

# USING RECIPES FOR A GREAT MAKERSPACE



Excerpted from **The Intentional Makerspace: Operations**, by the staff of Maker Works.

# Standard Operating Procedures

**Standard Operating Procedures** (SOPs) are recipes for anything that you need to do more than once.<sup>1</sup> Makerspace members use SOPs to operate machines safely and efficiently. Staff use SOPs to maintain machines, process membership transactions, and teach classes. You can even use an SOP to write an SOP.

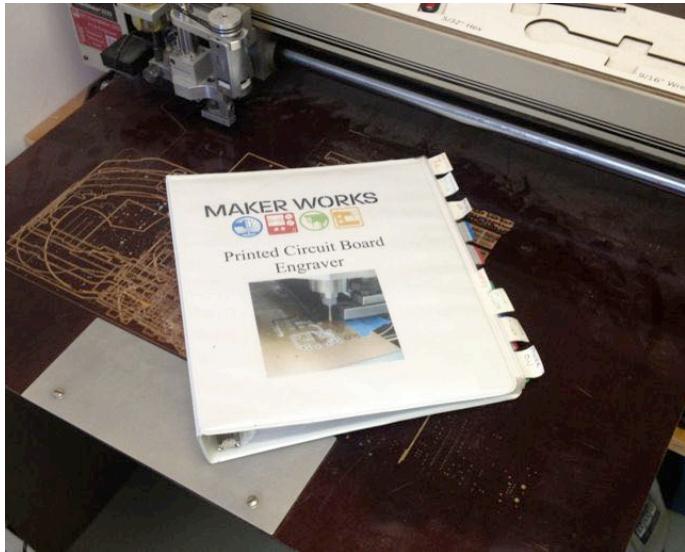


Figure 1: An SOP binder in its native environment.

SOPs are exactly like a recipe for a cake or soup. There's a list of required ingredients (1/2 cup flour, or a 1/2" end mill). There's a sequence of steps (make a roux, or set the spindle speed). Usually we'll find the required time listed, often a photo of the finished item, and even an indication of the skill level required.

SOPs in business are known under a number of different names like “operations manual” and “standard work”. Rosie the Riveter used them in WWII making bombers at Willow Run just a few miles from our shop; odds are your car was built using hundreds, if not thousands, of SOPs. International standards like ISO-9000 require the use of SOPs. As you read further in this book, you'll see that SOPs are a core element of much of what we're advocating.

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<sup>1</sup> Or something like a rocket launch, that you want to get right the first time.

But there's a downside: SOPs take a long time to write. At Maker Works, we spent three months writing SOPs before opening to the public. We are still writing SOPs for new tools, classes, membership transactions, and so on, and constantly updating the SOPs we've already written.

## SOPs take a really long time to write.

Sorry. That's the way it is.

If that's the case, there better be some really compelling reasons to use them.

## Why Use SOPs?

- SOPs codify the best practices for an operation. Everyone can use the safest, most efficient procedure, instead of what they *think* they remember from training, or even what they remember accurately from a trainer who maybe wasn't teaching the best method. SOPs make it easy to do the right thing!
- SOPs don't require the member to remember anything. In fact, we want to see the SOP open in front of a member as they work.
- SOPs make the member more independent, and require less staff time. When someone comes up to us with a question, often the first thing we will say is “What step of the SOP are you on?” This works, by the way, even if the staff person doesn't know the machine at all—just reading the SOP along with the member solves most problems. It's amazing how many questions go away when the SOPs are used!
- Conversely, in the absence of SOPs, all your staff time will be taken up with member questions. **All of it**, and then some. Not kidding on this one.
- SOPs give us consistent results. Each time our members use the plasma cutter, we want them to have good—even great!—and repeatable results.
- SOPs preserve the investment we make in the tools by reducing misuse and accidents. They improve everyone's experience by making it less likely that a user will make an adjustment or change to a setting that isn't helpful. (SOPs can

- define what actions are and are not acceptable, like changing configurations.)
- Because SOPs give us consistent results, we can improve on the SOP and expect to be able to tell if we've made an improvement. If each time we do a procedure we do it a little different, it could be very difficult to identify potential improvements or evaluate their results.
  - SOPs carry the member through the stage we call "unconsciously incompetent"—that is, the member doesn't know that they don't know. (Further stages are consciously incompetent, consciously competent, and unconsciously competent.) Don't count on members knowing things they might not actually know. We never want to hear "but I didn't know that operation was important".
  - SOPs are necessary for good instruction. Another TWI<sup>2</sup> tool we'll call "How to Instruct"<sup>3</sup> requires that the job being taught have an SOP.
  - Our SOPs are the basis of our safety and basic operation classes (or as one of us sometimes calls them, the "How Not to Kill Yourself" classes).
  - Training new staff is made much easier with SOPs documenting each step of handling member transactions and so on.
  - Just like teaching, writing an SOP is a learning opportunity.

Honestly, there are very few circumstances when writing an SOP will not save you time and expense. Most of the time, it will save many, many times the initial time spent. Even if it's just break-even, time spent writing an SOP is creating an asset, and as Josh put recently, is probably more interesting than the alternative—"How many times do you want to repeat the same thing over and over and over?"

Some years back, we visited a makerspace out on the East Coast that shared the following sad tale which illustrates a few of these points. They had a nice wood lathe in their woodshop, and someone came along who professed great skill and knowledge around the lathe and was interested in teaching a class on how to operate it. Sounds great,

they thought, so they set him up with some classes, and it sounds like all was well, at least for a bit. Then the lathe died. Apparently in a non-trivial, expensive-to-repair way. It turned out the expert was—well, not so expert. The manner in which the instructor operated the lathe *and had taught some number of other members* was destructive to the machine. They ended up with a broken machine plus a bunch of people who were incorrectly trained. (Fortunately in this case, the bad information wasn't safety related. What a worse mess that would have been!) How were the staff to know that the content being taught was destructive? There wasn't a defined, vetted process—an SOP—for teaching the class, so the class was whatever that person thought.

## Objections to SOPs

One objection we hear from time to time is that SOPs sound restricting, that they take the creativity out of making. ("Freedom From", anyone?<sup>4</sup>) We're going to argue exactly the opposite—SOPs let us get our work done faster and better, and let us continually improve. They free us from making easily preventable mistakes. (You may argue that it's your time, and hence your business if you want to waste it, but on shared equipment damage to a machine affects everyone.) SOPs give us more time to be creative where creativity is needed and valuable, but as we say, there's not a lot of room for creativity in how you install a router bit on the router. Use the time you save with SOPs to be even more creative in what you make.

Another objection is that SOPs turn our staff and members into robots, mindlessly following an SOP. Yes, one could force SOPs on people and stand over them with metaphorical whips, making sure they do everything exactly the same each time, but that's not a pleasant situation for anyone. Instead, SOPs must be provided in the context of giving our members and staff the tools and attitude to be **process engineers**, and asking them to always be on the lookout for improving SOPs or writing new SOPs when needed. Far from asking for a mindless, robotic presence, we want everyone to be thinking about

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<sup>2</sup>Training Within Industry, a WWII program described earlier in the book.

<sup>3</sup> Officially called "Job Instruction".

<sup>4</sup>"Freedom From" vs. "Freedom To" is a potentially useful concept around makerspace values that we discuss earlier in the book.

how to make things better—that is, delivering better value. Performing operations that add value are necessary, so let's make those easier, faster, even more fun if we can. Operations that are not “value added”—let's eliminate those.

SOPs are just tools, and they need sharpening and improvement just like a wood plane. (Later on, we'll see that improving SOPs is value added for the staff.)

An SOP that no one is allowed to improve is about as useful as a knife that no one is allowed to sharpen.

There's another objection to SOPs that you may run across, and it hinges on how people feel valued in their work. Creating SOPs will feel threatening to someone if they feel that their job or self-worth is dependent on knowledge that only they have. If they write it down, what value do they have? And they're right—SOPs and other Lean<sup>5</sup> practices only work if the introduction of these practices are not threatening people's jobs, but improving them. Otherwise, we're asking people to act against their own best interest. What would happen if respect and compensation are aligned with the ability to teach, to share, to document, to improve processes? Rewarding someone (even only with continued employment) only because of knowledge they're hoarding is not a productive place to be.

## What Does an SOP Look Like?

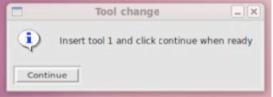
1	Install the first drill bit, T01, using the <b>Changing Bit and Setting Height SOP</b> .	
2	Run the G-code program by clicking on the "play" icon.  Key point: The program should immediately pop up a window asking you to install the first tool. Click Continue (or press return) since the first tool is already installed.	
3	When prompted, change drill bits if appropriate.  Key point: If you have consolidated drill bit sizes, you will leave some bits installed for more than one tool number.	
4	Remove the last drill bit.  Key point: Leaving the drill bit installed risks breakage.	

Figure 2: Some steps from a printed circuit board engraver SOP for drilling holes.

What's an SOP look like? Figure 2 has some sample steps from our printed circuit board engraver “learner” SOP. This is the SOP that members will use each time they operate the machine, and the one that forms the basis of our checkout class. (We'll discuss other types of SOPs shortly.) Physically, our learner SOPs live in white 3-ring binders by each machine. It should be easy for a member to find and refer to the SOP. (*Make it easy to do the right thing*.) All the operating SOPs for a machine are in one binder, often with tabs (and sometimes a table of contents for really big collections of SOPs).

An SOP describes the sequence of steps to accomplish a task. The number of steps is however many are needed—some SOPs will be very brief, others will be multiple pages. Often these SOPs will be executed as part of a larger sequence. For example, after using the “Mount a Tool” SOP on the ShopBot, a member then might use the “Touching off Z” SOP, followed by several more SOPs to finish creating their project. A very simple tool (say a laminator) might have just a single SOP.

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<sup>5</sup> Discussed earlier in the book. See also **SOP Resources** at end of this booklet.

Just like a food recipe, a Maker Works SOP has some front material:

- a title
- the result (hmmm, perhaps a photo?)
- when the SOP should be used (and what other SOPs might be appropriate for other circumstances)
- who should use the SOP (sometimes it is staff only, or even staff that have been through specific training)
- safety issues specific to the operation (which are in addition to the overall shop safety rules and perhaps a reminder of those for the machine)
- tools required
- time to complete the operation
- materials required

Then for each step, there are several items: **step number** (if needed), **step description**, **key point(s)**, **reason**, and **photo** or diagram.

Step numbers allow you to have the user repeat past steps or skip ahead—for example, “Remove the remaining 3 bolts by repeating steps 6-8” or “If the tool is already installed, skip to step 17.”

The step description spells out first what is accomplished and then how to do it. For example, “Remove the four cover bolts using a 5/8” socket”, or “Turn the controller on using the red toggle switch.” Steps are:

- Atomic—they can not be logically broken down into smaller steps.
- Bite-sized—the operator can remember the step and any key points during the step. If a step involves too many details, the operator may have to interrupt the step to consult the SOP.
- Logically grouped—a step may group a number of related sub-steps. For example, several screws of the same type and in the same location may be used to install a vise. They are all similar and perform the same function, so a single step could be to tighten all four screws. If several screws involved more than one function (e.g., one setting motor speed, another setting motor acceleration), then two steps should be used.

The “key point” is a separate element of the step description located right below it (or in a separate column) that provides additional information necessary for the safe, efficient completion of the step such as cautions, locations, alternatives, clarifications, or other useful details. For example:

Turn the power to the router off using the control panel power switch.

Key point: Rotate the red switch counter-clockwise so the pointer is to the “0”.

The key point does not provide more steps, it augments the existing step, and experienced users will generally know that information after using the SOP a few times.

SOPs may benefit from a separate “reason” for some steps. Normally it will be pretty clear why some step is called for, but if it is not, a reason (or key point) should be included so the user is aware of the function and importance of the step. For example, the order of steps may be very important to avoid damage to the tool—e.g., disengaging a brake before turning a spindle on. (You could combine this with the Key Point.)

Finally, having a photo or diagram is so important that we recommend assuming that each step will have one—you should have to make the case that a particular step doesn’t need a photo. Photos are usually very quick, but diagrams can often simplify or emphasize a particular aspect of an operation. Often a good compromise can be a photo modified with arrows or other graphics for emphasis or clarity.

iFixit.com has a long list of SOPs they call “repair guides” that step you through even complicated repairs like completely disassembling an Apple laptop to clean the keyboard. (Do not ask Dale why he is familiar with this particular guide.) They’re well worth looking at for a form an SOP can take.

## Types of SOPs

The form we just described is just one form an SOP can take, and the most common type we use. It is easy to up-

date (you can even write changes to the page directly in the moment), but does require reading skill.

As long as we are creating a *stable, consistent* process, the SOP might take other forms. For example:

MAKER WORKS Closing SOP Checklist 10/11/2015 v1.8		DATE:
THE LAST PERSON TO LEAVE MUST DO THE ENTIRE CHECKLIST. The only exception is if no one else has been in 1) since you last signed off or 2) since a staff person did the checklist AND told you that you were the last person in the shop. You still must check off the areas that you were using.		
COMMON ROOM (part 1)		
(Staff Only) Turn off TV (Big Screen) Display		
(Staff Only) Take care of unfilled Member Folders!		
(Staff Only) Close out cash register using SOP		
(Staff Only) Turn on answering machine		
(Staff Only) Post-shift huddle		
Close, latch 5 windows		
Lock exterior entrance doors (Rotate lock fully counter-clockwise and test)		
Turn off exterior light (left of door)		
Turn off Register 2X 3D printer (switch on back right side)		
ADMIN OFFICE		
Close, latch 1 window		
Turn off light		
Close door		
CIRCUITS ROOM		
Turn off PCB engraver (switch on front right)		
Close, latch 2 windows		
Turn off exterior light back of bench (switch down = off)		
Verify soldering gun unplugged, any soldering irons are off		
Turn off any other equipment		
Turn off lights (2 switches)		
COMMON ROOM (part 2)		
Turn off lights in common room (3 switches, next to conference room door)		
TOOL CRIB		
Unplug any tools (e.g., hot glue gun, heat gun) except battery chargers		
KITCHEN AND RESTROOMS		
Verify all counter appliances off		
Turn off lights (2 switches)		
CRAFT (part 1)		
Turn off three heat presses (note—yellow press switch is upside down)		
Turn off vinyl cutter (press blue button until machine is off)		
LASER ROOM		
Close, latch 1 window		
Turn off lasers A & B (vent fans should turn off automatically)		
Shutdown laser room computers (2) (via software)		
Turn off lights		
CRAFT ANNEX		
Use power strip (plug should be visible)		
Knock on office doors (3), make sure no one is inside		
Turn off Amaya embroidery machine (switch in rear)		
CRAFT ROOM		
Verify video projector is off		
Close, latch 3 windows		
Make sure lights are turned off		
Check Exterior Door between classroom and SkyShips		

Figure 3: Part of the closing checklist

**Checklist:** Pictorial or text, a checklist can optionally have one or more columns to record the completion of the step (and perhaps who and when). It's important to note that there's an implied order to the steps, which you can emphasize with numbering. We use a checklist for the SOP for closing up Maker Works at night—the last person checks each item off and signs the checklist (Figure 3). A list can serve as a reference—either as the entire SOP, or as a summary of the SOP that can be used once users have mastered the full SOP. Use an erasable material (e.g., laminated paper) to make a reusable checklist for operations that won't be completed in one go, or will be worked on by different people. This kind of reusable checklist can be fairly quick to create and easy to update.

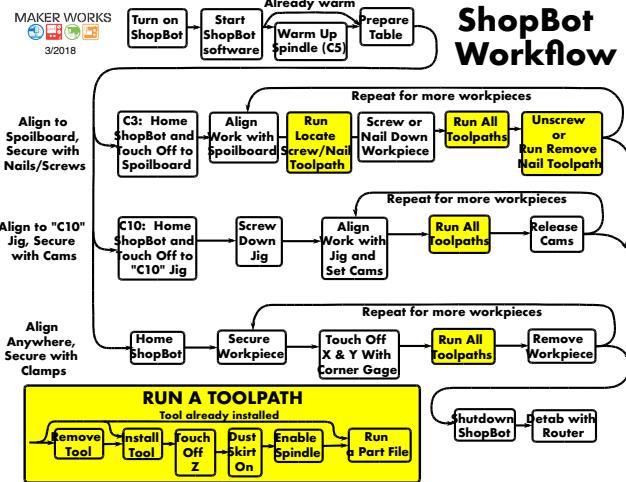


Figure 4: Example Flowchart

**Flowchart:** Some processes are not a single, linear sequence. (Check out some of our front desk processes sometime!) A flowchart can capture a multitude of decision points and alternative steps in a compact form. The steps can be steps of an SOP, or could refer to a separate SOP as in Figure 4. This form might take a little longer to create and update, but a visual diagram can be quick to use and can efficiently describe complicated options.



Figure 5: Custom metal jig for making up Learn to Solder kits

**Template or Jig:** Instead of text or a picture, sometimes you can create a physical template or jig that guides or facilitates the operation, as in Figure 5. Place object A here, B there, and so on. You can go further and make it hard to do the wrong thing by requiring every space be filled be-

fore the next step can be completed. The template could range from cardboard and gaffer tape to very finished. Needless to say, Murphy's Law suggests that the harder a template is to change or modify, the more likely it is that you'll need to.

## Pedestal Grinders

Grinding wheels are fragile! If they break, they can cause serious injury.

<b>YES</b>	<ul style="list-style-type: none"> <li>Carbon steel</li> <li>Alloy steel</li> <li>High speed steel (HSS)</li> <li>Stainless steel</li> <li>Tempered malleable iron</li> <li>Wrought iron</li> <li>Hard bronzes</li> </ul>
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<b>NO</b>	<ul style="list-style-type: none"> <li>Galvanized steel (dust is hazardous)</li> <li>Ceramic (requires special wheel)</li> <li>Aluminum (clogs wheel and can cause wheel failure)</li> <li>Brass (clogs wheel and can cause wheel failure)</li> <li>Carbide (requires different abrasive)</li> <li>Plastics, fiberglass, composites</li> <li>Any other materials</li> </ul>
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### BEFORE GRINDING

- Do not wear gloves. No loose hair, clothing, jewelry, etc. that could be caught in machine.
- Wear full-face shield.
- Use the machine-mounted safety shields.
- Identify the correct wheel type and grit size (see labels on machine).
- Verify tool rest is within 1/8" of the front and sides of the grinding wheel and level with center of wheel. The 1/8" check tool should not pass between the wheel and rest (test only with wheel at rest!). If too large a gap, notify staff to adjust.

- Verify upper guard is within 1/4" of the top and sides of the grinding wheel. If not, notify staff to adjust.
- If the wheel is not cutting well, has grooves, is not flat, or appears glazed, stop use and melt ask supervisor to dress the wheel.
- Always stand to one side of wheel starting grinder, in case wheel is cracked.
- If the grinder is excessively vibrating, stop use and notify staff.
- If grinder will not turn on, turn the grinder switch off, then press the black button on the yellow safety starter.

### GRINDING

- Grind only on the front of these wheels; never on the side. These wheels are not designed for side pressure and can fracture.
- Grind uniformly across the face—don't create grooves.
- Do not "jab" work into the wheel—bring the work gently into contact with the wheel!
- Never force work into the wheel with excessive pressure. (The motor should never slow down.)
- Work should be firmly supported by the tool rest.
- If work suddenly disappears, your fingers should not go into the wheel.
- Work may heat up! (Use water to keep cool.)
- Never grind small or brittle items that can be caught between the wheel and tool rest.
- Use Vise Grips for parts that are difficult to hold securely.
- Remove item from contact with wheel before turning off grinder.

### STAFF ONLY

- Adjustments to rests, guards (only with wheels at rest).
- Changing, truing, and dressing wheels.

chine to drill four holes in a block of wood in a single operation, each to the correct depth, with a jig to hold the wood block in an exact location (Figure 7). The SOP is now radically simplified from the earlier multi-step process. (Again, though, it has become quite specific in what it does.) Hopefully you can find these opportunities before you get to the SOP stage, but if you find your SOP doesn't seem realistic, maybe there's an opportunity to change the work itself. (Toyota encourages workers on their assembly line to create machines to make their work more efficient—search for the term “Karakuri Kaizen” for more details.)

**Audio or Video:** If someone's eyes or hands will be occupied with the task, perhaps audio or video can convey the process. Maybe there's a dynamic element of the operation that would be hard to convey with just words or pictures. Beware, however—such forms may be more time-consuming or otherwise difficult to improve. SOPs don't serve us if we can't improve them, and we always want to make it easy to do the right thing. Having a printed SOP means that staff can quickly slide a sheet out of a protective sleeve, write in a correction or clarification, slide it back in, and be done. (Well, at some point we want to update the SOP in our files.)

Figure 6: Example of Poster Form of SOP

**Poster:** The SOP doesn't have to be on multiple, small sheets of paper in a binder. We've experimented with posters for some processes, like using a grinder, as in Figure 6. Here there weren't step-by-step processes to convey as much as there were acceptable and non-acceptable materials, etc. Having the information easily visible and hands-free may increase its use.

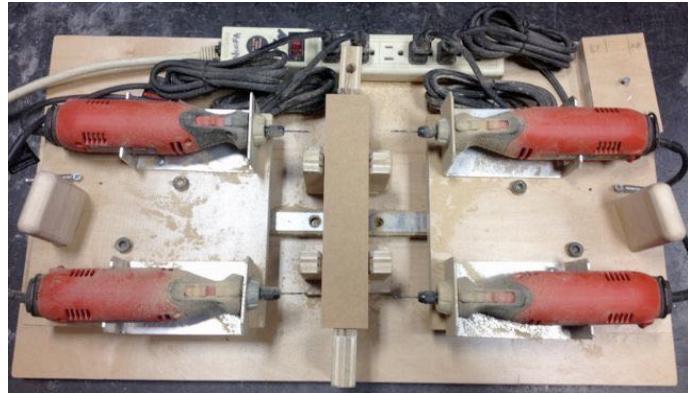
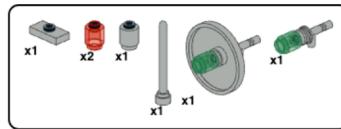


Figure 7: The "Drillerator 4000", an example of a special-purpose machine

**Machine:** Make it easy to do the right thing by creating a special-purpose machine. For example, we created a ma-



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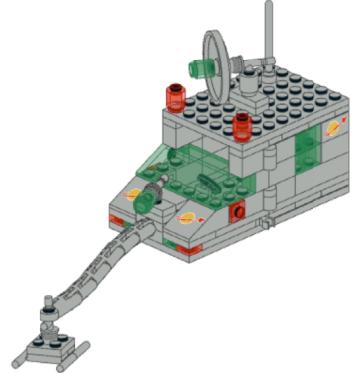


Figure 8: Example of wordless assembly diagram (from Web Lic)

**Wordless diagrams:** Lego makes wordless assembly manuals that, generally speaking, are quite good. (Figure 8 was not done by Lego, but is that same style.) You might find inspiration there, perhaps substituting photos for line drawings.

As Tom says, the non-negotiable part is that we'll have an SOP; the negotiable part is what form it takes. As long as we have some kind of SOP, we can improve on it. Having a uniform format for your SOPs will make it easier to write and update them.

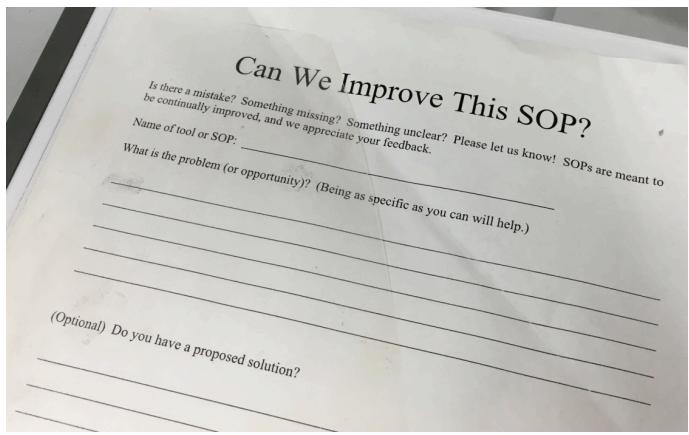


Figure 10: Example of seeking improvement for an SOP

## Also in the SOP Binder

What else is in the SOP binder besides the SOP?



Figure 9: What's new? This SOP got a major re-write, but most of the time we'll note the specific thing that has changed.

- On the cover we often list recent changes we've made to the SOPs (Figure 9). Handy when you add new accessories or make improvements.

- Inside the front cover is a form "How Can We Improve This SOP?" (Figure 10). It provides an opportunity for any user to make suggestions. If we really want improvements, we should make it really easy for someone to offer that feedback. (Which, by the way, you don't have to take!) It also makes it clear that we don't want users to make changes to the SOPs—that we'll leave to staff. (We'll properly vet those changes—not every staff person is qualified to make SOP changes on every machine).
- Overview/introduction to the tool: What it does, when used, specifications, capabilities. This is also a good place to list other resources, such as online manuals, user groups, forums, books, online documents, etc., that may be useful to the member.
- General makerspace safety policies.
- Tool-specific safety: These are elements of safety that are specific to the tool, but can and should also emphasize all appropriate safety issues even if mentioned in the general makerspace safety guidelines.
- Workflow for tool: When appropriate, an overall flow of the SOPs may be useful to lay out the order of operations when using the tool. A graphical flowchart can be employed if clearer. (See for example the flowchart shown earlier.)
- SOPs in order they are typically used. It is often helpful to add tabs to the SOPs so it is easier to locate a given SOP.

- Reference material: Example: tables for feeds & speeds; material charts; settings charts. (These are often located with the specific SOP where they'd be used.)

You could also have the manufacturer's operator's and service manual, your maintenance SOPs, any machine logs, and other resource material in the SOP binder. We typically keep these other things in a separate filing cabinet up front, but that does mean working on a machine often involves a trip to the front desk.



*Figure 11: You have to pick up the SOP to use this machine.*

Where should you place the SOPs? You might consider the following guideline: make it easy to do the right thing—and hard to do the wrong thing. Make it hard to ignore the SOP. For example, to reinforce the expectation that SOPs will be used, we put the closing SOP hanging in front of the alarm panel. You can't get to the alarm panel to set the alarm without having to handle the SOP. The milling machine SOP is hung in front of the controls (Figure 11). You have to physically remove the SOP to operate the machine.

Make sure there's a place to have the SOP open and consultable during use.

By the way, you'll notice the SOP binder above is scuffed and dirty. We love it when we see covers like that! **Beware the SOP in a clean binder!**

### A Cautionary Tale

"In September 2018, the USC team launched Traveler III, which may have been the first collegiate rocket to make it to space. The team expected it to reach about 370,000 feet, but the USC team failed to activate the avionics payload, so none of its flight data got recorded. Prior to the launch of Traveler IV, Tewksbury says, the team overhauled its operational procedures to avoid a similar gaffe."

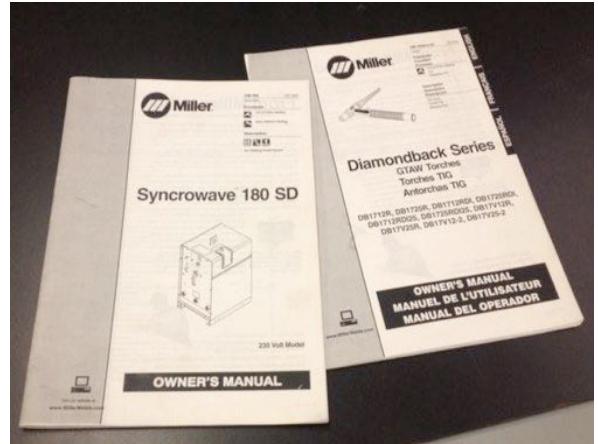
"A Rocket Built by Students Reached Space for the First Time", <https://www.wired.com/story/a-rocket-built-by-students-reached-space-for-the-first-time/>, posted 5/22/2019, accessed 5/25/2019

# How to Write an SOP

(We'll call this a "cooking" recipe—but before you make big changes, try it once or twice following the recipe so you have a baseline for comparison.)

## Ingredients:

- Existing documentation (manuals, books, etc.) and/or SOPs
- A partner
- Uninterrupted time
- Vision of success and/or specific outcomes
- Scope of the SOP with start and end points
- Knowledge of when SOP should be applied
- Pencils and note cards
- Domain expert (may be optional)

1	<p>Review the existing processes by reading documentation and/or SOPs.</p> <p>Key point: You may wish to highlight important points in the manual and later review to make sure they made it into your SOP.</p>	
2	<p>Perform the operation several times using the documentation and the domain expert to become familiar with the task, space, and materials.</p>	

	<p>Write down the individual steps and key points while performing the operation.</p>	
3	<p>Key Point: Use the left half of the note card. Focus on quantity rather than quality, with one step per note card. Physical cards are much preferred versus notes taken on a computer because note cards spread out nicely, are quick to re-arrange, etc. Note that an instant photo printer may be useful here, or sketches of what a photo or illustration should contain.</p>	
4	<p>Perform the operations using the steps you just created. Correct any obvious mistakes in technique, sequence, etc. Combine or split steps to create atomic, bite-sized, and logically-grouped steps.</p>	
5	<p>Add (descriptions of) photos or diagrams to each step unless it clearly does not need any.</p> <p>Key point: This goes on the right side of the note card.</p>	

6

Take the information from the physical cards (plus photos and illustrations) and place them in your SOP format.

6	Take the information from the physical cards (plus photos and illustrations) and place them in your SOP format.	
7	Use the SOP, tapering off supervision/evaluation of its use to a regular level as it proves to be safe and efficient.	
8	Establish a process to improve the SOP.	

12

7

Use the SOP, tapering off supervision/evaluation of its use to a regular level as it proves to be safe and efficient.



8

Establish a process to improve the SOP.

Key point: This can include getting feedback from users and periodic reviews. TWI also has a tool "How to Improve" (officially called "Job Improvements") you can use.

**Can We Improve This SOP?**

Is there a mistake? Something missing? Something unclear? Please let us know! SOPs are meant to be continually improved, and we appreciate your feedback.

Name of tool or SOP: \_\_\_\_\_

What is the problem (or opportunity)? (Being as specific as you can will help.)

(Optional) Do you have a proposed solution?

# An Exercise in SOP Writing

We highly recommend you try the following experiment in writing SOPs. We can just about guarantee that until you try writing an SOP, you won't have an appreciation of the process. You can also use this exercise during your staff training.

Grab a box or something box-shaped (we often use 4x4x4 blocks of wood), some wrapping paper (or newsprint), scissors, tape, and a straight edge.

Your job is to write an SOP for wrapping a present.

Set aside a good 45 minutes or so, grab a partner, and follow the "How to Write an SOP" SOP.

Yes, 45 minutes or more.

Come back here when you're done.



Figure 12: Yes, it's Minions Christmas paper. Don't judge.

So, was it an interesting experience?

Here are some questions to ask yourself and your SOP partner:

- Did you both agree at the start on what the outcome should be? For example, is it permissible to tape to the object? (In some families—Tom isn't saying whose, you understand—a person could be

ostracized for this Yuletide faux pas. In other families, merely the attempt to wrap a gift, versus using a gift bag, would be a Christmas miracle of the highest order.)

- Did you have a common set of words for the operations and results? Talk to an origamist sometime—they have a well-developed vocabulary for paper manipulation, though that's not something we would expect of our average user. It can sometimes be helpful to teach a special vocabulary so we then can use it in an SOP.
- Will the directions work for a left or right-handed person?
- How did you deal with directions and orientations?
- Does your SOP cover oblong or round objects?
- Did your SOP align the patterns on the wrapping paper? (Once again, it's not entirely clear you're going to be invited to next year's Christmas.)
- How did you deal with steps where you needed an illustration or photo? (Does it make sense that the default is to have an illustration or diagram for each step?)

If you have the chance, find someone else to use your SOP to perform the task. One memorable time one of our groups had omitted the step where the paper is cut off from the roll—it didn't even occur to them that after measuring the paper that the user wouldn't then cut off the paper. A second group, following their instructions to the letter, ended up with a wrapped box, but with the remaining roll of paper hanging off one end, still attached. Wish we had taken a picture.

## Your SOP Guidelines

Many people in your makerspace may create SOPs. It will help a lot if everyone creates SOPs using the same guidelines. Pick a software tool that everyone has access to (LibreOffice, Google Docs,<sup>6</sup> Word, etc.). Elements to specify or provide in your guidelines:

<sup>6</sup> Google Docs, at least at the time of this writing, is a nice solution since multiple people can collaborate, and it allows nice formatting. Just be sure that documents and folders are "owned" by a central figure or entity, rather than individuals who may come and go.

- Template for cover
- Where to store photos
- Front matter for SOPs (shop safety, etc.)
- Font face, size for titles and regular text
- Size of photos (e.g., specify the width in pixels, but with a maximum height)
- Page numbering
- Footer information (such as file name, date of last update, etc.)

## Improving SOPs

Your SOP is out in the shop. Ideally, the covers are looking well used, and there are smudges on some of the pages.<sup>7</sup> You're not done yet, though.

Make it easy for anyone who is using the SOP to provide feedback. Will you always act on that feedback? Not every time, but the harder it is to provide feedback, the less you'll get. We provide a form in the front of each SOP binder that asks for suggestions for improvements:

- Name of tool or SOP
- What is the problem or opportunity (as specific as they can be)?
- Optionally, do they have a proposed solution?
- Optionally, their name and contact information so we can follow up.

Monitor what questions or problems members are having. Ideally, each time someone comes up to a staff person with a question, we should ask ourselves if a system (for example, the SOP, or perhaps the way we've set up the machine) has failed.<sup>8</sup> Now, many times it's some unique situation that's unlikely to come up again (our members will tend to be very creative, after all). But if this is an issue that isn't in the SOP but seems likely to come up again, then it probably should go into the SOP (or perhaps a knowledge-base). This approach, letting the pain guide our response, works if the "pain" is minor. We

don't want to always be in a reactive mode, and we don't want injuries to members or damage to machines to be our notification that we have an SOP or other system to improve.

We have a staff huddle every Wednesday afternoon, and a regular agenda item is "Items of Significance(IOS) from the daily huddles". A tool broke. A member was unhappy with a policy.<sup>9</sup> We ran out of gas for the welder. In a surprising number of instances, we end up asking ourselves, do we need to change our SOP or other systems to prevent this from happening again?

You can also institute a formal SOP review on a regular basis. Having an outside "domain expert" may be helpful, though having an outside person with absolutely no experience may be even more informative since they will easily pick up on issues that the expert will forget are not common knowledge. Get both if you can.

## Summary

SOPs are nothing but recipes, and they let us deliver value consistently and sustainably. They're necessary for instruction, and the basis for continuous improvement.

Before you use them, they may feel constraining, a straightjacket on our creativity. But SOPs are shortcuts in the best possible sense, delivering us to our destination without getting stuck in swamps or deserts. If you want to spend time in the swamp, that's excellent. More power to you. But if you really wanted to get to that nice hill in the distance, SOPs get you there faster, so you can spend your time on what is valuable to you.

SOPs tell us how, but what's the reality of the workspace that we will try to execute these SOPs in? It's one thing to know you need a 5/8" wrench to tighten the bolts, but if there's no telling where it's hiding, are you closer to your goal? In the next section, on 5S, we provide—what else?—an SOP for creating organized workspaces that support our SOPs and all the other activity in our shops.

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<sup>7</sup> Dale has a wonderful old book of activities for kids from about 100 years ago. The pages that describe how to make cotton candy are a bit sticky.

<sup>8</sup>Note that we typically don't start from the viewpoint that the member failed to learn, for reasons we'll go into in other sections of this book.

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<sup>9</sup> I know—seems unlikely. But, once in a great while, it happens. Say, once or twice a day.

## SOP Resources

The idea of standard work (as documented in an SOP) is a cornerstone of Lean manufacturing and the Toyota Production System—the continuous improvement that Lean has as one of its goals depends on a stable process upon which to build. There are a lot of other useful tools in Lean for makerspaces, like 5S, so don't be too concerned about just extracting the SOP/standard work content from Lean.

**Kaizen Express** by Toshiko Narusawa and John Shook, 2009, Lean Enterprise Institute.

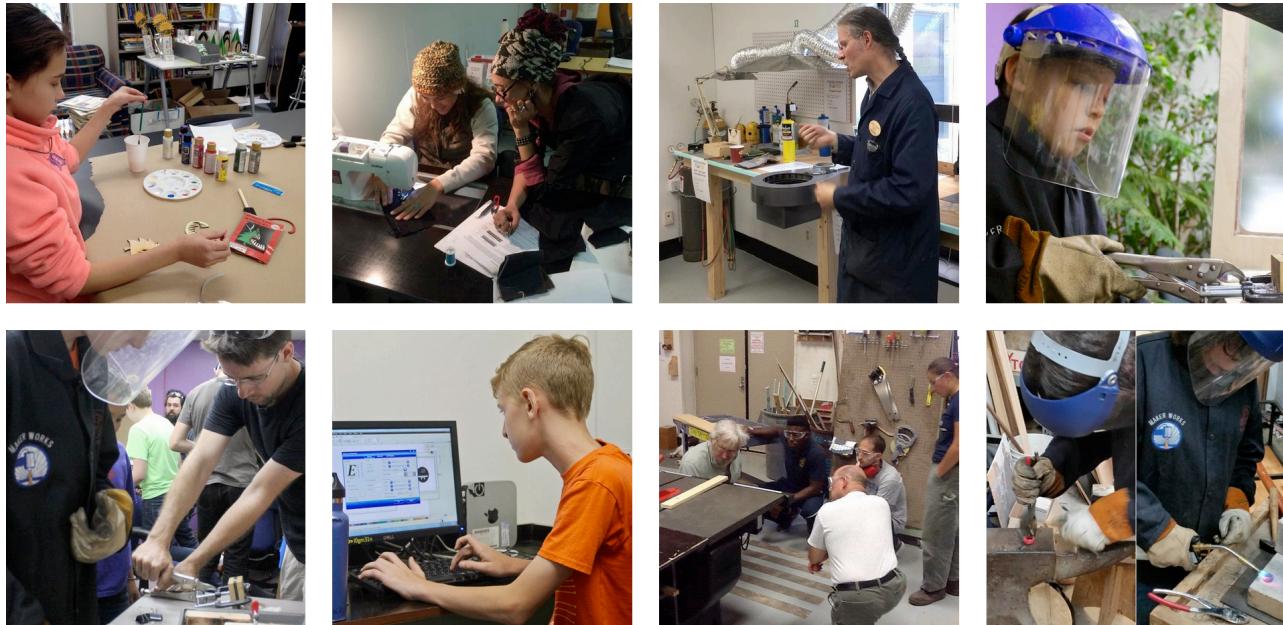
**The Toyota Way** by Jeffrey Liker, 2004, McGraw-Hill Education.

As we said in a previous section, SOPs are likewise a core of Training Within Industry, again as the basis for instruction and improvement. A good overview of TWI, including Job Instruction (SOPs) is at:

[www.allaboutlean.com/training-within-industry/](http://www.allaboutlean.com/training-within-industry/)

A Google search for “writing SOPs” will return a number of processes for writing SOPs, but the context may often be in fulfillment of regulations or certifications, and thus be a bit more formal than we typically need. That said, if you find another process works better in your organization, excellent!

# MAKER WORKS



Maker Works ([www.maker-works.com](http://www.maker-works.com)) is a makerspace in Ann Arbor Michigan. Started in 2011, the 14,400 square foot contains a full metal shop (machining, fabricating, welding, CNC plasma cutter), powder coating, wood shop, plastics, textile, jewelry, and, of course, lasers cutters and SLA and FDM 3D printing. It is organized as a for-profit with a triple bottom line: people, planet, and profit.

Since 2014, several times a year Maker Works has offered a one-week “Makerspace Operations Bootcamp” covering tools and techniques for smooth and safe makerspace operations, based both on our use at Maker Works and in other businesses we've been a part of. SOPs are just one of the many tools discussed, along with a comprehensive framework for business that relates the mission, vision, experience, guiding principles, systems, values, and bottom lines of the organization. For more details and a class outline, see [www.maker-works.com/mob](http://www.maker-works.com/mob).

**Summer 2019 Bootcamp: July 22-26**

**Fall 2019 Bootcamp: October 14-18**

This booklet is an excerpt from what we hope is an upcoming book on makerspace operations, based in large part on our bootcamp content. Other topics include organizing workspaces using “5S”, how to instruct, giving great service, lessons from Lean and Training Within Industry applied to makerspaces, and leadership. Download electronic versions of this booklet at our website.

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