

Machine Shop Usage

Underground Lab
Department of Physics and Astronomy

Safety training in shops is required by regulation. It applies only to the shop in which you are trained and does not satisfy the requirement in any other shop nor does training in any other shop satisfy the requirement for this shop.

INTRODUCTION

The Department of Physics and Astronomy operates a machine shop in its Underground Laboratory Facilities. From time to time students will need to fabricate devices for experiments for courses or research. To be able to use any piece of equipment in the shop you must do four things:

1. Have in your possession and wear at all times in the shop a pair of the appropriate safety glasses (available at the Bookstore),
2. Carefully read and understand this guide,
3. Fill out the one page safety questionnaire **Machine Shop Usage Safety Agreement** found on the web site and email it to the Machine Shop Director, Jeremy Peterson (email: jeremykp@byu.edu).
4. Take the **Machine Use Training** with one of the lab assistants and receive an "Authorization to Use" for each machine you wish to use. Your name will be posted by each machine when granted.

The Machine Use Training is a session with an instructor where you will be taught the do's and don'ts for a machine. This is required for each machine in the shop. After you have completed the Machine Use Training for a particular machine your name and identification will be added to the certification list which will be your permission to use that particular equipment. Use of a machine without certification is unauthorized and may result in loss of shop access and use privileges.

Project Storage

Projects and materials are not to be stored or left in the shop area, even for a short time. Any projects or materials left in the shop will be removed or discarded. If you want to keep it, please take care of it!

Use of Materials

If you didn't buy it or bring it, it isn't yours! Generally the shop does not supply materials for your projects. If you need materials, talk to your supervising faculty. Some materials are available for purchase from the Research Machine Shop and from the campus warehouse. Some odds and ends are stored in the shop, but before using or cutting something up please obtain permission.

Tool Checkout

All tools are to remain in the shop. Tools are not to leave the shop even for a moment. If you need a tool outside of the shop get it from your faculty supervisor or purchase it yourself.

SHOP SAFETY INFORMATION

General Safety Rules

Personal Responsibility - Safety First. You are ultimately responsible for all that you do! Follow all safety, operation guidelines, and check lists posted for each machine. Training is available for every piece of equipment available for your use. If you are unfamiliar with a machine or operation, please ask for assistance. Attempting to use machine tools without proper training may result in serious injury. You will be held responsible for damage caused by your neglect.

Eye Protection - Safety glasses with side shields or goggles must be worn at all times while in the shop areas. Approved eye protection will be labeled as meeting the ANSI Z87 safety standard. Ordinary prescription glasses do not qualify as approved eye protection and must be supplemented by goggles or safety glasses designed to fit over glasses. Face shields are not approved primary eye protection and should only be worn over approved safety glasses or goggles. It is your responsibility to provide your own eye protection. Do not expect to work in the shop facilities if you do not have your own eye protection! Both safety glasses and goggles are available at the bookstore and many local retailers.

Proper Apparel and Dress – Long sleeves, loose clothes, neck ties, jewelry, long hair, open toed shoes, etc.. can be hazardous in many shop situations. Before operating a piece of equipment, insure that these types of hazards are not present. Rotating machinery can not tell the difference between metal, cloth, or flesh. Loose apparel and long hair can be easily drawn into machinery and you with it. Remember, shop machines are powered by several horsepower and will not stop for flesh that gets in the way.

Working Alone - University policy, in accordance with state and federal regulations, requires that two persons be present in a shop facility when equipment is in operation. At no time are you allowed to work alone in the shop area (this means that another adult must be in the shop area with you).

Machine Guards - Machine guards are to be used at all times. If there is an operation that requires the removal of a guard, you must obtain permission from the Laboratory Supervisor.

Specific Shop Policies – Each machine may have posted rules, regulations, guidelines and check lists for its use. Please review the posted policies for the most current information.

Housekeeping Requirements – Every user of tools and machines is responsible to maintain and clean up after working in the shop area. This includes:

1. Before using a tool or machine, follow the proper preconditioning procedure.
2. After using a tool or machine, follow the proper cleaning and maintenance procedure.
3. Return all tools and tooling to their proper storage locations (please clean tools before putting them away).
4. Remove all chips, dust, cuttings, and turnings from machines, tools, work surfaces, and tables. Use rags and brushes to remove chips. Never use your hands or fingers to remove chips – cuts caused from such can cause very serious infections. Never use compressed air!
5. Clean all floor space of chips, dust, cuttings, and turnings. If oil is on the floor wipe it up with a rag and use an appropriate cleaning solution to degrease the floor – soap and water is available at the sink.

Parts of tools or machines produced by breakage or wear should be collected and brought to the attention of the lab supervisor. It is important that these items be brought to our attention so that the equipment and tooling can be maintained for safe operation.

Machine Operation - Only one person is to operate a machine at one time. It is extremely hazardous for more than one person to work the controls of a machine. If assistance is needed to support material being processed, the assistant should only provide support and allow the operator to provide all motion to the work piece or machine. Also, never walk away from a machine and leave it running, even for a moment. Never leave a machine running unattended.

Horseplay - Horseplay of any kind can be extremely hazardous in a shop area and is forbidden at all times.

Correct Tools - Always use the correct tool for the job. If you are not sure what is needed, please ask for assistance.

Sharp Tools - Sharp tools are safer, provide better results, and require less effort to accomplish a task. If you suspect that a tool is dull, ask for assistance to have it sharpened or replaced. If you have to apply a great deal of force then you should suspect there is something wrong – get assistance! Never hammer on machining equipment, machine tools, or the work piece while it is installed on a machine tool.

Safety Equipment - Know the location of safety equipment. Fire extinguishers, eyewash stations, emergency showers, telephones, etc. are only available if you know where they are.

Emergency Situations - Think first in an emergency! Call "911" if there is any question about the seriousness of an emergency. Your first responsibility is to get as much assistance as possible to the situation while providing emergency care to the best of your knowledge.

Fire Alarms - If the fire alarm sounds, immediately turn off all equipment you are operating and exit the building.

First Aid - Immediately report all accidents to a lab supervisor or a faculty member. Minor first aid is available for simple cuts or abrasions. BYU is not responsible to pay for medical services required by accidents within its shop areas unless specific liability is established. You should make medical care decisions based upon the assumption that you will be responsible for payment.

Material Spills - If you spill liquids or materials on the floor, immediately clean it up. If the materials are hazardous in nature, immediately notify the supervisor or a faculty member to determine what course of action should be taken. If no one is available to assist you please call BYU emergency services at x2-2222.

Respirators (breathing masks having two straps) - It is a violation of Federal OSHA regulations to misuse, improperly store, or improperly maintain a respirator. It is also a violation to possess, store, or use a respirator if you have not been trained, medically tested, and certified to use a respirator. Obtain permission from the lab supervisor before bringing a respirator into the shop. Do not participate in any operation requiring a respirator if you are not certified to use a respirator. Do not participate in any operation requiring a respirator in this machine shop.

Speeds and Feeds - Choosing and setting the correct speeds and feeds is critical to many machine operations. If you do not know how to determine these parameters, ask for assistance.

Unusual Noises - If you hear something unusual or suspect something has changed, stop what you are doing and check it out. Ask for assistance. Pay close attention to what you are doing at all times. It pays to be curious!

Lifting Heavy Objects - Get assistance. When lifting, keep your back as straight as possible and lift with your arm and leg muscles.

Moving Large or Awkward Materials - Ask for assistance from others. Clear a path to where the material is to be moved and warn others working near the path before moving materials.

Broken or Damaged Tools - Immediately report broken or damaged equipment or tools to the lab supervisor or assistant. It is expected that tools will break occasionally and equipment will suffer from wear and tear. It is important that these items be brought to our attention so we can properly maintain the equipment and tooling. Place dull or broken bits and cutters in the collection box.

Specific Safety Rules

CHEMICAL MANAGEMENT

Handling of Chemicals – Before handling any chemical, read the MSDS (Material Safety Data Sheet) for that material. Determine what personal protection equipment (PPE) is required and what safe handling precautions are required. You should always wear splash-proof goggles and appropriate protective clothing when handling hazardous chemicals. Before using any chemical you must first plan and have prepared the proper method for the disposal of it.

Hazardous Materials – Do not bring hazardous materials into the shop. If a hazardous material is needed, you must first obtain permission to bring such materials into the shop area.

Disposing of Chemicals - Never put anything but water down the drain! BYU has a chemical management department that will assist with the disposal of chemicals.

Chemical Amounts - You should only acquire the amount of chemicals required for your work to be done. Disposing of chemicals is often a greater expense than their initial purchase.

Mixing of Chemicals - Never mix chemicals of unknown origin or if you are not fully knowledgeable about the outcome. Many chemicals are incompatible and become volatile or toxic when mixed improperly. If you are in doubt, get assistance.

Chemical Storage - Improper chemical storage is a major hazard. Chemicals must always be stored in their original container. Never put chemicals of any kind in an unmarked container. Please discuss your chemical storage needs with the lab supervisor. When you are done with your project work, make sure that all chemical materials are properly cleaned away, stored, or disposed of.

GRINDING

Pedestal Grinders - The work support should be adjusted as close to the wheel as possible to avoid a pinch point. A grinder should not be used that does not have a wheel guard. Never hold work to be ground using gloves, they can be caught in the wheel and pull your hand into the grinder. Small work can be held using pliers or some other clamp. Do not use the side of the wheel for grinding. Never grind thin parts that can get wedged between the work rest and the grinding wheel (a pinch point). Do not grind non-ferrous (aluminum, brass, zinc, copper, etc.) metals. These materials fill the pores of the grinding wheel face and destroy its ability to cut. They may be sanded on the belt or disc sander.

Tool Sharpening (or workpiece grinding) - Cool your workpiece frequently to prevent the tool or workpiece from overheating and losing its temper. A properly cooled workpiece will have no signs of color change.

Wheel Mounting - All grinding wheels should be "ring" tested before being mounted to make sure the wheel is not cracked. Always mount the wheel using blotters between the wheel and the mounting flanges. Do not over tighten the mounting nut.

Wheel Dressing - Grinding wheels require dressing and truing to cut properly. If the wheel does not seem to be freely removing material or the material is quickly heating up, the wheel may need to be dressed.

LATHE OPERATION

Mounting Chucks - Always protect the bed of the lathe when mounting a chuck by using a board or a chuck cradle set on the bed ways. Do not remove or mount chucks unless you have been instructed on how to do it properly.

Chip Removal - Never remove chips with your hand or with the compressed air blow-gun. Use a brush, rag, wire, or pair of pliers to remove chips.

Rotating Parts - Lathe operations involve rotating chucks and workpieces. Use extreme caution to keep away from the rotating parts. Never touch the workpiece or make measurements while the part is turning. Remove long, stringy chips only when the lathe is stopped. It is a good idea to turn the spindle by hand, before turning the power on, to insure that there is no interference between the rotating parts and the machine. Note: If lathe chuck jaws are opened too far, they can come out of the chuck during lathe operation causing serious injury.

Changing Speeds and Feeds - Never change gears while the lathe is running. If you cannot get the machine to go into gear, rotate the spindle or lead screw by hand to align the gear set and allow the gears to engage.

Chuck Keys - Always remove the key from the chuck even if you will be using it soon. This needs to become a habit. NEVER LEAVE A KEY IN A CHUCK, even for a moment.

Mounting Stock in Chucks - Stock should not protrude from the chuck or collet (unsupported by a center or steady-rest) more than three times the stock diameter. Stock should not extend out the headstock end of the spindle more than twenty times its diameter.

Tool Alignment - Tools should be aligned with the spindle stopped. Proper tool alignment and height is critical for good material removal and part finish. Tools should be mounted with minimum overhang to provide maximum rigidity.

MILLING MACHINE OPERATIONS

Variable Speed Heads - On machines equipped with variable speed heads, speed should only be changed with the spindle running. In the case of our Bridgeport knee mill the machine must be powered off and rotation stopped before making speed changes.

Climb vs. Conventional Milling - Because climb milling causes less wear to the milling cutter, requires less cutting force, and leaves a better surface finish, it should be used whenever possible. When a milling cutter climb cuts, it tends to pull the work into the cutter. When milling thin sections using large cutters or on milling machines that have excessive backlash in the feed screw, it may be necessary to use conventional

milling. Please note, this is opposite what is typically done for woodworking which is conventional milling – that is the work piece moves against the direction of the cutter.

Removing Chips - Never remove chips with your hands. Use a brush to sweep chips from the part. Caution: the chips produced by milling cutters are very hot and can be thrown some distance.

Measuring - Never measure parts with the spindle turning. (Also, never set a measurement tool on a hard surface such as the bed of the mill).

Removing Mill Tooling - To remove tooling from the spindle, unscrew the draw bar with the wrench while holding the spindle brake on. Loosen the draw bar until it can be turned by hand. Loosen it one full turn by hand and no more. Then, tap the end of the draw bar to loosen the taper while holding the cutting tool with the other hand, as the tool may fall out of the collet. Then finish unscrewing the draw bar until the tool/collet is free. To install a collet/tool in the spindle, first clean the spindle taper and the collet/tool. Insert the collet/tool into the spindle and rotate it until the keyway on the collet/tool lines up with the key inside the spindle. Thread in the draw bar by hand until tight. Tighten with the wrench. Never leave the wrench on the draw bar.

SHEET METAL WORK

Shear – Used for cutting sheet metal .

- Eye protection must be worn at all times.
- Before the machine is used, all cuttings and scrap from the shear table and the surrounding area shall be removed.
- Users shall avoid touching knife edges when taking measurements.
- The shear table shall be kept free of loose tools and materials.
- Safety guards shall not be removed or tampered with.
- When clamping, the user shall keep hands away from the hold down.
- Only the persons operating the machinery shall be in close proximity of the shear.
- Scraps shall be removed promptly and deposited in the appropriate scrap bin.
- Machine capacity must not be exceeded – 16 gauge mild steel or soft aluminum alloy.
- Shears must only be used to cut materials specified in the manufacturer’s instructions.
- Force on treadle shall not exceed that which can be applied with one foot (if more force is required then you may have an inappropriate gauge or type of material and you need to consider sawing).
- Never jump on the treadle.

Bending Brake – For bending sheet metal only. Be aware, some alloys of aluminium are brittle, not intended for bending and will break if an attempt is made to bend it. Please ask for assistance.

- Eye protection must be worn at all times.
- Machine capacity must not be exceeded – 16 gauge mild steel or soft aluminum alloy.
- Force on the handle shall not exceed that which can be applied with one hand (if more force is required then you may have an inappropriate gauge or type of material).
- Operator’s hands must be located at a safe distance from the point of operation.
- Only the persons operating the machine shall be in close proximity.
- Never hammer on this equipment.
- Beware – misuse can result in the equipment falling over.

WIRE WHEELS

A face shield is required to be worn over your safety glasses when using a wire wheel.

WOODWORKING

Blade Rotation - Wood should always be fed into the cutter against the blade rotation. This is especially important with router and shaper bits. Always check blade rotation when performing operations that allow you to feed stock from more than one direction.

Rip Fence - Never use the rip fence on the table saw as a length stop when cross cutting wood. The cut off piece could get wedged between the saw blade and the fence and get kicked back at the operator. This is a serious source of injury.

Cutting Sheet Goods - Do not attempt to cut large or full sheets of material on the table saw without help.

Band Saw - Adjust the upper blade guide to about 1/2" above the surface of the material being cut. Use caution in backing out of cuts. This could pull the blade out of its guides resulting in possible hazard to the operator and/or blade damage. Please follow operator instructions attached to the machine.

Push Sticks/Blocks - When cutting small pieces of material, use a push stick/block instead of your fingers to move material through the cutter. Never push material through a cutting tool with your fingers or hands directly in line with the cutter.

Table Saw - Adjust the blade to protrude approximately 1/8" above the height of the material being cut. The exception is when cutting thin brittle materials such as Formica or Plexiglas. These materials require that the blade protrude approximately 1" above the material. Use extreme caution when cutting – this is the major source of injuries resulting in amputation.

Sanders, Planer, Joiner, etc - As with other power tools, always make sure that your work is securely held, and never lean into the machine as you push material into the sander/cutter. If you slip, a part of your body could be the next thing to go into the sander/cutter. Feed the workpiece carefully into a sander so as to prevent it from being pulled or twisted from your grasp. Never sand material that is thin enough to become wedged between the sanding belt/disc and the work rest.

Dull Tools - If a sander or cutter is burning the surface of your workpiece, and/or it takes more than moderate force to get the power tool to cut, the cutting edges may be dull. Alert shop personnel when you find dull or badly worn cutting tools.

Sharp Hand Tools - Never cut toward yourself when using sharpened hand tools. The workpiece should be secured in a vise or clamp instead of being held in your hand.