



**Safety Instruction Manual
Student Machine Shop**

**Pratt School of Engineering
Duke University**

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FOREWORD

This manual was created to provide an effective and informative Shop Safety Program for Duke University's Pratt School of Engineering. We recognize the necessity for a practical and applicable safety program. The cooperation of each student is required to make this program successful.

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TASK: Describe required safety procedures and practices.

PURPOSE: Specific safety procedures and practices are required in the machine shop, not only because it makes good sense, but because Federal Law requires it. Most importantly, failure to observe safety rules and regulations can endanger you and those around you in the machines shop. In short, the machine shop can be dangerous. The importance of knowing and following good safety practices cannot be over-emphasized, because this is the only way the dangers can be avoided.

PERFORMANCE OBJECTIVES: Students will develop an understanding of safety procedures and practices required in the machine shop. They will be able to apply these procedures in the operation of all machines present in the student shop. Access to the student shop will be suspended when there is failure to abide by these procedures and practices.

Guidelines for Shop Clean-Up

1. Safety Glasses

- **EVERYONE MUST WEAR SAFETY GLASSES IN THE SHOP.**
- **Even when you're not working on a machine, you must wear your safety glasses.**
- I have seen chips fly across the shop from a machine and hit someone in the eye that was not even close to the person working on the machine. From using a compressed air hose to clean a machine.

2. Other Important Issues

- **IF YOU HAVE A LONG BEARD OR LONG HAIR, TIE IT UP.**
(If your hair is caught in spinning machinery, it will be pulled out if you're fortunate. If not you will be pulled into the machine. I have seen this happen.)
- **NO LOOSE CLOTHING.**
Baggy pants, Ties, scarves, loose sleeves, etc. are prohibited.
- Use of gloves allowed only if moving large sheet metal around or large bars of stock
NEVER use gloves while machining
- **NO Shorts ALLOWED!** Long pants only!
Blue jeans are fine.
- **NO OPEN TOED SHOES.** Closed toed shoes **ONLY!**
Tennis shoes, steel tools, leather work boots are fine. **FLIP FLOPS ARE NOT ACCEPTABLE.**
- Remove ALL Jewelry
Watches, Rings, Necklaces, Large Hoop Earrings, Duke Badges, Lanyards.
- **All Electronic devices must be off while in class.**
I.E.: I-Pods, Cell phones, MP3's
- You must take the safety course before you are given permission to operate a machine in the student shop.

3. Safe Conduct in the Shop

- Always be aware of what's going on around you. For example, be careful not to bump into someone while they're cutting with the band saw. You will end up damaging their part, the tools, and maybe the machine itself.

Listen to the machine. If something doesn't sound right, turn the machine off.

Don't let someone else talk you into doing something dangerous.

Don't attempt to measure a part that's moving.

4. Machining

- Know your machine, know what it can and can not do.
IF you do not know how to do something, ASK ME that's what I'm here for.
- Check your work piece and make sure it is secure in the vise, 3 jaw chuck, etc.
- Special setups must be approved by the Student Shop Manager before they will be allowed to be machined.
- You must break down any special setup after you have finished using the machine.
- Never use a file without a handle. Files have tapered points and could be jabbed into your hand.
- When using a Jacobs chuck or a 3 jaw chuck, please be sure to take out the chuck key. I was almost killed at 17 when a fellow student behind me "JUST FORGOT" to take out the chuck key out of the lathe when he turned it on.
- **NEVER LEAVE A MACHINES RUNNING UNATTENDED!**
- Report all accidents to the TA and the Student Shop Manager.
- Never throw anything in the shop.
- Return ALL tools to their proper place when finished with them.

- You must clean up ALL of the floors before you leave. All small trash cans must be emptied into the large one. All chips and dirt on the floor must be swept up. All machines must be cleaned to the approval of the Student Shop Manager before leaving the Student Shop.
- If you think a machine is not working properly inform your TA or the Student Shop Manager so they can investigate the problem and figure out a solution.
- When metal is in question about being hot use the back of your hand by putting it close to the part without touching it and feel for heat coming off of the metal.
- **NEVER WORK BY YOURSELF IN THE STUDENT SHOP AT ANYTIME. THERE MUST BE TWO PEOPLE IN THE SHOP BEFORE ANY ONE PERSON MAY USE ANY MACHINE OR TOOL. NO EXCEPTIONS!**
- **ALWAYS CLEAN YOUR MACHINE AFTER USE!**
Leaving them dirty **WILL NOT BE Tolerated!** You will put your admittance into the student shop at risk if this happens. **No excuses and no exceptions.**
- **No FOOD or Drink Allowed in the Student Shop.**
- Emergency number is 9911.
- Don't rush or take chances. Obey All safety rules.
- Think through how you will machine your part before you actually start. In other words get a game plan together so you will know what you will be doing on your part to complete it.
- Please do not drink any alcoholic beverages before coming to the student shop. It is too dangerous and you will be asked to leave.

The 3 strike rule will be enforced on All these rules.

Guidelines for Shop Clean-Up

1. All clean-up will start 15 to 20 minutes BEFORE your time is over in the student shop.
2. Turn off the power supply to the machine before you start cleaning.
3. This will prevent you from accidentally starting the machine and possibly injuring yourself or someone else.
4. Remove all tools from the machine before you start cleaning. To reduce the possibility of accidental cutting, take out drill bits, cutters, lathe tools etc.
5. Store the tools in appropriate areas so you don't lose them or misplace them. This will allow everyone the ability to find the proper tools quickly and without frustration and wasting time.
6. Clean the chips from tools and chip pans. Start cleaning from the top of the machine downward. This is so you don't have to repeat your steps several times!
7. First clean the chips from the machines using a brush, broom, and dust pan. Wipe down the machine using the red shop rags supplied. Lastly, clean the area around the machines by using a brooms and dust pan. Be sure to dump out the dustpan into the trashcan.
8. After using a broom, you should vacuum the machines and working area.
9. When machines are cleaned you should put a light coat of way oil on the machine's moving parts. Ask the staff for additional information.
10. Do not over use compressed air. Do not blow air into bearing surfaces and do not scatter chips all over the work area. Shop vacuum cleaners can be much more useful than the air guns!
11. Report any damage, broken tools, or missing items to the student shop manager. This will help to keep the shop well supplied and operational.
12. Plan to spend at least 15 minutes on general cleaning around the work shop area. ALWAYS leave the machines and work area in better condition than you found it!
13. Failing to clean up will lead to a badge punch and potential suspension from machine shop usage.

Safety Instruction for Horizontal Band Saw

1. If you reach across or bend over the saw while it is operating you may be injured.
2. Stop saw when moving or replacing stock due to possibility of a laceration.
3. Support stock being cut off so it doesn't fall and injure anyone.
4. Always remove unused stock and place it in the proper location on the stock rack.
5. Be sure blades are in good condition before usage. If doubtful, check with instructor. A dull blade will cut a tapered work piece or take twice the time to make a cut.
6. If a blade should break during use, shut off the machine and wait until it stops before attempting to remove it.
7. Safety glasses must be worn at all times.

Safety Instruction for Vertical Band Saw

1. Always use wooden stock "pushers" when sawing.
2. Avoid excessive pressure; always try to keep hands out of line with blade if possible. Excessive pressure increases the likelihood of blade breakage which increases the chances of an operator's hands being cut.
3. Check machine speed and material being cut for proper combination. Extremely high speeds can cause a blade to be ruined in a short distance.
4. Adjust blade guide arm to just clear your stock.
5. When cutting round stock, use a vise to prevent rotating.
6. Do not cut material that is thin, such as sheet metal, without checking with the instructor.
7. Safety glasses must be worn at all times.

Safety Instruction for Drill Press

1. Drill press operators should be provided with and required to wear safety glasses which will prevent chips and other flying particles from entering their eyes.
2. Drill press operators should not wear gloves, finger rings, aprons, long ties, or loose clothing.
3. Use drills that are properly sharpened and run true so that work will not be spoiled and a possible accident avoided.
4. Be sure to remove the chuck wrench from the drill chuck before starting machine.
5. Never hold work being drilled by hand. Always clamp work to table or secure in a vise.
6. Be sure drill press is completely stopped before changing tools.
7. Remove burrs from drilled holes to prevent cuts.
8. Never reach around a revolving drill because clothing might be caught.
9. Keep your head back and away from the moving parts of the drill press.

Warning: Long hair can get caught in the press causing personal injury!

10. Use vise grips or pliers to hold thin work.

Note: Place wood under work when drilling into the part.

11. Be sure you know the proper speed to run (rpm) for each size drill, otherwise drill points are burned.
12. Never force or feed a drill too fast.
13. Chips should be removed from the table or work by use of a brush. A rag or the hands should not be used.

SHOP NOTES:

The principle hazard to the drill operator is that of bodily injury. The injury may be caused by contact with moving parts or tools, flying chips entering the eyes, or material falling on fingers or toes. The drill press operator can avoid injuries by observing the safety rules.

Safety Instruction for Pedestal Grinder

1. Safety glasses must be worn at all times in the machine shop area!
2. Be sure all guards are in place over all grinding wheels and check that the wheels are not loose. These guards are for your protection.
3. Check the clearance between the wheel and the tool rest. It should not be over 3/32" gap between the two. The rests should be adjusted before you start operating the grinder. (NEVER while the grinder is running or while the wheel is slowing down.)
4. Grind only on the face of the wheel; excessive side pressure can cause the wheel to break.
5. Use the entire face of the wheel to prevent grooving; this can slow down excessive wear of the wheels.
6. Do not strike the wheel or use excessive pressure suddenly; these actions can cause wheel breakage.
7. Stand to one side when starting the grinding machine. New wheels and old, damaged ones can break a part and this usually happens when the machine is started. Standing to one side will allow you to be out of the way of possible flying debris.
8. Hold work firmly to prevent slipping that could cause fingers to come in contact with the wheel.
9. Whenever possible use vise grips or some other suitable holding device; when grinding short or odd shaped pieces.
10. Never use a wheel that vibrates or is loose. To balance the wheel you must use the wheel dresser. Please see the shop manager for help with this.
11. Do not grind aluminum –aluminum dust can be dangerous! It will clog the pores on the wheel. Subsequent thermal expansion of the aluminum can cause the wheel to shatter! For aluminum, use hand files, sander or rotary file instead.
12. When a grinding wheel is too small to use safely please see the shop manager for help in wheel replacement.
13. Please clean off pedestal grinder with a brush when you are finished. As with all other machines always leave it better than you found it.

Safety Instruction for the Milling Machine

The milling machine, like any other machine shop tool, is not dangerous if certain safeguards are installed and if the operator uses safe operating practices.

The principal hazard to the milling machine operator is that of injury to the arms, hands, or fingers by contact with the cutter. Hands are frequently cut when they are used to brush away chips from various parts of the machine. **Eye injury can result from not wearing safety glasses.**

Observe the following precautions

1. Safety glasses are to be worn when operating the milling machine.
2. Milling machine operators should not wear gloves, loose or torn clothing.
3. Before inserting the collet or milling cutter into the spindle, ensure that both the collet and spindle hole are clean and free from nicks and chips.
4. To avoid striking a hammer on the cutter while setting up, the setup should be done as far away from the cutter as possible.
5. The floor about the milling machine should be kept free of oil and material that might cause slipping or stumbling.
6. While around a milling machine do not distract the operator's attention from his/her work while the machine is making a cut, this is decidedly unsafe and will not be allowed.
7. When a student has finished an operation, or before they leave their machine for any reason, they should shut off the power and make sure the machine has stopped running.
8. You should always be very alert and careful when operating the milling machine. It is considered one of the more dangerous machines in the shop.
9. Never try to clean the chips from the milling machine while it is cutting. The brush, or rag, that you use is liable to be caught in the cutter.
10. Never brush chips from the milling machine with your fingers, even when the machine is not cutting a part. The sharp edges of the chips may cut you.

11. It is wise to keep the cutter fluid used on the milling machine out of open cuts or sores. It may cause an infection.
12. Keep clear of the revolving lead screws or moving handles. If your clothing is drawn into the machine you may get hurt.
13. Be sure that your work is clamped tightly on the milling machine table or in the vise. With the power of the machine, work moving under the pressure of a cut will break the endmill before stalling the machine and the broken endmill may hit you.
14. Always use the hand feeds when you bring the work up to the cutter. Using the power feeds when the machine is adjusted for too deep a cut may break the endmill and throw the work off the machine.
15. For rough cutting feed the work against the revolving cutter (convention milling). By doing this, there is less danger of breaking an endmill or having work thrown from the machine.
16. Climb milling is only used for machining a finish pass on the work. It should be no more than .010 in depth and a constant even feed should be used.

Safety Instruction for the Lathe

The lathe is one of the most dangerous machines in the shop. The rotating chuck has a great deal of kinetic energy and can easily catch clothing, fingers, etc. To minimize possibility of injury the user is required to follow the appropriate safety rules and guidelines. The principal hazard for the lathe operator is potential injury of fingers, hands, and arms as a result of a contact with the point of operation, revolving spindle, or other moving machine elements. Objects that are thrown out of the working area due to high kinetic energy of the rotating parts can also pose a hazard. Primary motion is a rotation of the spindle and part. The secondary motion is a worm gear rotation and linear motion of the cutter.

1. Safety glasses **must** be worn at all times in the machine shop area whether working or not!
2. Loose clothing, ties, long sleeves, rings, large hoop earrings and wrist watches may become entangled in revolving lathe parts. Please remove these items before working.
3. Never turn away from the lathe while it is running. Always keep your eyes and your attention on the machine and the part you are turning on it.
4. Never leave the chuck wrench in the chuck socket at any time. If someone turns on the power, the wrench can be thrown out with high velocity. **Remove the chuck key from the chuck immediately after using it! MAJOR RULE It is either in your hand while you are using it or on the workbench. Never let the chuck wrench leave you hand to adjust anything on the lathe. You will get your badge punched on the first offence.**
5. Do not start the lathe if there are any operating knobs or levers that you don't understand. If you need help or advice just ask the Student Shop Manager.
6. Make sure that chuck, drive plate, or faceplate is securely tightened in the lathe spindle. If you don't check this the work can be thrown out from the machine!
7. When installing or removing the chuck, drive plate, or faceplate make sure the **machine's power is off!** Also use a wooden plate to hold the chuck until you can install it onto the nose of the lathe. Always get help because most lathe chucks are heavy and can crush you hand against the bed of the lathe.
8. Turn the chuck or faceplate through by hand before turning on the power; to be sure there are no binding or clearance problems.
9. When clamping work to the faceplate, be sure to balance it. This will prevent vibration and the possibility of damaged or poorly machined work. Spin the faceplate in neutral and readjust if grossly out of balance.
10. Keep clear of the revolving lead screw. Always keep it disconnected unless you are actually using it.

11. Move the tool bit to a safe distance away from the collet or chuck when inserting or removing work.
12. When setting up the tool holder, place it to the left of the compound slide to prevent the slide from running into and being struck by the lathe chuck or spindle attachments.
13. Don't run the machine faster than the proper cutting speed – consult a speed and feed table to determine the best speed.
14. Always clamp the tool bits as short as possible in the tool holder to prevent it from breaking or chattering.
15. Be sure that the tool bit is sharp and has the proper clearance. Ask for assistance if you are not sure how to make the adjustments.
16. Be sure that cutting tool is positioned on the centerline of your work to prevent parts from climbing over the tool or cutting above the center and dragging.
17. If the work is being turned between the centers, make sure that the proper adjustment is made between centers and that the tail stock is locked in place. Also double check the faceplate and drive dog to make sure they are secure.
18. Always remove the tool holder and tool post from the compound rest before filing or polishing work on the lathe. If any filing is done on work revolving in the lathe, file left handed to prevent slipping into the chuck. Never use a file without a handle.
19. Never put fingers in the arbor hole while the head stock spindle is revolving. Wipe out the arbor hold only when machine has reached full stop.
20. Reversing directional rotation of the headstock spindle should only be done when you are power tapping and you need to reverse thread the tap out of the hole.
21. Never try to take work from between the centers until the lathe comes to a complete stop.
22. Do not cut completely through when working between centers.
23. Stop the machine and clean your part off before taking measurements.
24. Before cleaning the lathe remove the tools from the tool post and tailstock.
25. Disengage the power feed when you are feeding close to a shoulder to prevent the toolbit from digging into the workpiece.
26. Plan to spend at least 15 minutes on cleaning around your work shop area. ALWAYS leave the machines and work area in better condition than you found it!
27. Failing to clean up will lead to a badge punch and potential suspension from machine shop usage

Safety Instruction for the Table Saw

The tablesaw, like any other machine shop tool, is not dangerous if certain safeguards are installed and if the operator uses safe operating practices.

The principal hazard to the tablesaw operator is that of injury to the arms, hands, or fingers by contact with the cutter. Hands are frequently cut when they are used to brush away woodchips from various parts of the machine.

Eye injury can result from not wearing safety glasses.

Observe the following precautions

1. Safety glasses are to be worn at all times when in the shop.
2. Tablesaw operators should not wear gloves, loose or torn clothing.
3. Before the operator starts using the saw be sure the floor and table are free from dust that could cause you to slip. This is just one of many ways you could cut your finger. Be careful and stay alert at all times to what you are doing.
4. Verify location of off switch. Check to make sure it is in working properly.
5. Check to ensure the fence is set properly and tight.
6. Push sticks must be used whenever an operation is performed that would require the operator's hands to pass within five (5) inches of the saw blade. Always use a push stick never just rely on your hands.
7. When boards over three (3) feet in any dimension are need to be cut, ask for help. They should be used to assist in supporting the work.
8. You should be kept the floor free of oil and material that might cause slipping or stumbling.
9. While around the tablesaw do not distract the operator's attention from his / her work while the machine is making a cut, this is decidedly unsafe and will not be allowed.

10. Be sure that your work never gets in a bind on the tablesaw. With the power of the saw, the work moving under the pressure of a cut, the tablesaw could bind up if you are not watching carefully and before stalling the blade it may throw the work being sawn back at you and it may hit you.
11. When a student has finished an operation, or before they leave their machine for any reason, they should shut off the power and make sure the machine has stopped running.
12. You should always be very alert and careful when operating the tablesaw. It is considered one of the more dangerous machines in the shop.
13. Never try to clean the chips from the tablesaw while it is cutting. The brush, or rag, that you use is liable to be caught in the cutter.
14. Always feed slowly as you bring the work up to the cutter. Pushing the work too hard or too deep a cut may throw the work off the machine.
15. Adjust the depth of cut just deeper than the thickness of your work.
16. Never reverse your cut this will throw your work out of the saw.
17. When you are finished with the tablesaw lower down the sawblade so it is below the top of the table.
18. Blade should be checked for tightness
19. Check the hood guard and anti-kickback devices for proper operation
20. All table saws must have a hood guard, splitter device installed. One or more of these devices may be removed ONLY if absolutely necessary to perform a specific cut (e.g. dado or rabbet) and only with the approval of a shop manager. These safety devices must be re-installed immediately after completing the cut(s).
21. The fence and miter gauge should never be used together. Use the fence for ripping and the miter gauge for cross-cutting.
22. Blade height should be set so that the top of the teeth extend no more than 1/4 inch above the wood.

23. The operator should stand to the side of the wood while it is being fed through the saw.
24. When changing the blade or servicing the saw, the power cord to the saw must be unplugged. The saw must be tested after disconnecting power and before beginning service.
25. Never run your tablesaw when you're tired. Fatigue leads to errors in judgment and mistakes. In fact, studies have shown that many serious tablesaw injuries occur to woodworkers when most other people are getting ready for a good night's sleep.
26. If the wood jams, turn off the power with the wood still in the blade; wait for rotation to stop, and remove your piece. Determine why the wood jammed. Wood can spring closed on itself due to the grain, or a knot may have come loose and caught in the blade guard. Restart the motor and start the cut again, moving through the existing cut and back into the uncut area. Never restart with the piece still in the blade or lower the piece onto the blade.
27. NEVER cut round stock, tubing, etc. on the table saw. The material's round surface against the rotation of the blade will cause it to spin out of control, which may cause injury.
28. Allow 20 minutes cleanup time when you are finished sawing your part.
29. As Always leave the tablesaw better than you found it.