**Tier 1 Checkoffs Study Guide**

**How to approach the checkoff**

Be sure to read all the way to the bottom of the page!
This deals with safety, so you absolutely must study so that you'll be able to show us that you know how to set up and run the machines (with help of a pocket reference), and convince us that you won't hurt yourself or the machines. We pass people that:
- Have prepared and can use the **pocket reference** to help them along with a small amount of help
- Don't blunder ahead when they don't know something, but understand it's OK to ask questions
- Can do most of the exercise by themselves, though we expect you might ask a question here or there
- Can answer all the safety questions and demonstrate safe practice

We've provided this guide to give you an idea of what a successful checkoff entails, and to help you study for the test without taking too much of your time.

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**Pass rate**

This test is pass or fail. So far, the pass rate is above 70%. Your chances improve markedly if you study with this guide and use the pocket reference guides.

**Study guides and resources**

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Use these resources to help you study. You can use the pocket reference guide (on your phone or printouts in the facility) to help you during the check off so make sure you understand it and are familiar with it. Be sure to keep reading after this table! There's a bunch of text below it that describes the checkoff in more detail!

<table>
<thead>
<tr>
<th>Pocket reference guides</th>
<th>Refresher videos</th>
</tr>
</thead>
<tbody>
<tr>
<td>We require you review these</td>
<td>We require that you watch these</td>
</tr>
<tr>
<td>Universal laser cutter</td>
<td>Link</td>
</tr>
</tbody>
</table>

[Link](https://docs.google.com/document/d/e/2PACX-1vSs9YtwZFe1e30tu8t...8Nj98JXRH7KYDLaiFa30BiAgCG6FRA98biy0tOtI_QpGib8u8HLOzula/pub?)
### When you arrive

Introduce yourself, get your safety glasses and open up the pocket reference. We’ll review the test, any questions you’ll have and then get going. We’ll ask you about the “Maker do's and dont's” video.

### Bandsaw

Be prepared to make a straight cut in a small piece of wood. Remember to use a push stick so that you keep your fingers away from the blade. Remember to lower the blade guard to a point just above the material so that the blade stays stiff (making it more effective) and so you protect yourself from coming into contact with the blade.

Remember for the checkoff:

- **Risks associated with bandsaws include:** cuts to the hand while changing blades (most common), cuts to hands while machine is on, dust inhalation, and hearing damage.
- **What PPE should you wear to mitigate the danger associated with these risks? What PPE shouldn't you wear?**
- **What should you do if you get injured?**
- **Sounds that might indicate that the bandsaw is not working properly:**
  - Grinding metal
  - Blade slowing down/lagging
  - Thumping sounds (occurs when blades are missing teeth)
- **What should you do if the machine breaks?**
Drill Press

Remember for the checkoff:

- **Risks associated with drill presses include:** Getting hair, loose clothing, or jewelry caught in a spinning drill bit; Getting cut by the flute of the drill bit; Material spinning out of control if not fixtured properly
- What should you wear to protect yourself against these risks? What shouldn't you wear?
- Remember to never hold a drill bit by the flute (the helical part that removes material), this can cut you
- What is a step drill and when should you use it?
  - Use a step drill with sheet metal and thin materials
  - Sheet metal easily spins out of control, step drills don’t have a helical flute so the material will not get caught and spin the material.
- **Sounds that might indicate that a drill press is not working properly:**
  - interrupted whirring or wobbling sound- could indicate that the bit is about to come loose
  - should not hear loud thumping when cutting hole- probably means the bit is too large and need to drill pilot hole first
- How should you properly fixture a part? How do you fixture round stock?
- Why do you need to fixture parts?

Be prepared to drill a hole using the depth gauge. When drilling a hole remember to:

a. Make sure you have your hair tied up completely. No loose clothing or jewelry.
b. Make sure you fixture the material properly.
c. Make sure you insert the drill bit properly (clamping it by the shank, not the flute!) and return the chuck key to it’s holder.
d. Make sure you adjust the table to 1” below the drill bit.
e. Make sure you adjust the depth gauge.
f. Make sure you adjust the speed appropriate for the hole size and material you are using.
g. Make sure you use pecking motion so that you can remove chips from the hole.

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Combination Disc/Belt Sander

Remember for the checkoff:

- **Risks associated with the sander include:**
  - Hair, jewelry, watches, or loose clothing getting caught in the belt
  - Parts can be thrown if not held down properly
  - Dust getting in your eyes, lungs.
  - Recently sanded parts can be hot
  - Sanding your fingers if you get too close
- What should you wear to protect yourself against these risks? What shouldn't you wear?
- **Why can’t you sand wood and metal on the same machine?**
  - Hot metal will ignite the wood shavings, fire hazard
- What should you do to mitigate dust?
- **What are belt sanders best for? Disc sanders?**
  - The belt sander is useful for smoothing large, flat surfaces
○ The disc sander is useful for sanding edges and angles

● What is proper sanding practice?
  ○ Holding it against the sander briefly, then pulling back, then repeating
  ○ Using pliers or a vise for small pieces
  ○ Keep your fingers away from the sander

● On which side of the disc sander should you sand? Why?
  ○ On the downward turning size
  ○ If you sand on the upward turning side, your part can be thrown up and out at you

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### Laser cutter

[Image of a laser cutter software interface with notes on how to change color for etching text.]
For each laser, we'll give you a file like the one pictured on the previous page. You will:

- Modify the file to cut and raster (engrave) correctly
- Load an acrylic sheet into the laser cutter
- Focus the laser
- In software, position the part in the correct spot for cutting
- Get everything to the point where you could cut the part, but don't cut it.

To do that, you'll need to know how to:

- Explain why it's important to ask questions when you get stuck (safety, not breaking machines, etc...)
- Set the Document Color Mode, Line Colors, and Line Widths in the drawing software.
  - **Document Color Mode** should be set to RGB
  - **Epilog settings**:
    - **Vector cut**: Stroke Width: <= .1pt, Stroke Color: RGB #000000
    - **Raster (Engraving)**: Stroke Width: > .1pt, Stroke Color: RGB #000000
  - **Universal settings**:
    - **Vector cut**: Stroke Width: <= .1pt, Stroke Color: RGB #FF0000
    - **Raster (Engraving)**: Stroke Width: > .1pt, Stroke Color: RGB #000000
- Turn on and focus the laser safely.
- Talk about safety for you and safety for the machine
  - Why you can't leave the laser when its running
  - Turn on the exhaust (to remove harmful gases produced during the cutting process, it is important to understand this)
  - Turn on the air compressor (to keep gases and debris away from the lens and optics, it is important to understand this)
  - Why it matters which materials you cut
  - What to do in case of a fire
- Send the drawing to the laser cutter and set the right material settings for the material you're cutting.
- Verify the part will be cut in the right spot on your workpiece/sheet of stock

If you've set it up properly, it would cut correctly, so we won't actually need to cut/engrave. We'll skip forward and have you show us how to clean up and shut down the laser cutter. We'll ask you a few questions about safety/material issues, sounds you should hear (smooth running motors, etc...) and should not hear (bangs, crunches, pops, anything out of the ordinary), while the laser is running and similar questions. Then we'll move you on to the next machine.

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**3D printer**

We will ask you how to start and stop jobs for each printer. We will also ask you to demonstrate using the Zortrax software. Various questions on both the 3D printer hardware and software will be asked.

Starting a job on the printers
- Dremel = USB (“save to file”; ‘Build’ → your file) WIFI???
● Ultimaker = SD card (“Save to file”; on machine: “Print” → your job)
● Zortrax = SD card (“Prepare to print” → “Save to print”; on machine: button to wake up, “Models” → your job)
● Stratasys = uses network with print queue, go to printer and press print
● Make sure trainees know how to not abuse an SD card

Stopping a job on the printers
● Dremel = press Stop
● Ultimaker = turn the knob to “abort” and press
● Zortrax = hold down the knob for 3 seconds
● Stratasys = press “pause” on display -> “cancel build”

Remember for the checkoffs:

Hardware
● Risks associated with the 3D printers include:
  ○ Heat hazards: touching a hot nozzle, bed, or metal objects in the printer
  ○ Cuts to the hand from using the putty knife without gloves to remove a print
● How does one remove a part from a 3D printer?
● What’s special about the Zortrax?
  ○ There is a bed connector in the back that you don’t want to hit.
● What’s special about the Dremel?
  ○ Removable glass print bed
● What about the Stratasys?
  ○ Removable print bed.
● How do you remove support material? How do you remove support material from Stratasys parts?

Software
● What is infill? When would you want maximum infill vs. light?
● What is support material? Do you want this, which options do you want?
● Support angle? What does this do? What are good settings?
  ○ The optimal angle is 45 degrees. Support angle is the angle from the vertical. This decides at what angle the printer starts using support material for things like overhangs.
● Where can you find support material used and print time estimate in the software?