IDIN Skill Builder: Hand-Held Foam Cutter Instructor Guide

Time Needed:

3 hours total

Number of People Needed to Run the Session:

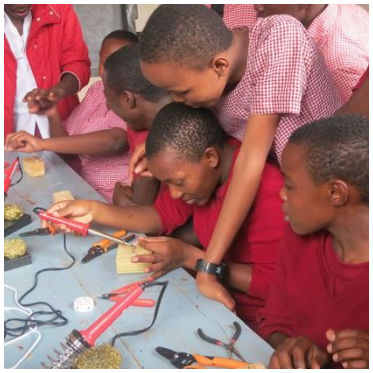
1 instructer per 15 participants

Space Set-Up:

This can be done in any space where participants have access to a clean, flat surface such as a table for easier assembly

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 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

Published 12 November 2015, Version 1.0

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.

Pliers:

- If one has poor technique while using pliers, is possible to jam part of one's hand in the pliers. This can leave a blood blister.
- When wire is cut, especially if it is thicker gauge, the piece can fly. Cut wire away from others, especially if they are not wearing safety gear.

Wire:

- 32 gauge nichrome wire is very thin. It is easy to pierce one's skin with the wire. This can introduce tetanus risks, and will cause bleeding.
- When in use, the nichrome wire is incredibly hot. It is possible to burn oneself on this wire.
- When cut, the thick gauged hanger wire can be very sharp. This can cut one's skin if it is not filed down.
- Using the foam cutter generates fumes. These fumes are hazardous to health and should not be inhaled directly.

Batteries:

- If batteries are shorted for a long period of time. They can explode. In exploding, there can be flying pieces of metal. The battery acid will also leak. It is important to buy quality batteries to avoid this outcome.
- When the batteries are shorted, they get very hot. It is possible to burn oneself on these batteries or any wire that is in contact with them. If the batteries begin heating, break the circuit immediately.

2. Overview

LEARNING OBJECTIVES

- ☐ Participants will learn how to manipulate thick gauged wire.
- ☐ Participants will learn how to use slip joint pliers.
- ☐ Participants will learn to make a complete circuit and what can cause the battery to short.
- ☐ Participants will learn to make prototypes using their foam cutter.
- ☐ Participants have made a nichrome wire foam cutter.

LESSON PLAN

1. Review what a hand-held foam cutter is. *5 min*
2. Complete pre-questions in the 'Build-It Module User Evaluation Sheet'. *5 min*
3. Make the hand-held foam cutter. Steps include 1) Make the battery holder; 2) Close the battery holder; 3) Wire the circuit. *45 min*
4. Complete the design activity. *1 hour, 25 min*
5. Reflection and feedback. *25 min*
6. Complete the post-questions in the 'Build-It Module User Evaluation Sheet'. *15 min*

3. Materials

TOOLS

	Item	Quantity Per 4 Participants
	Slip joint pliers with cutter	4
	Wire strippers	1
	Sand paper (small piece)	1
	Safety glasses	4

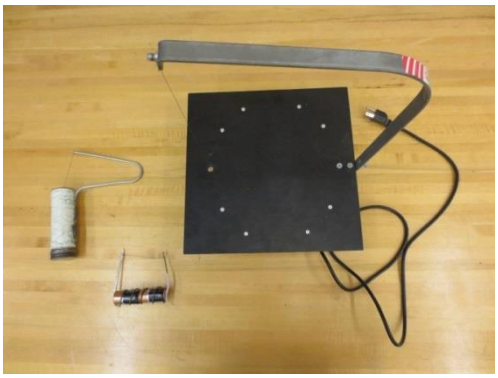
SUPPLIES

	Item	Amount	Cost
	D batteries	2	$4
	Nichrome wire (0.33 mm diameter, 32 gauge)	21 cm	$0.10
	Steel, unpainted clothes hanger (11.5 gauge)	1	minimal
	Coffee stirrer straw (3.3 mm diameter)	2	minimal
	Packing tape	1 piece	minimal
	Foam	1 large piece	minimal
	Single stranded wire	30 cm	minimal
		Total Cost	**$5**

4. Teaching Notes

WHAT IS A HAND-HELD FOAM CUTTER?

A hand held foam cutter allows people to cut interesting shapes from foam without needing electricity or a large machine. The foam parts can be used to create prototypes during the design process. Creating the product vision in foam allows the designer to make modifications, improvements and gather user feedback without the cost and time involved in creating a functional prototype.



Additionally, foam parts can be used when casting metal parts. Using the foam cutter, someone could make the part they want out of the foam, and then put it into the sand casting frame to create the mold. Unlike when using a solid part to make the mold, the foam can be left inside the mold. When the molten metal is poured in, the foam evaporates, leaving only the solid cast part behind.

MAKE THE BATTERY HOLDER

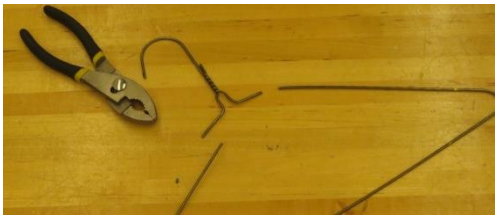
Skills

pliers

Tools

Supplies

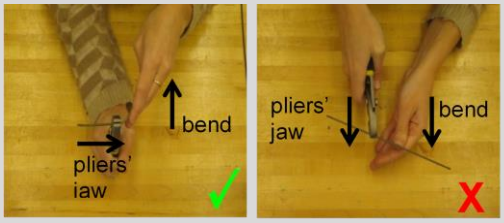
1. Cut the hook off the hanger using the cutter in the pliers.



TEACHING NOTE: *DEMONSTRATE PROPER USAGE OF SLIP JOINT PLIERS*

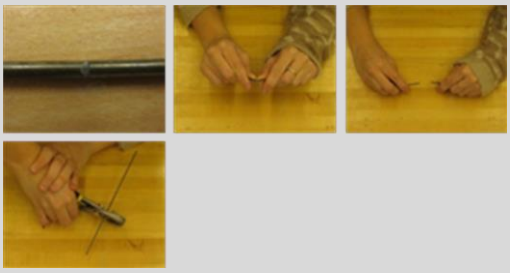
Hold the pliers toward the back. The plier handle acts as a lever arm on the plier jaws. Therefore, holding the pliers toward the back allows you to exert greater force in the jaws of the plier.

The plier is the vice. The simplest way to determine orientations when using the pliers is to imagine that the jaws of the pliers are the jaws of a vice. Thus, you should always bend the wire perpendicular to the face of the pliers' jaw.



Published 12 November 2015, Version 1.0

Cutting. There are two ways to cut thick gauged wire using the pliers without requiring too much force. First, you can nick the wire using the pliers' cutters. Then, you can bend the wire around the nick until it snaps. Second, you can put one end of the pliers against the table and push on the other end to increase the amount of force you could apply.

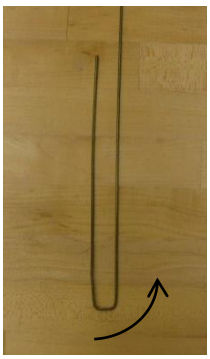


Straightening sharp bends. In order to straighten a sharp bend in the wire, it is easiest to put the sharpest point in the pliers' jaw. Then, bend each of the sides against the jaws until the bend is somewhat straightened out. After that, you straighten as you would for a slight bend.

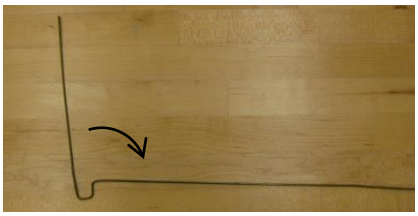
2. Straighten the hanger wire to remove any kinks or bends.

3. Make a 90° bend in the wire, offset 6" to 8" from the end of the wire.

4. Make a second 90° bend in the wire. The bend should be the width of the pliers' jaw.

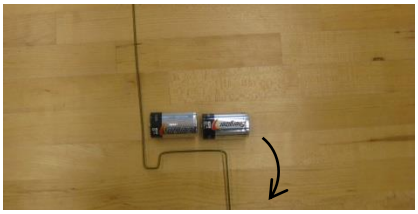


5. Make a third 90° bend in the wire. Again, the bend should be width of the pliers' jaw.

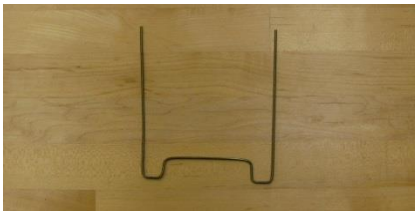


Published 12 November 2015, Version 1.0

6. Placing the batteries against the wire as a guide. Make a 90° bend. The location of the bend is the width of the pliers' jaw away from the end of the batteries.

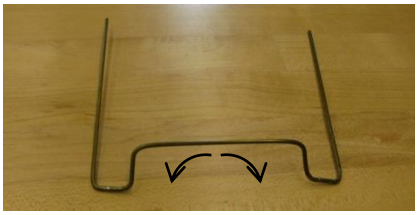


7. Bend the remaining end of the wire frame to mirror the completed side. Trim the ends of the wire such that they are below the length of the straw.



8. Bend the inner rectangle outward. The batteries will rest in this space.

   Teaching note: Explain that the rectangle should be bent outward such that when the batteries are placed, the arms of the foam cutter align with the center of the battery terminals.



9. Create a divet on each end of the frame. These divets will press into the center of the battery terminals to ensure contact.

   Teaching note: Explain that the foam cutter's arms should bend outward at this stage. When the nichrome wire is attached, it will pull the arms straight, ensuring the frame is tight against the batteries.

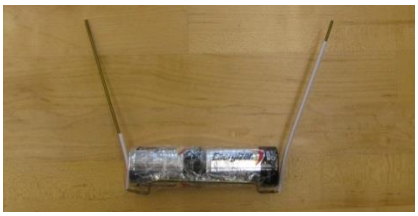
LEARNING OBJECTIVES ACCOMPLISHED:

- ☐ Participants will learn how to manipulate thick gauged wire.
- ☐ Participants will learn how to use slip joint pliers.

WIRE THE CIRCUIT

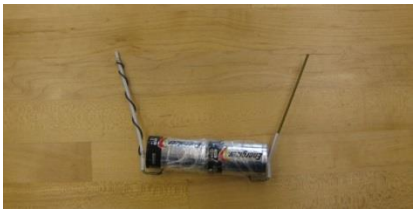
Skills	Tools	Supplies
pliers		
circuits		

10. Trim one of the straws so that it acts as the switch. Put shorter straw on the negative terminal. Put the longer straw on the positive terminal. Then, secure the batteries in the frame using tape.

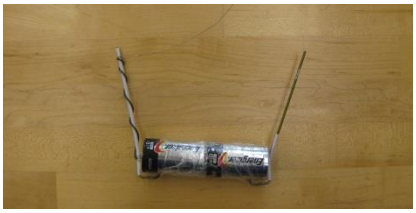


11. Use the wire strippers to expose both ends of the electrical wire. Wrap and secure the exposed wire on the long straw such that it will make contact with the positive battery terminal when the arms are in tension. Then, wrap the wire up the length of the straw. Wrap and secure the exposed end toward the top.

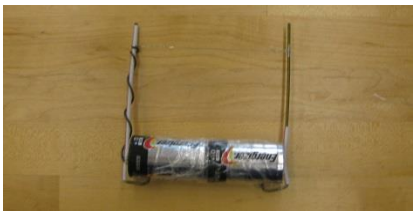
    Teaching note: The electrical wire will be attached outside the long straw and should never come into contact with the coat hanger wire frame. If it comes in contact with the wire frame, it will short the circuit.



12. Cut a piece of nichrome wire and knot one end so that it is in contact with the exposed end of the electrical wire attached to the straw.



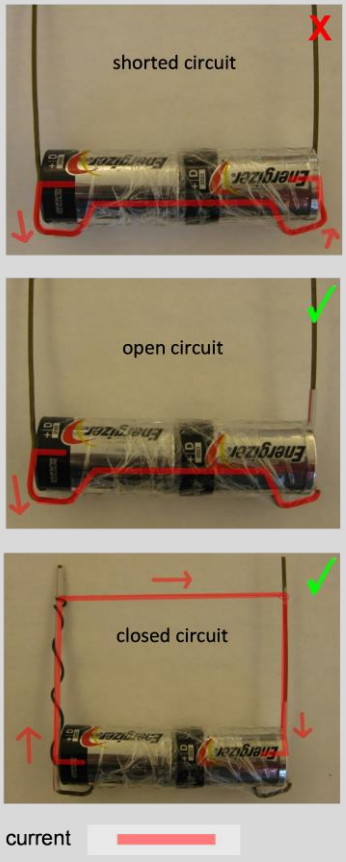
13. Sand the coat hanger wire where the nichrome wire will attach. Pulling the ends closed to create tension, tie the other end of the nichrome wire to the other arm in the sanded location.



TEACHING NOTE: *DEMONSTRATE HOW TO MAKE A CIRCUIT WITHOUT SHORTING*

Current travels the path of least resistance, not necessarily the desired path. Lower resistance materials pull larger amounts of current. In this circuit, the thick gauged coat hanger wire has a very low resistance while the nichrome wire has a higher resistance. If the coat hanger wire crosses the batteries, no current will travel to the nichrome wire, and the current draw will be high. In this case, the batteries will short (which can be identified by how hot the batteries are). Therefore, one end of the coat hanger wire is insulated with straw and coated in another conductive material that will allow the current to travel to the nichrome wire.

Selecting the correct wire. Nichrome wire is a combination of nickel and chromium. It is ideal for a cutting element because it can be easily heated to the desired temperature with a lower voltage and amperage, in comparison to other metals. A 32-gauge nichrome wire length of 90-100 mm can be powered by two 9V batteries.



Published 12 November 2015, Version 1.0

LEARNING OBJECTIVES ACCOMPLISHED:

- ☐ Participants will learn how to manipulate thick gauged wire.
- ☐ Participants will learn how to use slip joint pliers.
- ☐ Participants will learn to make a complete circuit and what can cause the battery to short.
- ☐ Participants will learn to make prototypes using their foam cutter.
- ☐ Participants have made a nichrome wire foam cutter.

DESIGN CHALLENGE

After the device is complete, participants should use their foam cutter to create a prototype in answer to a design challenge. The design challenge is intended to encourage participants to express themselves creatively. It is also intended as a vehicle by which they can practice their prototyping skills. Examples of design challenges include making an airplane, eyeglasses or a hammer.

DESIGN VARIATION

Filler rods can be used instead of the coat hanger for a more efficient foam cutter. They were not used in this instance because they are not as readily available. Filler rods are strong because they have a steel core, but very conductive because they have a copper coating. The copper has little resistance, so the electricity takes the easy path along the copper to reach the resistance wire, and does not heat up in the process! The copper also helps prevent rusting.

REFLECTION AND FEEDBACK GROUP DISCUSSION QUESTIONS

- What would you make with your foam cutter?
- When, as an engineering student, would it be beneficial to make a prototype?
- What other advantages are there in prototyping out of foam?
- Besides another foam cutter, what would you make with the new skills you've acquired?
- Which skill that you learned are you most excited about?
- Which skill that you learned would you like to have spent more time practicing?

ACKNOWLEDGEMENTS

Skill Builders are published by the International Development Innovation Network (IDIN). IDIN builds a diverse, global network of innovators to design, develop, and disseminate low-cost technologies to alleviate poverty. IDIN and its partners are funded by the USAID U.S. Global Development Lab. For more information, visit www.idin.org.

This document has been created by support from the following members of the IDIN network:

Anna Konstantinova	*Olin College of Engineering*
Benjamin Linder	*Olin College of Engineering*
Benji Moncivaiz	*Massachusetts Institute of Technology*
John Rosenwinkel	*Olin College of Engineering*
Amy Smith	*Massachusetts Institute of Technology*

Published 12 November 2015, Version 1.0