workpiece.
TAILSTOCK SPINDLE For holding drill chucks or lathe centers in the tailstock.
SPINDLE SPEED DISPLAY Shows the spindle speed in Rotations Per Minute (RPMs).
SPINDLE SPEED KNOB For adjusting the speed of the lathe spindle.
CARRIAGE (aka, SADDLE) Moves the tool post, cross slide toward or away from the chuck.
EMERGENCY STOP SWITCH For shutting off the spindle rotation and feeds in case of an emergency!
COLLET CHUCK For holding small diameter work pieces in the spindle of the lathe.
TOOL POST For holding and quickly changing between different Tool Holders.
TOOL HOLDER For holding lathe bits and other lathe cutting tools.

COMPOUND SLIDE HAND WHEEL For manually feeding cutting tools at an angle to the spindle.
CROSS SLIDE HAND WHEEL For manually feeding cutting tools across the spindle (the X axis).
CARRIAGE HAND WHEEL For manually feeding cutting tools in line with the spindle (the Z axis).
CROSS SLIDE FEED LEVER For turning the auto feed for the cross slide on and off.
CARRIAGE FEED LEVER For turning the auto feed for the carriage on and off.
SPINDLE ON/OFF & DIR. LEVER For turning the spindle on or off and for setting the rotation direction.
FEED DIRECTION KNOB To determine the direction of the carriage or cross slide auto feed.

## MANUAL LATHE SAFETY RULES

*For everyone using the manual lathe, without exceptions!*

1. Never wear long sleeves, gloves or any jewelry and always tie your hair back.
2. Keep ALL rags away from the machine while it is in motion.
3. Never use the lathe when tired or rushed for time!
4. ALWAYS remove the chuck key from chuck immediately after using!
5. Make sure that the chuck or faceplate is ALWAYS fully tightened onto the spindle.
6. Make sure your part is securely tightened in the chuck or collet.
7. Always check that the chuck or collet will clear the toolpost before you start.
8. Move the tool bit, tool post and/or tailstock a safe distance from the chuck or collet when inserting or removing your workpiece.
9. Don't run the machine faster than the proper cutting speed.
10. In setting up the tool holder, place it to the left side of the compound slide to prevent the compound slide from running into the chuck or spindle attachments.
11. Always clamp the tool bit as short as possible in the tool holder to prevent it from breaking or chattering.
12. Always make sure that the tool bit is sharp, at the correct height and has the proper clearance.
13. Filing on work revolving in the lathe is only done with permission and supervision!
14. If work is turned between centers, make sure that the proper adjustments are made between centers and that the tailstock is locked in place.
15. 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.
16. Set the tool bit on the centerline of work to prevent work from climbing over tool or cutting above center and dragging.
17. Don't cut work completely through when turning between centers.
18. Turn chuck or face plate through by hand before turning on the power to be sure there is no binding or clearance problems.
19. Stop the machine before taking ANY measurements.
20. Students are NOT ALLOWED to teach other students in the use of the lathe!
21. Leave the entire machine CLEANER than when you found it!

Be safe, ask if unsure, use your common sense, and look out for the safety of others.

## USING THE MACHINE

### 1. Three important elements.

To get an efficient process, good surface finish and correct geometry on the lathe, it is important to adjust the rotating speed (RPM), a cutting depth and a feed speed. Please note that these important elements cannot be decided easily, because these suitable values are quite different for each material.

ROTATION SPEED It is the number of rotations per minute (rpm) of the chuck or collet. When the rotating speed is high, higher removal rates are possible. But when too high, too much friction could be generated. However, since a little operation mistake may lead to the serious accident, it is better to set lower rotating speed at the first stage.

CUTTING DEPTH The cutting depth of the tool affects to the processing speed and the roughness of surface.

When the cutting depth is big, the processing speed becomes quick, but the surface temperature becomes high, and it has rough surface. Taking off too much material can break the tool or your workpiece. If you do not know a suitable cutting depth, it is better to set to small value. Always remove a very small amount of material on your final pass to assure a good surface finish.

FEED SPEED The feed speed of the tool also affects to the processing speed and the roughness of surface. When the feed is high, you can remove a lot of material quickly. When the feed is low, the surface improves. There are automatic feeds on these machines that can move the feed handles for you at a very accurate feed. These auto feeds maintain a consultant speed and result in nicer finishes. A beginner must always use the manual mode, until they have enough experience. A user should hold the handle of the automatic feed until the operation is complete and never walk away. Serious accidents may occur if the tool bit or any part of the post or the cross slides touch the collet or chuck!

## 2. Common lathe cutting tools.

Always use the correct and properly sharpened tool for the job. Dull tools lead to bad surface finishes, out of tolerance parts and potentially a hazard situation. Below are the three most common types of lathe tools.

THE LATHE BIT These can cut outside surfaces and edges. There are versions that consist of a piece of carbide brazed onto a rectangular steel bar. The ones in the above image are called “insert lathe tools.” It is because they have a carbide insert that can be replaced or rotated when they become dull. This is ideal for those that have little or no experience in grinding their own tools.

THE CUT OFF TOOL This tool (shown above) is also called a “parting tool.” It is primarily used for cutting off (aka, parting) the workpiece and making outside grooves. This tool can only cut “across” the part in one direction (along the X axis).

THE BORING BAR This tool (shown above) is mainly used to make diametrical (round) holes of any size and depth. Normally used to cut at an inside surface. It can make a hole that is much bigger and more accurate than a regular drill. The other big advantage is that a boring bar can make irregular diameter holes with flat bottoms. Drills and reamers are only available in “standard” sizes, but a boring bar does not have that limitation. In most cases, there needs to be an existing hole to fit the boring bar. This hole can be produced with the use of a regular drill bit.

## 3. Clamping workpieces using a Lathe Chuck.

A chuck is directly attached to the drive mechanism (spindle) of the lathe and rotates at variable speeds up to as much as 1000 rpm on this machine. A 3 or 6 jaw chuck has the ability to hold a wide range of cylindrical parts from .250” diameter, all the way up to 8” diameter.

To start, the operator clamps the piece of metal to be turned in the chuck. Depending on the size (diameter and/or length) of the part, will determine how much of it will need to be clamped in the chuck. These chucks are very accurate, but pieces of metal are not always perfectly straight and level. So, it is recommended that you use a dial indicator to check the concentricity your workpiece in relationship to the machine. This can be done by placing the indicator on top of the tool post with the dial stem touching the part and with the machine turned OFF, rotating the chuck by hand. Depending on the required precision, it is important to check the trueness of the part to within one or two thousands of an inch.

Once you are sure that the part is true, tighten the chuck as tight as necessary to hold the part without damaging the clamping surface. This is done by placing the "chuck key" in the key receptacle on the side of the chuck and turning it clockwise. *NEVER LEAVE THE KEY IN THE CHUCK!!!* Place the chuck key on the workbench, away from all moving parts. If the key is left in and the machine started, serious bodily harm will result! Check once more for “true” if the precision is necessary. Before even starting the machine, spin the chuck by hand to make sure it clears the carriage, cross slide, tools, tool post and/or all other parts of the machine!

There are also 4 jaw chucks where each jaw can be adjusted independently, these are for off-center lathe work and require special training. Consult the shop supervisor if your parts need this tool.

The spinning jaws on a chuck are very dangerous. At certain speeds, the jaws become an invisible blur! In a noisy environment, a spinning chuck may not appear to be spinning. Always be aware of the jaws as you are working on the lathe! Keep your hands, body and cutting tools well away from the chuck at all times!

## 4. Clamping work-pieces using the collet chuck.

A collet chuck takes the place of a 3, 4/ or 6 jaw chuck. It uses collets to hold diameters ranging from .125” to 1.313”. Since it relies on collets and has no spinning jaws, it is more accurate and safer way to hold your work. Make sure that the diameter of your workpiece matches the size of the collet within (+/-) .015” Any larger variations and the workpiece could slip, or the collet could be damaged!

Make sure the spindle is OFF and not rotating before inserting or removing collets or work pieces! Also, you should move the tailstock and carriage/saddle away from the collet chuck. The collet is inserted into the collet chuck by aligning the “key”. You have done this correctly when the collet slips almost completely into the collet chuck. Place your workpiece into the collet (at least 1” in for most diameters!). Then tighten the collet by pressing and holding the spindle lock knob and simultaneously rotating the collet chuck wheel away from you. To loosen the collet, press and hold the spindle lock knob and simultaneously rotate the collet chuck wheel toward you. It might take several rotations to release your part.

## 5. Tool post and cutting tool set-up.

The tool post is where the cutting tool and holder will be located. The tool post uses a dovetail design to enable a user to pre-set several tools for easy and accurate changes between cutting tools. The tool post is permanently mounted to the machine but can be move and rotated. The tool holders have knob on top to quickly adjust cutting tool heights.

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. This may damage your workpiece or break the cutting tool. If the tool is set too low, the tip of the tool will tend to gouge and/or cut too deep. It will also leave an undesirable "nub" when you reach the center of the workpiece.

A quick trick for setting the tool height is to gently squeeze a 6" metal scale between the cutting tool and your workpiece with the machine OFF and spindle stopped. Have the shop supervisor show you how to do this properly and easily. This technique will get you very close to the ideal tool cutting height with most lathe tools.

### 6. Moving the carriage and cross slide.

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 or the part (the X axis). The carriage and the cross slide are both moved manually by using hand wheels. The cross-slide hand wheel has dials that show DIAMETRICAL distances. Each graduation on the hand wheel indicates .001"of diameter movement of your tool. Movement of the carriage is measure with the use of a dial indicator mounted on the left side of the carriage. It is limited to 2 inches of travel for measurement purposes but can be set anywhere along the carriage's travels.

In addition, there are two levers on the carriage that turn on the carriage and cross feed *"power feeds."* One feeds (moves) the carriage at a predetermined speed and the other feeds the cross-slide. There is also a (push/pull) knob that changes the direction of both feed levers! To understand these features, you should test these operations well away from the chuck, at different speeds and while supervised. This will enable you to get the feel of the automated movements of the machine.

### 7. Compound slide.

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. There is no "power feed" option and it must be operated manually.

### 8. Tailstock and its features.

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 tailstock'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 *"Jacobs Taper"*). The tailstock is slid toward the workpiece and LOCKED DOWN, leaving about 1" of room between the drill and the workpiece. The tailstock hand wheel is then used to feed the drill into the workpiece. Unlike other machines, the lathe workpiece spins and the cutting tool stays still.

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 Jacobs taper adapter that is inserted into the tailstock (like a drill chuck). 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. This is done for pieces that are too long to be safely held in just a chuck or collet. Normally, if the length of piece is sticking out more than 5

times the diameter, a live center should be used. For example, if the part is 1" in diameter, it should not stick out more than 5" in length. Again, check with the shop supervisor for guidance! Live centers should not be used when the workpiece will be parted with a cut-off tool.

### 9. Setting workpiece length.

Finding the end of a cylindrical part sometimes requires actually touching the rotating part with the tool bit. Having checked that there are no chances of collision, and with the part rotating at a moderate speed. Very slowly ease the tool (along the z-axis, using the carriage hand wheel) toward the end of the part until it just touches. There will be very fine shavings on the cutting edge of the tool. Now use the cross-feed hand wheel (along the Y-axis) to move the cutting tool toward you and away from the part. Without removing the tool from its position, set the indicator marks on the dial to the zero mark. You may also choose to "clean up" the face of the part, by moving in a few thousandths (.001" to .010") and moving the tool across the face of the part to the center of the diameter. Remember to reset zero (on the dial indicator) after cleaning a face. Always ask for help when attempting any of these procedures for the first time.

### 10. Taking cuts on the lathe.

Always start with a lower speed of chuck rotation and take shallow cuts until slowly increasing the rpm's until the tool cuts smoothly and does not appear to heat up. This can be seen by (steel) chips discoloring to a blue tint, or when the cutting fluid starts to burn off in a visible vapor. Nice, smooth chips are ideal. If you get a long stringy cut instead of a chip, increase feed until material comes off in chips. The depth of the cut is regulated by the cross slide handle. Keep the ways and carriage clear of chips, and do not use your hands use a small brush. The chips can be very hot and are extremely sharp and can cause harm. The machine should be cutting quietly and there should be no shuddering or vibration. Until you get use to the operation of the piece of machinery test at various speeds and feeds (see below). When cutting steels too aggressively, it can heat up quickly. This heat can damage both the part and the cutting tool.

Use the correct cutting fluid for the job (see below). This will extend the life of the tool and keep the part from "work hardening" because of over-heating. Plastics cut very easily on the lathe and normally don't require a cutting fluid. The critical point to plastics is to not go too fast (may melt) and make sure your tools are very sharp!

### 11. Calculating Speeds and Feeds. *"A happy machine is a quiet machine!"*

"Speed" refers to the spindle (chuck) RPM (Revolutions Per Minute). "Feed or feedrate" refers to the amount you make the cutting tool move across or into your workpiece. Feeds and speeds affect the time to finish a cut, tool life, finish of the machined surface and power required of the machine. The cutting speed is mostly determined by the material to be cut and the material of the cutter. Lubricant plays a critical role in cutting. Make sure you use plenty of the correct type! Broken or abused tools are the responsibility of the user and will have to be replaced at your cost.

To find the right speed for any task, first ask a shop supervisor. If unavailable, use the *"Speed vs. Feed"* guidelines as a starting point. The feed rate depends on the width and depth of cut, finish desired and many other variables. THE most common mistake is to run the feeds or spindle speed too fast!

SPEED VS. FEED - BASIC GUIDELINES

IF THEN

You INCREASE the FEEDRATE too much… You risk taking too big a "bite" and will break the cutter.
You DECREASE the FEEDRATE too much… You risk "rubbing" (not cutting) and will wear out the cutter.
You INCREASE the SPINDLE SPEED too much… You will not cut, but instead burn up the tool with friction.
You DECREASE the SPINDLE SPEED too much Your cut will be very slow.
You find the right balance The machine will be quiet (not screaming or shaking)
You find the right balance You will be making (nice, not discolored) chips.
You find the right balance You will be removing material and the cutter will last!

## 12. Cutting Fluids and their applications.

Different applications and/or materials require slightly different cutting fluids. These fluids are designed to provide the correct amount of lubrication, cooling, better surface finish, increased tool life and more. All cutting fluids (especially WS11) should be thoroughly cleaned / removed from the machine when finished! The machine should be dry and a light "misting" of WD40 applied to the entire vice, tables and machine ways to prevent corrosion.

### Fluids:

- WS11 – Water soluble oil. A combination of 5% WS11 oil + 95% water. Resembles "milk"
- A9 Cutting Fluid. Specially designed for aluminum and other soft metals. Green in color.
- Moly Dee. A thick, black, heavy cutting fluid for steels and other tough to machine materials.
- WD40. Not a cutting fluid, only use to protect for corrosion on cleaned machines.

### Applications:

**Aluminum & other soft materials tapping: Use** A9 cutting fluid. Applied with a drip from the nozzle or brushed onto the tap.
**Aluminum & other soft materials drilling/milling/boring/etc.:** Apply liberal amounts of WS11 with an acid brush or spray bottle.
**Steel tapping & heavy cutting:** Use Moly Dee, applied with a drip or acid brush directly to the tap.
**Steel drilling/milling/boring/etc.:** Apply liberal amounts of WS11 with an acid brush or spray bottle.
**Plastics:** Most do not need any cutting fluids. Correct speeds & feeds are more critical.

## 13. Cleaning the Machine proper procedures for care and feeding.

The entire machine must be cleaned after every use. If another user needs the machine, immediately after you, make sure you discuss who will leave the machine clean. The process is simple and should not take more than 10 minutes. Make sure you are aware of clock to leave enough time to finish clean-up. The procedure is:

**A.** Turn off the machine and remove the tool holder. Brush, blow or wipe it clean.
**B.** Put away all your hand, set-up and cutting tools. If not sure where they go, ask a supervisor.
**C.** Use a brush or light blasts of air to remove the chips from the vice, table and ways.
**D.** Do not blast the chips and fluids across the shop, only use enough force to get the chips to the ground.
**E.** Brush or vacuum the difficult to reach spots. Wipe the spindle, slides, ways, tool post, chuck, etc.…
**F.** Wipe off ALL cutting fluids and oils from the ENTIRE machine. Top to bottom, machine must be dry.

G. Gently mist the slides, ways, chuck(s) with WD40. Move the carriage and slides to mist all surfaces.
H. Sweep the floor and surrounding areas. Chips are to be placed in chip buckets, not regular trash cans.
I. There should be NO visible chips of any size on the machine. Leave it cleaner than when you found it.

## 14. Unfinished Work and leaving your machine.

A machine may be left set-up with your job ONLY if you will be returning at the next available opportunity. If it is less than a 2 hour gap, the machine may be left as is, just sweep the floor. If it is to be more than two hours or you are unsure, the machine must be cleaned (as above) and all tools/cutters/supplies must be put away. Machine set-ups will be broken down after 4 hours or if there is an urgent need, unless other arrangements are made with a supervisor or shop manager. Make sure you leave a sign with your name, phone number and a time/date when you will be returning to use the machine.

## 15. OTHER CONSIDERATIONS to be aware of:

Never be afraid to ask for help and guidance, that is why the shop supervisor is there! When in doubt, always ask!
These are very capable machines but must be used correctly to avoid damage and accidents. *Learn how to use them correctly; there are no shortcuts in quality and safety!*
Come prepared. Have your material/parts, complete (accurate) drawing(s), a plan of action and list of tools you will need.
Cutting tools are VERY expensive and easy to break or dull. You are responsible if they are broken or damaged.
Don't leave rags, measuring or other precision tools on the machine. They will get damaged, contaminated, or fall off.
Double check your set-up before starting any operation. Check for tightness/rigidity, correct speeds/feeds, obstructions, tool post locked, etc.
Re-read the safety rules, your life and health depend on it!

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| MEMS User | Date |
| ME Machine Shop | Date |