

Build a Trebuchet From Scrap Wood!

By: Kyle Farris (04/10/06)



Total Project Cost: Approximately \$25 USD.

Author-Rated Ghetto-ness Factor: 3/10

For all of you folks that have that un-dying urge to build destructive medieval castle siege engines, you have come to the right place. This project is great for a school project (that's why I built it...). I made it out of extra wood I had laying around my house from other projects and such. Also, you can often find wood good enough to use for this in construction site dumpsters. When you have completed this tutorial and followed all the steps, you will have a powerful ancient catapult that can launch a golf ball many a yard.

Now, as I mentioned, you will need some wood, that is obvious. There may be a few things you will need to pick up at your local Home Depot, Wal-Mart, or Michaels. Either way, we are looking at a cost-effective and very easy-to-build weapon of mass chaos and destruction (humor here, people...). The materials you will need are as follows (obviously, considering the nature of this article and of this site, you may use different materials, but try to stay in proportion with mine as best as possible.):

- Wood:
 - Main Wood - 2.5"(width) x 5/8"(thickness): 41 feet total
 - 4 x 55" = 220"
 - 4 x 36" = 144"
 - 3 x 13.5" = 40.5"
 - 2 x 31" = 62"
 - 2 x 13" = 26"
 - Wood for diagonal supports - 1.5"(width) x 5/8"(thickness): 9 feet total
 - 2 x 32.5" = 65"
 - 2 x 20.5" = 41"
 - Wood for counter-weight box - 4.5"(wide) x 3/4"(thick): 4 feet total
 - 2 x 11.5" = 23"
 - 2 x 6" = 12"
 - 1 x 10" = 10"
 - 1 x Wooden Dowel for axel rod (5/8" diameter)

You will also, undoubtedly, need tools and some hardware. Most people will have the hardware they will need, if not, again, it is all very cheap stuff. Tool-wise, the tools I used were not exactly cheap, but substitutes can be made. At the very least, you WILL need a drill and a decent set of drill bits. The tools and hardware I used consisted of a **drill, small drill bits for pre-drilling screw holes, 5/8" wood-boring bit, miter saw, tape measure, hammer, 1.25" wood-to-wood screws, 5 small eye-hook screws, 2 long eye-hook screws, material for a pouch (denim, netting, etc...), and a large roll of jute twine** (very cheap at Home Depot)

Measure Twice, Cut Once...

We need to start out by cutting all the pieces of wood that we will need.

I gave you a brief look at the sizes of wood you will need to have after they are cut. I will go into more detail now... Keep in mind; I am going to give you exact directions on how to build the trebuchet that I built. Doing it your own way is *always* promoted here at GhettoRight; just make sure you stick with these basic ratios in your head:

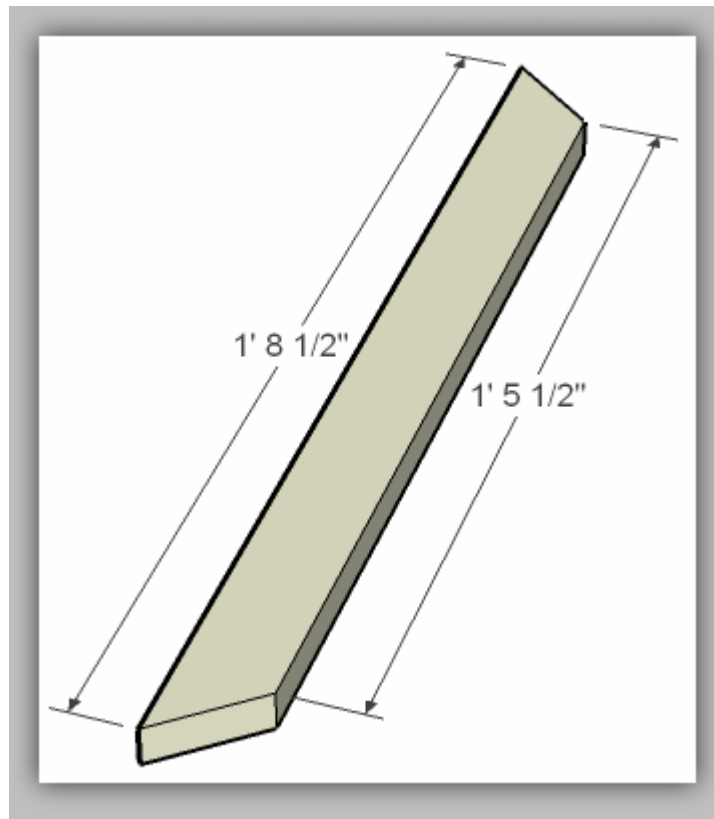
- The ratio of the *long* section of the throwing *arm*, to the *short* section of the throwing *arm* should be about **5:1** or (4:1 if you are planning to throw massive objects to cause great and glorious destruction).
- The ratio of the *counterweight* to the *projectile* should be about 100:1. If you use a 10:1 ratio, you may be sadly disappointed!
- A good point to *cock your trebuchet* back to is about 30 degree under the horizontal plane of the axle rod.
- The *vertical arm* that holds the axle rod and should be as long as the short arm + the height of the counter-weight container + the distance between the container and the short arm (if any...) + about 2" of lenience for the counter to clear the trough at the bottom of the machine.

Okay, any more detail than that would be too much to provide on this site. Those are good rough ratios to help guide you if you choose to stray from the rigidity of this article. From now on, I will assume you are making exactly what I did.

So, here is a list of all the cuts you need to make with your wood.

Actually, the only ones that really need to showing are the two types that have angles on the ends. Keep in mind that these are 45-degree angles:

In the whole scheme of things, this is the smaller of the two diagonal supports for the vertical beam that supports the axle rod that the main launch arm rotates around. It is important that the vertical beams stay as stiff and sturdy as possible. When you are dealing with the forces a trebuchet creates, you need to keep in mind the stresses that the centripetal forces create in the x, y, and z planes. If you do not attach the vertical planes PERFECTLY vertical (essentially impossible), you are going to have the frame moving in unpredictable, or, rather, undesired ways. For these reason, there needs to be myriad supports holding up the vertical support beam. This is the small one. There is another that is 12" longer, but is the exact same design. I will show you how these will attach later. For now, simply stick with cutting the pieces you need. This is using the 1.5" x 5/8" wood.



It's a good thing to start out with the base of the trebuchet. The pieces for the base and the arm, in my design, happen to be the same. Therefore, for this reason, we can cut all four pieces in one fell swoop.

Base and Throwing Arm of Trebuchet:

Type of Wood	Number of Pieces	Length of Cut
2.5" x 5/8"	4	55" (4' 7")

Now we need to cut the pieces that will hold the trebuchet together.

Short Base Cross Beams:

Type of Wood	Number of Pieces	Length of Cut
2.5" x 5/8"	3	13.5" (1' 1.5")

We will need something for the projectile to slide on in the horizontal plane (before the trebuchet actually launches it and while it slides in the instant before it does). Also, the longer piece under the base is the same length; so, it will be cut now as well.

Projectile "trough" and Long Base Cross Beam:

Type of Wood	Number of Pieces	Length of Cut
2.5" x 5/8"	4	36" (3')

Now is good time to begin cutting the vertical support arms. As you can see, I am trying to cut all the 4.5" x 5/8" pieces first.

Vertical Support Arms:

Type of Wood	Number of Pieces	Length of Cut
2.5" x 5/8"	2	31" (2' 7")

Now, for something you will not see on the picture on the main page of this tutorial (I forgot to add it and was too lazy to redo all the rendering and stuff...). Click here to see what I mean... You will need to make supports that will hold the vertical support arms up in the left-right direction (if you consider the arm to swing front and back). These are extremely important...

Diagonal "Left-Right" Vertical Support Arm Supports (ironic, eh...?):

Type of Wood	Number of Pieces	Special Cuts	Length of Cut
2.5" x 5/8"	2	Opposing 45 degree cuts on each side like seen in picture on previous page .	13" (1' 11")

Small Diagonal "Forward-Backward" Vertical Support Arm Supports:

Type of Wood	Number of Pieces	Special Cuts	Length of Cut
1.5" x 5/8"	2	Opposing 45 degree cuts on each side like seen in picture on previous page .	20.5" (1' 8.5 ")

Long Diagonal "Forward-Backward" Vertical Support Arm Supports:

Type of Wood	Number of Pieces	Special Cuts	Length of Cut
1.5" x 5/8"	2	Opposing 45 degree cuts on each side like seen in picture on previous page .	32.5" (2' 6.5")

Counterweight Box:

Type of Wood	Number of Pieces	Length of Cuts
4.5" x 3/4"	2	11.5"
	2	6"
	1	10"

We're All Cut Up, Let's Assemble...

Let's hope that WE are not all cut up just the wood, please...?

NOTE: Make sure to *pre-drill* all screw holes before inserting any screw!!!



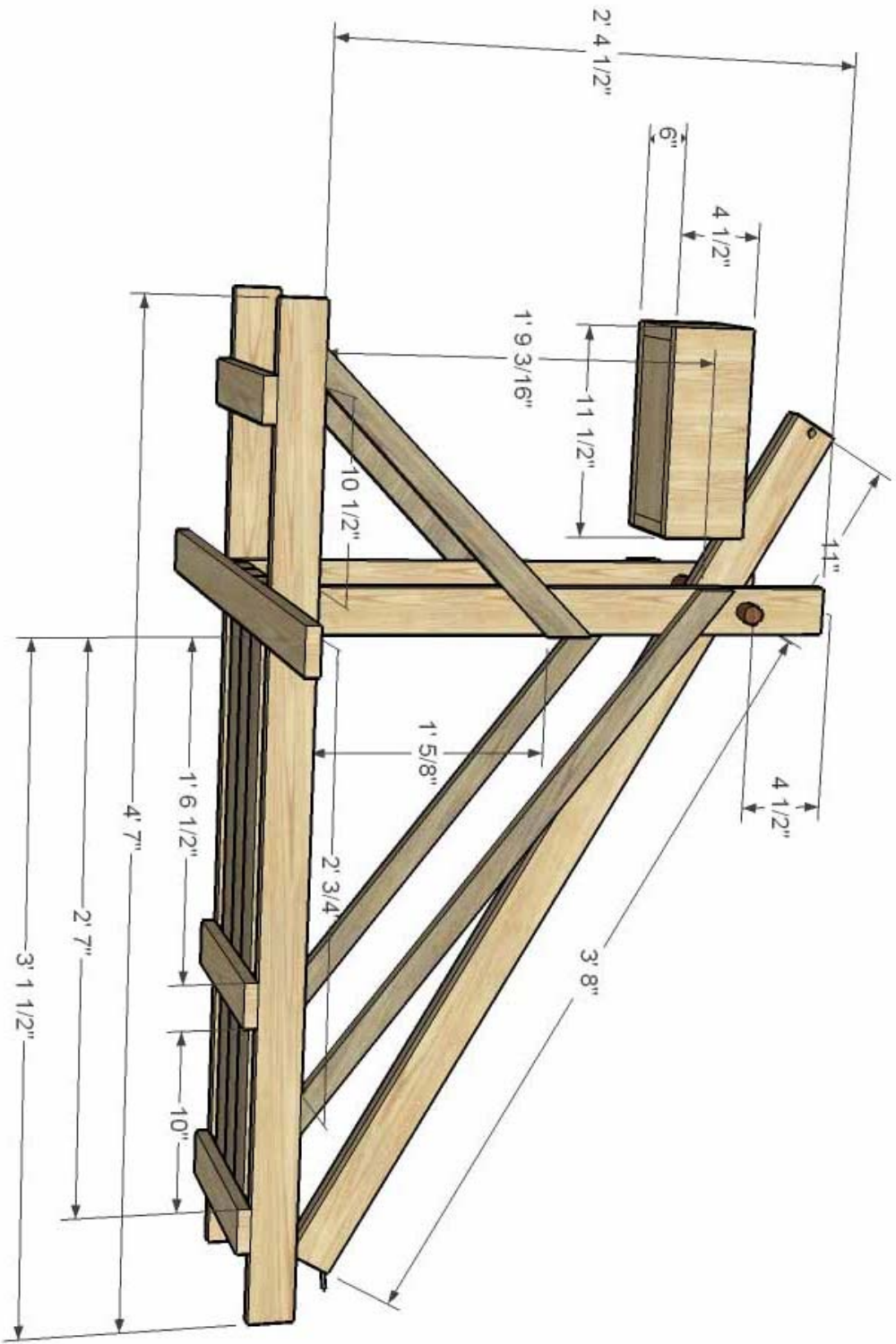
Take 2 of the 55" pieces and 2 of the 13.5" pieces and attach them like this. They are to be placed about 4" from both ends of the main support beams.



Grab one of the 36" pieces and place it like in this picture. It should be placed 3' 1.5" from the edge of the far end of the main support beam to the inside edge (considering that anything pointing towards the center of the machine is "inside")... If you need more explanation, look at the great schematic on the next page with all the lengths you need labeled on it. In addition, it should stick out 1' on both sides of the base.

Also, to add support for the "trough" pieces, I added another piece here. You cut this third 13.5" piece earlier. It's outer edge is 16.5" from the end of the main support beam to its outside edge.





We're going vertical...

...after we finish some more horizontals...



Ok, I forgot to take a picture in between, so, I will explain both of the new components in the picture on this page.

Considering that I designed this model, you'd think I would get it right. But, as you can see, it's a little ghetto... The measurements I gave you, however, should be correct (i.e. the trough pieces should not be hanging off in the back).

Anyways, this is simple enough, all you need to do is place all three of the remaining 36" pieces in the middle of the trebuchet as shown in this picture. Space them as evenly as possible. Also, my tests have shown that using only two pieces may work better. Also, it is also a good idea to actually make this a "trough" and not a slide. In this way, you may gain better accuracy (maybe not, I have not tested this...).

The next thing to be focused on is the vertical support beams. They will need to be screwed in to the main base beams (not the long base crossbeam (unless you want to...)). Screw two screws in from the outside and one from the inside.

Take a good look at this; it is how you will install all of the diagonal support



arms. There is another more detailed picture on the next page.

You'll Be Shooting Things to Diagon Alley If You Add Support Diagonally.

For all you Harry Potter fans... Sorry, I know, it was LAME...

Actually, don't listen to that title at all... you HAVE to add these supports or your trebuchet will die a very young death...



Ok, you need to be careful with this part of the construction. As you saw in the picture on the previous page, the edge of these diagonal support arms need to be flush with the vertical support beams. As you can see in the above picture, you need to have the support arms actually on the edge of the main base support beams. The same goes for long and short support arms. I don't really need to tell you where they go since there is only one place that all of these criteria get met. If you need clarification, again, look at the good schematic on page 7; it will have all the measurements you should need on it.



Sorry, I had to go inside, it was getting dark outside... Oh, and sorry for the filth that is my college apartment kitchen... Anyways, as you can see, all the supports are installed. One thing you may notice is that the "Left-Right" diagonal supports are also now installed. These, I believe could have been made longer and then, consequently, supported more near where the torque of the twisting throwing arm will be, but, I ran out of wood. This is the best I could do.

Also, You may have noticed that I started adding some twine around the joints. Really, this is cosmetic (to cover the screws) but I can't see why this wouldn't actually add more support...

One Rod, Three Holes...

What a lucky rod...



As you might be able to see, I rather messed up with the first holes. I will tell you how to do it correctly the first time around.

Ok, now it is time to bust out that 5/8" wood boring bit. But, first, before you starting boring this wood (similar as how I am probably doing to you...), you need to take some measurements. Measure 4.5" from the top and make a line across the entire width of the vertical support. Now, along that line, place the tape measure and mark the center. In my case, it was at 1.25". Put a vertical pencil mark there. Do the same thing on both vertical beams. Now it is time to bore. Place the pointy tip of your bit on the intersection of the

lines and, while holding the vertical support from behind, bore all the way through being careful not to burst through the other side.

The next step is, if you choose to, to screw the two remaining 55" beams together. This will be the arm. The reason I made it thicker is so that it wasn't wobbly. There is a downfall to this; however, it may cause degradation in performance because of the added weight. There are other designs that I will discuss later on.

Now you need to bore a hole through the throwing arm. Measure 11" from one end and make a line across the width of the arm. Now, like you did before, measure the width of the arm and mark the middle point. For me, again, it was 1.25". Make a vertical mark there to create a cross. Bore through it as you did with the vertical support beams.

Now, slide the wooden dowel through all of the holes. It may be difficult. This is a good thing. You may need to use a hammer to get it to go through.

Counterweight Container:

Ok, well, this is really up to you. I will be explaining how to build what I built for my trebuchet. There are many great designs. I just kinda ghetto-rigged one using what I had. Of course, it is not nearly as ghetto as it could be. This project is relatively un-ghetto.

This box is good for holding many different kinds of weight. You can use wet sand when you are done. In order for all the wet sand to not leak out of the bottom, you can use some caulk, glue or anything that will fill up the cracks. Shoot, you can even put a Ziploc bag baggy in there. Trust me, if I was not shooting for a pseudo-accurate medieval look, I would have done all sorts of crazy stuff. Duct tape would also be a great way to seal up the cracks and such. More on the next page...

Boxy is Foxy...

For all of you that didn't know...

The construction of the counterweight box is quite simple. All you need to do is get the pieces you cut out for it (described at the bottom of page 2) and screw them all together while making sure that you always pre-drill. I was unfortunate and the crappy drill bit I was using broke off inside the second hole I drilled in the box. As you can see on the next page, if you don't pre-drill it can cause ugly side-effects.



It will still work, but it is very depressing. I will be duct taping this bad boy as soon as I am graded for my World Civilizations I class. Mr. Dandrow is a very cool professor (in case anyone from UCF is reading). Also notice that I drilled holes for the jute twine that will attach it to the throwing arm...



You can see a little bit better, how I constructed the box. The bottom piece (10" x 4.5" piece) is hugged by the other four pieces - the 11.5" x 4.5" piece being the outermost of all the pieces. It can be better seen in the 3D rendering snapshot of the underside of the box. You can download the rotate-able 3D rendering at: <http://www.ghetorigin.com/tutorials/trebuchet/3d.php> .

Ok, Now It's Time For the Tricky Stuff

Triggers, pins, and strings. Why does that sound bad?

Undoubtedly, the most crucial part of building a trebuchet is all the things I will be talking about next. Of course, however, some personal tweaking on your part is more than likely. Nevertheless, I will give you a very close idea as to what you need to do.

Release Pin:

I will be explaining how to install this part of the trebuchet as if you were to have to beams attached together. You can, however, do this same sort of procedure with only one beam as the throwing arm.



Ok, you need to whip out your 1/8" steel rod and cut it down to about 7" or 8". You can use most basic pliers for this (if you have strong hands).

Ok, now, as you can see, I have inserted the skinny steel rod in between the two boards that make up the throwing arm. Put it in there about 3/4" from the top of the beam and then use a hammer to lightly tap the rod into the wood even further. You should, ideally, have about 4" of the rod in the wood and about 3"- 4" sticking out.





The above picture now has jute twine wrapped around the boards to squeeze the rod in between the two boards. While wrapping the arm with the twine, pull as tightly as possible on every wrap cycle. Wrap as far down the beam as the rod goes in the wood.

More Tricky Stuff...

Huks on a arm, wrkd four mee!

Trigger Mechanism:

I am going to explain a very simple trigger mechanism. The best way to do this is with pictures. So, here ya go! You will need 4 small eye screws and 2 long ones.

Ok, this part was fairly easy. All you need to do is screw in two eye small eyehooks into the section between the two boards that make up the throwing arm (or somewhere in the center). The top hook will be what you tie the sling to, the bottom one is for the trigger mechanism (explained on next page...).





Ok, the next step is to take the two remaining small eye screws and screw them into the middle of the slide. Since I have three boards that make up mine, I screwed them into the middle board. Once you have done this, you can cock the throwing arm like shown in the picture to the right, using one of the long eye screws as the trigger pin. Ok, so, what about the other long pin, you ask...

Ok, well in my final design, I actually went with a longer eye screw for the trigger screw (bottom screw) on the throwing arm. This gave me a higher cock angle (I will talk about these things later...). An almost essential thing to do is attach a piece of string to the trigger pin so that you can stand away at a safe distance from the trebuchet when firing it.

Even More Tricky Stuff...

Warning: Attempting to throw a human being will not work...

Ok, you've done all the things that are necessary in order to do this next step: making the projectile pouch and strings.

Pouch:

Ok, this is a relatively generic design, and, I can thank the folks at www.ripcord.ws for the idea. That, by the way, is a SUPERBLY helpful site when it comes to tweaking your trebuchet... Anyway, you can use a number of different materials to make the pouch. I personally chose this net-like material made from the same thing as the jute twine. It went

well with the overall look of the trebuchet and it would fly through the wind easier than materials that are solid like denim.



Since I am planning to throw golf balls, I will design a pouch that is best design for one. So, simply cut out a rectangular piece of whatever you are going to use. In my case, I folded the corners down to the underside of the rectangle and temporarily stapled them in place so that the edges would not fray. You can sort of see what I am talking about with the gray dotted lines. If you are using the material I am, make sure to fold all the edges so that they don't fray and cause the net to fall apart (this will also allow a stronger hold for the jute twine for the pouch strings later. The next step is to cut out triangles from the side of the, now, octagonal shape of material as seen in the picture above. Use the jute twine to tie all the matching numbers together *except* for the two "1"s. This should create a nice cupping net. The holes where the "1"s are where the strings that will attach the pouch to the trebuchet go.

Strings:

This is a simple section. All you need to do is cut two pieces just twine. Cut one to be 55" and the other to be 57". Tie one end of each of the two strings to one of each of the two "number 1" holes on the pouch. On the 57" string, attach a small eyehook to the end that will slip over the release pin. Attach the other string's free end to the top ring on the throwing arm of the trebuchet.

These numbers are only good *starting numbers*. They will more than likely not be your final numbers. If you build my exact trebuchet, then you should try cutting the strings to 35" and 37" and follow the same steps. These lengths worked best for me...



The Most Tricky Of Them All...

The ultimate test of your patience...

Now that you have all of your parts together, you are ready to FIRE!



Well, how did it go? Haha, well, if it didn't go so well then don't feel too bad. Only expert trebuchet builders get this right on the first try. You see, the most difficult part of building a trebuchet isn't the building itself, it's the tweaking.

On my first shot, my golf kind of flung out backwards somewhere. This was okay, though, I thought, because I am never that lucky. Well, after a few modifications and about an hour or so of constant reconfiguration, I found out my trebuchet's maximum throw distance capability. With the box I made for counterweight, the distance wasn't so far. You can test you trebuchet's true throw distance by pulling the short arm down with your arm. Just **PLEASE BE CAREFUL.**

I have told you a few things that you can do to make your trebuchet shoot farther. But, to be honest, the best thing to do is visit this guy's web site: <http://www.RipCord.ws> It has absolutely everything you would ever want to know about how to build and tune trebuchets.

Another thing I would like to mention is that if you didn't catch the links on the earlier pages, then please go to my 3D page:

<http://www.ghettorigit.com/tutorials/trebuchet/3d.php>

This page will provide you with many different ways to view the plans for my trebuchet in fully rotate-able 3D.

Also, please check out the video I have made of this bad boy actually launching at:

<http://www.ghettorigit.com/tutorials/trebuchet/video.php>

Again, please be careful and don't break any windows or anything. I am not to be held responsible!