Boiler League of Tag Presents...

How To Flywheel For Dummies:
An informative guide on how to modify flywheel blasters

Andrew Magro, edited by Wil Stuckey

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Introduction

Hello! This guide is intended to guide a new hobbyist through modding their first flywheel blaster, making upgrades to that blaster, and to dispel some common myths about flywheel blasters. Because this is a Boiler League of Tag guide, we’ll be referencing some services available to Purdue students, like the free 3D printing at WALC.

To use this guide effectively, you’ll need to know how to solder. This guide will not teach you how to solder, but you can learn the skill very quickly and easily by watching a YouTube video or two.

We did not factor the cost of tools into this guide because Boiler League of Tag modding workshops provide a limited amount of tools for you to use. However, we do recommend that you can get access to the following tools to be able to mod flywheels without being at a workshop:

- Soldering Iron and solder
- Hot Glue Gun
- Dremel (optional, hand saws and knives work too but it’ll take a lot longer)
- Screwdrivers
- Knife
- Needle nose Pliers

What will this guide not cover? Generally, advanced modifications or circuitry like Arduino controlled blasters, Ammo counters, Internal LED lighting, Mosfet circuits, full auto flywheel blaster guides*, and other stuff that is difficult for first time modders is not covered in this guide. BLT recommends that you successfully mod a basic semi auto blaster before you move on to more advanced techniques. However, if you think you can do it, we will help you with them during modding workshops if you ask.

*There are circuit diagrams for a variety of full auto blasters in the back of this guide. This guide will not walk you through step by step how to mod a full auto blaster, but you should be able to figure it out yourself using the circuit diagram and some basic info found in the “Your First Flywheel Build... For Under $50!” section

*Mod your blaster at your own risk. Boiler League of Tag is not responsible if you break your toy beyond repair when following this guide
LiPo Battery Safety

Why shouldn’t you use IMRs or other high powered AA batteries? Because IMRs can’t even handle the draw current from even the stock motors. Also, we aren’t lazy. Rewiring a blaster to use a LiPo pack is not difficult. Finally, cost. IMRs and a charger cost about the same as a LiPo pack and balance charger. DON’T USE IMRS

This guide uses LiPo batteries to power your flywheel blasters. LiP0 batteries, or Lithium Polymer batteries, are a type of battery commonly used for hobbies like RC cars and planes due to their high capacity and high discharge rates. LiPo batteries are safe for all Nerfing applications, but only if you follow some safety rules. Failing to follow these safety rules could result in your battery catching on fire… but like that’ll only happen if you’re an idiot so don’t be scared

1. Don’t stab/cut/throw/burn/destroy your battery. Duh
2. ALWAYS use a proper balance charger when charging your battery. The charger cost is taken into account for the total cost of your first flywheel build
3. Charge your battery away from flammable stuff. Just in case
4. If your battery feels inflated like a balloon, DON’T charge it. Just throw it away
5. Don’t over drain the battery pack. When you use the battery, the battery’s voltage will drain. If you let it get below a certain point, the battery will no longer be safe to use. This probably won’t happen while Nerfing unless you never charge your battery, but try to use a voltage alarm anyway. A voltage alarm beeps when the battery’s voltage gets too low
6. Don’t store your battery in a very hot place
7. Don’t store your battery fully charged. Instead, store your battery at about 50% charged
8. Make sure the voltage for your motors and your battery match. LiPo voltage is indicated by the number of cells (s). Nerf blasters will either use 2s (7.4 V) or 3s (11.1 V) batteries. Aftermarket motors will specify what voltage pack to buy to use them properly.
9. Don’t overdraw your battery pack, or hook it up to a circuit that draws more power than the battery can provide. LiPos have a **C-Rating** and total **Amp Hours** printed on the side of the battery. Use these to make sure your pack provides enough power. (Example on next page). You won’t have to worry about this on your first flywheel build, because we have already chosen the battery for you!
Example: You have 2 Neo Hellcat motors powering your blaster. Each Neo Hellcat uses 40 Amps or current, so your circuit pulls a total of 80 Amps (A).

This is your battery:

It’s rated for:
- 1800 mAh or 1.8 Amp Hours
- 65 C (sustained) - 130 C (burst) Discharge

It’s maximum current output would then be:
- $1.8 \times 65 = 117$ A max current (sustained)
- $1.8 \times 130 = 234$ A max current (burst)

80 A ≤ 117 A (sustained) and 234 A (burst), so this battery is safe to use with the 2 Neo Hellcat circuit. If only the burst current value of the battery was higher than 80, the battery would still be ok to use.
Your First Flywheel Build... For Under $50!

This tutorial will walk you through how to build a competitive entry level flywheel blaster for under $50! Hopefully, this tutorial will dispel the “flywheel modding is too expensive and hard to do” shtick that everyone keeps insisting is true. Also, we do provide purchase links for everything but feel free to shop around for different sellers to find the items cheaper/reduce shipping costs.

Before we get started, note that this guide assumes you’re modding a Nerf Stryfe. This guide will also work for literally any other semi auto Nerf Blaster (including the ones listed below); you just won’t be able to use the flywheel cage we’re going to 3D print. You’ll have to use the stock cage instead or Google search around for a different flywheel cage.

Blasters this guide will work for (minus flywheel cage replacement):

Nerf Modulus (ECS-10), Nerf Demolisher, Nerf Evader, Nerf Desolator, Nerf Jyn Erso and Cassian Andor blasters (although you will lose audio function) Nerf Rayven, Nerf Hailfire (this one is tricky to put back together though, lots of small parts), Rebelle Rapid Red

Step 1: Choose between a 2s (7.4 V) or a 3s (11.1 V) battery

<table>
<thead>
<tr>
<th>2s pack</th>
<th>3s pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Fits inside of stock battery tray easier</td>
<td>-Might require some cutting to make the battery fit inside the battery tray, or you'll have to get creative on where you put it</td>
</tr>
<tr>
<td>-Cheaper beginner motors. High end 2s motors cost the same-ish as 3s</td>
<td>-More expensive beginner motors. High end 3s motors cost the same-ish as 2s</td>
</tr>
<tr>
<td>-2s batteries are cheaper than 3s</td>
<td>-3s batteries are more expensive than 2s</td>
</tr>
<tr>
<td>Less future modding potential</td>
<td>-More potential for future mods to boost your blaster’s performance</td>
</tr>
<tr>
<td>-Less aftermarket motor support</td>
<td>-Many more aftermarket motor options</td>
</tr>
</tbody>
</table>

In general, a 2s battery will be better for you if you aren't planning to continue modding later on, while a 3s battery will be better for you if you are planning on making better flywheel blasters in the future.
## Step 2a: Purchase Materials (2s battery)

<table>
<thead>
<tr>
<th>Part</th>
<th>Purchase Link</th>
<th>Total Price (w/out shipping)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x Meishel 2.0 2s motor</td>
<td><a href="https://outofdarts.com/collections/motors/products/meishel-2-0-130-2s-motor-for-nerf-blasters">https://outofdarts.com/collections/motors/products/meishel-2-0-130-2s-motor-for-nerf-blasters</a></td>
<td>$7.00</td>
</tr>
<tr>
<td>1x OFP Stryfe_RS Cage 42mm</td>
<td>File here: <a href="https://drive.google.com/drive/folders/0B-gnUFDEokkUSWFpcUxjVUFQYk0">https://drive.google.com/drive/folders/0B-gnUFDEokkUSWFpcUxjVUFQYk0</a> Print here: <a href="http://guides.lib.purdue.edu/3dprinting/Home">http://guides.lib.purdue.edu/3dprinting/Home</a></td>
<td>FREE</td>
</tr>
<tr>
<td>4x Set screws</td>
<td><a href="https://outofdarts.com/collections/parts/products/flywheel-cage-screw-set-4x">https://outofdarts.com/collections/parts/products/flywheel-cage-screw-set-4x</a></td>
<td>$1.00</td>
</tr>
<tr>
<td>2x Stock Flywheels</td>
<td>(They're the flywheels that come in the blaster straight out of the box)</td>
<td>FREE</td>
</tr>
<tr>
<td>1x XT60 Connector (The link gives you an extra connector and a LiPo voltage checker)</td>
<td><a href="https://www.amazon.com/gp/product/B06XDW58HT/ref=ox_sc_act_title_4?smid=A3QFTW0W8OXK38&amp;psc=1">https://www.amazon.com/gp/product/B06XDW58HT/ref=ox_sc_act_title_4?smid=A3QFTW0W8OXK38&amp;psc=1</a></td>
<td>$5.98</td>
</tr>
<tr>
<td>1x Cherry/ZF DB2 Microswitch (Good idea to order more just in case)</td>
<td><a href="https://www.newark.com/zf-switchessensors/db2ca1lb/microswitch-hinge-lever-spdt-10/dp/59K9990">https://www.newark.com/zf-switchessensors/db2ca1lb/microswitch-hinge-lever-spdt-10/dp/59K9990</a></td>
<td>$1.56 (1 switch)</td>
</tr>
<tr>
<td>Some wires, preferably in red or black (You can find cheaper wires)</td>
<td><a href="https://www.amazon.com/gp/product/B00TG1TRL2/ref=oh_aui_search_detailpage?ie=UTF8&amp;psc=1">https://www.amazon.com/gp/product/B00TG1TRL2/ref=oh_aui_search_detailpage?ie=UTF8&amp;psc=1</a></td>
<td>$5.48</td>
</tr>
<tr>
<td><strong>GRAND TOTAL (No shipping)</strong></td>
<td></td>
<td><strong>$43.98</strong></td>
</tr>
</tbody>
</table>
Step 2b: Purchase Materials (3s battery)

<table>
<thead>
<tr>
<th>Part</th>
<th>Purchase Link</th>
<th>Total Price (w/out shipping)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x OOD Valkyrie 3s motor</td>
<td><a href="https://outofdarts.com/collections/motors/products/valkyrie-130-2s-neo-motor-for-nerf-blasters">https://outofdarts.com/collections/motors/products/valkyrie-130-2s-neo-motor-for-nerf-blasters</a></td>
<td>$8.00</td>
</tr>
</tbody>
</table>
| 1x OFP Stryfe_RS Cage 42mm        | File here: [https://drive.google.com/drive/folders/0B-gnUDkE0kEU3WFpcUxjVUFQk0](https://drive.google.com/drive/folders/0B-gnUDkE0kEU3WFpcUxjVUFQk0)  
Print here: [http://guides.lib.purdue.edu/3dprinting/Home](http://guides.lib.purdue.edu/3dprinting/Home) | FREE                         |
| 4x Set screws                     | [https://outofdarts.com/collections/parts/products/flywheel-cage-screw-set-4x](https://outofdarts.com/collections/parts/products/flywheel-cage-screw-set-4x) | $1.00                        |
| 2x Stock Flywheels                | (They’re the flywheels that come in the blaster straight out of the box)                                 | FREE                         |
| 1x Turnigy 2200 mAh 3S 40C LiPo   | [https://hobbyking.com/en_us/turnigy-2200mah-3s-40c-lipo-pack.html](https://hobbyking.com/en_us/turnigy-2200mah-3s-40c-lipo-pack.html) | $15.01                       |
| 1x XT60 Connector (The link gives you an extra connector and a LiPo voltage checker) | [https://www.amazon.com/gp/product/B06XDW5BHT/ref=ox_sc_act_title_4?smid=A3QFTW0W8OXK38&psc=1](https://www.amazon.com/gp/product/B06XDW5BHT/ref=ox_sc_act_title_4?smid=A3QFTW0W8OXK38&psc=1) | $5.98                        |
| 1x Cherry/ZF DB2 Microswitch (Good idea to order more just in case) | [https://www.newark.com/zf-switches-sensors/db2ca1lb/microswitch-hinge-lever-spdt-10/dp/59K9990](https://www.newark.com/zf-switches-sensors/db2ca1lb/microswitch-hinge-lever-spdt-10/dp/59K9990) | $1.56 (1 switch)             |
| Some wires, preferably in red or black (You can find cheaper wires) | [https://www.amazon.com/gp/product/B00TG1TRL2/ref=oh_aui_search_detailpage?ie=UTF8&psc=1](https://www.amazon.com/gp/product/B00TG1TRL2/ref=oh_aui_search_detailpage?ie=UTF8&psc=1) | $5.48                        |

GRAND TOTAL (No shipping) $50.39
Step 3: Taking Apart Your Blaster

So now that you’ve gotten all the parts you’ll need, it’s time to take apart your blaster. This is quite simple. All you need to do is unscrew all the screws and pry the shell open. Make sure not to lose any screws, small parts or springs! Once you open the blaster, it should look like this:

Before you do anything, take a picture of the internals so you know how to put it together again later. All the plastic parts and springs inside need to be removed and kept safe. We will be reusing them when we reassemble the blaster. All the electronic parts can be ripped out and thrown away. We aren’t going to use them anymore.

Now, examine the stock flywheel cage. It should look something like this:

1. We want to rip all that circuitry out and disassemble the cage as much as possible.
2. Once you have completed this, you’ll need to very carefully pry off the 2 white plastic disks (the flywheels) off the motors. This can be done with a screwdriver, and a bit of elbow grease. Be careful not to break your flywheels… if you do, you’ll have to buy new ones.
3. Once the flywheels have been removed, you can discard the stock cage. We will no longer need it.

This guide will not cover how to paint a blaster, nor how to integrate blasters together. However, if you were planning on painting your blaster or doing an integration, this would be the time to do so while no internals are inside the shell.
Step 4: Constructing New Flywheel Assembly

Now that the old flywheels have been removed, it’s time to test fit our new flywheels! First, you’re going to need to clean up your 3D printed flywheel cage. When you pick up your cage from WALC, there’ll be a lot of unnecessary plastic called “support structures” you need to trim off the part. Use needle nose pliers, a knife, and some sandpaper if you have it to remove the supports from inside the cage where the motors go, and from inside the screw holes. Your cage should now look something like this:

At this point, try to test fit your motors into the cage. You’ll notice that the motors do not sit flush with the top of the cage and the set screws will not fit in the set screw holes far enough to screw into the motors. To fix this, slowly widen the holes indicated in the picture on the right using a knife or a file until everything fits nicely. Be careful not to widen the holes too much or break the plastic!

Once your motors test fit into the cage nicely, it’s time to permanently mount them. First, check the back of the motors near the metal leads. You’ll see one lead on each motor is marked with a red dot. When you place your motors into the cage, **make sure the red dots are NOT facing the same direction.** Otherwise, one flywheel will push the dart forward while the other flywheel pushes the dart backward! Once the motors are placed correctly in the cage, secure them in place by screwing in the set screws. The set screws will fasten the motor inside of the cage!

Correctly oriented motors will look like this:

*Note that the cage in this picture is NOT the same cage you are using (The pink cage above is though!) This picture just illustrates how the red dots on the motors are on opposite sides*
Step 5: Replacing the Rev Trigger Switch

An important part of any flywheel blaster is the rev trigger. When you push down the rev trigger, it presses a switch that completes the circuit and allows electricity to flow into the flywheel motors. The switches that come in any stock Nerf blaster are not strong enough for our upgraded battery, so we’ll replace them with something better: A microswitch!

Before we place the microswitch, let’s learn about how they work. A microswitch has 3 different terminals: C (common), NO (normally open), and NC (normally closed). Each terminal will be labeled. To use a microswitch as a normal switch (the circuit completes when the switch is pressed), you’d attach one wire to C and one wire to NO. This is how we will be using the switch in your blaster.

1. Now, let’s place the switch! Put the rev trigger and the rev trigger spring back into the blaster.

2. Then, place your microswitch in such a way that whenever the plastic part of the rev trigger is pushed down, it also presses down the microswitch. You will have to cut out some plastic bits to make the microswitch fit. There is no one way to place the microswitch, so do what works best for you!

3. Once you get the switch in the right spot, you can glue it in place with a dab of hot glue. Just make sure you don’t cover up the microswitch’s terminals.

4. Remember to mark down the C and NO terminals so you know where to solder the wires later! If you placed the microswitch correctly, it should look something like this:
Step 6: Wiring the Blaster

Before you do this step, you’ll need to learn how to solder. If you don’t already know how, watch a couple How To videos to get an idea. Soldering is not all that hard to do adequately.

Now that you have all your parts assembled, it’s time to wire your blaster! All you have to do is solder your parts in accordance with the circuit diagram below:

SOLDERING TIPS:

- Don’t solder directly to your battery, solder the XT60 connectors the battery plugs into
- Try to use the heat-shrink to cover up as many exposed solder joints as possible
- Remember to test your circuit before you solder the XT60 connector, ideally with a less powerful battery. 9 volts are pretty good for testing if you have one.
- If your flywheels spin the wrong way during testing, swap the polarity (switch the red and black wire) on your battery conntector. This will make the current flow through your circuit in the opposite direction and reverse the direction your flywheels spin
- Don’t short your battery. Duh.
- Measure how long of a wire you need before you cut it
- Remember to route your wires around the mag-well and under the dart pusher!
Troubleshooting:

My blaster revs up but jams every time I pull the trigger:
The Flywheels may be spinning the wrong direction. If they are, try reversing the polarity of your battery connector. Alternatively, make sure you are testing your blaster with new(ish) darts. Old/soft darts will jam no matter what blaster they are in.

My blaster does nothing when I try to rev it:
You may have a bad solder joint in there somewhere. Open it back up and check your joints. Alternatively, you soldered to the wrong terminals on the rev trigger microswitch.

There is a crackling noise, sparks, smoke, and/or my battery is getting very hot:
Unplug your battery NOW. You have a short in the circuit somewhere, and continued use may cause a fire. Open it back up and figure out where the wires are touching.

My blaster immediately revs as soon as I plug in the battery:
You may have soldered your wires to the NC instead of the NO terminal of your microswitch.

My trigger is sticking in the back or forwards position:
One or more of your wires may have come loose and are getting in the way of your moving parts. Open it up and hot glue those suckers down. Alternatively, you may have forgotten a spring or two. Check and make sure all springs are present in your blaster.

Aaand STOP HERE. You’re done! Once your blaster’s circuit is soldered and functional, put your blaster back together and have fun owning the noobs using springers.
So you’ve put together your first flywheel build, but you still want more power? There are three main parts you can swap out to increase the performance of your blaster past what the beginner builds above yield: Flywheel motors, Flywheel Cages, and Flywheels.

**Motor Upgrades**

Swapping to better motors will increase the performance of your blaster. There are a couple things to consider when choosing a new set of motors:

1. **Size:** Flywheel motors come in two sizes, either 130 or 180. 130 sized motors should be able to fit into most blasters without any shell cutting. 180 sized motors will require shell cutting to fit them in the blaster.
2. **Voltage:** Some motors are designed for 2S (7.4 V), and some motors are designed for 3S (11.1 V).
3. **RPM:** This is how fast your motors spin. Ideally, you want your motors to spin somewhere around 35,000 RPM. Any higher than 40,000 RPM and darts will slip in the wheels.
4. **Torque:** Torque controls how fast your blaster spins up, how much your flywheels will lag in between each shot, and how high crush your flywheel cage can have. We want to maximize torque.
5. **Stall Current:** This is the maximum amount of current each flywheel motor can draw. Add up the stall current for each motor used in your circuit. Your battery should be able to discharge this much current, otherwise get a new battery. (The batteries recommended in the starter builds can safely run two of all the motors listed below)

What motors should I upgrade to? BLT has listed recommended upgrade motors below, in order of increasing performance. Motors can be purchased at [https://outofdarts.com/](https://outofdarts.com/). More in depth motor comparisons and data can be found at [https://suild.com/motor-chart](https://suild.com/motor-chart)

### 2S Flywheel Motors

<table>
<thead>
<tr>
<th>Motor</th>
<th>Size</th>
<th>Voltage</th>
<th>RPM</th>
<th>Torque (gf*cm)</th>
<th>Stall Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meishel 2.0</td>
<td>130</td>
<td>2S (7.4V)</td>
<td>33,000</td>
<td>356.9</td>
<td>18.8</td>
</tr>
<tr>
<td>Fang Revamps</td>
<td>130</td>
<td>2S (7.4V)</td>
<td>37,000</td>
<td>500</td>
<td>28</td>
</tr>
</tbody>
</table>
### 3S Flywheel Motors

<table>
<thead>
<tr>
<th>Motor</th>
<th>Size</th>
<th>Voltage</th>
<th>RPM</th>
<th>Torque (gf*cm)</th>
<th>Stall Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OOD Valkyrie</td>
<td>130</td>
<td>3S (11.1V)</td>
<td>35,000</td>
<td>410</td>
<td>14</td>
</tr>
<tr>
<td>OOD Kraken</td>
<td>130</td>
<td>3S (11.1V)</td>
<td>35,000</td>
<td>740</td>
<td>26</td>
</tr>
<tr>
<td>MTB Hellcat</td>
<td>180</td>
<td>3S (11.1V)</td>
<td>36,300</td>
<td>740</td>
<td>23.8</td>
</tr>
<tr>
<td>MTB Neo Rhino</td>
<td>130</td>
<td>3S (11.1V)</td>
<td>36,700</td>
<td>743</td>
<td>24</td>
</tr>
<tr>
<td>MTB Neo Hellcat</td>
<td>180</td>
<td>3S (11.1V)</td>
<td>36,600</td>
<td>1260</td>
<td>40</td>
</tr>
</tbody>
</table>

For 2 stage flywheel builds, your motor criteria should be a little different for the second set of motors. Torque isn’t quite as important, but now you’re going to want to have about 50,000 RPM or higher in the second set of motors.

- There is a brief guide/wiring diagram for 2 stage flywheel builds later in this document.
- Note that 2 stage flywheel builds should only be done on 3S.
- Motors that say “OVERVOLT” should be used with caution. They will work, but they are very likely to burn out if you screwed something up.
- None of the batteries recommended in the starter builds can handle 2 stage builds.

### 2nd Stage Motors

<table>
<thead>
<tr>
<th>Motor</th>
<th>Size</th>
<th>Voltage</th>
<th>RPM</th>
<th>Torque (gf*cm)</th>
<th>Stall Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fang Revamps</td>
<td>130</td>
<td>3S (11.1V)</td>
<td>55,500</td>
<td>765</td>
<td>42</td>
</tr>
<tr>
<td>MTB Wolverine</td>
<td>180</td>
<td>3S (11.1V)</td>
<td>66,785</td>
<td>1091</td>
<td>69</td>
</tr>
</tbody>
</table>
For the pusher in a fully automatic blaster, torque really isn’t that important. Additionally, the RPM of the motor should be matched up to about how many darts per second you want to shoot.

- There is a brief guide/wiring diagram for full auto blasters later in this document
- In Arduino and Ammo Counter builds, increasing darts per second greatly reduces the functionality of the Arduino/Ammo Counter
- All full auto blasters should **ideally** be running on 3S.
- All dart per second stats are calculated using a Rapidstrike pusher.

### Full Auto Pusher Motors

<table>
<thead>
<tr>
<th>Motor</th>
<th>Size</th>
<th>Voltage</th>
<th>RPM</th>
<th>Darts Per Second</th>
<th>Stall Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTB Rhino</td>
<td>130</td>
<td>3S (11.1V)</td>
<td>33,300</td>
<td>~9</td>
<td>8</td>
</tr>
<tr>
<td>MTB Honey Badger</td>
<td>130</td>
<td>3S (11.1V)</td>
<td>64,751</td>
<td>~18</td>
<td>20</td>
</tr>
</tbody>
</table>
Flywheel Cage Upgrades

Next to motors, changing your flywheel cage is the second best way to increase your blaster’s performance. The main aspect of a flywheel cage that increases performance is known as Crush. When a flywheel cage has higher crush, that means the gap between the flywheels is smaller. Lower crush flywheel cages have a larger gap between the flywheels. **High crush cages increase the FPS of your blaster** because they compress darts passing through the flywheels more than normal. However, **high crush cages are significantly more likely to destroy darts** via shredding and decapitation. **High crush cages also cannot shoot harder tipped darts** like Little Valentines or FVJs.

<table>
<thead>
<tr>
<th>High* Crush</th>
<th>41.5 mm</th>
<th>42 mm</th>
<th>42.5 mm</th>
<th>43 mm</th>
<th>43.5 mm</th>
</tr>
</thead>
</table>

*41 mm flywheel cages do exist, but please don’t use them

Flywheel cages can either be 3D printed, or machined out of metal. The main advantage to 3D printed flywheel cages is that they are essentially free for Purdue Students, assuming you can find the .stl file. Purdue Students can 3D print flywheel cages here: [http://guides.lib.purdue.edu/3dprinting/Home](http://guides.lib.purdue.edu/3dprinting/Home)

Metal flywheel cages are higher end and higher precision than 3D printed cages, but are considerably more expensive. Additionally, metal cages will reduce the flywheel noise in your blaster and can allegedly increase your blaster’s accuracy. Purdue students that have experience using CNC machines can mill out their own metal flywheel cages at the Bechtel Innovation Design Center.

Let’s talk about canted flywheel cages. The flywheel motors in a canted cage are slightly offset from one another. The idea is that the offset motors will impart “spin” onto darts they shoot, which stabilizes the dart to improve accuracy. This is true... to an extent. Canted cages do work, but only up to about 120 FPS. If they shoot darts any faster than that, the darts will spin uncontrollably out of the barrel and go like 2 feet. If you absolutely must use a canted cage, try to use motors that are recommended with it. Or just don’t use a canted cage.
Common Flywheel Cage Choices

- **Open Flywheel Project (OFP) Original Cages (BLT’s Choice)**
  - Flywheel cages recommended by the Boiler League of Tag. 3D printable and available in 41.5mm -> 43.5mm crush. 2 stage model is also available
  - [https://drive.google.com/drive/folders/0B-gnUFDEokkUSWFpcUxiVUFQYk0](https://drive.google.com/drive/folders/0B-gnUFDEokkUSWFpcUxiVUFQYk0)

- **Open Flywheel Project (OFP) Morpheus Cages**
  - 3D printable higher accuracy versions of the original OFP cages. However, these cages MUST have a brass insert to function properly and as a result shoot at lower velocities than the original OFP cages. Available in 41.5mm -> 43mm crush
  - [https://drive.google.com/drive/folders/1oe6VWd2emEWX8le_ECMde8R1fo29yZpm](https://drive.google.com/drive/folders/1oe6VWd2emEWX8le_ECMde8R1fo29yZpm)

- **Open Flywheel Project (OFP) Eclipse Cages**
  - This cage absolutely MUST be metal. The tolerances are so tight on this cage that you cannot 3D print them.
  - This cage has such high crush it has its own proprietary flywheels. If you are using an eclipse cage, you absolutely must use eclipse flywheels
  - Eclipse cages require so much torque to use that you can’t really use any of the motors we recommend in it. If you want to use an eclipse cage, you’ll have to research to find proper motors
  - Eclipse cages absolutely destroy darts. A dart will last maybe 2 shots through it
  - Eclipse cages shoot up to 200 fps with just one stage. Wow.

- **Artifact Red Cage**
  - Basic metal flywheel cage with low-ish crush. Good for HvZ and noise reduction, not good for high performance

- **Worker Silver Cage**
  - Basic metal flywheel cage with low-ish crush. Good for HvZ and noise reduction, not good for high performance

Other premium aluminum flywheel cages we did not list exist, but they’re all crazy expensive and really aren’t all that better than a good ol’ 3D printed OFP cage. If you’re rich, you can find them easily on Google
Flywheel Upgrades

The last good way to increase the performance of your blaster is by upgrading the flywheels themselves. Many variables go into how your flywheels effect your blaster’s performance. We’ve highlighted some of them below

- **Weight:** Lighter flywheels spin up faster, while heavier flywheels have less of a performance decrease between shots. Additionally, both of your flywheels should weigh as similarly as possible
- **Concavity:** Flywheels with a higher concavity will grip darts over a larger surface area, increasing performance and decreasing dart wear
- **Diameter:** Certain flywheels have a slightly larger diameter than others, increasing the “crush” of your flywheel/flywheel cage system
- **Surface Finish:** Serrated wheels offer very little gains in performance over smooth wheels and severely increase dart shredding. Don’t get serrated wheels if possible.
- **Material:** Most flywheels are made from a plastic called Delrin. These wheels are good. A small number of flywheels are made from aluminum or another type of metal. Darts will slip on metal flywheels, decreasing performance. Avoid metal flywheels if possible

Certain aftermarket flywheel cages, such as the OFP Eclipse cage, come with or recommend the use of a certain kind of flywheels in their cage. If this is the case with the cage you are using, make sure to use the recommended flywheels

Common Flywheel Choices

- **Containment Crew Cyclones (BLT’s Choice)**
  - High weight, high crush flywheels. Cyclones should only be used in pair with motors that provide a good amount of torque. These wheels will effectively increase the crush of your flywheel cage/flywheel system by ~.5 mm due to their large diameter

- **OutofDarts Insutantos**
  - Very low weight flywheels. Due to their low weight, these wheels will spin up extremely fast. However, these wheels are somewhat fragile and shouldn’t be used with any higher than 35mm crush
- **Bulldog Flywheels**
  - Middle ground between Cyclones and Insutantos. Can be used in higher crush systems and have better performance than Insutantos. Lighter than, but do not have as good performance as Cyclones

- **BlasterParts Blue Flywheels**
  - “Budget flywheels” for people that don’t want to order from ChinaLand. Cheaper than the first three options but don’t perform as well as them either

- **Worker White Flywheels**
  - High performance wheels, but they WILL shred your darts due to the serrated surfaces.

- **Worker Black High Crush Wheels**
  - Simply put these wheels kinda suck. They have a potential to break motors if used in crush any higher than 35 mm, and the serrated surfaces will shred darts
Two Stage Flywheel Systems

Two stage flywheel systems, also known as “afterburners”, are blasters that use two sets of flywheels to propel darts instead of 1 set of flywheels. Two stage systems can achieve considerably higher performance than one stage systems, not including particularly expensive one stage builds like the OFP Eclipse. Two stage flywheel systems also have a considerable amount of drawbacks. Running 4 motors instead of 2 increases the current draw on your battery, so you’ll have to buy a new LiPo pack that can handle the motors. The increased current draw can also burn out cheap microswitches. Significant shell cutting is required to fit a two stage flywheel cage into any blaster. Two stage systems are also significantly noisier than one stage systems.

Before using the circuit diagram below to make a two stage flywheel system, ask yourself a few questions

1. Am I currently using the highest performance motors on the market?
2. Am I currently using the highest crush flywheel cage I can get (not including OFP Eclipse)
3. Am I currently using the highest performing wheels I can get my hands on?
4. Am I comfortable cutting the shell to make a two stage cage fit?
5. Do I still want to shoot darts faster?

If your answer to all of those questions is yes, then buy a pair of second stage motors from the motor upgrade section above, print out a two stage 41.5 mm crush OFP cage, and proceed to the wiring diagram below:
- When you finish wiring the flywheel assembly as shown in the picture, you'll have two “leads”, or areas that need to get connected to the circuit, just like with a one stage build. All you have to do is wire those two leads into the circuit exactly the same way as you would a one stage cage.

- If the wheels are spinning in the wrong direction to shoot darts, reverse the polarity of those two leads. (Ex. Instead of hooking that red wire in the diagram up to positive, hook it to negative instead)

- The 1st stage motors are the ones the darts pass through first
So you have a full auto flywheel blaster instead of a semi auto blaster but you still want to mod it? This section provides simple wiring diagrams for a couple of popular full auto blasters. You should be able to use the information in the “Your First Flywheel Build... For Under $50!” section in combination with these wiring diagrams and a bit of Google research to successfully modify your blaster. Do note that you’ll need to purchase more parts in addition to the ones in the “Your First Flywheel Build” section. You’ll also need to make sure your battery can discharge enough current to run all three motors.

**Blasters Covered in this Section:**

- Nerf Rapidstrike
- Nerf Hyperfire
- Nerf Vulcan, with a set of flywheels put in the front to shoot darts harder

**Blasters NOT Covered in this Section**

- Any Nerf “smart” blaster (Regulator, Infinus, etc.) Can’t rewire them easily because of the computer chips
- Any Arduino controlled blaster. We’re gonna write a different guide for those
- Autostryfes. The tiny yellow gear boxes you need will give out after a few weeks of use
- Nerf Stampede. Can’t make this one shoot harder or faster without destroying the gearbox
Rapidstrike Circuit Diagram

*This is a (BLT recommended) “Dead Center” Rapidstrike circuit. There are a few other ways to wire a Rapidstrike floating around out there if you don’t like this one.
*When modding a Hyperfire, you absolutely MUST get a new flywheel cage. The stock cage cannot shoot faster than ~120 fps without misfiring darts.

Hyperfire Circuit Diagram
**Flywheel Vulcan Circuit Diagram**

*Building a flywheel Vulcan takes a considerable amount of shell cutting and requires you to mount your own flywheel cage instead of using supports that are already there.*

*The polarity of the original Vulcan motor does not matter*