COMBAT ZONE

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Featured This Month:

BUILD REPORT:

Siafu and the Army of Ants – Part 1

● by Pete Smith

I've built a few Antweights (1 lb) over the years. It's never been a weight class I was particularly interested in, but with many events only hosting Ants and Beetleweights (3 lb) I have built them just to make up numbers or for my (then young) son to compete with.

However, I have perhaps the singular honor of never having won a fight with one! They all performed like the ill thought-out and hastily-built machines they were. Their wheels would fall off and the speed controllers would burn out or would simply decide not to move at all once they were in the arena.

With the success that the Weta and Trilobite Beetleweight kits are having through Kitbots (**www.kitbots.com**), I decided it was time to design and build a really competitive Antweight. I named it Siafu – the Swahili name for the fearsome Army ants of the genus Dorylus.

I decided my first serious Ant would be a drum bot. I've watched the success of Team Pneusance's Poco Tambor and decided I wanted to build a bot as (or more) effective as that, but in a kit form that would allow others to enter the sport with an effective bot right from the start.

I design my bots in 3D using SolidWorks and keep close track of the weight of all the components in a spreadsheet. The latter is very important because it's too easy to find yourself with a bot that is overweight for a competition, or one that has an ineffective weapon or inadequate armor.

Fingertech Robotics (**www.fingertechrobotics.com**) is the leading supplier for Antweight parts, and their TinyESC v2 speed controllers and Silver Spark drive motors are becoming the standards by which all others are measured. With

that in mind, I based my first layout around them.

Figure 1 shows two Silver Sparks, Lite Flite wheels, and a 36 mm brushless outrunner.

The 36 mm outrunner was chosen because it has a 5 mm shaft. I envisioned replacing it with a new shaft that would run the full width of the bot, and placing the outrunner within the drum itself. It did not take long, however, to find problems with the design. The Silver Sparks are quite long and this forced the bot (and hence the drum) to be quite wide. Similarly, the large diameter of the outrunner forced the drum to be even larger. A few trial chassis and drum designs showed that keeping such a design within 16 ounces would be very difficult. The long shaft on the outrunner would also make replacing the drum very difficult if it was damaged.

FIGURE 1

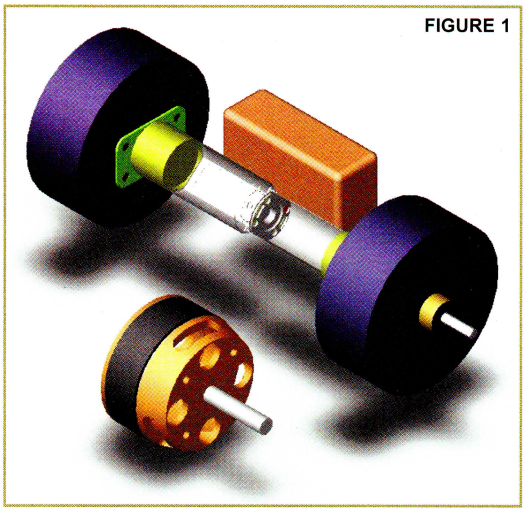
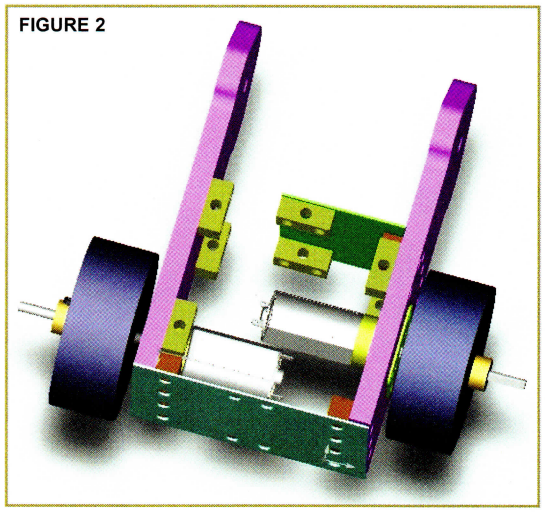


FIGURE 2



I then tried a design (**Figure 2**) that staggered the Silver Sparks and would use a more conventional inrunner and belt drive for the drum (similar to that on Weta). This reduced the width and the weight of the bot. While the staggered wheels might have made driving a little more interesting, I felt this could be made to work. Unfortunately, a problem arose with the belt drive system. The inrunner took up a lot of space, and belts and pulleys that small would be problematic to attach to the drum. Again, I had run into a dead end.

The answer came when I found a small motor (**Figure 3**) at the same supplier as I use for the Kitbots 1,000 RPM Beetle motors. These motors were listed as 1,000 RPM at 6V and used a motor about one half the length of that on the Silver Sparks. The question to be answered was, would these smaller motors have enough power to drive an Ant?

To answer that, I built a small test chassis (**Figure 4**). It used two of the new motors, a couple of the TinyESC speed controllers, a 2S LiPo battery, and 1.375" Banebots wheels. It was then weighted up to close to one pound and given some extensive testing.

The motors proved to have more than enough speed, and did not heat up even after three minutes. However, they lacked pushing power. The same motor is also available with 500 RPM at 6V, and I decided that would be ideal. I increased wheel size a little and that resulted in a good balance of speed and power.

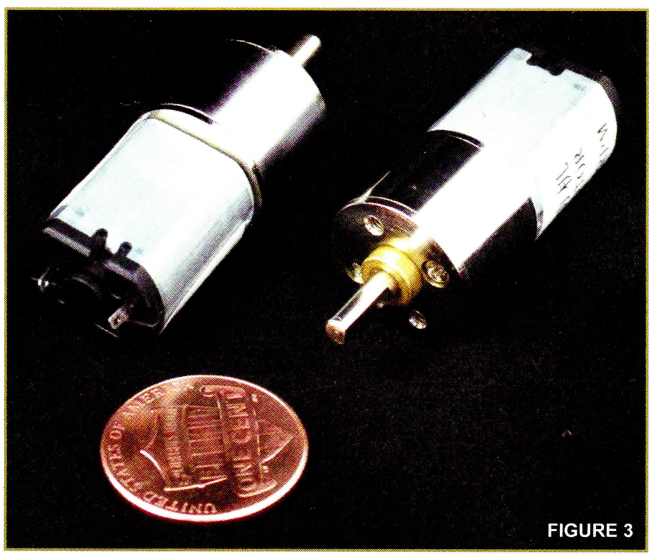
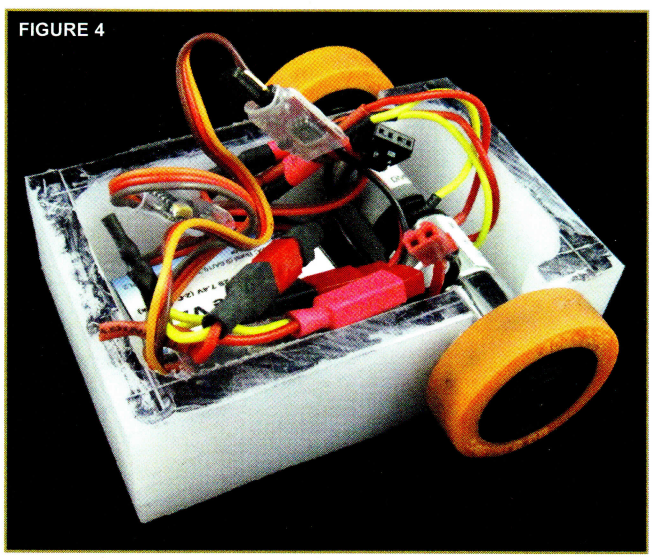


FIGURE 3

FIGURE 4



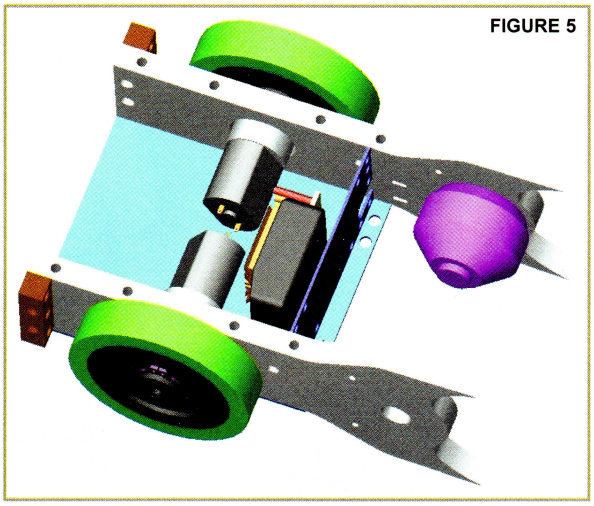


FIGURE 5

This left the problem of how to power the drum. Poco Tambor had been successful for years and its builder, Chuck Butler, kindly showed me how its drum worked. It uses the outrunners 1/8" shaft at one end of the drum and a 1/4" bolt running in a bronze bearing at the other. The 1/8" shaft allowed me to choose a smaller 28 mm diameter outrunner which could fit in a smaller drum. The motor chosen had 1,740 kV which would give a drum RPM of about 12.5K at 7.2V.

The final layout (**Figure 5**) shows the small drive motors, 1.875" Banebots wheels, and the new 28 mm outrunner. Getting the motor into the drum again frees up plenty of space for an 18A reversible speed controller for the weapon.

Part 2 of this series will complete the design process and provide a list of the parts used. SV

EVENT REPORT:

Happy 10th Birthday for Motorama – Motorama 2012

● by Pete Smith

This February 17th–19th, the Northeast Robotics Club (**www.nerc.us**) hosted the 10th annual combat event at the Motorama Motorsports Extravaganza and Custom Car Show (**www.motoramaevents.com**) in Harrisburg, PA.

One hundred robots were entered in a total of seven weight classes from the 250g Fairyweights to the 30 lb Featherweights. Ninety five passed through safety checks and actually competed. This figure was down only slightly from last year, so the sport seems to be weathering the recession reasonably well.

As usual, the two smallest weight classes did battle on the Friday before the main show opened. These weight classes are fun to compete in, but lack the size and action required for a paying audience in a venue on the scale of the size provided by Motorama. The fights for these weight classes are fought in a small 8 x 8 area (which doubles as a very useful test box for the big bots during the main event).

Nine 250g Fairyweights and 20 1 lb Antweights took part.

While this competition took place, NERC members and volunteers assembled the main 16 x 16 arena. The weight limits for robots are decided by the arenas. The big arena's 1/2" of polycarbonate plastic "glass" is only really safe for bots up to the 30 lb Featherweight class.

In the Fairyweights, Kongol with its moving blade arm had a good run while a new bot, Tracked Terror, overcame drumbot Lolcat and then the wedge Baby V to get first place.

The Antweights were hard fought. Wedges Antelope and Kobalos, and full body spinner See You Next Wednesday (**Figure 1**) and bar spinner Vile Ant made it through to the semis, and Vile Ant

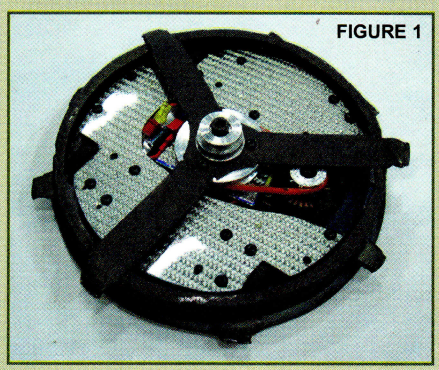


FIGURE 1

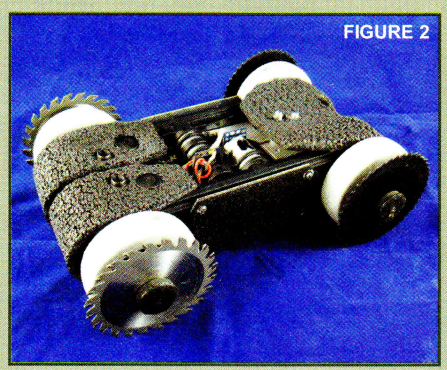


FIGURE 2

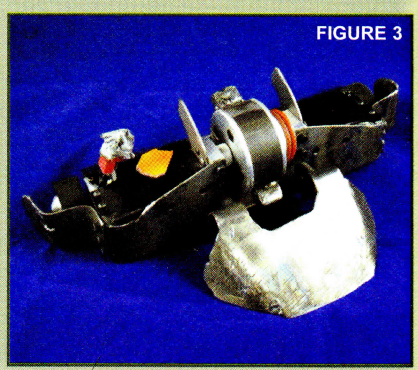


FIGURE 3

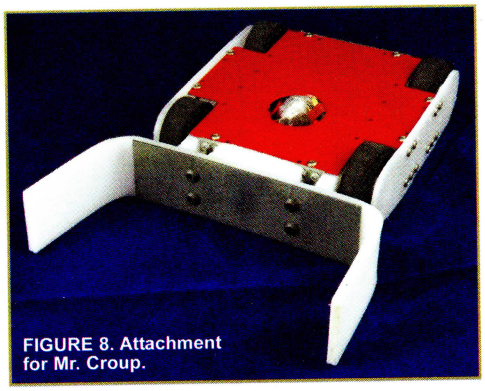


FIGURE 8. Attachment for Mr. Croup.

FIGURE 9. Damage from Ripto.

attachment. A large dustpan type scoop would have been useful to help control an RC toy based bot, Chobham, which defeated Trilobite in a judge's decision. I will also replace the 7075 aluminum in the plain wedge with titanium, since it suffered a lot of damage (**Figure 9**) in its fights against Ripto.

It's not enough to just focus on making your bot. You need to also look at your possible opponents and be ready for when you meet them in the arena. SV

BUILD REPORT:

Siafu: an Army of Ants – Part 2

● by Pete Smith

In Part 1 of this series, I outlined the design process I went through to establish the basic layout of my new drum Ant kit. In Part 2, I will detail the design of the drive motor mounts, the hubs and wheels, the drum and its mountings, and the design of the front wedge profile.

The new motors are similar to the larger ones used in my Weta and Trilobite Beetleweight kits. They have a cylindrical gearbox and a motor no larger in diameter than the gearbox. There are two M2 tapped holes in the front of the gearbox – again similar to the larger motors.

I designed a flat plate that could be mounted onto the front of the motor (**Figure 1**). The first plates I made were 0.030" thick aluminum but while these worked, I found that 2 mm long screws were a little too short and 3 mm ones were a little too long and interfered with the mechanism inside the gearbox. A thicker 0.060" plate allows the 3 mm screws to secure the plate without damaging the internal gears. Four holes sized for #2 screws provide a method to secure the gearbox to its place in the chassis.

In the past, I have used Dave's hubs and Lite Flite wheels (**Figure 2**) in my small bots. These have worked well. They are light and resistant to damage, but I have found that the Loctite® required to secure the outside washer can make it hard to remove, plus access to the motor mounting screws is difficult without removing it. This can be a problem in a competition if a wheel or motor is damaged and needs to be replaced. A different Loctite may help, but I decided to try out another design of the wheel and hub in the Ant.

Banebots (**www.banebots.com**) offers an alternative hub and wheel. The hub is hexagonal (**Figure 3**) and is held to the motor

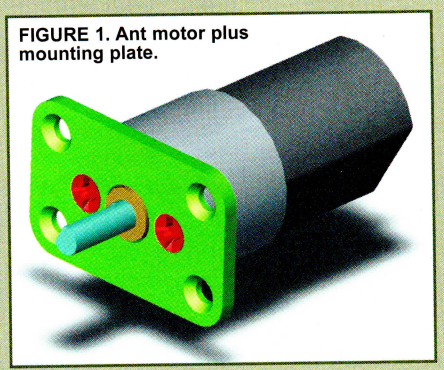


FIGURE 1. Ant motor plus mounting plate.

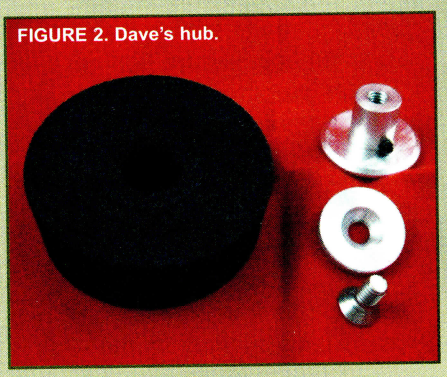


FIGURE 2. Dave's hub.

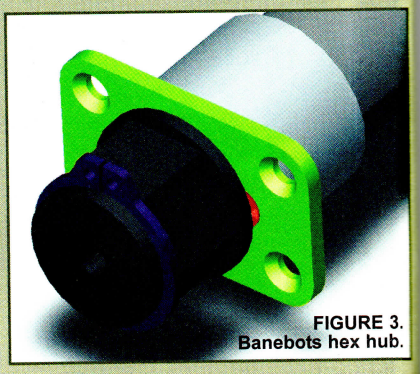


FIGURE 3. Banebots hex hub.

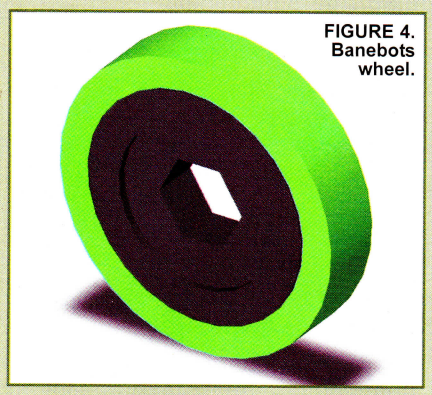


FIGURE 4. Banebots wheel.

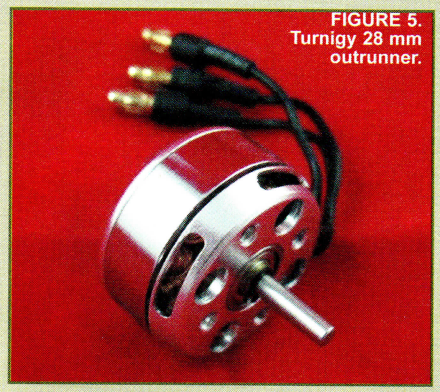


FIGURE 5. Turnigy 28 mm outrunner.

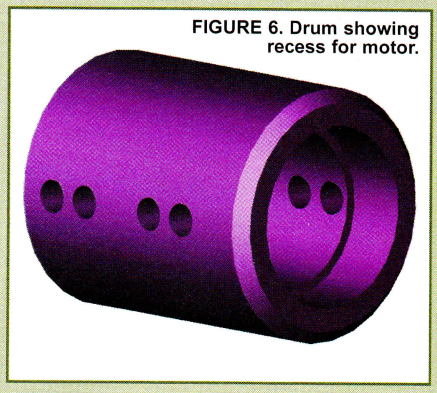


FIGURE 6. Drum showing recess for motor.

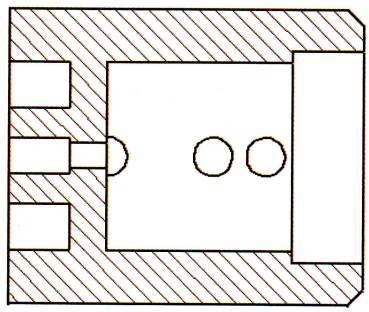


FIGURE 7. Section through drum.

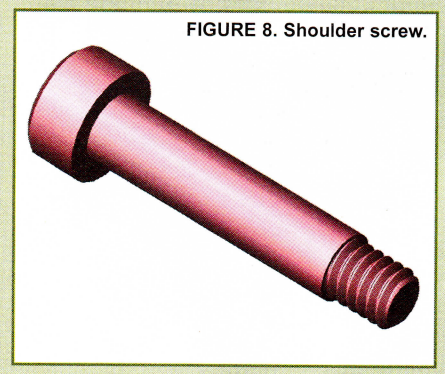


FIGURE 8. Shoulder screw.

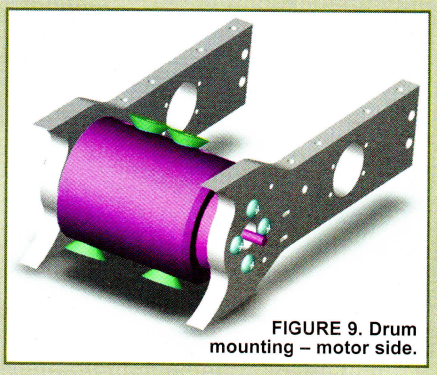


FIGURE 9. Drum mounting – motor side.

shaft with a set screw just as on a Dave's hub. However, the wheel (**Figure 4**) – which has a matching hex – is held with an external retaining clip (circlip) rather than by a washer and screw. By using the Banebots wheel in my design, replacing a failed wheel or drive motor is made simpler since the clip is quickly removed and access is made easier. The design of the bot will also allow the use of the Dave's hubs, so the design is not dependent on a single source.

The weapon motor I plan to use (**Figure 5**) is a Turnigy Aerodrive SK3-2822-1740kv outrunner from **www.hobbyking.com**. The drum will rotate around the motor at one end and on an axle running on a flanged bearing at the other. The drum design (**Figures 6 and 7**) has a recess the diameter of the motor bell at one end, and a bore and thread at the other that is designed to locate and secure a shoulder screw (**Figure 8**). These screws have a hardened and ground shaft which makes an ideal axle.

The bell of the motor will be pressed and glued into one end of the drum, then that end of the drum will be secured to the chassis using four M3 screws put into the motor's front face mounting holes (**Figure 9**). The other end will be secured with the shoulder screw running through a flanged bearing and a couple of nylon washers (**Figure 10**). The wires from the motor will run back along the chassis wall into the inside of the chassis.

The drum will be machined from 7075 aluminum. This grade of Al is very tough but still easy to machine. Two 1/4" flat head screws will be fitted on either side of the drum to act as teeth.

To help the bot deal with wedges and brick bots, I want the chassis to bring other bots up into the spinning teeth on the drum. To do this, I have adopted a chassis profile similar to that used on Team Pneusances Beetleweight Grande Tambor (**www.buildersdb.com/botpics/8203.jpg**). The profile (**Figure 11**) allows the chassis rails to act as wedges even if it is inverted. The points of the wedge are somewhat vulnerable to horizontal blade spinners, but I think for most other fights they will give the bot an advantage.

Part 3 of this series will cover the ordering of parts, and assembly and testing of the first rolling chassis. SV

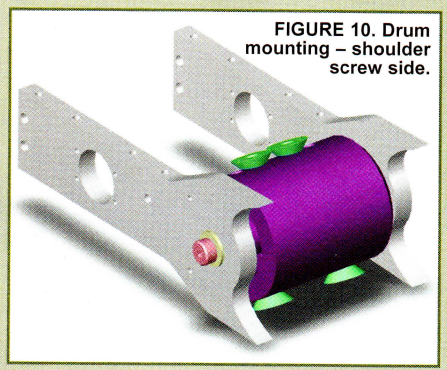


FIGURE 10. Drum mounting – shoulder screw side.

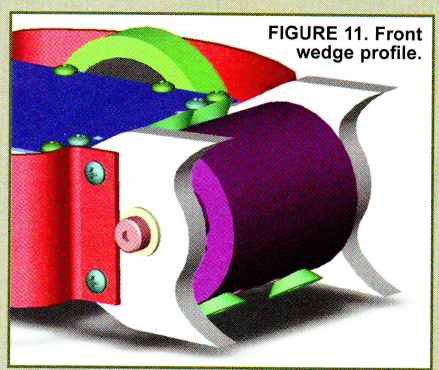


FIGURE 11. Front wedge profile.

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Featured This Month:

BUILD REPORT:

Siafu: An Army of Ants – Part 3

● by Pete Smith

In Part 2 of this series, I completed the design process for my new Antweight drum bot. In this part, I will show how the parts were manufactured, provide a list of the other parts used, and how they went together to make a drivable chassis.

The various body panels were to be water cut. I created a dxf file of each part (**Figure 1**). Remember to remove any features from the model that will not be included in the cut; in my part, that was the holes for mounting the top and bottom panel. I added a 1" square to the drawing so that the manufacturer would know the correct dimensions of the part.

I decided to order 10 of each part since I was pretty confident in the design, and the cost of 10 sets of parts was not that much more than the cost for one or two. The parts were ordered from Westar (**www.westarmfg.com**), the water jet company associated with Team Whyachi.

The parts soon arrived (**Figure 2**). I ordered the required screws from **www.mcmaster.com** and cut the required sections of nutstrip from what I had in stock.

I fitted mounting plates to two of the motors (**Figure 3**). The thicker plate worked well, and standard 3 mm long screws

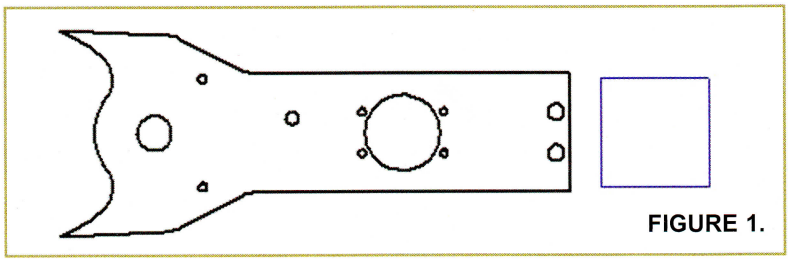

FIGURE 1.

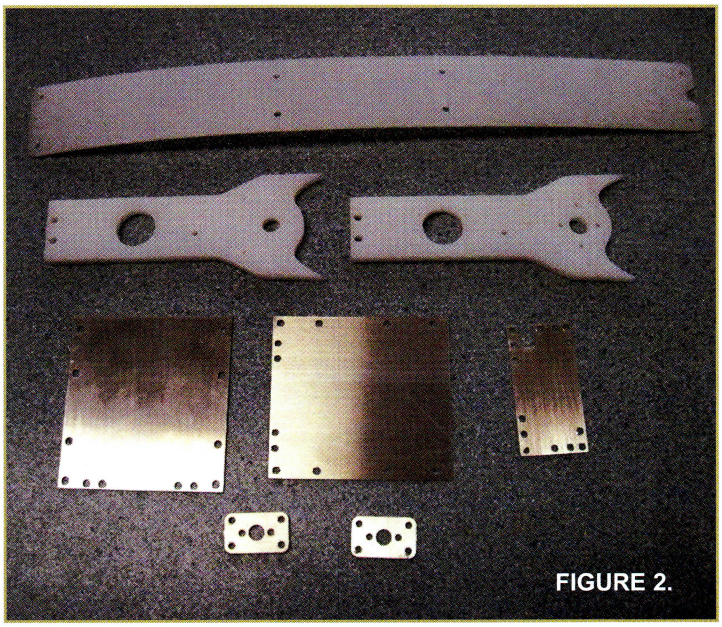

FIGURE 2.

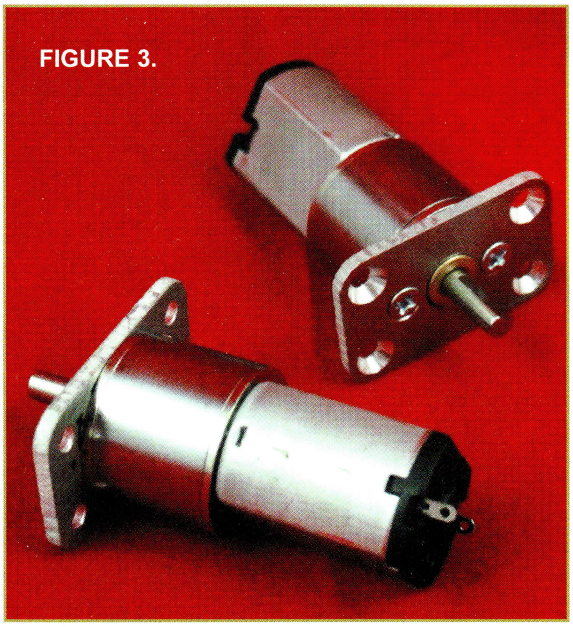

FIGURE 3.

secure the plate without interfering with the gears.

A few holes in the chassis plates were a little too small to clear the 4-40 screws used, but once these were drilled out the chassis came together easily (**Figure 4**). It is as robust as I could have wished for and should prove tough enough for combat.

I had previously purchased most of the other parts I intended to use in the design. This allowed me to create 3D models of the parts and also get accurate weights to put in a spreadsheet to make sure the design did not go overweight.

The weapon speed controller is a Turnigy Trackstar 18A TTS-18A (**Figure 5**); this has excessively long leads and an unnecessary on/off switch. I trimmed the leads, shorted out the switch leads so it is always "on," and replaced the signal leads with those suitable for an Orange Rx 415 micro receiver. This reduced the weight from 0.9 oz to 0.7 oz, and more importantly, made it a lot more compact (**Figure 6**).

This controller is easily programmed using its matching program card, but to date I can only get it to run at 50% when in reverse. I believe this can be manually programmed using the TX and various beeps from the motor, but I've not tried to do that yet. Reverse is useful if the bot gets inverted.

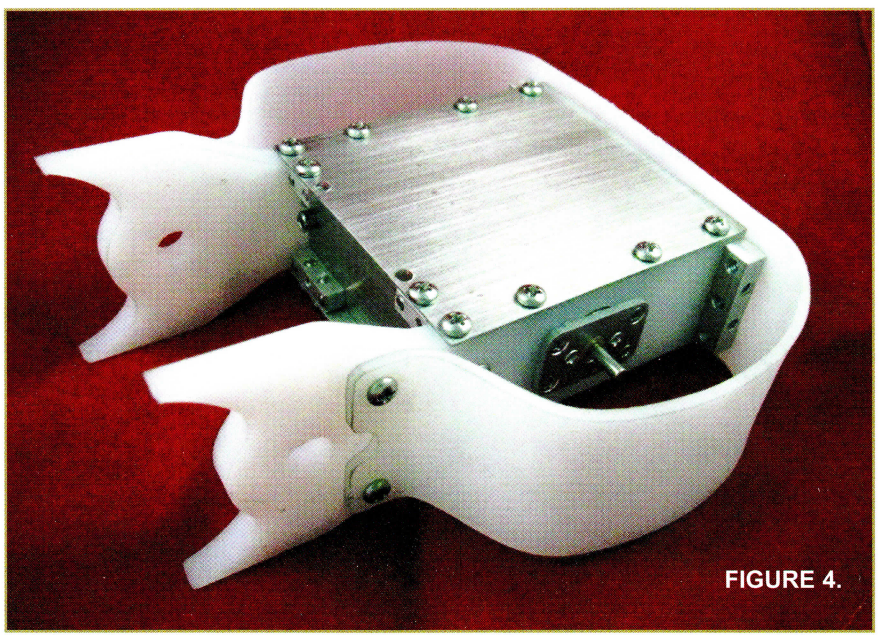

FIGURE 4.

Weta uses a 850 mAH 3S LiPo, so I thought that a Turnigy nano-tech 300 mAH 2S would probably suffice for the Ant, but there will be room and weight for a bigger pack if required.

The drive's ESCs will be either Fingertech (**www.fingertechrobotics.com**) tinyESC v2 or Botbitz (**www.botbitz.com**) ESCheap6 style. Actually, for the prototype it will be one of each because I blew the second of each set by plugging a battery in the wrong way. JST connectors may be polarized, but not well enough to prevent accidental reversal if you are not paying attention. Both were fitted with the signal cables to match the Micro RX and covered in new heat shrink (**Figure 7**). The tinyESC v2 is smaller and lighter and has an excellent reputation, but the ESCheap6 is — as the name suggests — a little cheaper.

I added the drive ESC, RX, and

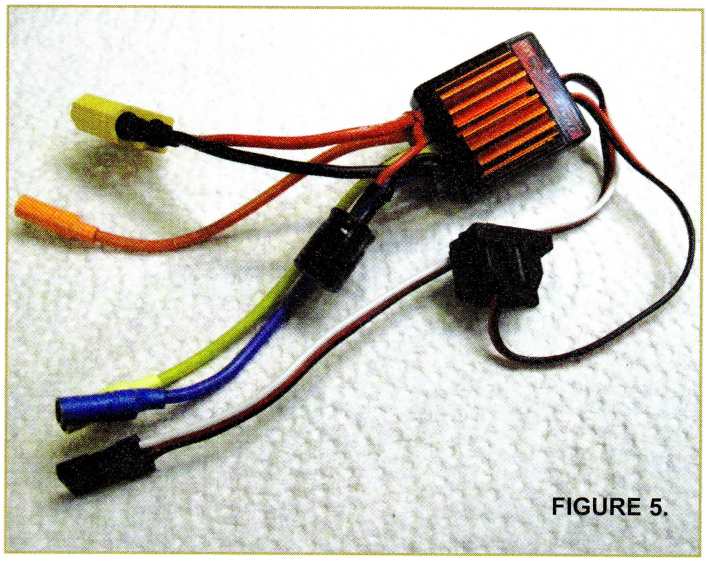

FIGURE 5.

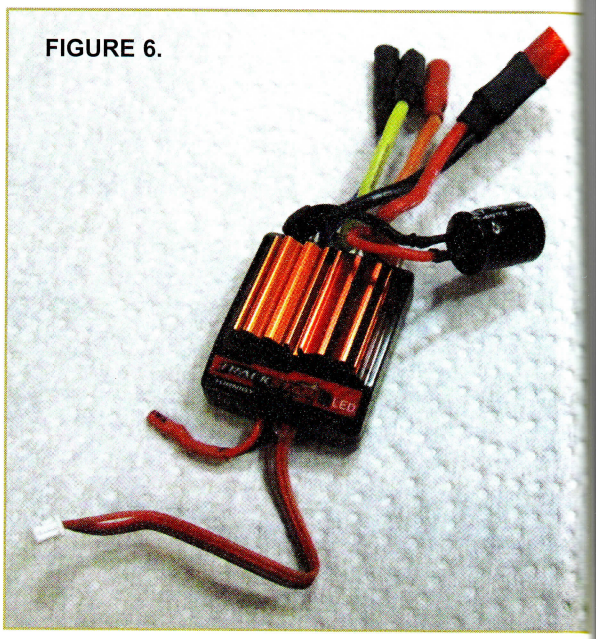

FIGURE 6.

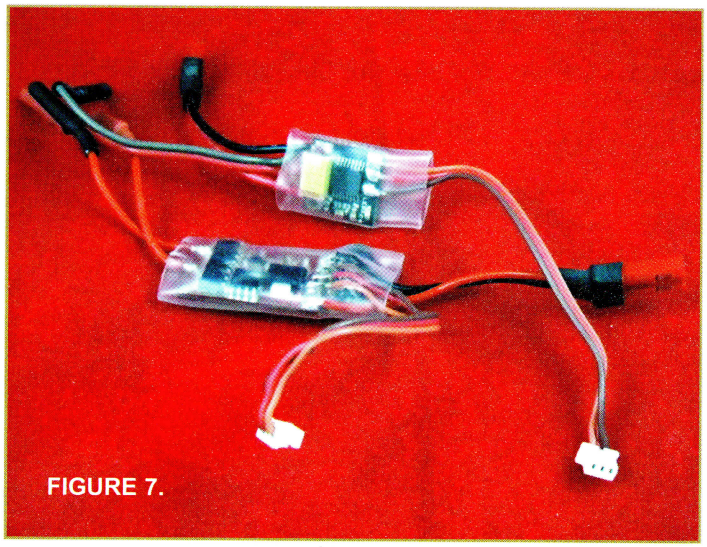

FIGURE 7.

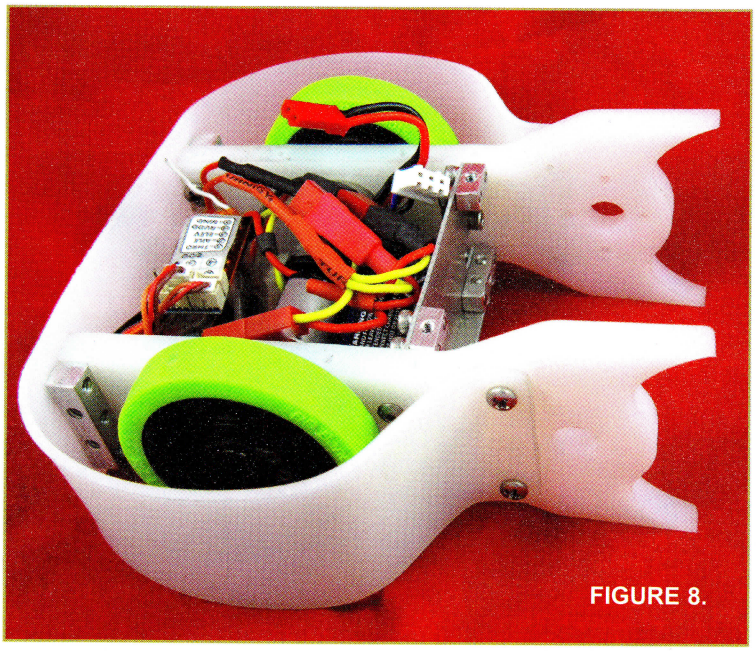

FIGURE 8.

battery to the chassis (**Figure 8**) and gave it its first test run. Performance was as expected and video of the first run can be seen on YouTube by searching "Saifu first run"

Part 4 will describe how I made the drum for the bot, and completed the rest of the build. SV

EVENTS

Recent Events

Winter Challenge 8 was held by RoboCore at the Faculdade de Jaguariúna, Brazil, June 7-10th.

Upcoming Events

Australian Robowars Nationals 2012 will be presented by the Queensland Robotic Sports Club in Brisbane, Queensland, Australia, September 29th through October 1st. SV

COMBAT ZONE

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BUILD REPORT:

Siafu: An Army of Ants – Part 4

● by Pete Smith

In this final part of my Army of Ants series, I will describe how I made the drum for Siafu and completed the rest of the bot build.

The drum is made from 7075 aluminum. It's a very tough but still easily machined alloy and ideal for this application. I started by machining the outer diameter (**Figure 1**), and then used a 1/2" drill and a boring bit (**Figure 2**) to machine out a recess to mount the motor.

When I neared the

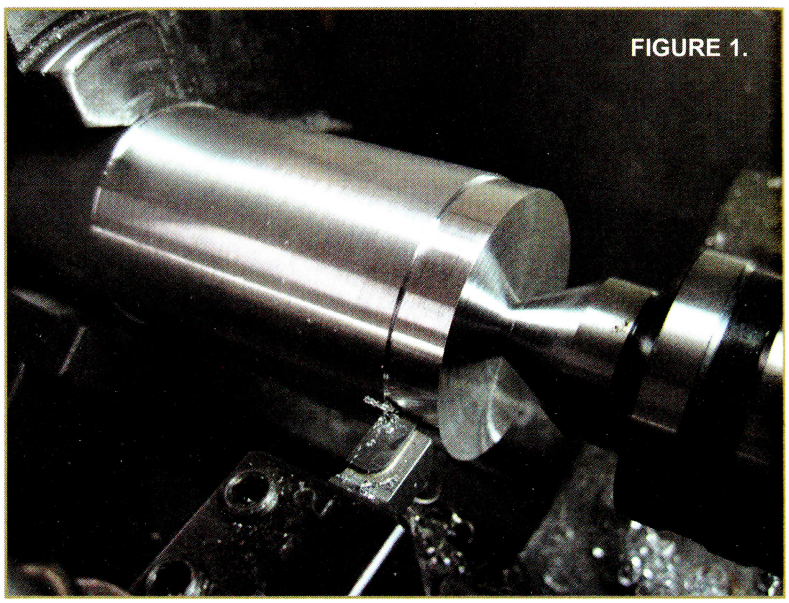

FIGURE 1.

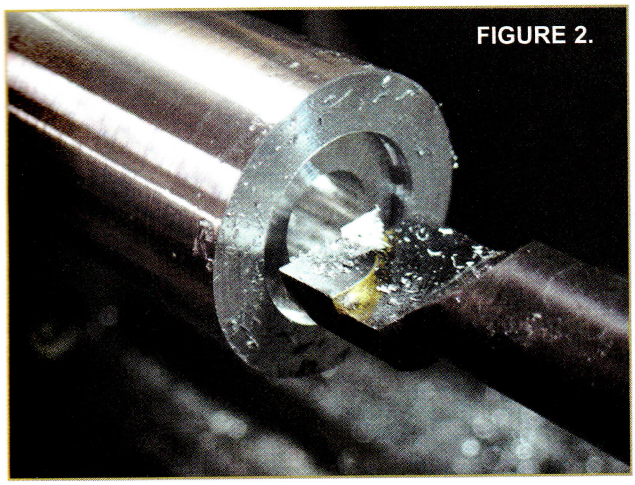
FIGURE 2.

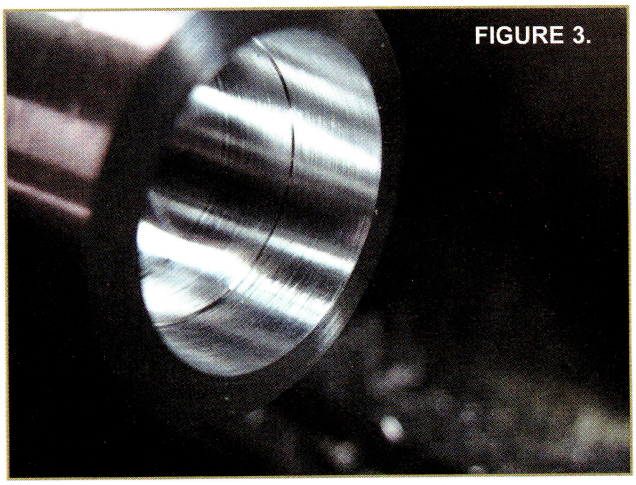
FIGURE 3.

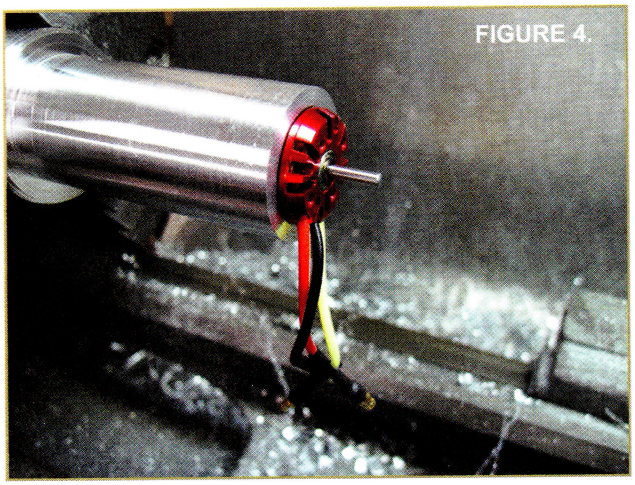
FIGURE 4.

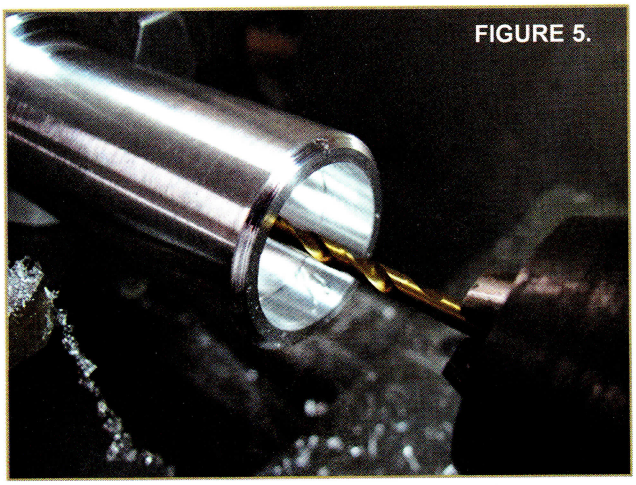
FIGURE 5.

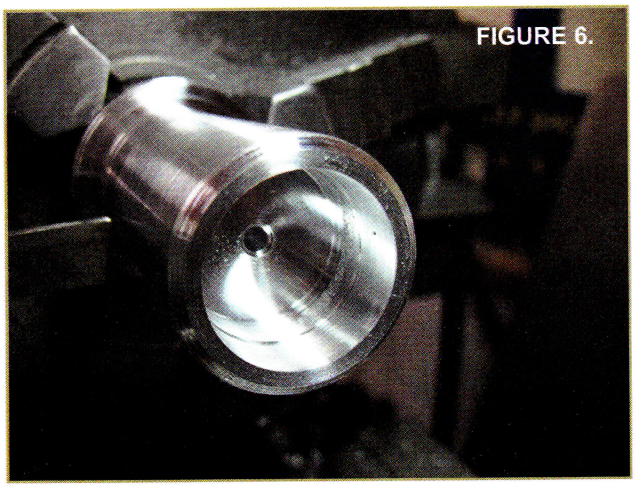
FIGURE 6.

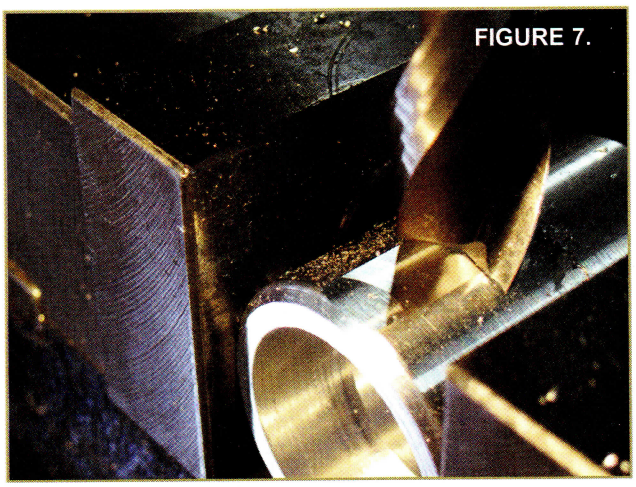
FIGURE 7.

dimension of the motor's diameter, I produced a step in the bore (**Figure 3**) to form a seat for the outer section of the motor. When that section of the bore is a close sliding fit for the motor, the exact depth can be set as in **Figure 4**.

I added a chamfer on the outer edge to ensure it will safely clear the motor's wires, and then center-drilled the hole (**Figures 5** and **6**) for the fixed axle that will protrude from the other side of the drum. I then cut the part off to the correct length.

In order to ensure the tooth mounting holes are opposite each other, I first machined a 0.020" deep flat (**Figure 7**) and then turned the part over so that it rests on that flat. A second 0.020"

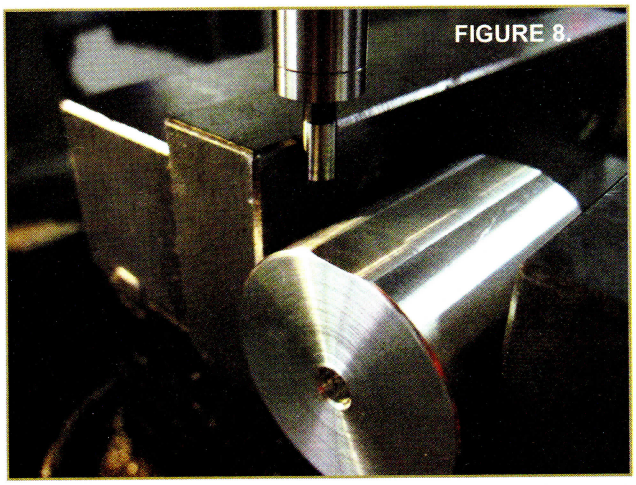
FIGURE 8.

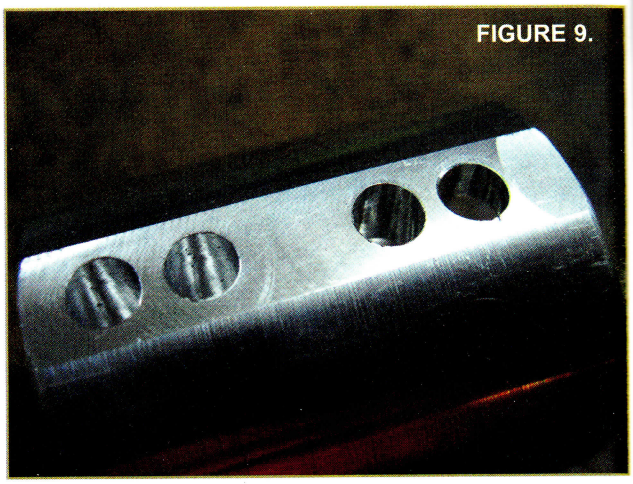
FIGURE 9.

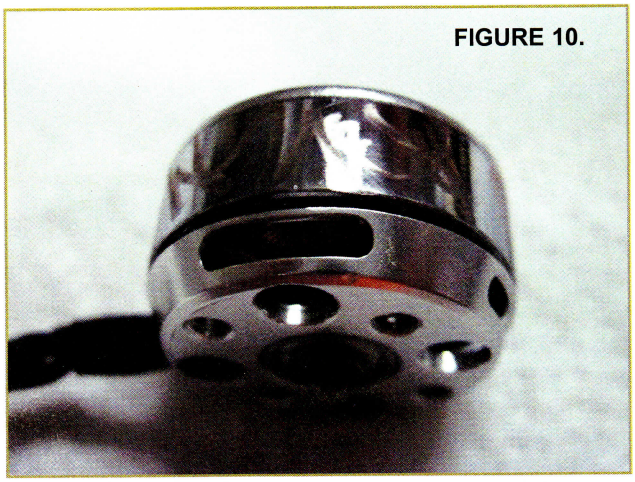
FIGURE 10.

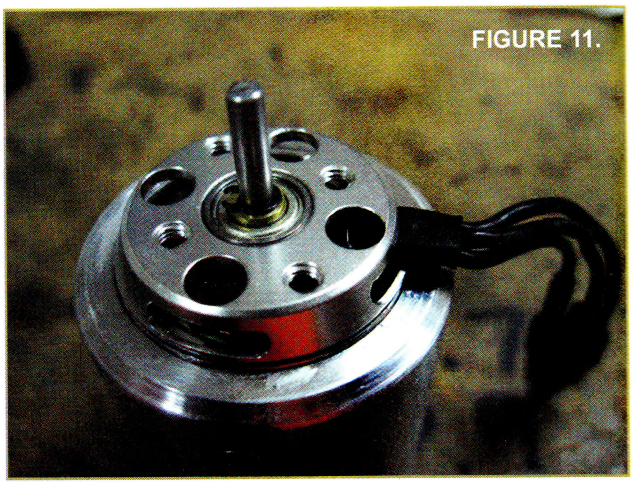
FIGURE 11.

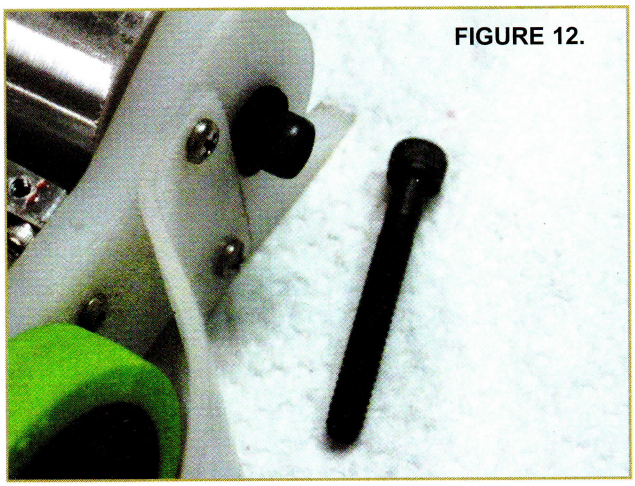
FIGURE 12.

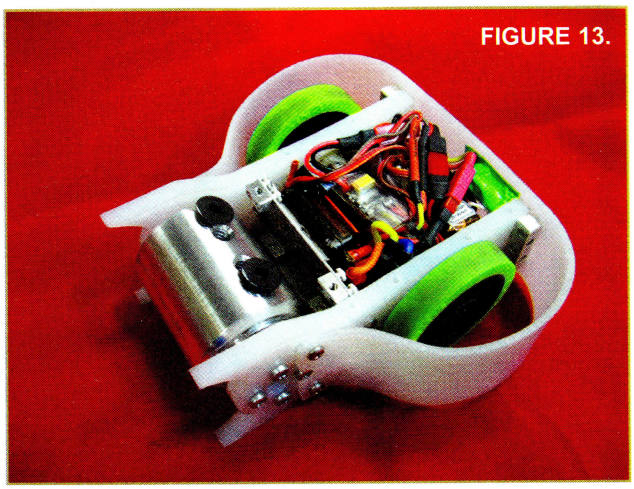
FIGURE 13.

flat is then machined on the opposite side.

An edge finder was used (**Figure 8**) to accurately position the drill for the four holes on each side (**Figure 9**) that will be tapped to mount the teeth.

Once the teeth mounting holes were tapped 1/4-20 (the blind holes require the use of both standard and bottoming taps) and the axle mounting hole tapped with a 10-24 thread, I roughened the surface of the motor (**Figure 10**) with a Dremel, then glued the motor in place using a thin layer of Shoo Goo. I made sure that the motor was sitting squarely on the

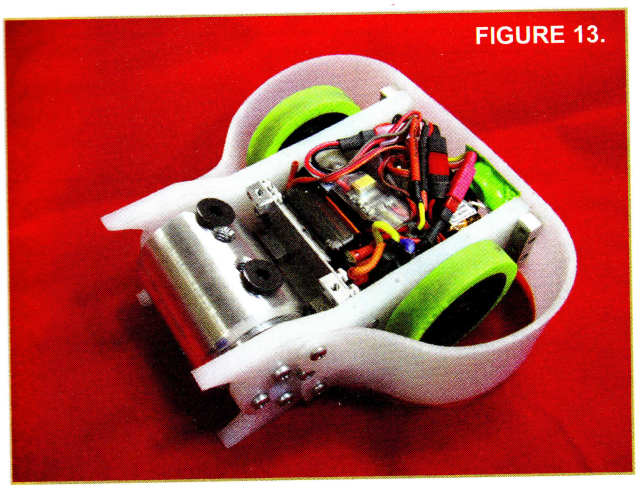
FIGURE 13.

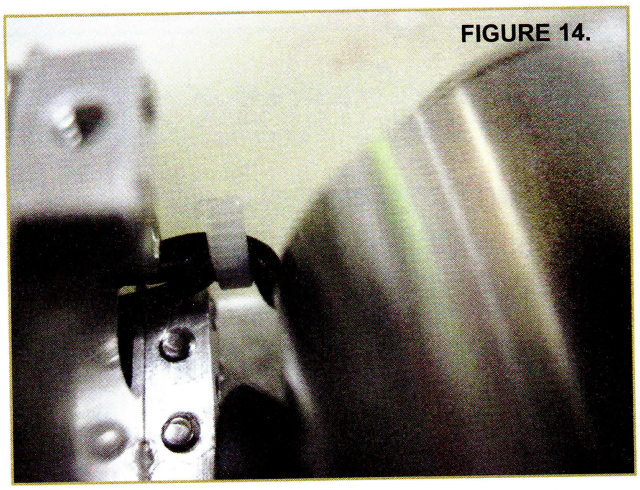
FIGURE 14.

step and then let the glue set (**Figure 11**).

The original intent was to use a shoulder screw as the axle on the other end of drum. However, I made an error in the first drum I built, and drilled and tapped with the wrong thread (10-24 rather than 8-32). I recovered from the error by using a partially threaded 10-24 bolt (**Figure 12**) where the unthreaded section of the bolt is coincidentally the same diameter as the shoulder of the original designed screw. Team Pneusance's Poco Tambor uses a similar solution.

I cut off the excess shaft on the motor, added (use loctite) the 1/4-20 flat head screws as teeth, then fitted the drum and installed the weapon and speed controllers into the chassis (**Figure 13**).

The wiring is a tight fit. The cables for the motor could rub against the drum, so they are held clear by a small tiewrap (**Figure 14**), utilizing slots provided in the chassis wall.

The completed bot and one of its spare drum assemblies can be seen in **Figure 15**. There are some balance issues with the first drum I built, but I hope that those can be resolved with modifications to that drum or one of the others planned as spares. Having fully assembled spare drums is required as replacing a weapon motor during an event would be impractical.

Testing did reveal that the drum can easily run for more than three minutes on the small 2S 300 mAh LiPo battery used. I also plan to try out a 3S battery of a similar size if I can get the drum operating smoothly enough, as the added KE in the weapon and the added speed of the bot could prove useful.

Saifu competed in its first event on July 14th at the Schiele Museum in Gastonia, NC. Also taking part was Klazo, another bot built on the same kit chassis by Mike Jeffries. This could be a great start to a small army of Ants. SV

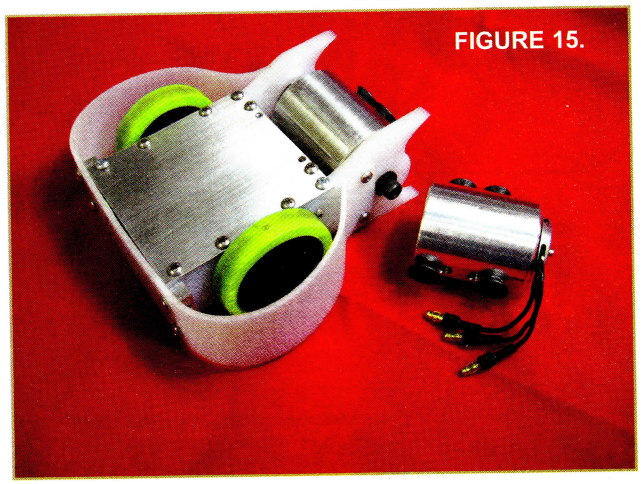
FIGURE 15.

EVENTS

Australian Robowars Nationals 2012 will be presented by the Queensland Robotic Sports Club in Brisbane, Queensland, Australia, September 29th through October 1st. Go to **www.robowars.org/forum**.

Mecha-Mayhem 2012 will be presented by the Chicago Robotic Combat Association in Cleveland, OH on October 13th through October 14th. Go to **www.thecrca.org**. SV