Denhac Metal Shop Safety

Course Objectives:

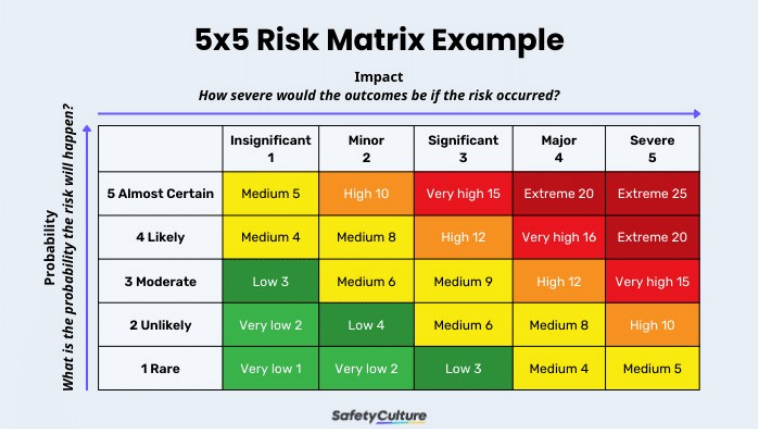
1. Learn how to use the shared machines safely and responsibly. The machines are dangerous and will hurt you, others, or become damaged if used carelessly.
2. Build safety habits that develop awareness, caution, and care for both yourself and others.
3. Go over the safe operation of the following equipment: Horizontal Bandsaw, Metal Chop Saw, Angle Grinders, Belt Sander, Bench Grinder, and the Drill Press.

Personal Safety:

- Appropriate attire
  - Suggested that all clothing be made from natural fibers. Cotton burns, plastic melts.
  - Eye protection required!
  - Closed-toe shoes – preferably resistant to metal chips / slag.
    - Optimal: boots with long pants covering the tops.
    - Leather spats available.
  - Do not roll pants up at the ankle. Sparks can catch in the fold then cause a fire.
  - Tie up loose hair.
  - No loose clothing or accessories. E.g. hoodie drawstrings.
  - Long sleeves have a risk profile comparable to gloves, more discussion later.
- Available PPE
  - Note: most of the PPE is located in the drawers in the wood shop.
  - Safety glasses, work gloves, hearing protection, respirators, face shields.

Industrial Risks:

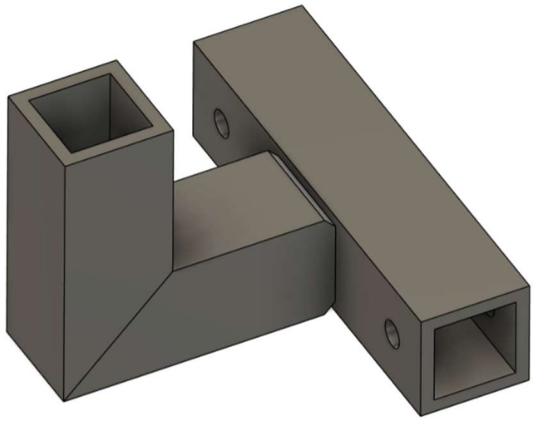
- We are including this section to provide a common framework for discussing then mitigating risks.
- 5X5 risk matrices are a common tool for evaluating risk.
- Risk = likelihood * consequence
- Risk is reduced by:
  - Preventing the likely causes through training, appropriate body position, not using damaged equipment etc.
  - Decreasing the effects / consequences by wearing proper PPE, clothing, and watching out for bystanders.
- Swiss Cheese / Belt and Suspenders approach – multiple layers of redundancy combine to minimize risk.
  - Primary vs secondary safety features.



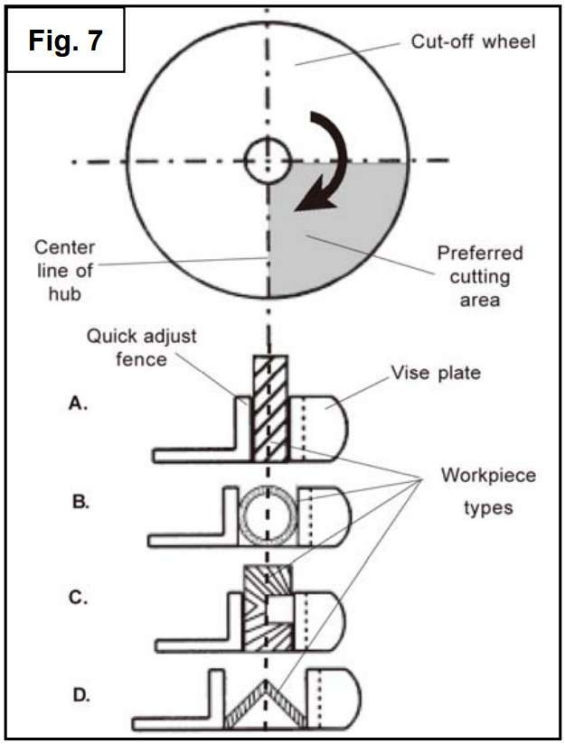
- Piling all available safety gear on your head may not be the safest option.
    - Make sure to cover your bases. Don't sacrifice a primary safety feature for a secondary one.
- Case study in balancing risks: Gloves and machinery.
    - Actual OSHA guidance
    - Degloving accidents are horrific.
        - When gloves get caught in rotating machinery (drum sanders, bench grinders, lathes, or milling machines,) they can pull fingers, hands, or the rest of your body into the machine.
    - Gloves also protect your hands against burns, cuts, metal splinters etc.
    - This is a similar risk to wearing long sleeves in the metal shop. If you are wearing long sleeves be wary about getting your clothes stuck in the machinery.
    - EVALUATE THE ACTUAL RISK!

Wall Hook Activity:

- As a demonstration of metal shop safety, we will be cutting parts for this wall hook. See handout.
- Planned Operations
    - Remember to account for kerf (Kerf: the amount of material removed during a cutting operation.)
    - Operation order:
        - Chop saw – cut the stock to 9 inches
        - Horizontal bandsaw – cut the 45 degree angle.
        - Angle grinder – cut 4" piece
        - Bevel 2X edges for future groove weld
        - Drill Press



Operation 1: Chop Saw



- Before we start
  - Cut metal is sharp and hot.
  - Metal splinters are a thing.
  - Keep all parts of your body away from moving parts.
- How to properly secure stock in a vice
- Metal Chop Saw
  - Raise the saw after disengaging the lock.
  - The cut angle can be changed easily.
  - **Make sure your stock is securely clamped into the vice**, like the bandsaw.
  - The on switch has a safety lock.
  - This is a dry cutting machine.
  - Let the saw fully spin up before contacting the material.
  - Do not use the saw unpowered!
    - The motor may lose power during a cut.
    - This is typically because the power spike caused by the machine has tripped a breaker (especially if you are using an extension cord)
  - Let the blade teeth do the work, do not jam the saw down. You shouldn't need more force than the weight of your arm.
- Operational safety
  - Remember that safety is a habit.
  - Think about the full workflow. Anticipate where things might go wrong.
  - Slow is fast. Rushing makes mistakes.
  - If interrupted, turn off machinery. When you return, start your mental checklist from the top. Do not assume the setup is still safe, or you remember where you left off in the process.
  - Be VERY careful about working late at night, especially alone!
  - Hospital admissions studies show that the vast majority of serious injuries occur at the end of the day. One last operation before dinner.
    - https://www.youtube.com/watch?v=ZVqa7j6jG0Q

Operation 2: Horizontal Bandsaw

- Keep all body parts away from the saw blade.
- Gloves optional.
- Raise the bandsaw arm by holding via tensioning knob.
  - Raise it carefully, don't let it fall.

- Familiarize yourself with the descent controls.
    - Descent control knob and locking lever.
- Characteristics of this machine:
    - The speed of the blade can be adjusted via pulleys.
    - Belt tensioner mechanism.
    - Adjust the blade guide to support as much of the blade as possible. This makes your cut more accurate and safer.
    - The saw can be used in the vertical position.
- Change the cut angle by loosening the 3 bolts, slide then rotate the vice.
- Make sure material is securely attached in the clamp.
    - Be careful towards the end of a cut – the detached material can go flying!
- Cut operations:
    - Keep one hand on the tensioning knob and one on the descent controls while cutting.
    - Be aware of the pinch points, don't get too close to the blade.
    - Loosen the speed knob slowly until the arm starts to slowly descend. Adjust descent rate to produce ideal size metal chips.
        - Wall hook activity: the top and bottom faces of the square stock will require a slower descent rate compared to the side walls.
    - Cutting too quickly can cause the blade to become stuck / slip off the rollers.
    - The saw will hit a limit switch and shut off at the end of a cut.
    - **Never walk away from bandsaw mid cut.**

Chip form	Chip condition	Chip color	Blade speed	Blade feed	Other
	Thick & Hard Thick & Short	Blue & Brown	Decrease	Decrease	Check Cutting Fluid & Mix
	Thick & Hard Brittle	Blue & Brown	Decrease	Decrease	Check Cutting Fluid & Mix
	Thick & Hard Strong Springiness	Silver or Light Straw	Suitable	Decrease	Check for Proper Pitch Blade
	Thin & Hard Springiness	Silver	Increase	Decrease	
	Thin & Curl Springiness	Silver	Suitable	Suitable	
	Thin & Straight Springiness	Silver	Suitable	Increase	
	Powdered	Silver	Decrease	Increase	
	Thin & Curled Very Tight	Silver	Suitable	Decrease	Use Coarser Tooth

Very fine pulverized chips. Feed speed should be increased.

Thick, heavy or blue colored chips indicate that the saw blade is being overloaded.

Loosely rolled chips indicate Optimum cutting conditions.

Lecturing Part 2: Electric Boogaloo

- Heavy machinery safety
  - Do not use damaged or malfunctioning equipment.
  - If there is any concern while using the machinery, turn it off.
  - Follow machine specific safety precautions as well as general safety precautions.
  - Be gentle & nice to the machines <3
  - Keep your eyes on the machine while it is on.
  - Visually inspect machinery for functional issues.
  - If a machine isn't functioning, post pictures and as many details as you can on the help-metalworking channel.
  - Message @metalworking-maintainers on slack!
- Community safety
  - Be aware of the people around you.
  - Stop if someone is distracting you!
  - Maintain situational awareness—other people may not recognize hazards.
  - Please message the help-metalworking channel if you are at all unsure about something or want a machining buddy.
- Dust safety
  - Wear a respirator and ensure proper ventilation when creating dust.
    - Take care of your community too!
  - Human respiratory systems ARE PERMANENTLY DAMAGED by inorganic glass shard shaped microscopic dust.
    - Tens of thousands of people die from this every single year. Different names for similar diseases. Silicosis, mesothelioma, asbestosis. These diseases have been killing people for centuries – see the old Colorado silver mines.
    - The microscopic shards get stuck in your lungs and can never be broken down. Medical context: Inhaled microscopic shards cause chronic inflammation and fibrotic scarring inside the lungs.
      - Damage is cumulative and often permanent.
  - **Red flag**: you are coughing for days after breathing in dust.
  - Denhac Specific
    - Clean up after yourself – don't generate a communal health hazard.
    - Rule of thumb – crack open the garage door / use fans
    - Close door to the woodshop area when producing dust.

Operation 3: Angle Grinder

- Gloves are recommended.
- Close toolboxes prior to grinding. Clean general workspace of flammable material.
- Use two hands while operating the equipment.

- Tool Setup:
    - Keep the handles attached to the tool.
        - Only time they should be detached is while switching from one side to other.
    - Be aware of the rotational direction – metal sparks will fly out.
    - Make sure your guard is attached and positioned to best deflect metal shavings.
        - Make sure the guard is attached securely.
    - Be careful about cross threading the equipment.
- Different types of angle grinder discs:
    - Cutoff discs – prone to shattering dangerously.
        - Side loads on this disc while rotating are DANGEROUS.
    - Grinding discs
    - Flap discs
    - Diamond cutting discs
    - Wire Brush discs.
- How to switch discs:
    - Unplug the angle grinder when changing discs. Only use appropriately sized discs.
    - Check that discs are good quality / not chipped.
    - Push down the rotational lock button and use the key to loosen the retaining nut.
    - Use the best disc for your task.
    - Do not overtighten the angle grinder – designed to self tighten.
- Using the tool
    - Proper footing is important.
    - When you are holding the tool, hold it such that your arms do not cross the plane of the cut.
    - Make sure the power cord won't accidentally be cut.
    - Make sure your stock is fully secured! Especially when using a cutoff disc.
    - DO NOT stop the wheel with the lock! This will damage the equipment.
    - Do NOT set the angle grinder down while it is still spinning! Conservation of angular momentum is a thing.
    - Be aware of the tool duty cycle. While using an angle grinder it will get hot. Using a hot angle grinder will drastically reduce tool lifespan.

Operation 4: Deburring & Beveling

- Belt Sander
    - Allowable materials: steel, aluminum
    - Don't wear gloves – degloving risk.
    - Check the belt integrity before using it. A torn belt is a safety hazard.
    - Always brace your part against the table.
    - Can modify table angle.
    - Do not use the edge of the belt sander.

- Bench Grinder
    - DO NOT wear gloves while using this machine! High degloving risk.
    - We are NOT set up to use aluminum on this machine!!
    - Make sure you have a secure grip on the part.
        - Can use vice grips.
    - Press lightly into the grinding / wire wheel. Let the wheel do the work.
    - Let the part cool down if it becomes too hot.
        - When steel gets too hot it work hardens.
        - Can keep water nearby to cool down the part.

Operation 5: Drill Press

- Figure out how you will secure your stock.
- Insecure stock can quickly become a projectile.
- Can clamp the vice onto the bed.
- Make sure that you do not damage the equipment while making thru holes.
    - Use sacrificial wooden blocks OR aim for the hole in the vice.
- Adjust the table bed height / rotate the bed to best fit your stock with sufficient room for the drill bit.
- Secure a 3/8” drill bit into the chuck.
    - Use the chuck key to hand tighten. Tighten all 3 locations.
    - Do not put the drill bit flutes into the chuck.
    - Make sure sufficient drill bit shank length is installed into the chuck.
- DO NOT leave the chuck key in the spindle, it will become a projectile.
- The spindle speed can be adjusted via the belts on top.
- Pay attention to chip size.
    - Do not let long chips collect around the bit.
    - Periodically clean chips off with a brush.
    - Forming a ‘rats nest’ is dangerous! Especially at high speeds.
- Cutting fluid should be used if you notice the drill bit heating up / thermal discoloration on the chips.

Final Remarks:

- Not all of the equipment needs authorization – use best practices.
- At the end of the day remember to clean up your space!
    - Soon to come: cleanup checklists!
    - Put away all tools.
    - Sweep up metal shavings.