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JULY 2008

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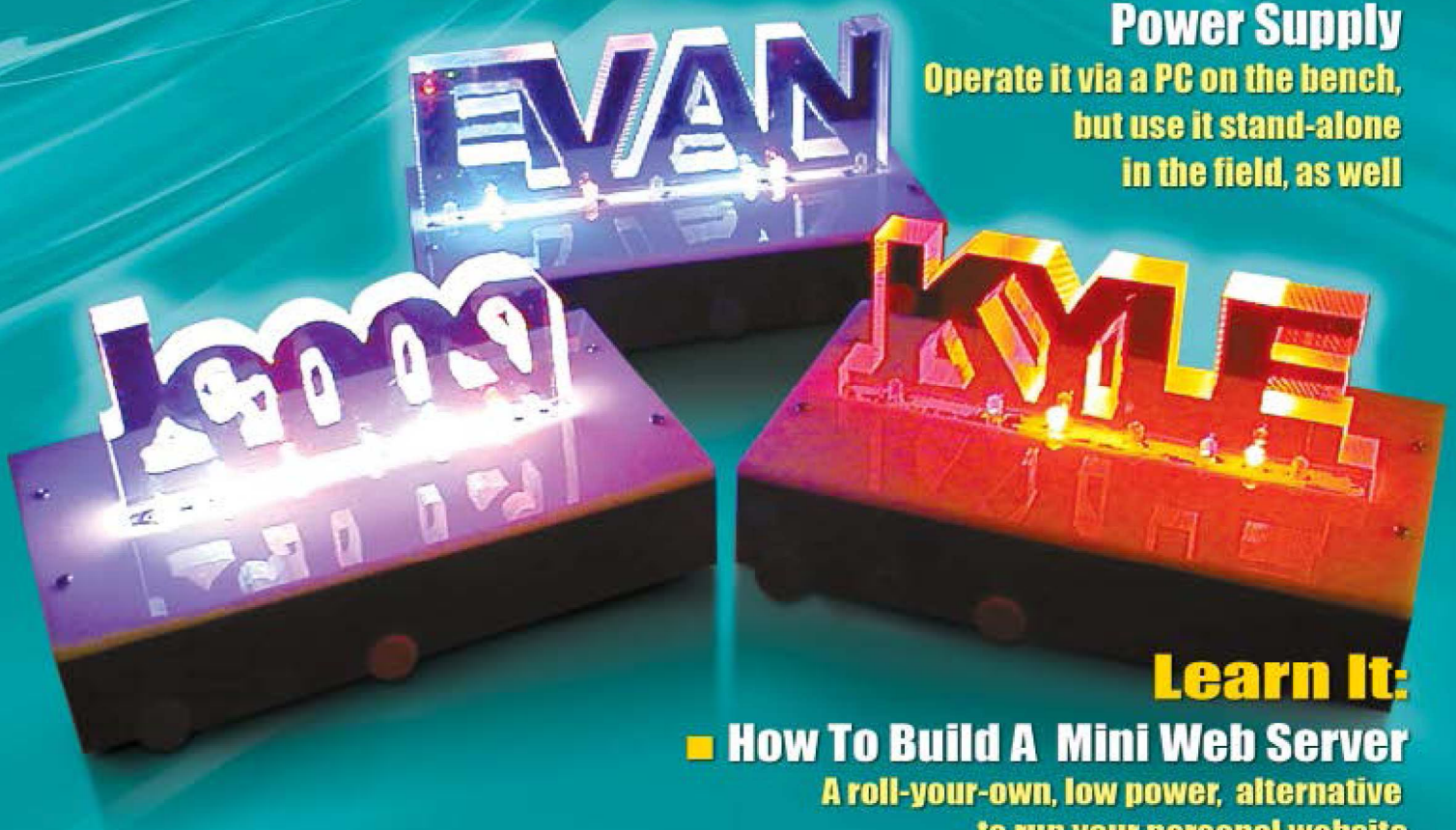

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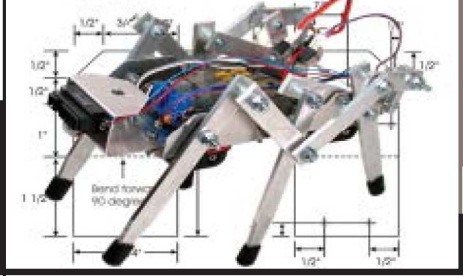


■ BY VERN GRANER

POWER FLOWERS

Last month, I presented the workbenches of the rich (or not) and famous (or not) and recounted their tips, tricks, and general advice for creating a suitable hobbyist workbench. I also introduced the *Workbench Design Challenge* contest with some really great prizes contributed by Parallax. In case you missed it, check the Workbench Design Challenge details and official contest rules on the *Nuts & Volts* web forum (see Resources)

As I am still in the process of summarizing the great feedback I received from folks about the Habitat article, I'm not quite ready to publish Habitat for Hobbies Part 2. Instead, I've decided to take a different approach this month and present a simple robotic project that should be within the grasp of most electronic hobbyists. The idea is to create some neat moving effects using a single servo motor and something many of us have lurking in a cabinet in the kitchen.

ORGANIC ROBOTICS?

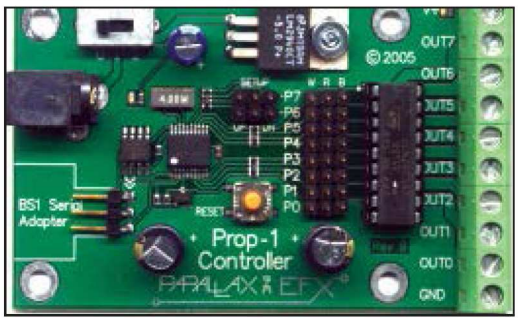
One evening after dinner at "Casa Graner," I was sketching some designs in a notebook while my wife Kym was bustling around the kitchen. I was bouncing some ideas off of her when she mentioned that most of the things I had been designing were very industrial-looking. She encouraged me to try and find something more organic to create or simulate. As I continued to sketch up some ideas for animatronic sculptures, she reached into the dishwasher and retrieved a vegetable steamer. As she flipped it from open to shut while preparing to put it away, inspiration struck. I asked her if I could borrow the steamer for a moment and I went upstairs to my workbench. It took about an hour, but when I was done I had cut a servo-sized hole in the bottom of the thing, added a servo, and some rudimentary connecting rods to the "petals" of the steamer. The Power Flower was born!

POWER FLOWER — ACTIVATE!

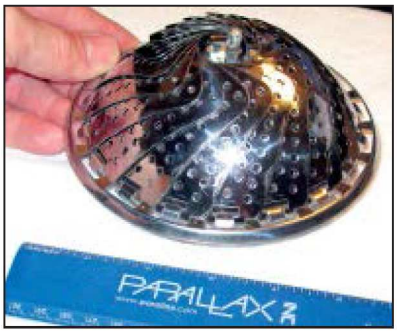
I brought the device downstairs and showed my wife how I could cause the flower to open and close in a very familiar organic way just by moving one servo. The thing really did look like a metal flower opening its petals to the sun. My wife was very impressed with the result and then, noticing the large servo-sized hole in the steamer, told me to hold on a second while she wrote "pick up four vegetable steamers" on the shopping list. Oops.

As I discovered, the Power

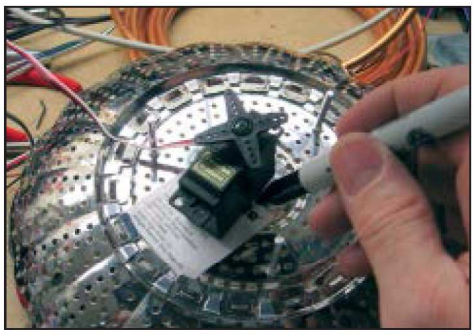
■ FIGURE 1. EFX-TEK Prop-1 microcontroller board.



■ FIGURE 2. Vegetable steamer.

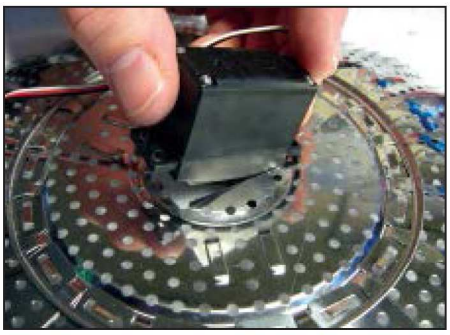


■ FIGURE 3. Open the steamer on your workbench.



■ FIGURE 4. Center the servo motor horn and draw an outline around the servo.

■ FIGURE 5. Cut along the lines.



■ FIGURE 6. Test to make sure the servo fits properly.

Flower is surprisingly simple to make but, when completed, looks very complex and exciting. By mixing in a microcontroller and a few simple sensors, you can make your Power Flower react to light or sound. Add a few LEDs and you can have it blink or fade colorful lights. The resulting project is relatively inexpensive (costing on the order of less than $20 per flower, depending on what you have laying about), yet can be made active and even interactive with just a little bit of effort. Better yet, all the software to get started is available from the *Nuts & Volts* website (**www.nutsvolts.com**) with this article. The software will allow you to make your flower (or flowers) move using an inexpensive EFX-TEK Prop-1 controller (Figure 1) and will help you get started controlling your very own garden of Power Flowers! All we have to do is gather a few parts and get to building.

THE PARTS

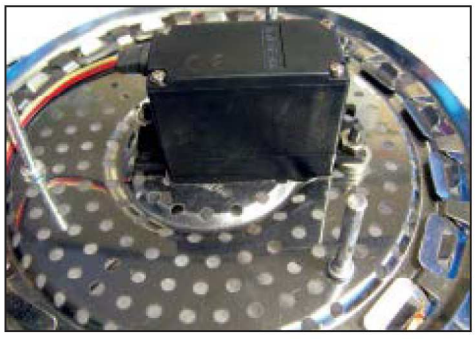
We'll begin with the basic parts you will need to create the flower (an itemized list of the parts, sources, and part numbers are located in the sidebar). First, you'll need a vegetable steamer such as the one shown in Figure 2. I have found these steamers in the kitchen utensil isles of the grocery store. They are usually available in multiple sizes. I suggest you use a smaller 6" sized one for your first version of the flower as there are fewer "petals" to push around so your servo strength will not be as important.

Next, you will need a servo motor. Most any servo you have handy will do. In my first flower, I used the Futaba 3003, but in later flowers I used the Parallax Servo that comes bundled with the "what's a microcontroller" kit. You will need the quad-point horn in order to attach the four push-rods to the petals. Though the first prototype of the flower I created used some stiff piano wire as push rods, I found that a model airplane steel clevis, a bit of 2-56 threaded rod, and some ball links worked much better. The ones I used are shown in Figure 8.

PREPARING THE "PETALS"

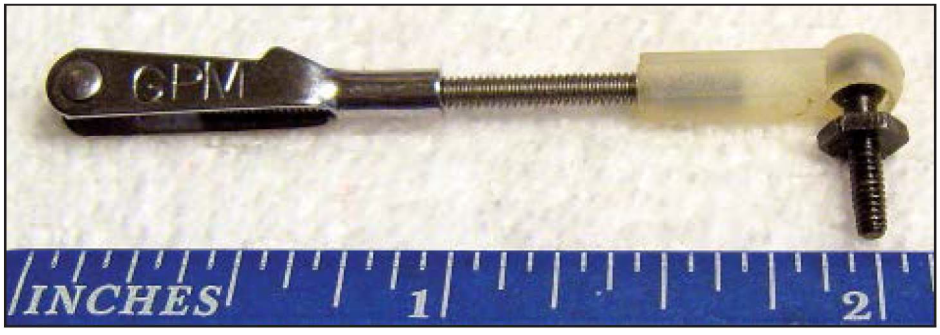
The steamers, when new, tend to be somewhat stiff to operate. In fact, a brand new steamer will sometimes require more torque to open and close than a relatively low-torque servo can provide. The solution is to either 1) reduce the friction of the steamer, or 2) buy a higher torque

■ FIGURE 7. Drill holes and use screws to mount the servo to the back side of the steamer.

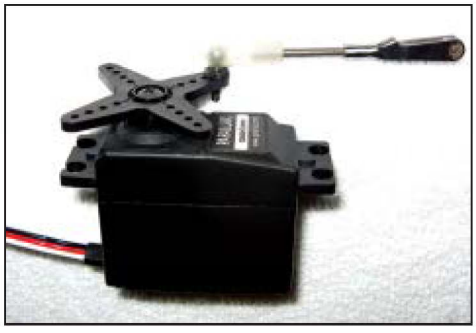


■ FIGURE 8. Model airplane clevis and ball links.

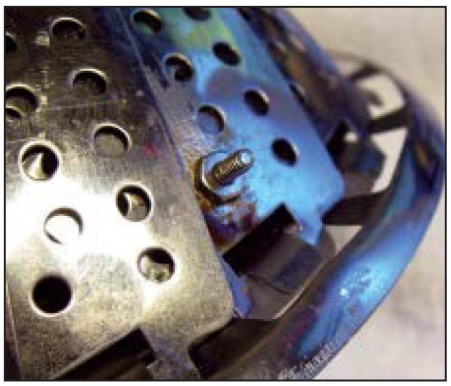
■ FIGURE 9. Cut approximately 1.75" of 2-56 threaded rod and attach the clevis and ball links.



■ FIGURE 10. Attach the ball link to the servo horn.



■ FIGURE 11. Solder one of the washers (included in the ball links package) into the slot of a small machine screw.



■ FIGURE 12. Insert the washer/screw combo into one of the holes on a petal (as shown) and tighten a nut on the outside of the petal.

■ FIGURE 13. Attach the clevis to the washer/screw combo to anchor the rod to the petal.

servo. I chose to simply reduce the friction of the steamer. To do this, I went around the edge of the steamer base and slightly loosened each of the metal tabs that hold the petal to the center. Next, I would slightly bend each of the petals so they wouldn't rub against each other quite so hard. Lastly, I added a dab of light machine oil to each of the metal tabs that held each petal to allow them to move more easily. When you are done tweaking, you should be able to flop the steamer from open to fully closed without it binding in any position. This can be tricky and might take a bit of patience, but once you have it, the petals should open and close with just gravity as you flip the steamer from upright to inverted. Once you've prepared the steamer, it's time to start construction.

ASSEMBLY

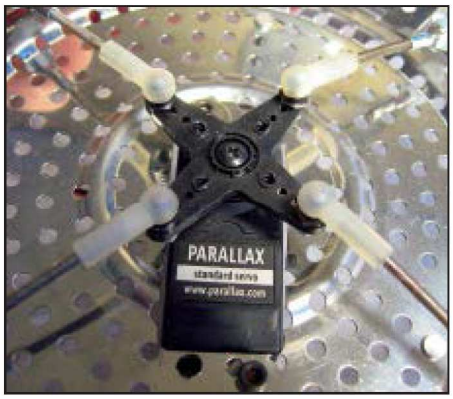
To make your first flower, start by opening the steamer on your workbench (Figure 3). Place the servo motor so that the motor shaft is as close to center as you can make it, then trace the outline of the motor on the metal using an indelible marker (Figure 4). Once you have the tracing, use a tool with a cutting blade to cut the rectangle of metal from the center of the steamer (Figure 5). Note: Remember to wear ear protection as doing this tends to be rather loud!

Once you have the hole in the steamer, test fit the servo and make sure it drops into place (Figure 6). Once you have it in place, mark the four mounting holes, then drill at least two holes to mount the servo (Figure 7). You may be able to get away with only two screws to hold the servo in place as not much torque is present on the servo when it is in operation. In most cases, you should mount the servo from the bottom of the steamer so that the servo horn can be as close as possible to level with the petals as the petals move from their open state to their closed state. I chose to add a small stack of washers to make the servo horn more parallel with the push-points on the petals of the flower, but this may not be necessary depending on the size and shape of the steamer you are using. Your results may vary, so experimentation is encouraged.

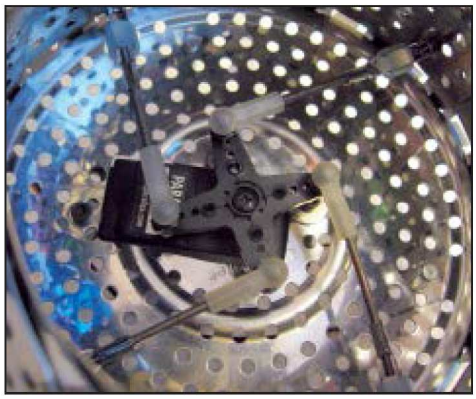
CLEVIS, PUSH RODS, AND BALL LINKS

Open the packages and retrieve one ball link and one clevis from

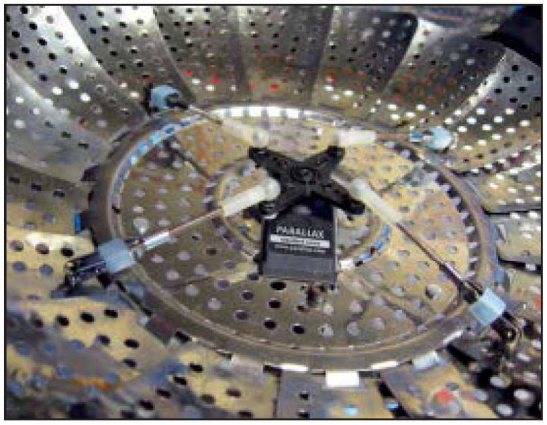
■ FIGURE 14. Attach the other three rods in this manner.



■ FIGURE 15. Move the servo through its length of travel, then insert the center screw to hold the servo horn in the position that allows the flower to go from open to closed.



■ FIGURE 16. The Power Flower should be able to fully open and close after adjusting the petals and hinges where the petals meet the base.



■ FIGURE 17. The Power Flower in a fully-open position.

■ FIGURE 18. Kym Graner creating an interior for the Power Flower.

■ FIGURE 19. Vern and Kym Graner testing the flower centerpiece.

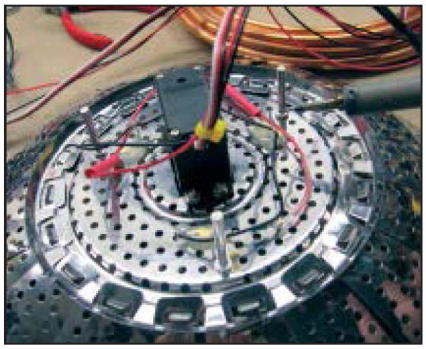
each package (Figure 8). Cut four lengths of 2-56 threaded rod approximately 1.75" long. The threaded rod I had was easily cut with a good pair of tin snips. The length isn't critical as both the clevis and the ball link allow you to adjust the length of the entire assembly, much like a turnbuckle. Attach one of the ball links and one clevis to each piece of threaded rod making four links as shown in Figure 9. Attach each ball link to one of the points of the servo horn as shown in Figure 10.

MOUNT FABRICATION

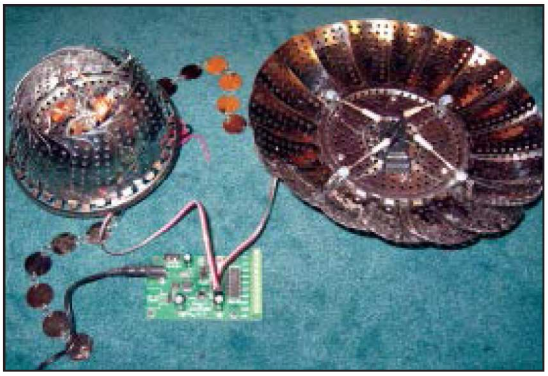
Finding a secure way to mount the clevis to each of the steamer petals was an idea from P.Y. Hung, a long-time member of The Robot Group and one of the roboteers that worked on building a Power Flower for an interactive sculpture called "The Mechanical Flower." P.Y. simply soldered a washer into the slot of a pan-head screw to make a simple and elegant mounting point for each push rod (Figure 11). Make sure you use forceps or needle-nose pliers to hold the screw as you do this as the piece will get very hot. It might be best to have another set of hands or a small vise to make sure the washer stays in place when heat and solder are applied.

Once you have made four of these screw eyes, mount one to each petal (Figure 12). Note carefully the position shown in Figure 11 as there is normally only one hole in the petal that will allow the flower to open and close completely and not bind. Once

■ FIGURE 20. Attaching some LEDs to the flower base allows the flower to "glow" from the inside.

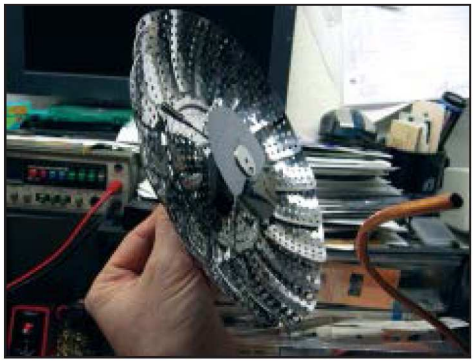


■ FIGURE 21. Two Power Flowers connected to an EFX-TEK Prop-1 board.

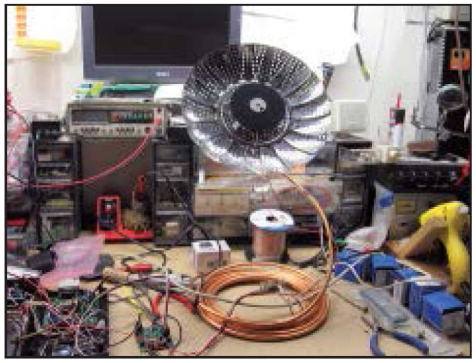


■ FIGURE 22. LEDs bent to shine outwards to light the petals. The 3.5" floppy disk hides the light source.

■ FIGURE 23. Power Flower with 3.5" floppy disk center.



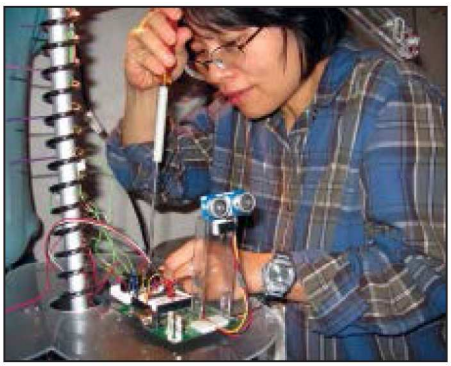
■ FIGURE 24. Power Flower mounted on a "stem" of 1/4" copper tubing.



■ FIGURE 25. The component parts for Denise Scioli's "Mechanical Flower" sculpture.

■ FIGURE 26. Denise Scioli test-fits a Power Flower in the :Mechanical Flower steel bowl.

■ FIGURE 27. Clear Acrylic "leaves" being added to the Mechanical Flower.



■ FIGURE 28. P.Y. Hung wiring up the Sonar Sensor for the Mechanical Flower.

■ FIGURE 29. Denise Scioli and P.Y. Hung with the Mechanical Flower sculpture at Dorkbot in Austin.

■ FIGURE 30. Kym Graner at Dorkbot describes the creation of the "ShyUltraViolet" sculpture.

■ FIGURE 31. The ShyUltraViolet Power Flower sculpture by Kym and Vern Graner.

in place, you can opt to position the securing band onto the clevis (Figure 13), but I've found it not a necessity as these bands are really designed to hold the clevis together in the face of buffeting winds that rattle the control linkages of model aircraft. If you prefer an all-metal look, you can omit these.

Once you have all four clevises (clevi?) mounted, you should push the servo horn down onto the servo and attempt to rotate the servo through its full sweep from open (Figure 14) through midpoint (Figure 15), and finally to the full-closed state (Figure 16). In most cases, you will have to twist the servo a bit then lift and drop the horn back on it when you hit the servo end stop point. You should position the horn on the servo so that the full-open to full-close states leave a bit of slack. It's best not to hit the end-stop of the servo during the range of motion of the flower (Figure 17).

PARTS LIST

- 1 Vegetable Steamer 6" (grocery store)
- 1 Parallax standard servo part #900-00005 (**www.parallax.com**)
- 1 EFX-TEK Prop-1 controller part #31101 (**www.efx-tek.com**)
- 1 Great Planes 2-56 threaded ball links part #GPMQ3841 (**www.greatplanes.com**)
- 1 Great Planes 2-56 threaded steel clevis's part #GPMQ3791 (**www.greatplanes.com**)
- 2-56 threaded rod (hobby store)
- Misc. washers, nuts, and bolts

DECORATION TIME!

Now that you have a completely assembled Power Flower, it's time to brighten it up a bit with some decorations. Kym decided to make some artificial stamens out of springs, copper tubing, and solder wick (Figure 18). We attached it to the center of the flower using hot-melt glue (Figure 19). Once we had the center decorated, I took the flower back to my workbench to add some black light LEDs to the inside base of the flower (Figure 20).

I then built a second Power Flower. I connected both flowers to an EFX-TEK Prop-1 microcontroller (Figure 21) and then re-purposed some code to make the flowers move through their range of motion in a pseudo random pattern. The EFX-TEK controller is really handy and inexpensive. It uses the venerable Parallax BASIC Stamp 1 as its brain and the software posted with this article can control up to six flowers from this single controller.

After checking out the motion, I decided that the second flower needed a center of some type. Looking around, I spotted an old 3.5" diskette. I cracked open the housing, took the

mylar media (Figure 22), and glued it to the center of the flower using some screws as stand-offs (Figure 23). I mounted this second flower on a temporary stand of 1/4" copper tubing (Figure 24) for testing.

By now, I was playing with an idea for a robotic sculpture that would cause the flower to open or close based on ambient sound levels around the flower. My wife dubbed the concept the "ShyUltraViolet" and I put together a concept video that describes this concept and then shows the flower going through a sequence of full-closed, to full-open (see Resources for video link).

THE MECHANICAL FLOWER

I was showing the prototype Power Flower around at one of the Robot Group's meetings when Denise Scioli and P.Y. Hung took an interest in creating one of their own. Denise had a concept for enclosing the flower in a very industrial-looking metal shroud that would be suspended from an industrial dishwasher hose spring (Figure 25).

Denise built one of the Power Flowers and placed it inside the bowl (Figure 26) where the reflections of the petal motions were greatly amplified. She also worked on creating some clear acrylic petals (Figure 27) to surround the flower and P.Y. worked on wiring these up. They then worked together to design software for the BASIC Stamp 2 that would change the flower's position and lighting based on using a Parallax Sonar Sensor to determine the distance of the observer from the front of the sculpture (Figure 28).

DORKBOT HERE WE COME!

Since we have a very active "Dorkbot" community (see Resources for link) in Austin, we decided that it would be an idea venue for us to display the Power Flowers in their different guises. Denise and P.Y. brought out the Mechanical Flower (Figure 29) and Kym talked about the creation of the flower (Figure 30) and showed off the prototype ShyUltraViolet (Figure 31).

I hope these examples are inspirational and that you will consider making your own Power Flower. The device should be easy to build in a single weekend and the resulting motion is down-right hypnotic to watch. You can drive the servo with any microcontroller you have handy and decorate the flower with any technical flotsam and jetsam that may have washed up on the shores of your shop.

If you do build a Power Flower, please drop me a note and let me know how it's working for you. As always, I can be reached at vern@txis.com. **NV**

Special thanks to Kym Graner and Denise Scioli. Also, I'd like to say a special thank you and good luck to Pui Yee Hung, a long time roboteer who is leaving Austin for the wilds of New York. We'll miss ya P.Y.!

RESOURCES

- EFX-TEK: **www.efx-tek.com**
- Parallax: **www.parallax.com**
- Dorkbot Austin: **www.dorkbotaustin.org**
- ShyUltraViolet / Power Flowers Video: **www.youtube.com/VernGraner**
- The Mechanical Flower: **http://makerfaire.com/pub/e/838**
- The Robot Group: **www.TheRobotGroup.org**
- The Workbench Design Challenge: **http://forum.servomagazine.com/viewtopic.php?t=8180**
- *Nuts & Volts* Web Forum **http://forum.servomagazine.com/viewtopic.php?t=8180**