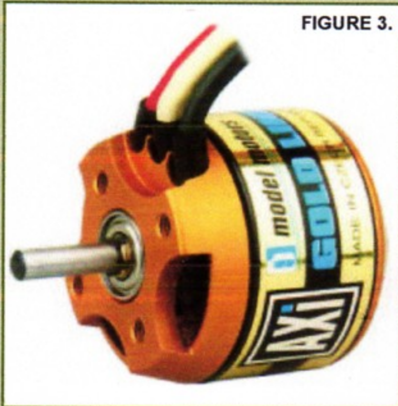


FIGURE 3.

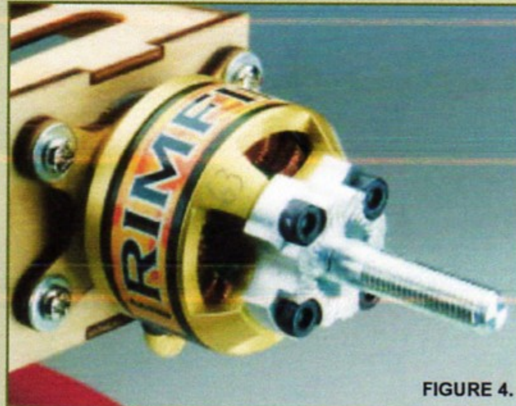


FIGURE 4.

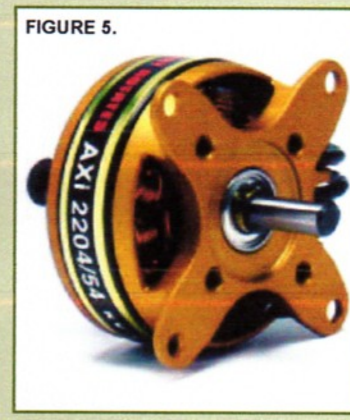


FIGURE 5.

clearance all around an outrunner, to prevent its outer spinning can from touching any structural part of the robot that could be bent during combat.

Popular brushless outrunners are the ones from Turnigy and the more expensive ones from the famous Czech Republic company AXi, pictured in **Figure 3**. We've also tested very good outrunners from E-Flite (such as E-Flite's Park 250) and Little Screamers (such as the "De Novo" model).

One important thing about outrunners is that they should be mounted "behind the firewall" for combat applications. Firewall is the flat panel, cross-shaped mount, or standoff at the front of a model airplane where the motor is attached to. Supporting the motor in front of the firewall (as shown in **Figure 4**) is a good idea in model airplanes to help the motor cool down with the aid of the propeller air flow. The motor shaft mostly sees axial loads in this case.

Pulleys used to power robot weapons put large bending forces on the motor shaft. So, for combat applications it is important to support the motor by mounting it as close to the output shaft as possible, behind the firewall, as shown in **Figure 5**.

To mount outrunner motors behind the firewall, you might need to reverse the position of the output shaft for it to stick out from the face where the firewall is attached to. This can be done through the repositioning of the shaft retaining clips or screws.

Since most brushless speed controllers do not allow the motor to reverse its spin direction during combat, the use of brushless motors in combots is usually restricted to weapons that only spin in one direction. Reversible brushless speed controllers will soon become cheap and small enough to allow their widespread use in the robot drive system, as well.

More information on brushless motors can be found in the wikipedia link at **http://en.wikipedia.org/wiki/Brushless_DC_motor**. SV

MANUFACTURING: Hobbyweight Weapon Blade and Hub

● by Pete Smith

I needed a new blade for my 12 lb Hobbyweight combat robot Surgical Strike — an existing titanium blade with steel teeth was becoming increasing bent and if it lost a tooth in a fight, then it became so unbalanced as to be useless. I had the idea of combining an easy to manufacture 7075 aluminum hub with a watercut steel blade (**Figure 1**).

The hub has an accurately bored center that allows the use of a heavy duty keyless bushing (McMaster part 1058K13) and a 5/8" case hardened steel shaft (McMaster part 6061K111). A center boss locates the blade and takes much of the stress of any hits, and six 1/4-20 hex head screws attach the two parts together.

The blade is 14" long, 1.5" wide, and 1/4" thick. I had it cut from 4140 ChromeMoly steel and hardened to RC45 by Team Whyachi (**www.teamwhyachi.com**).

I had them make a pair; the cost was less than $150 each. If you wish

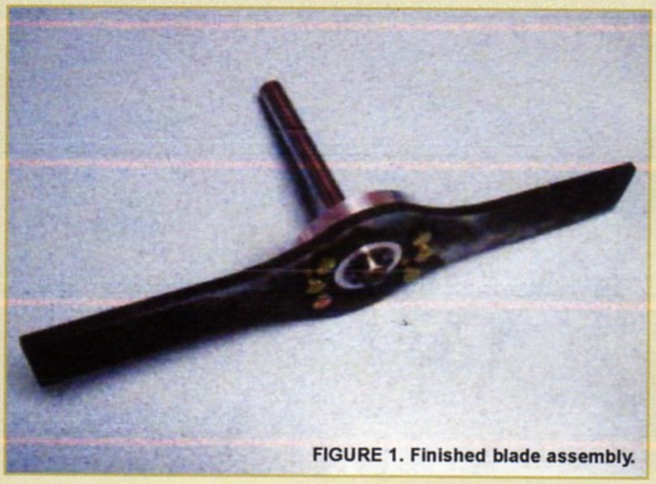


FIGURE 1. Finished blade assembly.

FIGURE 2. Face and turn to major diameter.

to make the blade yourself or have one made for you, then PDF, IGS, and DXF files are available in the article download on the *SERVO Magazine* website or through the Kitbots' website (**www.kitbots.com**).

The hub is fairly easy to make on any lathe capable of taking a 3.5" diameter workpiece.

Drawings and an IGS file for the hub are also available in the downloads.

Safety Warning: Lathes are not toys and can easily injure or kill if used incorrectly. Read and follow all the manufacturer's safety notes. Do not wear loose clothing or jewelry, and always wear safety glasses.

I secured the 3.5" diameter bar in the three jaw chuck, faced off the end, and turned the exterior down to the required 3.25" (**Figure 2**). I was making two hubs, so I turned down a long enough section to allow for the two hubs plus the two cutoffs required to separate the parts from the original bar. I used 7075 aluminum as it is one of the toughest grades available, yet still machines easily.

The boss for the blade was turned down to the correct diameter (**Figure 3**) and I test-fitted the blade to the hub to check that it was a precision fit (**Figure 4**). If the fit is too loose, it will allow the blade to become unbalanced and also adds a lot more strain on the securing screws.

The next operation required the most accuracy. The bore for the keyless bushing has the tightest tolerance; this is required to ensure that the bushing grips the hub correctly. I first center-drilled (**Figure 5**), then drilled the part (**Figure 6**) with the biggest drill bit I had. I then used a boring bit (**Figure 7**) to increase the diameter to the required dimension. This requires patience (not really my forte) and frequent measuring. I bored the hole deep enough to allow for two hubs and the required cutoffs.

I then cut off the first hub and repeated the boss machining operation to make a second hub and cut that off, as well.

I used the blade as a pattern for positioning the mounting holes in the hub. I positioned the blade on the hub and used an appropriately sized transfer punch to locate one of the holes. I then drilled and tapped that hole and then repeated the operation for the remaining holes, adding each mounting screw in turn

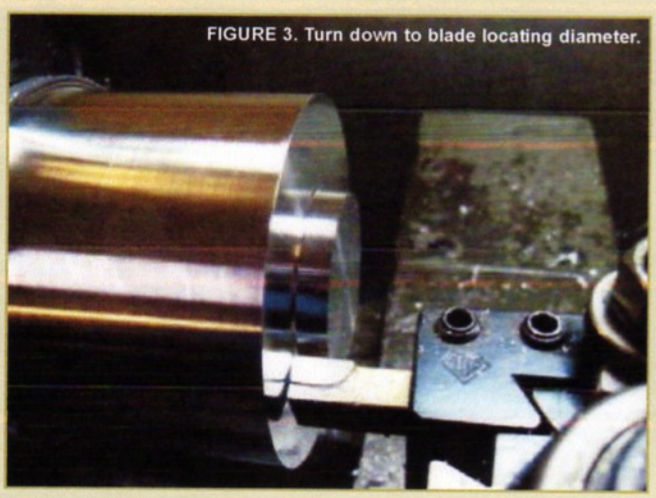


FIGURE 3. Turn down to blade locating diameter.

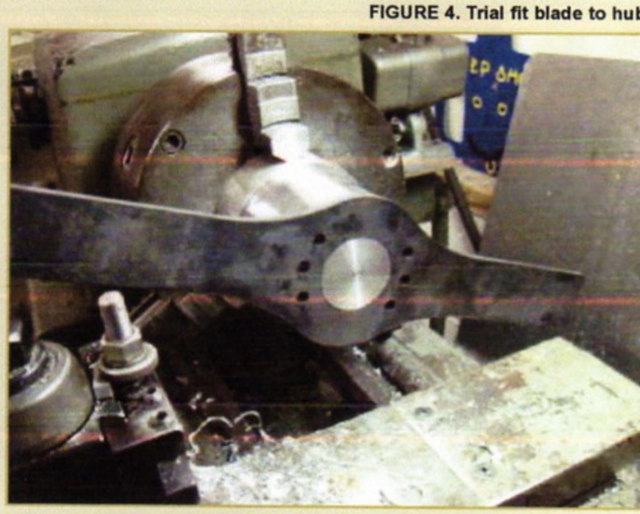


FIGURE 4. Trial fit blade to hub.

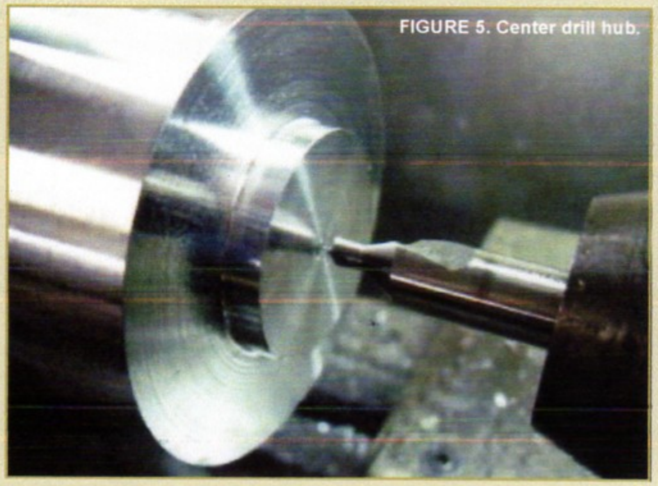


FIGURE 5. Center drill hub.

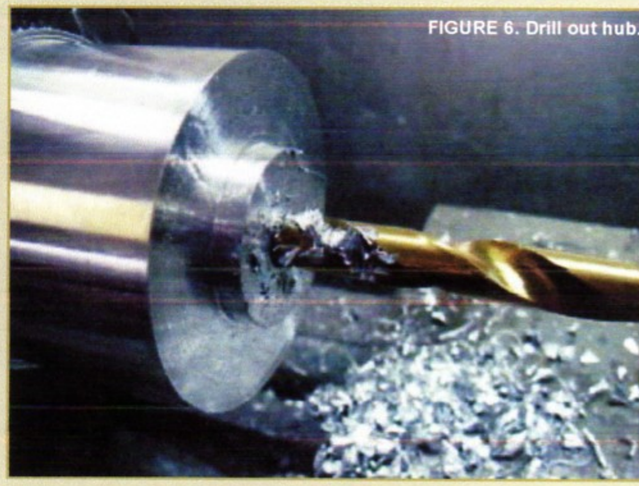


FIGURE 6. Drill out hub.

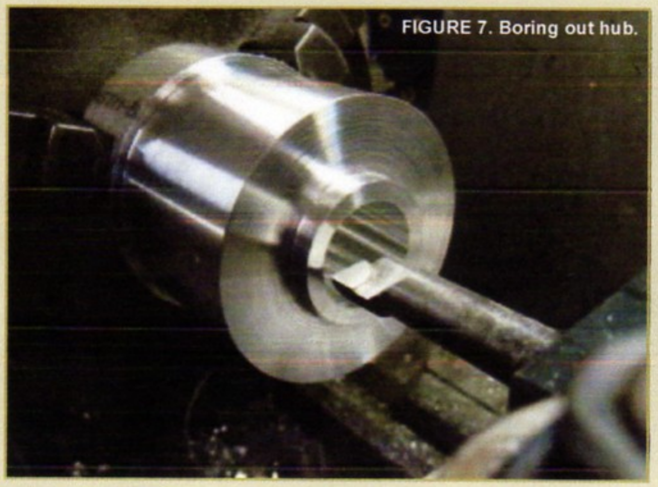


FIGURE 7. Boring out hub.

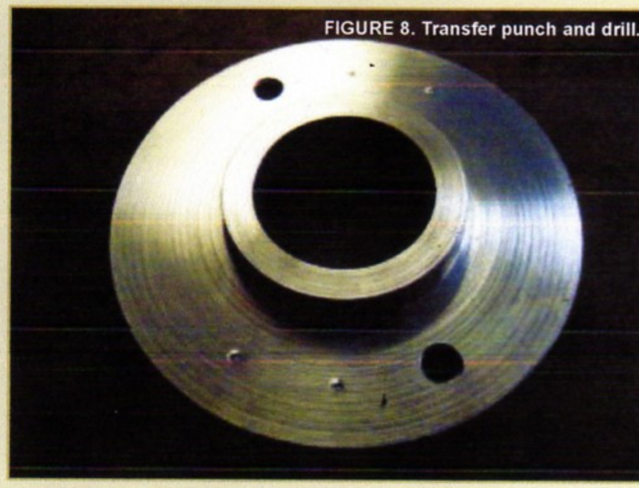


FIGURE 8. Transfer punch and drill.

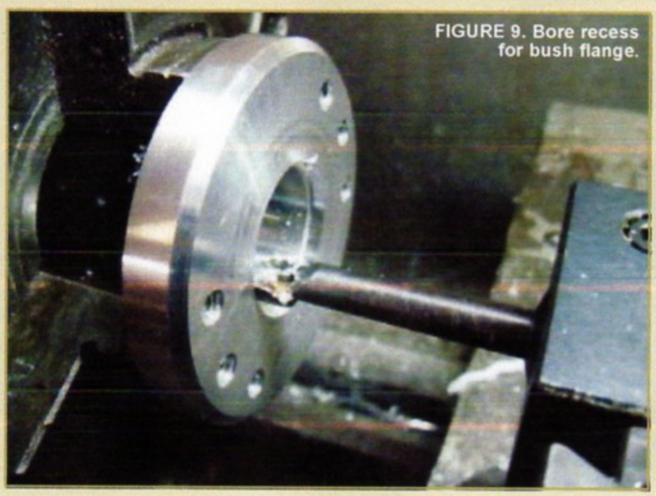


FIGURE 9. Bore recess for bush flange.

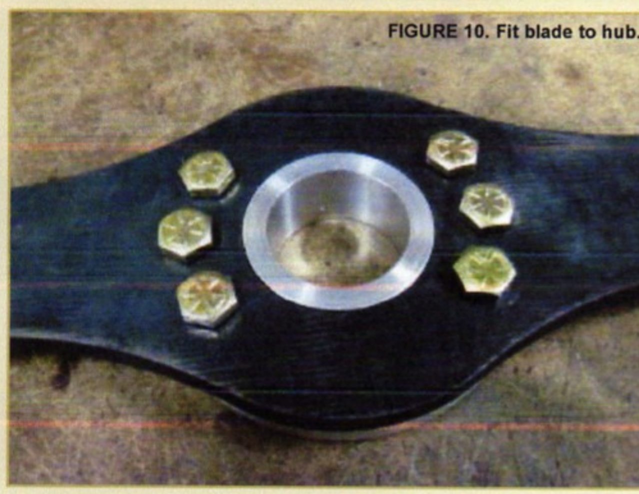


FIGURE 10. Fit blade to hub.

(**Figure 8**). This ensured that they all lined up correctly. One could use a rotary table or indexer to locate the holes, but the above method worked well enough for the small number of parts I was making.

The last machining operations were on the top side of the part. A recess was added to allow the flange of the bushing to sit flush with the top surface (this protects the expensive bushing and shortens the overall length of the assembly). This was done using the boring bar and is a simple clearance fit (**Figure 9**). I also added a small chamfer on the top outside edge to improve appearance and lose a little weight. It should be noted that neither of these operations required great accuracy or exact concentricity with the rest of the part. A three jaw chuck will produce very accurate work as long as the part is not taken out of the chuck between operations. The part is remounted in the chuck using the blade boss for these topside operations, so strict accuracy is not maintained. If you do need high accuracy and have to move the part between operations, then a four jaw chuck and careful setup is required.

I fitted the blade to the hub using Grade 8 hex head screws (**Figure 10**). The hex heads are a little more likely to get damaged in combat, but will be much easier to replace if they do as you can usually get a pair of Vise-Grip pliers to get a solid grip on even a badly damaged head. Socket head screws often have the hex sockets damaged and can be a pain to get out in a hurry.

The new blade and boss were tested at the Franklin Museum event in Oct '10 and proved to work well. I would get the next set of blades a little harder perhaps, but it's always a balancing act between being too hard and breaking, and too soft and bending/blunting. I might also try a longer and thinner blade to give a little extra reach. SV

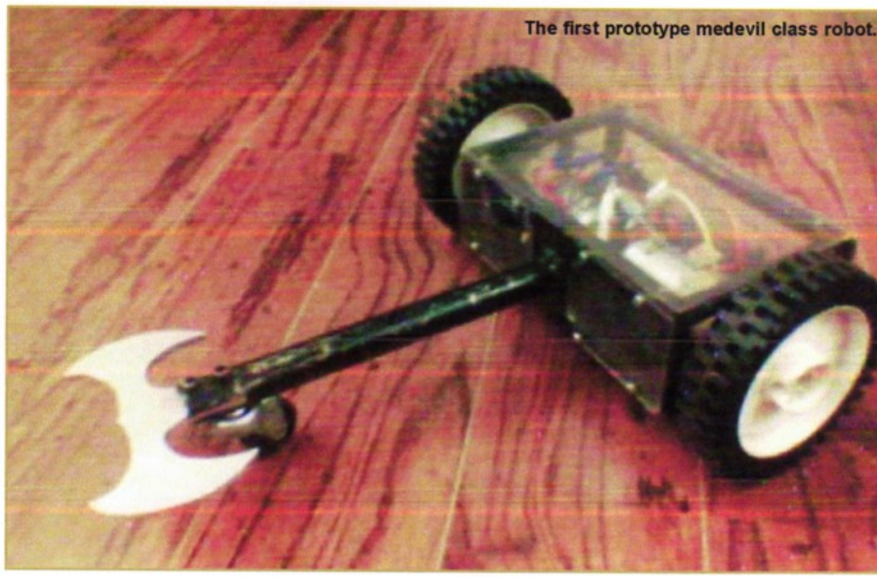
PARTS IS PARTS: Mtroniks Viper

● by James Baker

The Mtroniks Viper series of boat speed controllers have been used in many of my robots in the past. Made in Great Britain, these controllers offer full forward and reverse functions, one touch calibration, and advanced failsafe functions. They also have a built-in battery elimination circuit and motor stall protection.

There are a lot of speed controllers available for sub-featherweight robots (under 30 lbs) from lots of different manufacturers, and all have their advantages and disadvantages. For one specific application, I consider the Mtroniks Viper to be unrivaled. One of the areas of robot combat I am involved in is providing the opportunity for the paying public to come and drive identical robots in combat against each other. This "arrive and drive" attraction features robots specifically designed to fight only each other, in a quick assembly combat arena. This controlled combat format allows the robots to be optimized for long run times, quick battery changes, exciting battles, and reliable operation in any kind of weather. Yes, you read that right, these robots often run in the rain.

My smallest arrive and drive robots weigh under two lbs and use a pair of Viper15 speed controllers



The first prototype medevil class robot.

(which are 100% waterproof) coupled with silicone covered motors, and a single sealed 7.2 volt 3,000 mAh NiMH battery. The 15 amps rating of these controllers is more than enough to run these fast little machines without ever breaking a sweat — even in heavy rain. I have actually given demonstrations to potential customers where I have run one of these robots in a bath full of water. These robots actually float, but do regularly submerge completely when they crash into other objects. This rather extreme demonstration serves

Medevil in 2009, still with original controllers.