Charcoal Press

This project is a very low-cost device for forming charcoal briquettes. It is composed of three welded metal parts and a wooden block. To make it, you will learn to use a band saw, a sander, a drill press, the OMAX water jet cutter and several hand tools. You will also learn to do some basic welding.

Materials Needed

1/2”	Steel Pipe
2”	Steel Pipe
1/8”	Steel Plate
4”x4”	Wood

Tools/Machines Needed

Water Jet Cutter
Welder
Drill Press and Bits (15/16”)
Belt Sander
Hacksaw or Bandsaw
Files (round and flat)
Ruler
Calipers

Teaching Notes
Build-It Background

The Build-It modules were designed to give students experience with a variety of tools and manufacturing techniques while at the same time exposing them to some simple, appropriate technologies. These modules show them both the rapid prototyping equipment that is available at MIT as well as techniques that are used in workshops in the developing world. We have developed four modules that cover a broad range of tools and techniques:

Charcoal Press	Corn Sheller (cast)	Corn Sheller (sheet)	Water Filter
drilling	3-D printing	water jet cutting	sawing
sawing	casting	sheet metal fabrication	drilling
sanding	sawing	spot welding	ceramics
filing	filing	riveting	sanding
welding	sand blasting	fasteners	filing
water jet cutting			

These modules were designed to demonstrate and use equipment at MIT that we wanted our students to learn how to use. They can easily be adapted to use other tools and equipment. Design teams in D-Lab II are made up of four students, so each team had one student doing each of the different modules, thus ensuring that the team had seen all of the different tools and techniques. In the spirit of sustainability, the end result of the module is that students produce a useful item that will be disseminated to community partners in future D-Lab trips as they learn how to use the tools and equipment.

Each of these projects takes three 1.5-hour sessions; it is best that these sessions are a full week apart, to give the students time to finish the necessary work before the next session. It is intended that the projects are done as part of a hands-on tutorial, with plenty of guidance from the teacher. Some instructions are given in the text of the exercise, but it is assumed that the teacher will go over basic safety and training for each piece of equipment prior to the students using it. If the students do not have a lot of machine experience, you may want to do the projects in small groups (4 to 8), so that the students can be closely supervised. It is often useful for the students to work together in pairs to help each other through the process. This document includes notes from our experiences at MIT, if you have any comments or insights to share, please e.mail them to me (Amy Smith).

Notes on the charcoal press:

The students in D-Lab II have all been exposed to the charcoal project as a case study on the design process. The evolution of the design is an interesting one, and eventually leads to the following insight: “If you want to make something ten times cheaper, remove 90% of the material”. A collection of photographs is included at the end of this note.

The material you will need for each press is roughly as follows:

½” steel pipe (~1 foot)
2” steel pipe (~3 inches)
1/8” steel plate (~7” x 3”)
4” x 4” wood (~6”)

Don’t cut the pieces to length for the students, but rather have them cut pieces off of longer pieces of stock—it’s important that they get used to starting from the material in it’s raw form.

Session 1

Cutting the pipe:

You will need two pieces of ½” pipe, one 7.5” long, one 2.5” long. You can cut it using a hacksaw or a band saw.

If using a band saw to cut the pipe, be very careful that the pipe is firmly gripped—the saw teeth will catch on the surface of the pipe it can cause the part to spin (with a surprising amount of force). You can use a vise to hold the part so that it won’t spin.

To cut steel, the band saw should be set at a cutting speed of about 100 ft/sec. Be sure that the guard is set to the right height before beginning to cut.

Once the initial cut is made, turning the pipe slowly as you cut into it makes a cleaner, squarer cut.

If you are using a hack saw to cut the pieces, be sure that the pipe is held firmly in a vise, near the place where you are making the cut.

You will also need to cut a piece of 2” pipe that is 2.5” long for the cup.

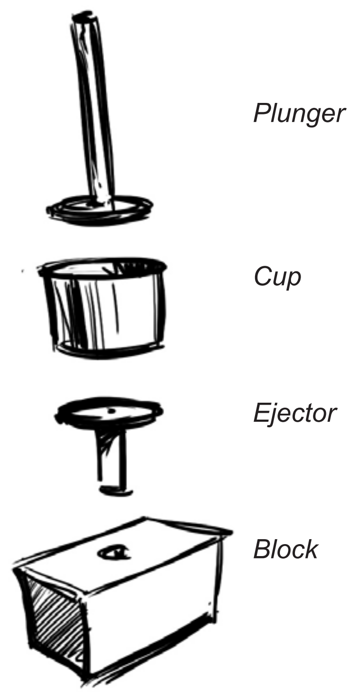

Fig 1 The four components of the $2 charcoal press

Cutting and drilling the wooden block:

Cut a 6” long piece of 4” x 4” wood. You can use either the band saw or a hand saw to cut the wooden block.

A coarser blade may be used to cut the wood, but it is not necessary. You can use the belt sander to smooth and bevel the edges.

Mark the middle of the block (you can do this by drawing diagonal lines from corner to corner, or by measuring.

Put a 15/16” drill bit in the drill press and line the tip up with the center of the block. A Forstner bit is a good option for this application, as it leaves a clean, smooth, flat bottom to the hole. If you use a twist drill, you should step up to the 15/16” hole, that is start by drilling a smaller hole, then move up to the larger bit size.

Drill the hole at least 2.6 inches deep, so that the ejector can easily fit into the hole when the briquettes are being formed.

Additional Teaching Notes

You may also want to talk with the students about pipe nomenclature—in the case of steel pipe, ½” refers to the inner diameter. You can also explain the difference between welded pipe, which will have a small ridge running through it (which can be a problem if something needs to be rotated inside of it), and seamless pipe. You can also talk about the different materials that pipe is made from and what the merits are of each.

You might want to try to have the students do some cuts with the hack saw as well, so that they can see that sometimes it’s just faster to do things by hand.

Session 2

Cutting the end plates:

The end plates of the two plungers must fit easily inside the cup. Measure the inner diameter of the large pipe and allow for 1/16" radial clearance. You will need two of these parts. You will also need an endplate for the cup.

In one method, the end plate will be press fit in and then welded along the seam, as shown in Figure 2a. For this, you will need a more precise measurement of the inner diameter: allow for a 0.002" interference fit, meaning that the inner part is slightly larger than the outer part, and will therefore stay in place when forced into position. The larger the interference, the tighter the fit; if the interference is too great, then the parts will not be able to be fit together. We will be welding the two parts together, so the fit need only hold the part in place while we are welding it, and the interference can be relatively small. Also note that more compliant materials, such as wood and plastic, can have larger interferences.

The other method for making the cup is to make a end plate which is slightly larger than the pipe, and then welded where they rest together, as shown in Figure 2b.

For this, you can have a greater tolerance on the diameter of the end plate, as it merely needs to be bigger than the pipe, it does not need to fit precisely inside. There should be about 1/16" overhang, in order to make the welding easier. It will be necessary to hold this part in place when welding.

Think about the pros and cons of each method of forming the cup and choose one of these methods and determine the dimensions of the three end plates.

The end plate of the cup will have a 0.8" hole in the center so that the ejector can fit through it. We will use the water jet cutter to make these parts. If you are unfamiliar with the OMAX software and other CAD programs, you may want to run through the tutorial before starting. Use the OMAX Layout program to generate the tool path for the three end plates. You will be shown how to use the water jet cutter in class.

Fig 2a Press fit an endplate configuration

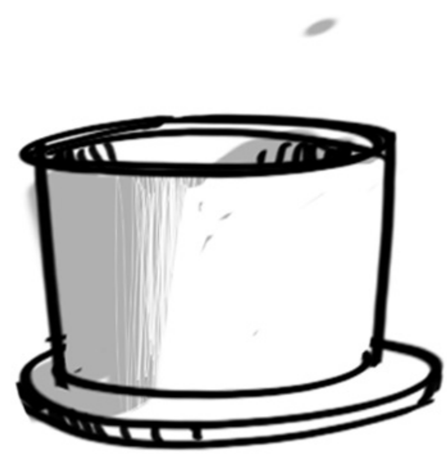

Fig 2b Overhang endplate configuration

Session 3

Welding the parts:
Now that the pieces are cut to size you will put them together to make the final parts. Welding is the process of joining two pieces by melting the adjacent material and having it re-solidify to form a joint. In some cases, a filler material is added.

There are four types of welding that we can do at the welding shop: oxy-acetylene welding, arc-welding, MIG welding and TIG welding, of which the first two are most widely available in the developing world.

Welding is easiest to do if the two pieces are of a similar material and of similar thickness. Otherwise, one part may melt completely while the other heating up. If one part is bigger than the other, it is necessary to adjust the application of heat so that the two parts melt at the same time.

When welding, it is very important that the pieces are held together firmly before you start welding, so that adjacent material will melt together and form a good joint and so the pieces do not move during the welding process. You will use the welding fixtures in the shop to hold the pieces together while you weld them.

Be sure to use protective clothing and goggles, as the radiation and extreme light can be dangerous to your skin and eyes

Fig 3a Welding in Haiti: Oxyacetylene welding in a village without electricity

Fig 3b Using electricity from utility pole to arc weld on the side of the street

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