#### MACHINE TRAINING MANUAL STRUCTURAL ENGINEERING LABORATORY (LSEL)

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The following equipment requires specific training prior to use by a student.

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## A. Clausing Drill Press

Before being authorized to use this equipment, students must:

- 1. Receive practical instruction from Prof. Kurtz or an Engineering Technician.
- 2. Review the instructions found on the Powerpoint presentation.
- 3. Review the safety rules found below.
- 4. Achieve a perfect score on the written and practical quizzes.

#### Cautions

Never wear loose clothing or jewelry near a drill press. Long hair must be tied back into a bun. Clothing with strings must never be worn. Getting loose items caught in the spindle can lead to severe injury or death.

Never drill a part that is not secured to the drill press. Parts must be fastened directly to the drillpress or fastened in a vice. If heavy drilling is performed, the vice must also be fastened directly to the drillpress.

Never inadvertently pull the feed lever outward (to the right) while drilling, as this engages the autofeed feature, causing the machine to automatically feed the drill downward.

### Parts of the Clausing Drill Press



#### Beginning

- 1. The table of the drill press should be kept clear of all unnecessary materials
- 2. Safety glasses with side shields must be worn.
- 3. Remove loose fitting clothing, jewelry, and tie back long hair into a bun (no ponytails).
- 4. Give the work your undivided attention. Do not be distracted by others or attempt to hold a conversation while operating a drill press.
- 5. Do not wear gloves or anything that would allow a hand, fingers or clothing to be wrapped around the revolving bit.

Aligning the Stock

- 1. Center punch (or use a center drill if the milling table is used) the drill-hole location into the stock.
- 2. <u>Secure the stock in a vice or directly to the table</u>. The large Accupro vice is sufficiently heavy to drill up to 3/8" diameter holes without also fastening the vice to the table. Larger holes or the use of a smaller vice requires that the vice be securely clamped to the table. **Never attempt to hold the stock by hand**.
- 3. Tap the Accupro vice with a rubber mallet until the drill bit aligns perfectly with the dimple created by the center punch.

**Operational Safety Rules and Instructions:** 

- 1. Adjust the spindle speed with the spindle running. All other adjustments must be made with the power off!
- 2. Students are not to drill any hole in excess of  $\frac{1}{2}$ " diameter with the Clausing drill press.
- 3. Select the spindle speed for drilling steel based on the graph that is found next to the drill press; the larger the drill, the slower the spindle speed should be. If the spindle speed is too fast, the metal stock will overheat and dull the drill bit.
- 4. Obtain a drill bit from the drill cabinet and double-check its diameter using the drill guide. If the hole diameter will be <sup>1</sup>/<sub>4</sub>" or larger, then the hole should be pre-drilled with a smaller diameter drill bit, first.
- 5. Insert bit into drill chuck and tighten with the chuck key. Immediately remove the chuck key from the chuck. <u>Never leave a chuck key in the chuck</u>.
- 6. Long stock should be additionally supported on rollers, with the excess to the left of the operator. If the stock rotates it will hit the post, not the operator.
- 7. Support the underside of the stock to be drilled with parallels.
- 8. Never start the machine without the table clear of everything except the stock you are drilling.
- 9. Keep hands and fingers at least 3" from rotating drill bits.
- 10. Before drilling, apply a few drops of cutting oil with a brush.
- 11. When drilling, apply a sufficiently slow feed rate (the rate of downward movement of the spinning bit) so that the steel chips do not form continuous strands.
- 12. If the metal is turning purple or the cutting oil is burning rapidly, the bit is either dull or the spindle speed is too fast. Turn off the machine and select a different drill bit, placing the dull drill bit in the designated area.
- 13. When drilling deep holes, frequently raise the drill bit from the hole to remove cuttings and apply a few drops of cutting oil.
- 14. Never grab the chuck to stop it from spinning.
- 15. Never inadvertently pull the feed lever outward (to the right) while drilling, as this engages the autofeed feature, causing the machine to automatically feed the drill downward.

16. Always clean the drill press table and work area upon completion of the drilling task with a brush. Sample Written Quiz Questions:

1. Label all of the parts in the diagram below.



- 2. Circle the correct arrangement of long stock in the drill press.
- 3. Explain why it is necessary to frequently raise the drill bit from the hole, when drilling deep holes.
- 4. What is the correct spindle speed for a  $\frac{1}{4}$  diameter drill bit? Refer to the chart below.



Drill Speed vs. Drill Size

- 5. True or False. Never adjust the spindle speed of the Clausing drill press while the spindle is spinning.
- 6. Explain how the user knows the correct feed rate when drilling steel stock.
- 7. Explain what is wrong with the setup shown. (show no parallels).

#### Sample Practical Quiz:

Layout and drill the part shown:



1/8" x 1" x 3" Steel Stock with ¼" holes

## **B.** Clausing Drill Press with Milling Table

The Clausing Drill Press and Milling Table are suitable for Light-Duty Milling, only!

- 1. Maximum mill diameter: 3/8"
- 2. Maximum depth of cut for end-milling: 0.020" per pass.
- 3. Be sure to tighten all set-screws on the milling table before beginning.

## C. Concrete Mixer

Before being authorized to use this equipment, students are required to achieve a perfect score on the written quiz.

### Cautions

Keep hands, tools, and other objects far away from the gear drive of the mixer.

If cement contacts the eyes, immediately wash with water.

Insert photo of parts, including the agg hoppers

#### Safety Equipment Required

- 1. Safety glasses must be worn. Cement is highly caustic and can cause permanent eye damage if not rinsed immediately. If cement contacts the eyes, immediately rinse thoroughly with water.
- 2. Rubber gloves should be worn or students should avoid prolonged contact with cement. Short-term contact with skin is not dangerous, but long-term contact can lead to burns and skin damage. Chronic contact with wet cement can often lead to painful burn-holes in the skin, particularly the fingertips. Wash and dry affected areas as soon as possible, following contact. The burns caused by concrete may be slow. You may not feel anything until several hours later. That's why it's important to wash concrete off your skin right away.
- 3. Dust masks should be worn while weighing dry materials.

#### Typical Concrete Mix Procedure

- 1. Weigh out all ingredients. The maximum practical capacity for this mixer is approximately 4 cubic feet (600 lbs), but mixes of more than 2 cubic feet (300 lbs) will tend to be difficult to accomplish, particularly in mixes that utilize superplasticizers.
- 2. Be sure the drum handle is locked
- 3. Insert the coarse aggregate, followed by the fine aggregate, followed by approximately 2/3 of the mixing water (and air entraining agent, if used).
- 4. Turn the mixer on for 30 seconds, unlocking the handle and lowering the drum as low as possible, without dropping any material on the floor, then re-lock the handle.
- 5. Insert the cement, followed by the remaining 1/3 of the mixing water.
- 6. Turn the mixer on for 2 minutes, lowering the drum as much as possible.
- 7. Rest for 2 minutes. Scrape any unmixed material sticking to the side of the drum.
- 8. Turn the mixer on for 2 minutes, lowering the drum as much as possible.

#### Clean-up Procedure.

- 1. Scrape as much concrete out of the mixer, as possible, and place on a plastic sheet to harden.
- 2. Rinse and scrub the mixer into a plastic-bag-lined 5-gallon bucket and allow to harden.
- 3. The mixer should pass a "white glove test"; if any residue is found on the inside of the mixer, it must continue to be scrubbed and rinsed.
- 4. NEVER put cementitious materials down the lab sink. It will harden and ruin the plumbing.
- 5. 24 to 48 HOURS AFTER MIXING. The student who has done the mixing must return and discard the waste materials. Hardened concrete must be taken to the concrete dumpster. Clear liquid must be poured down the sink. Return 5-gallon buckets to storage underneath the aggregate hoppers. Any student who fails to remove waste materials within 48 hours will be banned from mixing in the future.

Sample Written Quiz Questions:

- 1. True or False. Once hardened, solid concrete waste materials should be placed in the trash receptacle in room 111.
- 2. Explain all of the safety risks of concrete mixing.
- 3. Label the parts shown (insert picture)

## D. Grizzly Bench Grinder/Sander



#### Parts of the Grizzly Bench Grinder/Sander

#### **Cautions:**

Small parts can become dangerous projectiles if not firmly held by the user

Sparks can cause severe damage to eyes, if not properly protected.

The spinning disk will cause severe abrasive damage to the skin and can easily remove fingernails. Fingers should always be kept at least 1" from the spinning disk.

Keep the workpiece away from the gap between the spinning disk and table. A narrow workpiece can be drawn into the gap, pulling the user's fingers with it.

The workpiece can become extremely hot and should be cooled with water, periodically.

Uses and Misuses of this Machine

- 1. This machine is to be used for deburring and light material removal for metals or wood.
- 2. This machine should not be used for the bulk removal of large amounts of material.

Beginning

- 1. User must wear a clear full-face shield.
- 2. User must wear hearing protection.
- 3. User must not wear gloves or loose-fitting clothing which can get caught by the spinning disk
- 4. Grinder/Sander must be fastened to the bench.
- 5. Be sure that no loose parts are near the machine.

Operation

1. Turn the grinder/sander on by pressing the green button

- 2. Hold the workpiece firmly with one hand, placing the hand firmly on the table for stability. <u>Always hold the workpiece at a downward inclination, on the left-hand side of the disc.</u> Never put the workpiece on the right-hand side of the disc, as this will send sparks into the user's face.
- 3. Cool the workpiece periodically in water, if it becomes hot.

#### Afterwards

The accumulation of metal fillings can form a dangerous, hardened obstruction near the spinning disk. This hardened obstruction can get caught in the machine and pose a safety hazard. The area must be swept clean of all metal dust at the end of the work period, particularly directly underneath the machine.



Thoroughly clean dust from underneath and around the machine, at the end of the work period!

Changing the Sanding Disk

- 1. Unplug the machine from the power source.
- 2. Unscrew the knobs which connect the table to the machine.
- 3. Pull off the old disk. Try to remove the entire disk in one piece.



4. Remove any remaining glue by turning the machine on and using a blunt piece of steel rub the glue off, over the entire surface.



5. Remove the backing from the new disk and apply the sanding disk <u>concentrically</u> to the metal disk. Press the disk firmly in place.



6. Replace the table. Plug in the machine.

## E. Hand-Held Grinder

Before being authorized to use this equipment, students must:

- 1. Receive practical instruction from Prof. Kurtz or an Engineering Technician.
- 2. Review the instructions found on the video presentation.
- 3. Review the safety rules found below.
- 4. Achieve a perfect score on the written and practical quizzes.

### Cautions

Never use this equipment without a full-face mask and gloves.

Never use a cutting wheel for grinding. Cutting wheels are only designed for cutting.



#### Terms - Cutting Wheels and Grinding Wheels

A cutting wheel is thin – typically about 1/16" thick. Like a saw, a cutting wheel is designed to cut materials. A cutting wheel must never be used to grind metal. It is not designed to resist forces that are perpendicular to the disk. If a cutting wheel is used for grinding it will shatter and send sharp, dangerous projectiles in all directions.

A grinding wheel is thick – typically 1/8" to  $\frac{1}{4}$ " thick. With greater thickness and internal reinforcement, a grinding wheel is designed to resist forces that are perpendicular to the disk.

#### Prepare the work area.

- 1. Shield the immediate area so that others are safe from sparks.
- 2. Be sure that there are no flammable materials near the work area.
- 3. Clamp the workpiece to a table. Never grind or cut metal that is not secured!

#### Instructions for Use

- 1. Hold the grinder with one hand on the handle and one hand on the body.
- 2. Turn the switch on. Watch the wheel spin. Do not use the grinder if the wheel flutters or vibrates excessively. If the wheel vibrates excessively, turn the grinder off and replace the wheel.
- 3. When grinding or cutting, apply modest pressure. If excessive pressure is used, the wheel can shatter and send sharp, dangerous projectiles in all directions.
- 4. Be sure that sparks are directed towards a screen. Never allow sparks to near other people.
- 5. When done grinding or cutting, turn the switch to off and lay grinder down with the wheel facing upwards. Never leave an unattended grinder with the wheel touching the table because an accidental start of the machine will cause the grinder to spin out of control.

- Changing a Grinding or Cutting Wheel
  1. Unplug the power cord!
  2. Push and hold the spindle lock and turn the wheel until the lock engages.
  3. Use a Vice-Grip to loosen the lock-nut.
  4. Insert a new wheel, replace the lock-nut, and tighten firmly.

## F. Kalamazoo Band-Saw

Before being authorized to use this equipment, students must:

- 1. Receive practical instruction from Prof. Kurtz or an Engineering Technician.
- 2. Review the instructions found on the Video presentation.
- 3. Review the safety rules found below.
- 4. Achieve a perfect score on the written and practical quizzes.

### Cautions

Never turn the bandsaw on unless the work is securely held in the vice!

Moving bandsaw blades can cause rapid, deep cuts and possible dismemberment!



#### **Operation**

1. Place the stock in the machine and use the feed control knob to lower the band until it is slightly above the stock. Measure directly off of the band to the end of the stock (see photo below) to set the desired length.

#### (insert photo)

Note: this is the only accurate way to cut steel. A direct measurement off of the band should yield an accuracy of 1/32" or better. Save the pencils, pens, Sharpies, and crayons for the carpentry shop.

Clamp the stock by tightening the vice clamp. If multiple pieces of the same length will be made, set a stop, as shown. Never attempt to cut anything in the bandsaw without securing it in the vice. Be particularly firm with round materials that are cut on an angle – unsecured stock will spiral forward, out of the machine, often damaging the blade.

#### (insert photo)

- 3. Be sure that no one is near the band!
- 4. Pull the red on/off knob up. Note that coolant should flow onto the band. Do not cut steel if the blade is not continuously cooled with a water-soluble-oil coolant. Never use plain water as a coolant, as it will rapidly corrode the machine and the band.
- 5. Lower the head of the machine very slowly by opening (counterclockwise) the feed control knob very slightly. Cut the stock.

#### Angled Cuts

- 1. Loosen the bolt that secures the front plate of the vice.
- 2. Use a protractor to set the angle, hold the protractor on the front plate of the vice, while sighting the blade.

#### (insert photo)

- 3. Resecure the front plate of the vice.
- 4. Layout and cut the stock, as with straight cuts.

#### Changing the Blade

- 1. Unplug the machine.
- 2. Raise the blade cover and loosen the blade tension knob.

#### (insert photo)

- 3. Remove the rear blade guide.
- 4. Remove the blade. For the safety of others, immediately break the blade into pieces, folding it sharply, by stepping on it.
- 5. Insert the new blade onto the rollers, pulling it upward to seat it in position. Reinsert the rear roller guide. Tension the blade, close the cover, and plug the machine in.

#### Sample Quiz

1. Identify all of the parts shown.



### Practical Quiz

Make a square cut with the Kalamazoo bandsaw of a 1" square steel tubing to a length of 4 <sup>3</sup>/<sub>4</sub>" (tolerance +/- 1/64").

## G. Magnet Drill Press

Before being authorized to use this equipment, students must:

- 1. Receive practical instruction from Prof. Kurtz or an Engineering Technician.
- 2. Review the instructions found on the Video presentation.
- 3. Review the safety rules found below.
- 4. Achieve a perfect score on the written and practical quizzes.

### Cautions

Never wear loose clothing or jewelry near a drill press. Long hair must be tied back into a bun. Clothing with strings must never be worn. Getting loose items caught in the spindle can lead to severe injury or death.

Never drill a part that is not secured to the drill press. Parts must be magnet-connected directly to the drillpress or fastened in a vice.

Parts of the Magnet Drill Press



#### Appropriate Uses of the Magnet Drill Press

The magnet drill press is appropriate for drilling steel parts that are too bulky for the Clausing drill press such as heavy steel shapes or weldments. Typically:

- The press is magnet connected to the piece that is being drilled (such as a large I-shape), or
- The press is magnet connected to a steel table and is used to either drill a part that is fastened to the table or to a drill price vice.

#### **Operation:**

- 1. Turn the magnet switch to OFF.
- 2. Insert a drill in the chuck and tighten with the chuck key.
- 3. Position the drill directly over the layout mark or punch mark by tapping the front of the motor with a rubber mallet until the machine is positioned perfectly.
- 4. Turn the magnet switch to ON. If fine position adjustment is necessary, loosen the fine adjustment lever and gently adjust the drill position by tapping the motor with a rubber mallet, then re-lock the lever.
- 5. Select an appropriate speed, based on the diameter of the drill (see speed selector guide, mounted to the machine).
- 6. Turn the Motor on using the White Forward button (NEVER DRILL IN THE REVERSE DIRECTION).
- 7. Use the feed handle to advance the drill at a rate such that the filings are small, discontinuous chips (if the filings are continuous strands, you are feeding too quickly.)
- 8. Press the Motor OFF button.

Sample Written Quiz: Label all of the parts of the Magnet Drill Press



## I. MIG Welding Machines

### Welding Risks

Arc welding has several kinds of risks:

- 1. Electrical Risks
- 2. Heat Risks
- 3. Light-Related Risks
- 4. Fire Related Risks
- 5. Asphyxiation Risks/Fumes/Respiratory Risks

#### 1. Electrical Risks

Arc welding is based on the creation of an electrical circuit, and a "break" in the electrical circuit, where the electricity is forced to travel through a gas (that becomes ionized in this process). The resistance in gas (think about the difficulty electricity has traveling through air) creates an "arc." An arc is comprised of electrical energy lost as heat and light. It is this intense heat that melts the steel.

Arc welding is safe because the electrical resistance of the welder is orders of magnitude higher than the steel. Consequently, the welder can safely touch metal that is connected to the circuit, without risk of injury, provided that the welder is wearing the proper clothing. The welder must be wearing closed-toed, rubber-soled shoes, a dry long-sleeved shirt, and dry pants. If the welding is conducted with wet clothing or in a wet area or without the proper footwear, the risk of electrocution is significantly increased.

#### 2. Heat-Related Risks

The welding process melts steel (melting point: 2700°F). Weldments can remain hot for a very long time. Always wear gloves, safety glasses, a welding mask, a long-sleeved shirt, long pants, and closed-toed shoes when welding. Always protect others from sparks using welding screens.

#### 3. Light-Related Risks

The electric arc produces intense ultraviolet radiation that can cause eye and skin damage. Much like sun exposure, risks increase with the level of exposure (both time and distance). Contrary to popular belief, viewing an electric arc from welding will not cause immediate blindness and occasional exposure is not harmful. However, extended viewing of an arc can cause severe scarring of the cornea and may even result in blindness. Similarly, moderate skin exposure to electric arcs does not normally result in noticeable damage. However, extended periods of skin exposure will result in painful sunburns. Chronic exposure to electrical arcs may increase the risks of cancer, similar to sun exposure.

# Students must always wear a welding mask, safety glasses, long-sleeve shirt (or welding jacket), long pants, and closed-toed shoes, when welding.

4. Fire-Related Risks

Welding sparks can ignite fires. Flammable materials must not be kept within 10 feet of a welding area. Students should pay particular attention to drawings, which should not be kept on the welding table. Keep all trash off of the floors, particularly underneath welding tables.

5. Asphyxiation Risks/Fumes/ Respiratory Risks

The MIG welding process utilizes an inert shielding gas ( $Argon/CO_2 mix$ ) to prevent the oxidation of the molten steel. This can deplete the breathable oxygen in the welding area, if sufficient ventilation is not provided.

Welding can produce hazardous fumes. Never weld galvanized steel, as the ignited zinc coating produces a dangerous. Always remove oil from steel before welding, to minimize dangerous gases.

During welding, always turn on a fan and the Weld Gas Extractor.

#### ALWAYS

- Wear safety glasses, welding mask, long-sleeved shirt (or welding jacket), long pants, and closed-toed rubber-soled shoes.
- Screen the welding area to protect others.
- Clear the area of flammable materials or anything wet.
- Weld materials that are free from oils or other coatings.
- Turn on fans and the Weld Gas Extractor.

