Robot Rumble

Build Your First Combat Robot

Brandon Bennett Young

Fast and easy to build, this 3D printed "antweight" is great for learning robot construction and battle skills

Photographed by Brandon Bennett Young »

Want to build your own battle robot? Today's the day. Kerfuffle is a mini bot designed to inflict mechanical damage to other machines in caged combat. If you've ever seen the show *BattleBots* then you already have a very solid idea of how these robots operate.

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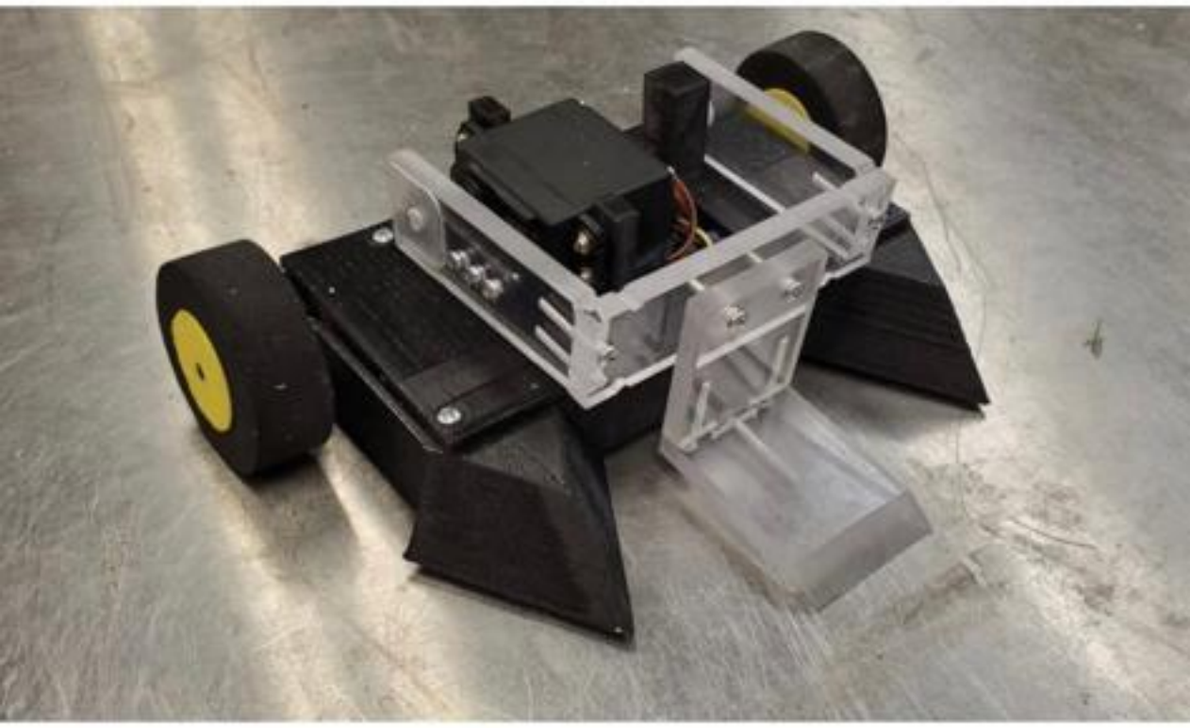
Kerfuffle is a 1lb robot in the plastic antweight class, meaning it's not made with any of the high-grade metals or plastics, such as steel or nylon, that you may see being used on the heavyweight robots on TV. Kerfuffle is designed as an entry-level robot using inexpensive, 3D-printable materials that allow for many more people to take their first steps into the world of combat robots. For weaponry it relies on a wedge shape to get under opponents and a lifter arm to flip them over, meaning it's safe for beginners to practice — and even fight other Kerfuffles — without need of a protective arena.

I designed the machine originally to fight in my school's competition and it proved to be very effective. Since the first version in 2019, Kerfuffle has been tuned to become more competitive, leading to the successful Version 2 that you'll build in this guide.



Version 1 of Kerfuffle, 2019. Photographed by Brandon Bennett Young »

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PRINTING THE PARTS

The first and most critical tool you'll need for this build is a 3D printer. The Ender 3 from Creality is one of the most popular and least expensive printers on the market with a price tag around $200. Other quality printers like the Prusa i3 MK3S are also great options, especially for higher quality materials like nylon, but they cost closer to $1,000. For our Kerfuffle, an Ender 3 is more than sufficient since we will be using PLA or PLA+ filament which are much less expensive and do not require a high level of tuning to print. These machines can be purchased online or in-person at stores such as Micro Center. Or you can send the 3D files out for printing by a service such as Shapeways.

Alongside the printer, be sure to pick up a roll of PLA+ filament in whichever color you prefer. Brands like Duramic3D and Inland have produced materials that have held up well in long-term use. Regular PLA can work too but I recommend PLA+ because it's tougher.

For print settings, I recommend roughly 4 walls and 50% infill. These settings can vary as you have more experience both printing items and fighting robots over time, but these will serve as a nice starting point.

BUILD YOUR KERFUFFLE COMBAT ROBOT

Once you've printed your parts and received the components, we can get to the fun part: building!

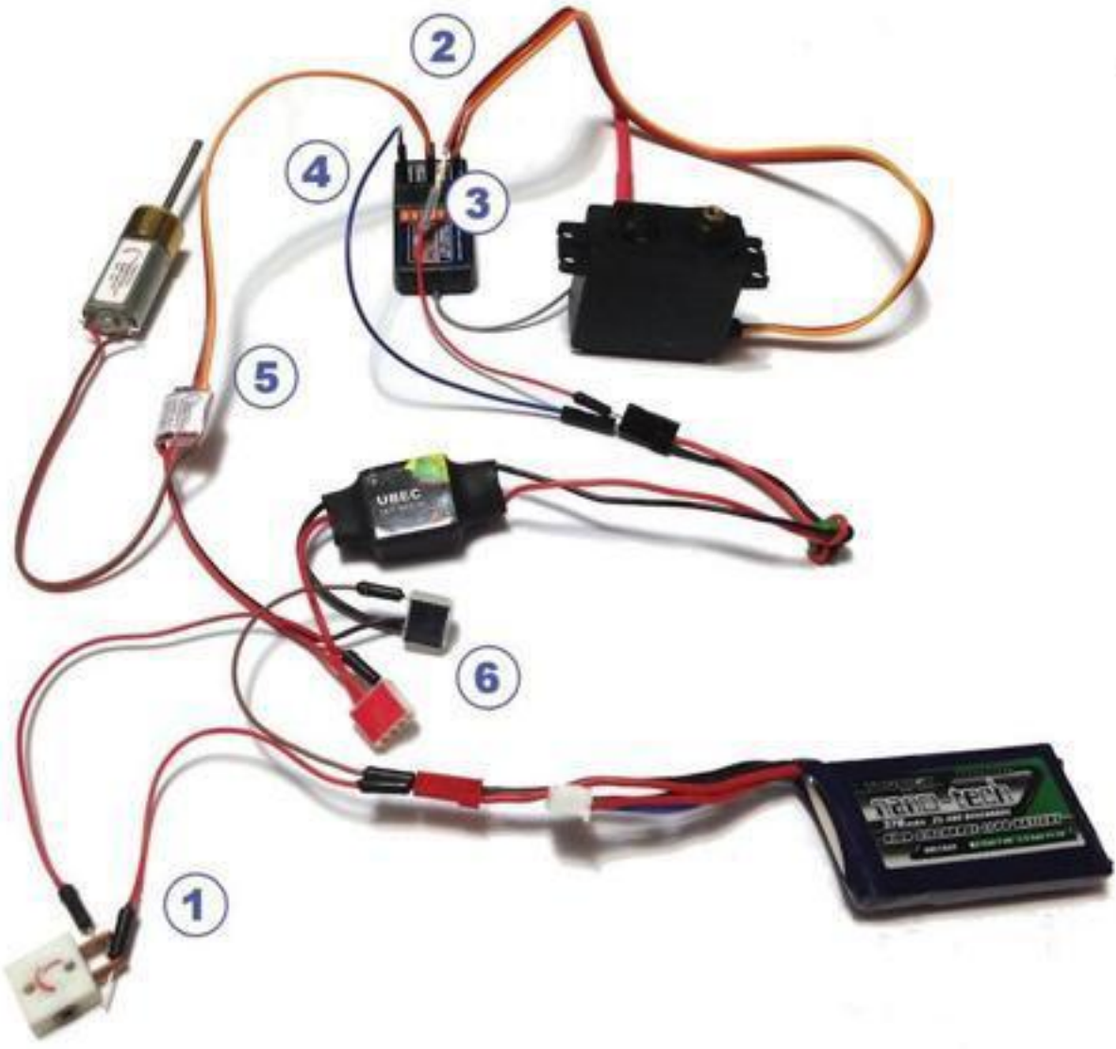
1. SOLDER THE ELECTRONICS

FingerTech's diagram (Figure **A**) shows a typical wiring setup with a gearmotor and servo. But we'll solder our connections, and also add a JST battery connector.

Solder the ESCs to the gearmotors

1a. Solder the ESCs to the gearmotors

The Silver Spark motors have one tab near a red dot and another tab without one. This corresponds to the polarity of the motor. Each tinyESC **5** has one purple and one blue wire. Solder one of these wires (which one doesn't matter at this point) to one tab then the other color to the other tab.



FingerTech Robotics Photographed by Brandon Bennett Young

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Do the same process to connect the other tinyESC to the other motor, but flip the polarity of the wires. For example, if you soldered blue to the tab near the red dot on one motor, then solder the purple wire to the same tab near the red dot on the other motor.

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I recommend adding heat-shrink tubing to cover the joints from potentially shorting and to add strength to the connection.

1b. Solder the power connections

Solder all the red wires from the tinyESCs and the 9V regulator **6** to one of the tabs of the FingerTech mini power switch **1**. On the other tab, solder the red wire from the female JST connector. The female is the connector that the other connector goes inside of. This allows the (male) plug on the battery to plug directly into the connector, providing power.

The mini power switch works by tightening a screw which connects the two tabs. Once this screw makes contact the circuit is complete and electricity is able to flow. In order to make sure all components of the robot will turn off once the power switch is loosened, we connect all the red wires to one location, ensuring there is only one way for electricity to flow. We connect the other tab on the switch to the battery to ensure power is being received.

1c. Solder the ground connections

Solder all the black wires from the tinyESCs and 9V regulator to the black wire on the female JST connector. These connections don't need to be separated by the switch since we already separated the red wires. By connecting the black wires we complete the circuit, leaving only the switch to allow you to turn it on and off.

Congratulations. You've now soldered all of the most important connections in the robot!

:ONNECT THE RECEIVER AND SERVO

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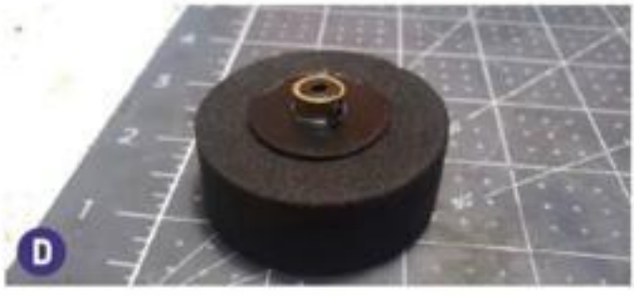
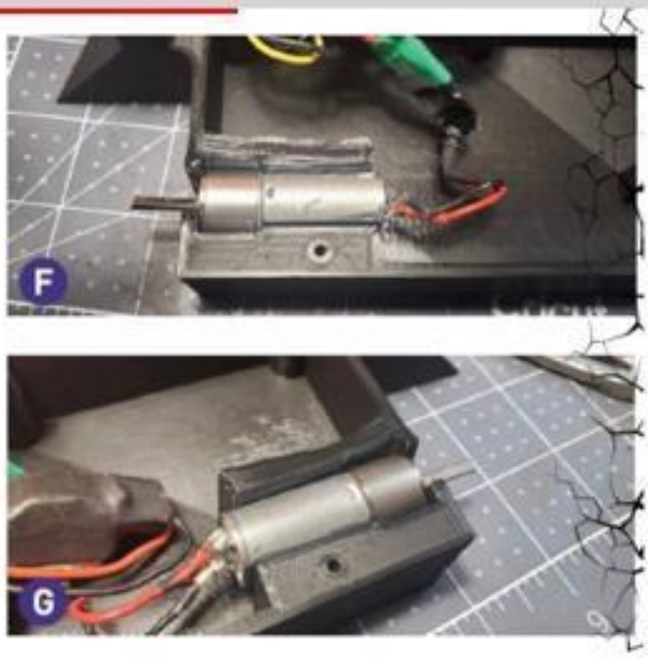
2. CONNECT THE RECEIVER AND SERVO

Connect the receiver leads from the tinyESCs to channels 1 and 2 on the receiver **3**. These will allow you to control the drivetrain using the right s tick on your transmitter.

Connect the receiver leads from the servo **2** to channel 3 on the receiver. This will allow you to control the lifting arm using the throttle channel on your transmitter.

Connect the receiver lead from the 9V regulator **4** to channel 4 on the receiver. This allows the regulator to power the servo so it can use its full capacity.





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3. BUILD THE WHEELS

3a. Glue hubs into the wheels

Add a dab of hot glue onto the larger half of a 3D-printed wheel hub and insert it into the center of a foam wheel (Figure **B**).

Flip the wheel over, add a dab of hot glue onto the smaller half of the hub (Figure **C**) and insert it into the center of the larger half. Press the pieces together to make sure the hubs properly bond to the foam wheel.

3b. Glue Lite Hubs into the hubs

Add a bit of hot glue to the nylon body of a Lite Hub then insert it into the center of the printed hub in the wheel (Figure **D**).

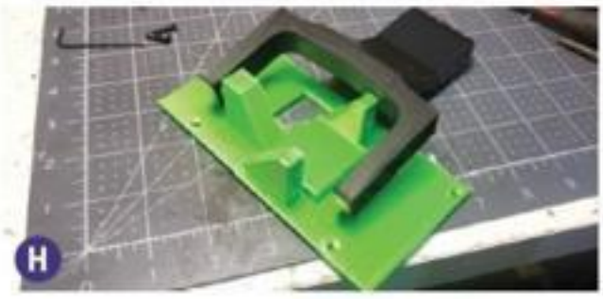
Repeat Step 3 for the second wheel.

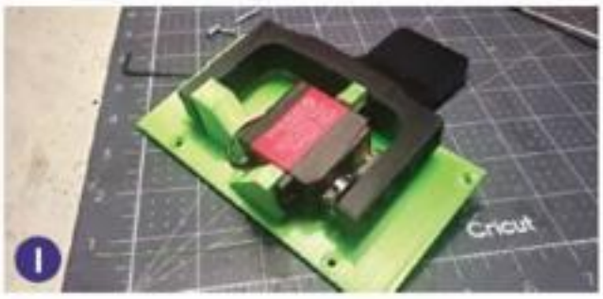
4. MOUNT THE DRIVE MOTORS

a dab of glue to the bottom of each motor mount
ıe chassis (Figure **E**).

Now you'll heat the rear section of the chassis to insert the Silver Spark gearmotor. Turn on the heat gun and let it come up to temperature. Focus it on one motor well at a time: Once the plastic becomes soft, insert the drive motor into the slot. Ensure the gearbox is thoroughly mounted and sitting in the hot glue. Then bend the plastic in slightly so it helps support the motor. Remove the heat gun and let the plastic cool so it hardens in place (Figure **F**).

Repeat this process for the second gearmotor (Figure **G**).





Photographed by Brandon Bennett Young »

5. ASSEMBLE THE LIFTING ARM

Slide the lifting arm over its supporting arm on the top plate, as shown in Figure **H**.

Attach the ***servo horn*** to the output shaft of the servo. The servo horn is a component that connects to the output shaft's ***splines*** (like gear teeth), which allows you to transfer its power to something else. Slide the servo directly into its mounting area. It should sit snugly next to the lifting arm (Figure **I**).

Attach M3 bolts through the lifting arm into the servo horn (Figure **J**). Due to the servo horn's design you will need to insert one screw first then attach the second one after it. You may need to trim screws to fit exactly.

6. SCREW IT ALL DOWN

Screw the servo into its mounting holes in the top plate, using the four #6×½" Plastite screws.

Attach the wheels to the gearmotor shafts by tightening the Lite Hub setscrews using the 0.050" hex
nch.

Finally, attach the top plate to the robot chassis using

Finally, attach the top plate to the robot chassis using the five #4×3/8" Plastite screws (Figure **K**). Enjoy your completed Kerfuffle!

READY TO RUMBLE!

So now that you have a completed machine, what do you do with it? First, practice with your robot. Turn it on, using the 3/32" hex wrench to screw down the mini power switch. Use the transmitter's right stick to move the robot (front/back and left/right) and the left stick to move the lifting arm servo (up/down).

• **Practice driving.** Get the hang of how your robot drives, and become accustomed to how it moves — this will allow you to compete more effectively later on.

• Do figure-8s — it's a great way to get used to the robot's steering as well as get a good read on its speed.

• **Practice fighting.** Because this machine has no dangerous spinning elements, you can easily build clones of it and hold mini sumo competitions where you have timed skirmishes and try to out-drive and out-fight each other.

• To attack, approach a raised area on your opponent. Because Kerfuffle relies on lifting (Figure **L**), it needs to get underneath the other robot, so find areas on your opponent where the arm can get below to maximize lifting ability.

• Wait until you are firmly under the opponent to lift. If you try to lift too early it can leave you exposed to attack, so be patient before using the weapon.

• If Kerfuffle gets flipped over, use the lifter arm to flip it right-side-up again!

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Nathan Story Photographed by Brandon Bennett Young

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• **Fight at events!** Check robotcombatevents.com to find combat robot events in your area. Check when/where competitions are happening and see which ones are hosting "Plastic Ant" classes as part of their competition, such as MACRO's events held in Severn, Maryland (Figure **M**). I highly recommend going to events as this is where you will get connected to members of the combat robot community and further learn about the sport.

If you're looking for tips and tricks, or would just like to meet other combat robot enthusiasts, the Combat Robotics group on Facebook is where many of the builders (especially the ones from *BattleBots*) discuss robot designs.

With these tips you're well on your way to entering the world of combat robots! Happy building!

KEEPING UP WITH KERFUFFLE

Since I first shared this Version 2 design, Kerfuffle's shape has changed dramatically as competition pressed further development. You can see Version 3.0 (Figure **N**), Version 3.3 (Figure **strong text**O), and newer designs by following my team Bone Dead Robotics on Facebook or @bonedeadrobotics or @bonedeadrobotics on Instagram!

YOUR NEXT COMBAT ROBOT

Ready for kinetic weapons?

• First, build a protective test box or safety arena (see

• First, build a protective test box or safety arena (see page 54).

• Try building Irkin (Figure **P**), my plastic antweight vertical spinner bot: grabcad.com/library/irkin-1lb-plastic-ant-combat-robot-1

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• Or add new weapons to Kerfuffle, like my sawbot Version 3.1 (Figure Q)!

TIME REQUIRED: 3-4 Hours + 1–2 Days Print Time

DIFFICULTY: Easy–Intermediate

COST: $300–$400

MATERIALS:

Most of Kerfuffle's parts come from FingerTech Robotics (fingertechrobotics.com) which provides all the components you need to make 1lb and 3lb combat robots:

» **Gearmotors, Silver Spark 16mm, 22.2:1 gear ratio (2)**

» **Electronic speed controllers, tinyESC (2)**

» **LiPo battery pack, Galaxy 3S (11.1V) 300mAh**

» **Voltage regulator, 9V 4.5A**

» **Foam wheels, 2.00"×0.75"**

» **Lite Hubs (1 pair)**

» **R/C transmitter, T6A**

• • • **/C receiver, TR6A**

» **Servomotor, ANNIMOS 20kg metal gear** Amazon #B076CNKQX4. If you substitute the HXT 12kg from FingerTech — it has less power but still plenty for 1lb robots — you'll also need to buy the FingerTech metal servo arm.

» **Plastite screws: #4×3/8" long (5) and #6×½" long (4)** from a local hardware store

» **Machine screws, M3×15mm long (2)**

» **Heat-shrink tubing** from hardware store or Amazon

» **3D-printed robot parts: chassis, lifting arm, top plate, and wheel hubs** Download the free 3D files from grabcad.com/library/kerfuffle-1lb-plastic-ant-combat-robot-1

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TOOLS:

» **3D printer with PLA+ or PLA filament**

» **Phillips head screwdriver**

» **Soldering iron and lead-free solder**

» **Hot glue gun**

» **Heat gun**

» **Hex wrench, 3/32"** to operate the mini power switch

» **Hex wrench, 0.050"** to tighten Lite Hubs setscrews

TIP: If there is difficulty inserting the Lite Hub, I recommend cleaning up the hub opening with a small drill bit or hobby knife.