# IDIN Skill Builder: Sheet Metal Bucket Instructor Guide

**ime Needed:**

7 hours total, or 2 x 3.5 hour sessions

**Number of People Needed to Run the Session:**

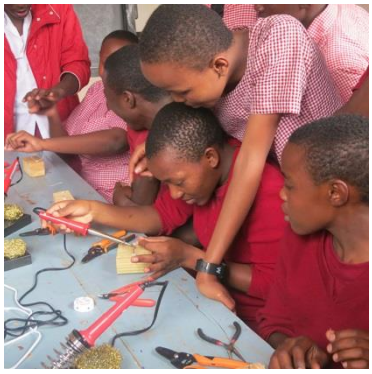
1-2 instructors per 8 participants

**Space Set-Up:**

This activity should be done in a room with sufficient table space. The tables should be sturdy ones that can withstand repeated impact from a metal flat bar.

## 1. Introduction

**PHILOSOPHY**



Many people around the world go through their lives rarely using their inherent creative instincts to make a useful object with their own hands. However, a belief in one's individual ability to create technology can lead to a sense of agency and a belief that one can create positive change in the world. This idea embodies the purpose of a Skill Builder.

Those who participate in a Builder leave believing they can be creative, work with technology, and build tools to solve problems present in their own lives or in the lives of others. The experience provided is transformative; if they can successfully build this device, then by extension, they can build another. For example, creating light is a magical experience, endowing a person with the ability to replicate the power of the sun. As a person said in Zambia following a Builder, "I was a dull knife and you sharpened me."

This kind of transformation is only achieved by having participants build on their own terms, exploring the use of tools with guidance from an instructor. It is important that their devices work so they are successful and feel a sense of accomplishment; but even more important is that they felt they did it themselves and believe they could do it again.

Skill Builders are the building of a piece of technology as a means to acquiring fabrication skills, working with materials, and learning physical principles. This can range from using wire strippers and a soldering iron to create an LED light to using a hammer and chisel to shape wood into a spoon. The key to inspiring change in participants does not lie within the device created; it lies in the skills gained and the newfound sense of ability felt by participants.

For those who have never used the tools before, the initial stages of the Builder will feel awkward. Participants may "fail" at steps in the process. They should be guided out of these stumbles, not have the



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stumbles solved for them. Struggling with the process and resolving issues on one's own are important in building the feeling of agency that is necessary to use these skills to address problems in the world.

Skill Builders are also a powerful experience for the instructors. When the participants have successful devices, the pride they have will be reflected in the pride instructors feel. The instructors are the first link in passing along the philosophy and skills transmitted. If the instructors are steeped in these principles, the participants will carry the philosophy and skills forward in their lives and will share with those around them.

**GUIDELINES**

To be an effective instructor and create a valuable experience for the participants, keep the following ideas in mind while delivering the Skill Builder.

- Allow participants to work through the steps at their own pace. It is important that everyone gets to practice using each of the tools. Since this is the first time most people have used them, it will take longer than you might expect. The length or number of sessions should account for this. If you find you still go over, arrange for more time.
- Encourage participants to form pairs and help each other through the activity. Ensure there is not a dominant person in each pair who does all of the tooling and machining.
- If a participant is having trouble, encourage those around him or her to provide help so the participants can learn from each other. When a participant has solved a problem, have them demonstrate the solution to the group so they can take credit.
- If a participant makes a mistake, help them to diagnose the problem and fix it. This should be done by encouraging them to share their thoughts on the problem and the solution, before offering your own diagnosis and solution. Avoid correcting the mistake for the participant except in extreme situations.
- It is important to practice showing, instead of telling. A visual demonstration goes much farther than an oral description of the task. During the Skill Builder, be vigilant to ensure there is more showing than speaking.
- Encourage participants to use spare materials to practice the skills before using the tools to make the final product.
- Observe and advise the participants on their technique in using the tools so they have the opportunity to improve.
- Complement the participants as they successfully complete steps in the construction process, emphasizing that they are responsible for accomplishing the task.
- Promote a sense of camaraderie in the group. Ways to do this can include a group picture, having each person sign each other's device, or taking time for each person to demonstrate their functional device. Place emphasis on each participant's success in creating a working device to increase their confidence.
- Keep the guiding principles described in the philosophy section in mind as you deliver the curriculum.

**PREPARATION**

To set the Skill Builder up for success, do the following ahead of time:

- Make the device yourself to discover what steps participants might find difficult and to ensure all tooling and machinery is functional.
- Set aside one set of Skill Builder parts for yourself and subassemblies to show key steps. As you lead the participants through the Skill Builder, you can demonstrate steps using your own set of parts.
- Set up at least one completed device that participants can reference as they complete the activity.
- Prepare extra material that the participants can use to practice skills.
- Print one 'Participant Skill Builder Photo Guide' per participant.
- Print one 'Skill Builder Module User Evaluation Sheet' per participant.
- Prepare supplies and tools at the work stations.
- Ensure a first aid kit is available.

- ☐ Ensure there are enough safety glasses for you and all participants to each have a pair throughout the activity. Ensure other personal protective equipment is available where necessary.

**SAFETY**

Below is a list of safety concerns relevant to this Skill Builder.

Flat Bar:

- Shaping sheet metal using a flat bar produces a very loud noise. Hearing protection is advisable.
- Wear eye protection while shaping the metal in case any particles split from the sheet metal.
- Keep hands and fingers clear of the flat bar when shaping the sheet metal.
- Be aware of surroundings so as not to accidentally hit someone else with the flat bar.

Tin snips:

- Keep fingers clear of the blades when cutting the sheet metal.
- The cut edges of sheet metal can be very sharp and have nasty burrs. Some people prefer to use gloves for this reason. Otherwise, pay attention to the edges and file them down as necessary.

## 2. Overview

**LEARNING OBJECTIVES**

- ☐ Participants will learn how to create drawing aides.
- ☐ Participants will learn how to draw concentric circles and make a bucket pattern.
- ☐ Participants will learn the difference between left, right, and center tin snips and how to properly use each one.
- ☐ Participants will learn how to shape sheet metal using tin snips and a flat bar.
- ☐ Participants will make a water bucket out of sheet metal.

**LESSON PLAN**

1. Review the skills to be taught and the technology to be built, including supplies and tools needed. *20 min*
2. Complete pre-questions in the ‘Skills Builder Module User Evaluation Sheet’. *5 min*
3. Draw and cut out the body of the bucket. *1 hr*
4. Shape the body. *3 hrs*
5. Draw and cut out bottom of the bucket. *15 min*
6. Attach the bottom to the body. *1 hr*
7. Reflection and feedback. *25 min*
8. Complete the post-questions in the ‘Skills Builder Module User Evaluation Sheet’. *15 min*

## 3. Materials

**TOOLS**

| | Item | Quantity Per 8 Participants |
|---|---|---|
|  | Straight tin snips | 2-4 |
|  | Right curved tin snips | 2-4 |
|  | Left curved tin snips | 2-4 |
|  | Flat bar | 8 |
|  | Marker | 8 |
|  | Pliers | 1-2 |
|  | Hammer | 2-4 |
|  | Ruler | 1-2 |
|  | Flat file | 2-4 |
|  | Scissors | 1-2 |
|  | Large diameter round object (ie. PVC pipe; approximately 6” or 15.2cm in diameter) | 1-2 |

**SUPPLIES**

| | Item | Amount | Cost |
|---|---|---|---|
|  | Aluminum sheet metal, 20-gauge or smaller | 6 $ft^2$ (1.8 $m^2$) | $5-10 |
|  | Twine | 4 ft (1.2 m) | minimal |
|  | Scrap wood block (approximately 2” x 4” x 6” or 5cm x 10cm x 15cm) | 1 piece | minimal |
|  | Tape | 1 ft (30 cm) | minimal |
|  | Nail | 1 | minimal |
|  | Butcher paper or newspaper | 6 $ft^2$ (1.8 $m^2$) | minimal |
| | **Total Cost** | | **$5-10** |

## 4. Teaching Notes

### INTRODUCTION TO THE SESSION

Metal buckets are invaluable tools not only for carrying water back and forth, but also other objects such as tools, food, and lots more. Although a bucket takes a lot of time to make by hand, a well-made bucket will be a long-lasting and useful tool.

### DRAWING AND CUTTING OUT THE BODY

**Skills**

sketching

cutting sheet metal

**Tools**

**Supplies**

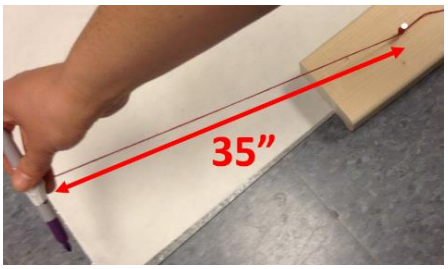
1. Hammer the nail into the middle of the scrap wood block so that the nail is secure and at least ½" (1.3cm) of the nail remains exposed above the wood. The block should be about the size of a hand and be thick enough for a nail to be driven into.

2. Measure and cut a piece of string to at least 3½ ft (1.07m). Tape one end of the string to the marker (do not tape to the cap).

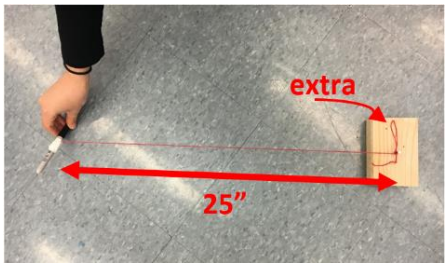
   *Teaching note: Explain that if the ruler is not long enough, string can be measured in segments by folding the string across the length of the ruler.*

3. Tie the string to the nail such that the distance between the nail and the marker measures 35” (89cm) when taut. The length of the string affects the rate of curvature for the top edge of the bucket.

   *Teaching note: The dimensions described here are one option for participants. They should be encouraged to vary these measurements to determine the effect on the shape of the bucket using the butcher paper medium.*

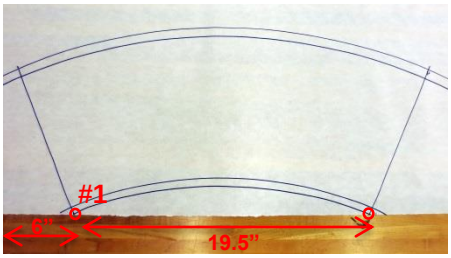



4. From the marker attached to the string, measure 25” (63.5cm) and mark this point on the string. Tie the string around the nail so that the 25” (63.5cm) length is free to draw a circle. The difference between this value and the previous value is the approximate height of the bucket. In this case, that is 10” (25cm).



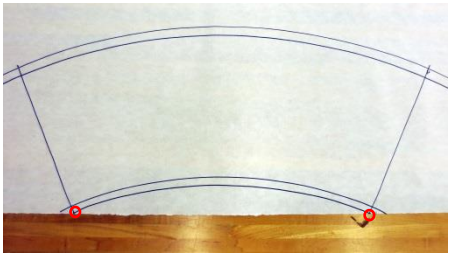

5. Tape down a piece of butcher paper. On the longer edge of the paper, measure 6” (15cm) from the corner. From this mark, measure another 19.5” (49.5cm) along the edge. This second measurement is the approximate circumference of the bottom of the bucket.

   *Teaching note: Sketching on butcher paper allows one to see what kind of shape will form before committing to the sheet metal. Encourage participants to mock their buckets in the butcher paper.*

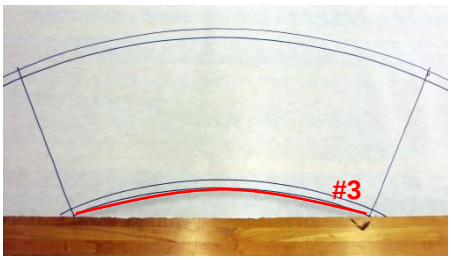



6. Place the drawing tool on the table or floor such that the marker will touch both marks when the string is taut.

   *Teaching note: It is useful to use tape to secure the wood block so that the circles are all drawn with the same center.*



7. Draw an arc on the butcher from the first mark to the second mark. This will be the bottom edge of the bucket.



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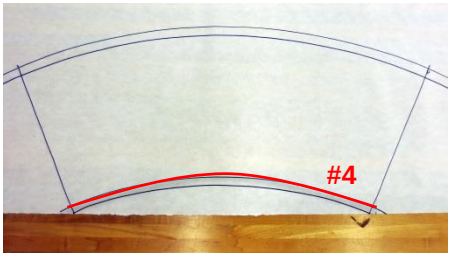
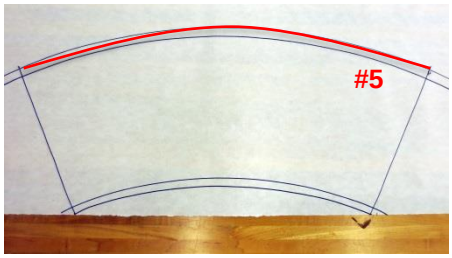
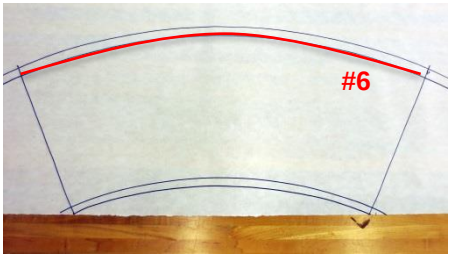
8. Release the string knot slightly so that the length of the string is just over 25” (63.5cm). Draw another arc. This will give a guideline for bending the bottom edge of the bucket.



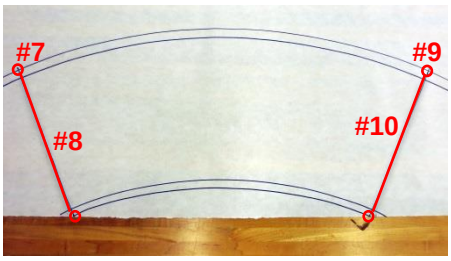

9. Fully untie the knot in the string made earlier so that the drawing radius measures 35” (89cm). Keeping the block in the same location, draw another arc as long as is allowed by the amount of butcher paper.



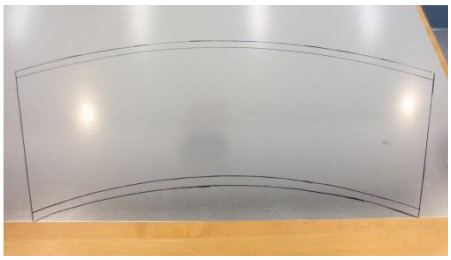

10. Double knot the string and draw a final arc. This one will be slightly inset from the previous line, and provides a guideline for bending over the top edge.




11. Remove the marker from the string. Stretch the string so that it intersects one of the two end points of the smallest arc. At that position, mark where the string intersects the largest arc. Repeat for the other side. Connect the marks on the largest and smallest arcs with a straight edge to form the sides of the bucket.




12. Cut out the butcher paper sketch and determine whether it will create a bucket as desired. After adjustments are made, transfer the sketch to the sheet metal.





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13. Use the curved snips to cut along the top and bottom arcs of the bucket pattern and straight snips for the sides.

***TEACHING NOTE:*** *DEMONSTRATE PROPER USAGE OF TIN SNIPS*

*Mark the cut.* Before cutting any material from the sheet metal, it is important to sketch guidelines for the desired cut onto the metal. Typically, these guidelines are first drawn in another medium, such as paper, and then transferred to the sheet metal.

*Use the correct directional snips.* For the straight edges, use the straight snips. For the top and bottom arcs, use the correct directional snips that orient in the way that the arc curves.

*Place the metal into the mouth of the snips.* Make sure that the sheet metal is inserted as far as possible into the mouth when cutting.

*LEARNING OBJECTIVES ACCOMPLISHED:*

- ☐ Participants will learn how to create drawing aides.
- ☐ Participants will learn how to draw concentric circles and make a bucket pattern.
- ☐ Participants will learn the difference between left, right, and center tin snips and how to properly use each one.
- ☐ Participants will learn how to shape sheet metal using tin snips.

**SHAPE THE BODY OF THE BUCKET**

**Skills**

shaping sheet metal

**Tools**

**Supplies**



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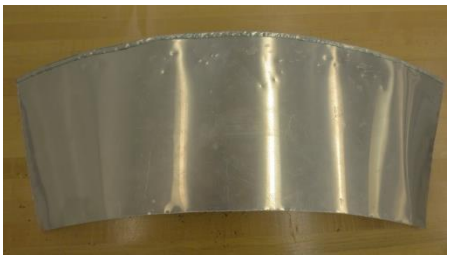
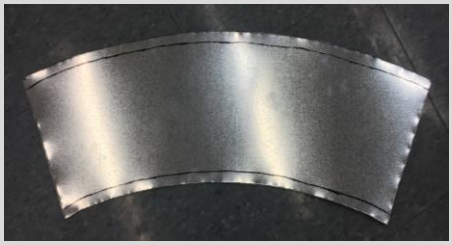
14. The top edge will be bent over 180 degrees according to the sketch made earlier to create a smooth edge that will be less likely to cut a finger (as is the case with thin sheet metal). Folding over the top edge also adds structural integrity to the bucket. The top seam should be outward facing.



***TEACHING NOTE:*** *DEMONSTRATE PROPER USAGE OF A FLAT BAR TO CREATE A SEAM*

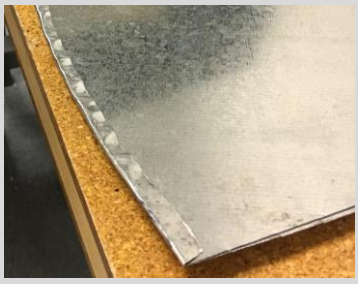
*Mark the fold.* Before bending any metal, it is important to sketch guidelines for the desired fold (or seam) onto the metal.



*Have good body position.* Hold the flat bar near the middle to bottom half with your dominant hand, and hold the sheet metal against the table surface with your non-dominant hand to keep it in place. The sheet metal could also be clamped to the work surface.

*Use the table's edge. Make changes gradually.* The approximately ¼" to ½" (0.64cm to 1.3cm) of sheet metal below the drawn line should be over the edge of the table. Using a downward trajectory and relying on the edge of the table to facilitate the bend, begin shaping this tab. Changes should be made incrementally, from right to left, then back again, to ensure that the metal is shaped slowly and does not develop any kinks.

*Change angle and leverage as needed.* Once the tab has been folded 90 degrees, flip the sheet metal over so that the tab faces upward. Begin shaping the fold with the flat bar using the top of the table as the counter surface. Again, work from right to left and back again. Keep working until the tab is completely flattened against the sheet metal and there are no gaps between it and the rest of the sheet metal.



15. Fold the bottom edge along the sketch drawn earlier until the tab is at a 90° angle. This bend should be made such that the tab faces outward from the bucket.

16. Shape the sheet metal into a circle so that the straight edges will touch when very little force is applied. Use a round object as a surface against which to shape the metal.

*Teaching note: Explain that participants will have to be especially patient during this step. Large kinks in the metal can result in a leaky final bucket. This step is meant to take a very long time.*

*Teaching note: Demonstrate that should the bottom tab kink, the participant should rotate the sheet metal to flatten out the kink against the table surface. This will effectively thin the sheet metal in that area.*

***TEACHING NOTE:*** *DEMONSTRATE PROPER USAGE OF A FLAT BAR TO CURVE SHEET METAL*

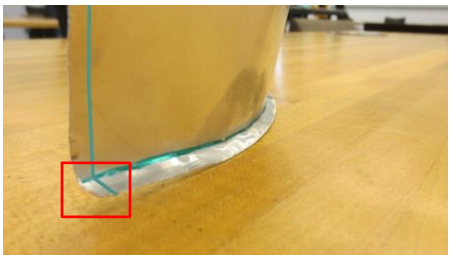
*Clamp the round object onto a flat surface, such as a table.* It is important to ensure that this object is clamped soundly and securely to the table. Any movement by the object will decrease the force transferred to the sheet metal.

*Place the sheet metal against the round object.* Hold the flat bar in your dominant hand and the sheet metal with your non-dominant hand

*Begin shaping the sheet metal against the round object with the flat bar.* Work from the right-most edge to the left-most edge of the sheet metal. Do this incrementally so that the metal does not have any kinks. Further, take pauses to shape the bottom tab so that it remains flat and at 90 degrees.

*Keep shaping the sheet metal until you feel as though the two edges can touch with little force applied.* Only until you are confident of this step can you move on.

17. To connect the sides of the bucket, a small piece of sheet metal needs to be removed. From one of the ends, cut off a portion of the tab that is equal to the width of the intended fold for the seam.



18. Fold each of the two straight edges almost completely over (more than 90 degrees), with an offset of about ½" (1.3cm). These two edges are meant to hook together, and are therefore folded in the same direction.

19. Hook the two folds together and use the flat bar to fully flatten the seal. If needed, insert the round object into the bucket to create a surface against which to shape the sheet metal.

*LEARNING OBJECTIVES ACCOMPLISHED:*

- ☐ Participants will learn how to shape sheet metal using a flat bar.

**MAKING THE BOTTOM**

**Skills**

cutting metal

**Tools**

**Supplies**

20. Trace the bottom of the bucket (from the outside of the tabs) onto a piece of flat sheet metal. Secure the string to the middle of this outline with tape. Increase the twine length so that the radial distance between the two circles would equal the width of the bottom tab. Draw this outer circle and cut it out.

21. Fold the edges of the circle in along the inner outline. Once the edges are folded 90 degrees, place the bucket inside the circle aligned with the outline made previously and continue to fold the edges over until they are flat. Now, the tab on the bottom edge of the bucket is sandwiched in the fold.

22. Finally, fold the entire edge up so that it is flush with the sides of the body. This will ensure that the bucket is as water-tight as possible.

    *Teaching note: It is helpful to insert the round object into the sheet metal bucket while folding up this edge. It creates a surface against which to shape the edge and minimizes potential deformation to the bucket walls.*

*LEARNING OBJECTIVES ACCOMPLISHED:*

- ☐ Participants will learn the difference between left, right, and center tin snips and how to properly use each one.
- ☐ Participants will learn how to shape sheet metal using tin snips and a flat bar.
- ☐ Participants will make a water bucket out of sheet metal.

**REFLECTION AND FEEDBACK GROUP DISCUSSION QUESTIONS**

- Besides another bucket, what would you make with the new skills you've acquired?
- How long did you think it would take you to make the bucket when you first started?
- What was the most interesting thing you learned while making the water bucket?
- Which skill that you learned are you most excited about?
- Which skill that you learned would you like to have spent more time practicing?

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