



The Appropriate Technology Collaborative

Plastics Recycling Project Report 2019

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The Appropriate Technology Collaborative

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COLLEGE OF
ENGINEERING



MICHIGAN STATE UNIVERSITY

HUMANITARIAN ENGINEERING: PLASTICS RECYCLING REPORT



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Michigan State University College of Engineering

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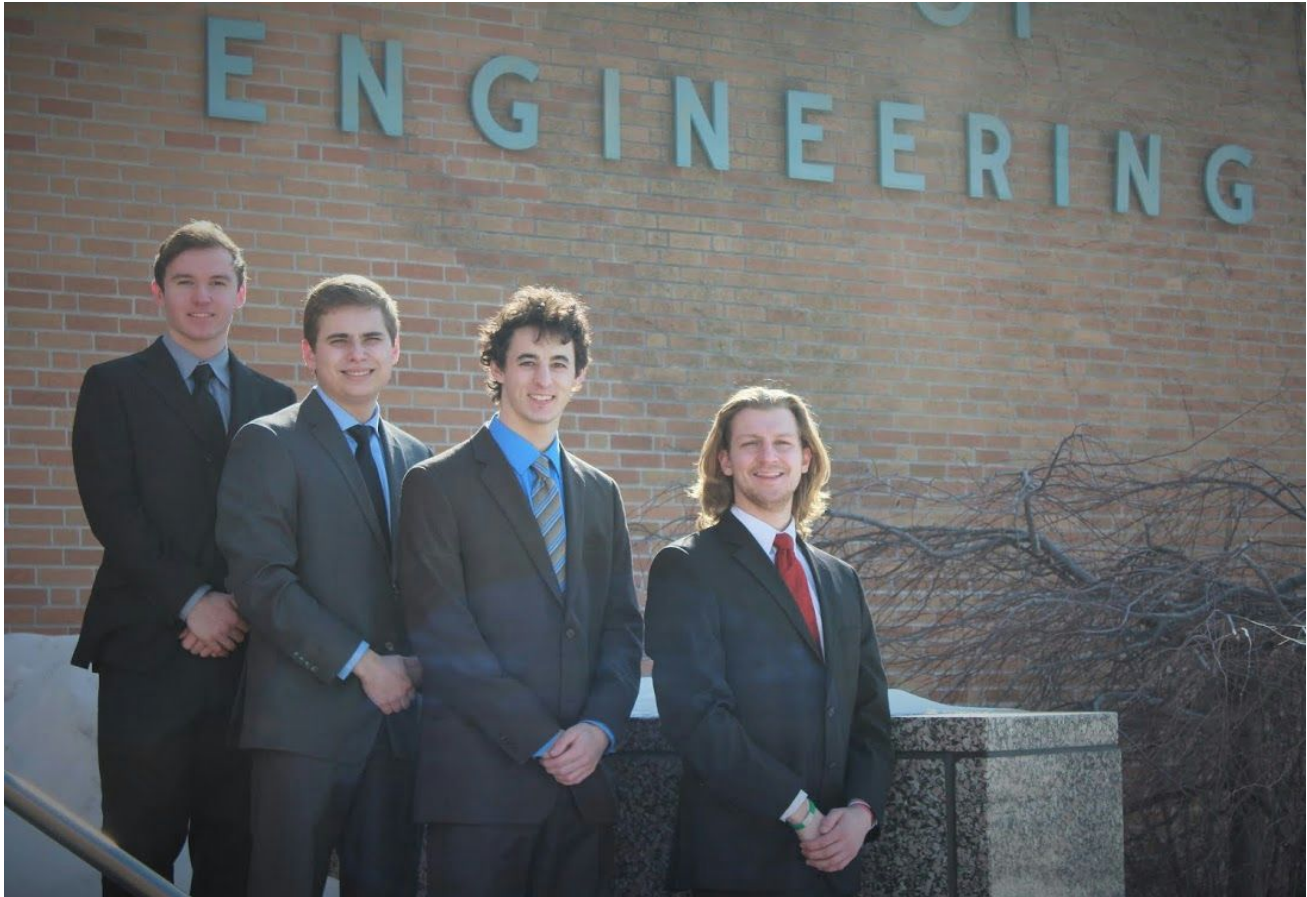
Bicycle-Powered Plastic Shredder

Manufacturing and Assembly Instructions

Designed by: Mark Taylor, Micah Appel, Arthur Paquier, Leo McLaughlin



The 2015 MSU Plastics Recycling Team



Left to Right: Leo McLaughlin, Arthur Paquier, Micah Appel, Mark Taylor

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Required Materials

Parts List				
Base and Stand and Tray			Saftey hopper	
Qty.	Dimensions	Material	2 16" by 12"	1/16" steel sheet metal
1	51"x31" 3/4"	plywood	2 16"	1" by 1" anlge iron
2	42"	Steel angle iron	16 7/16" diam.	Bolts
8	5/16"	1" steel bolt	32 7/16" diam	Washer
45	1"	wood screws	16 7/16" diam	Nuts
2	13"	4"x4" wood	2 16" by 15"	1/16 steel sheet metal
1	16"	4"x4" wood	12 4" by 3"	1/16" steel sheet metal
4	24"	2"x4" wood	Shafts, Bearing housing, Drive chainring	
2	16"	2"x4" wood	1 44"	1" Steel round
2	23"	steel angle iron	4 1"	Rotational bearings
8	5/16"	2.5" steel bolts	8 9/16"	Bolts
6	5/16"	6" steel bolts	16 9/16"	Washers
24	5/16"	washers	8 9/16"	Nuts
12	5/16"	nuts	12 6" by 6"	1/4" Steel plate
8	5/16"	3" steel bolt	2 2 1/2"	Steel Spur Gears
Sizing tray			1 3"	1 1/2" Steel round
2	12"	1" by 1" wood	1 53 tooth	chainring
2	21"	1" by 1" wood	2 1/4"	Setscrews
1	12" by 21"	Chicken wire	Bike supplies	
		Staples	1 Bike	
Bike Support			2 11 speed Chain	
2	50"	3/4" square tubing		
1	4.5"	1" diam. Round solid		
2	14"	1/2" by 1/2" angle iron		
2	14.5"	1/2" by 1/2" angle iron		

Required Tools

In order of appearance:

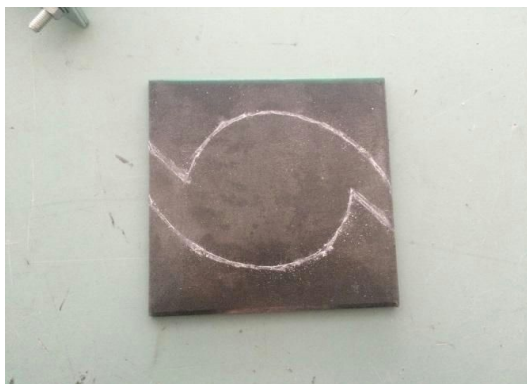
1. Bench Vise or Clamps
2. Angle Grinder - Pneumatic or Electric
3. Drill Press
 - a. 1" Drill bit
 - b. 9/16" Drill bit
 - c. 1/4" Drill bit
4. Spot Welder
 - a. Welding helmet, gloves, and jacket
 - b. Water bucket to quench welds
5. Table Saw or Circular Saw
6. Right Angle Speed Square and Tape Measure
7. Phillips Head Screwdriver
8. Socket and Wrench
 - a. 9/16" Socket and Wrench
 - b. 1/4" Socket and Wrench
9. Tap and Die Tool
 - a. 1/4" Tap Drill
 - b. 1/2" Tap Drill
10. Stapler and Staples

Manufacturing Instructions

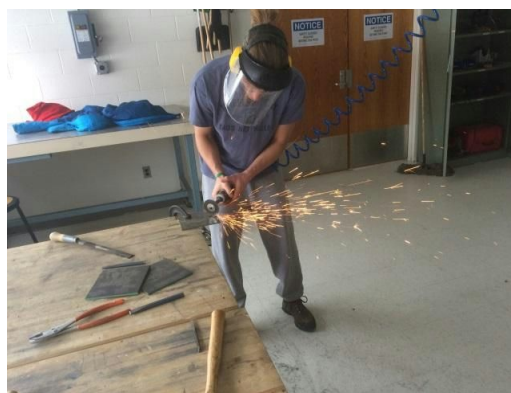
These manufacturing instructions will follow the first-time process of manufacturing the required parts for assembling a bicycle powered plastics shredder. Different tools may be substituted to complete the manufacturing processes.

1. Manufacturing the Shredder Blades

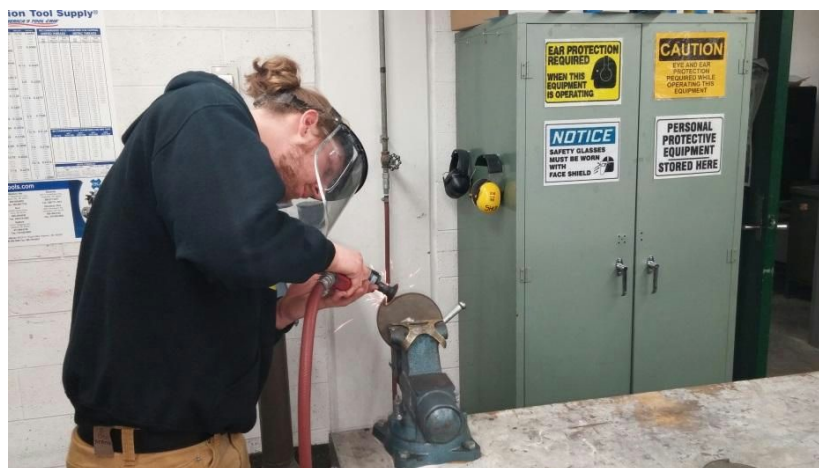
- Trace the attached blade template onto the 6"X 6" steel plates and use a punch to stamp a hole in the center



- Use a pneumatic or electric angle grinder to cut out the blade geometry



- Grind down the edges of the blades and sharpen the teeth using an angle grinder



- Clamp down up to 4 blades to the drill press bench. Drill holes at the center point in the order of center drill, 1/4" diameter, and then 1" all the way through all blades.

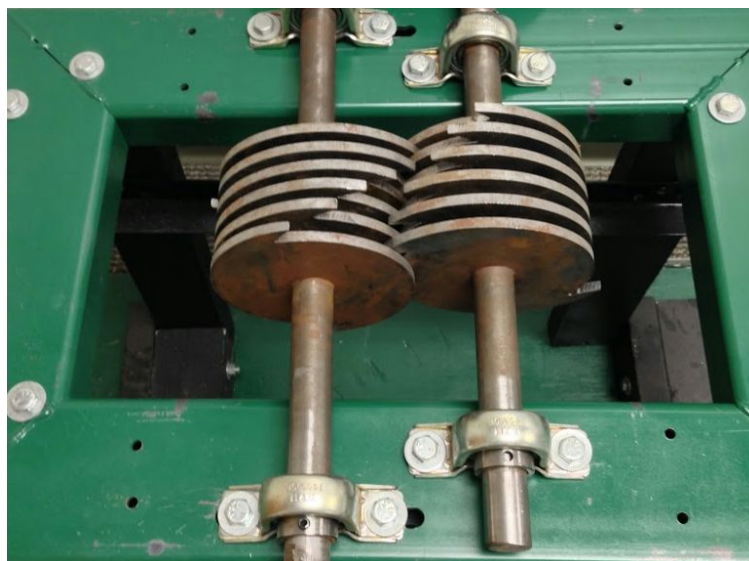
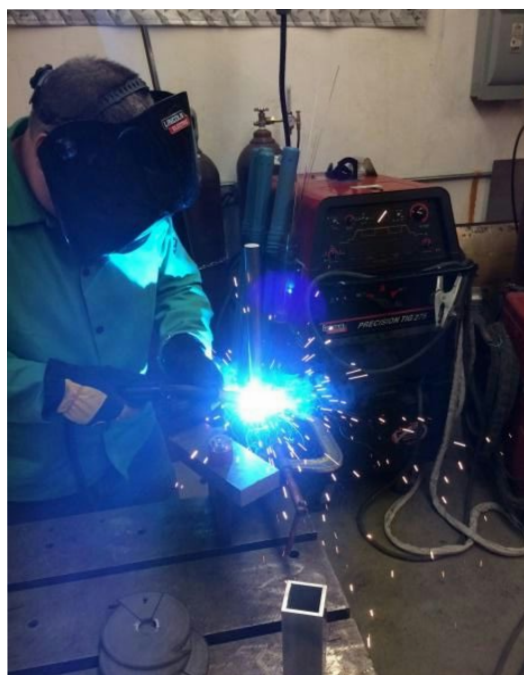


- Clear debris off of the blades as you drill to ensure a clean cut



2. Welding the Blades onto the Shaft

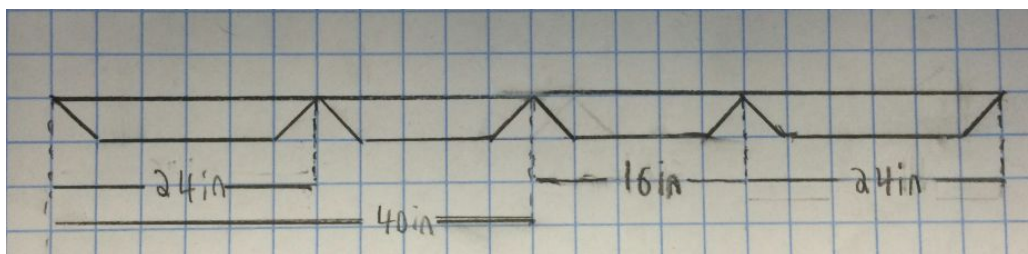
- Lay out the blades in a helical orientation, increasing the rotational angles of each blade by 15 degrees. This is the orientation used to attach onto the shaft
- Weld the blades onto the shaft leaving 0.3" of space in between each blade. This can be done by placing two pieces of metal of 0.3" thickness in between the blades as you weld



3. Making the Base and Support Frame

The base and support frames can be manufactured to your desired dimensions, the instructions outlined here follow the dimensions used in the original model.

- Cut 2" by 4" steel tubing into 80" long pieces and make a mark 24" in from each end. Make a mark at 40". Then cut in an angle of 45 degrees at each mark, bend at right angles and weld
- Drill holes for the bearings and support stand using a 9/16" drill bit in the configuration shown below



- Drill 4 holes at the locations of the bearing slots
- Cut 4, 24" long segment of the 2" by 4" wood
- Cut 4" long sections of steel L beam to form support brackets
- Drill 9/16" holes in the brackets and wood to accommodate the bolts to the supports

4. Securing the Wood Support Structure



- With the four 24" inch sections of 2" by 4" wood, attach each to the base using 4" bolts through the L brackets and secure
- Cut two 16" long segments of 2" by 4" wood and secure them to the bottom of the support legs on each end using 3 wood screws on each side

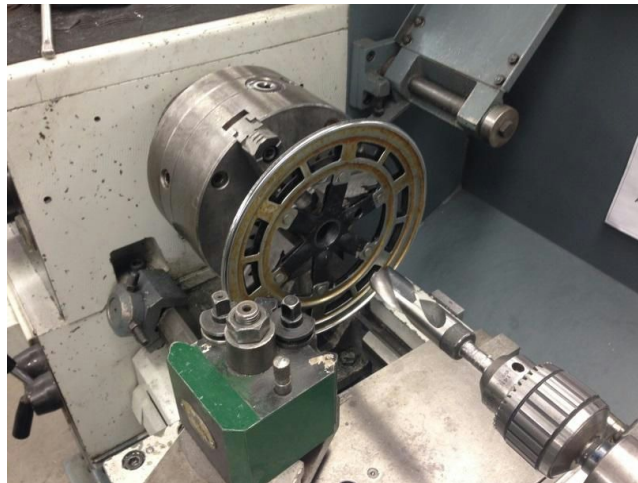


5. Manufacturing the Drive Chain Ring

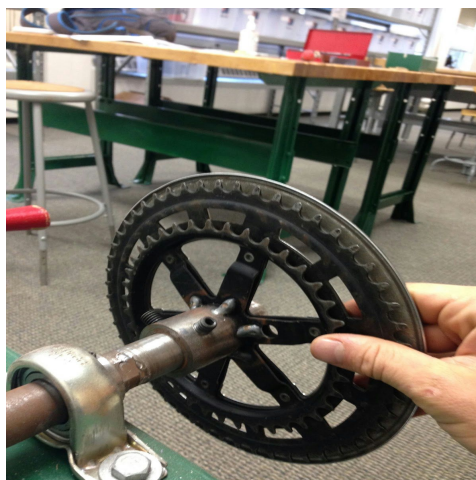
- Cut a 1 ½" steel rod into a 3" segment
- Weld the steel segment concentrically to the chain ring



- Center drill and incrementally step up to a 1" drill bit



- Drill and tap 2 holes in the collar for two 3/8" set screws 90 degrees apart



6. Manufacturing the Sprocket Drive (Alternative to using gears)

- Cut a 2 ½" cylindrical stock of your choice into a ½" thick piece
- Take a bicycle chain and trim it to the desired length that fits snug around the circle
- Weld the bicycle chain to the outside of the circle and secure through a chain link
- Use a bicycle sprocket as the opposing gear and weld each onto the blade shafts



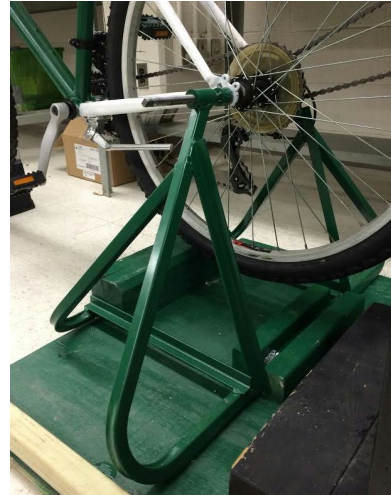
6. Manufacturing the Rear Wheel Support

- Measure and cut two 50" pieces of square tubing
- Place bends to create 24" base, and a 8" gap at the ends
- Bend other tubing section to create 18" base, and a 12" gap
- Weld the second bent tubing to the original at an angle of 45 degs.
- Weld support angle iron between both supports and near junction as shown in figure below

To create the hub screw fastener:

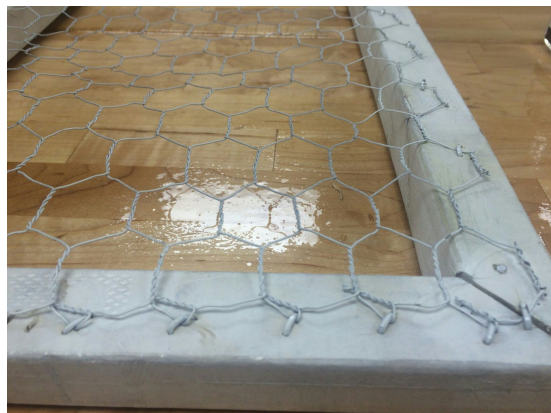
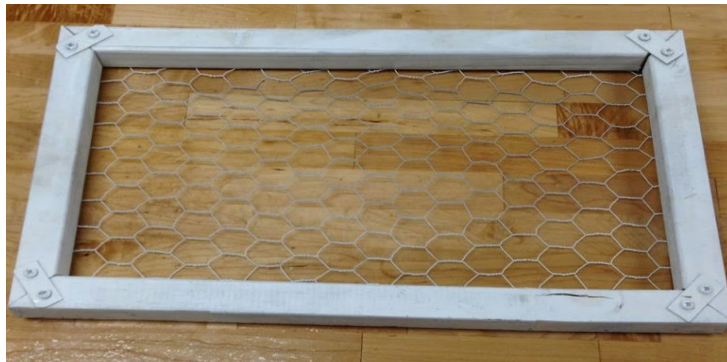
- Using a ½" threaded steel rod, bore out a 15mm hole in two shafts
- Drill and tap the shafts to fit the threaded rod

- Weld one bored shaft to threaded rod, weld the other bored shaft to the support



7. Manufacturing the Plastic Flake Filter

- The filter can be made using 21" long 1" by 1" wood cut at 45 degree angles
- Cut 4 support brackets of steel and screw into the filter at each corner
- Attach chicken wire to the filter using wood staples at each interface



8. Manufacturing the Hopper Guard

- Cut 1/16" steel sheets into 16" by 12" rectangle
- Cut out 2" by 4" rectangles from the bottom corners of each side



- Drill four 1/4" holes in the bottom section of the larger rectangle to fasten to the base
- Mill or cut two slots 5 6/8" and 10" into the top of the sheet



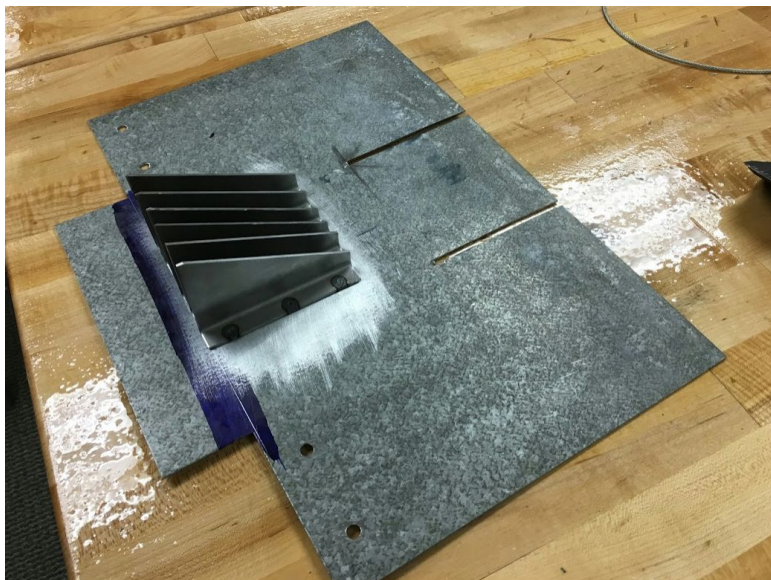
- Cut out 12 sheets of steel with into 4" by 3" rectangles dimensions
- Cut out triangles of dimensions 4" by 2" into sheets. Final shape pictured below



- Bend end to a 90 degree angle 15/32" into the sheets



- Spot weld angles onto side walls ensuring proper spacing $5/8''$ between each piece



Assembly Instructions

The assembly instructions will follow the finished product process of assembling the shredder from the parts outlined in the manufacturing section.



Begin with a base plate of your choice

Align supports to your shredder dimensions and fasten to the base (Black)

Align supports for your bicycle stand dimensions and chain clearance and fasten to the base (Green)



Secure support structures using wood screws from the bottom of the base

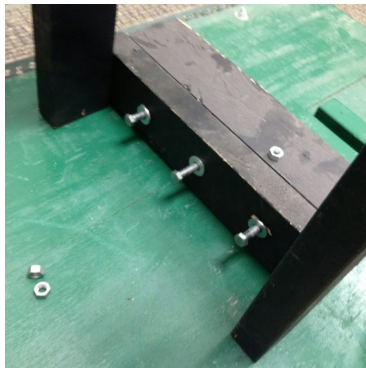


Bolt stiffening structure to base

(Optional depending on the thickness and material of your base plate)



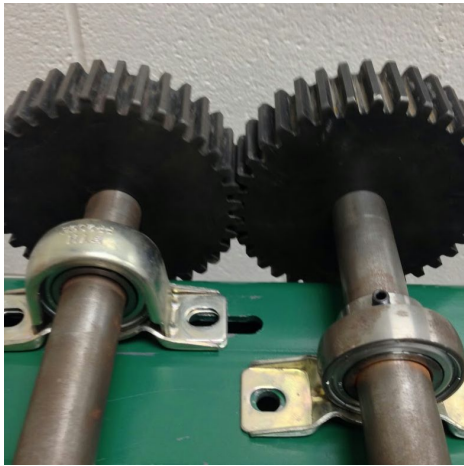
Bolt the stand to the support structures on base.



Bolt the base to the stand supports using 8 2.5" steel bolts



Line up the bearing housings with the drilled holes on the base



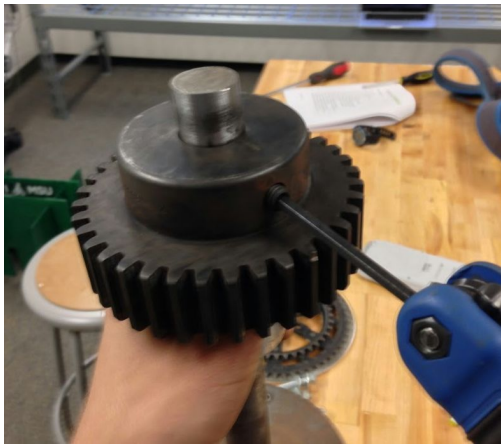
Slide bearings onto shaft until set screws align with flat section on shaft



Tighten set screws using a 2mm hex wrench



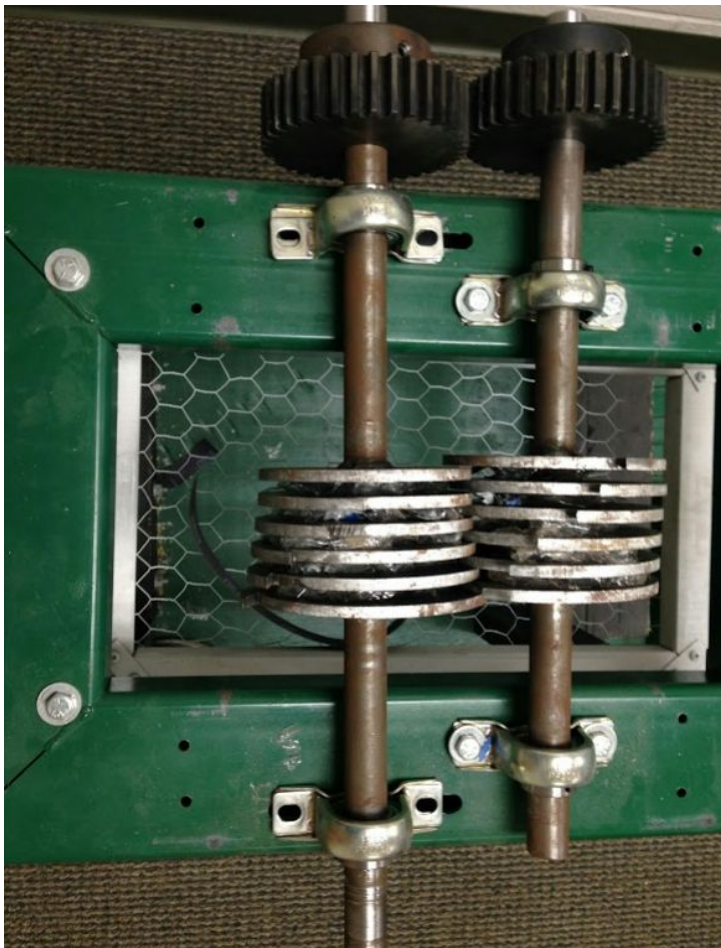
Slide on gears to both shafts until set screws align with flat section on shaft



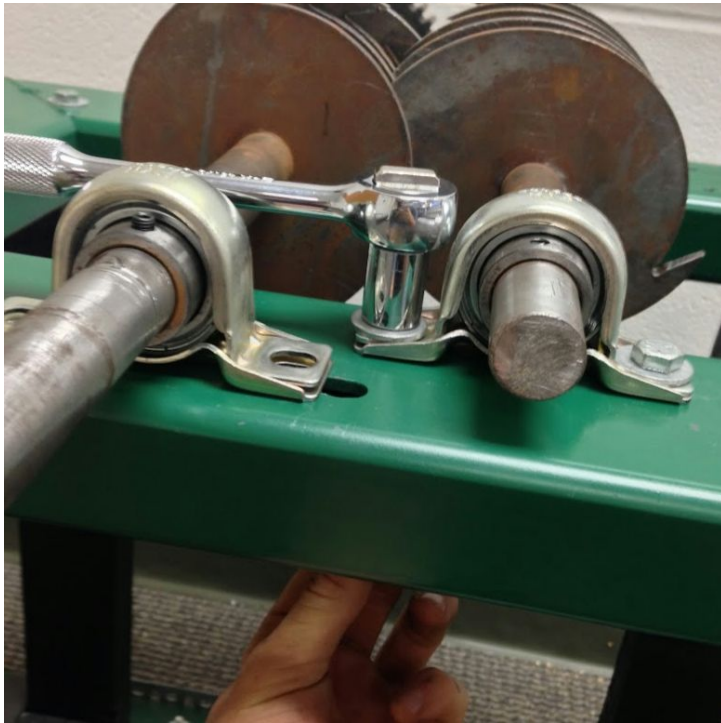
Tighten set screws using a 5 mm hex wrench



Slide on drive chainring until set screws align with flat section on shaft



Place the shaft on the bearing housings and ensure there is no interference with the blades and the gears are meshed



Bolt bearings housings to the base and ensure blades rotate without binding. (If blades touch move shaft with adjustable bearing locations.



Place safety guide on and bolt it to the base



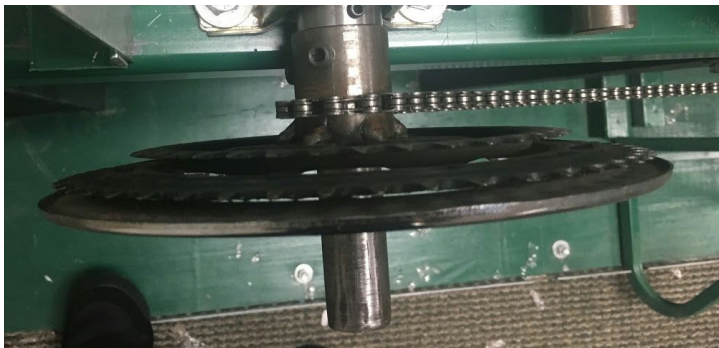
Measure the required length of chain to connect the shredder to the bike



Use a chain break or master link to adjust the length of chain and reconnect it



Take off the back wheel of the bike and place drive chain on the smallest cog



Put chain around the shaft but not on the drive chainring and place wheel back on the bike and secure tighten the bolts with a 15mm wrench



Place bike chain on the largest cog and connect wheel back on the bike and tighten the bolts with a 15mm wrench



Slowly rotate drive chainring backwards while placing the chain on the largest chainring. Continue to rotate backwards until the chain is fully around the chainring.



Ensure the bicycles chain is placed on the largest cog option.

Operations

Before



After



Start by preparing the bottles to be shredded. Cut off bottle tops and remove labels

Start pedaling forward at a 80-100 rpm cadence



Have an assistant place bottles into the safety guide one bottle at a time.



If the machine seizes on a hard material stop pedalling. Rotate the drive chainring backwards and remove obstruction.



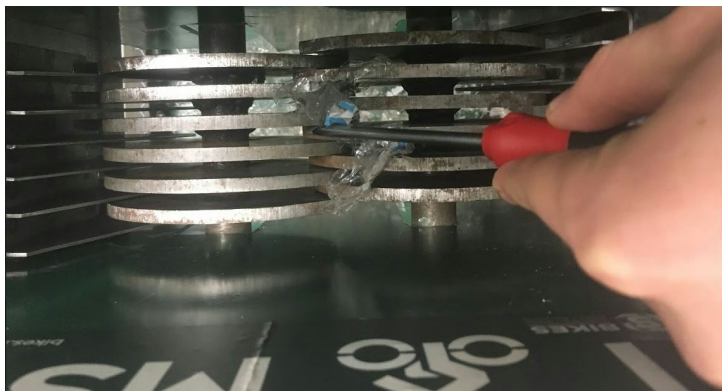
When all bottles are shredded remove the filter screen and run through the machine again to ensure proper shred sizes

Cleaning and Troubleshooting

To ensure proper function and longevity of the shredder, cleaning out any plastic buildup in the teeth is very important.



Make sure nobody is on the bike or pedaling when completing this step



Take a long flathead screwdriver and push any plastic buildup from the teeth

For any bike maintenance refer to the guide provided by the world bike relief provided below

[LINK](http://www.worldbicyclerelief.org/storage/documents/wbr_bicycle_maintenance_manual.pdf)

http://www.worldbicyclerelief.org/storage/documents/wbr_bicycle_maintenance_manual.pdf

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