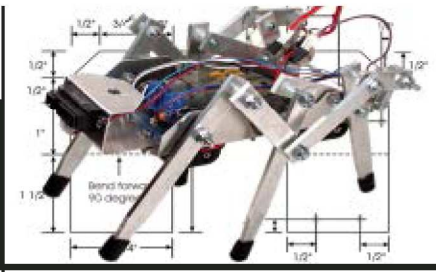
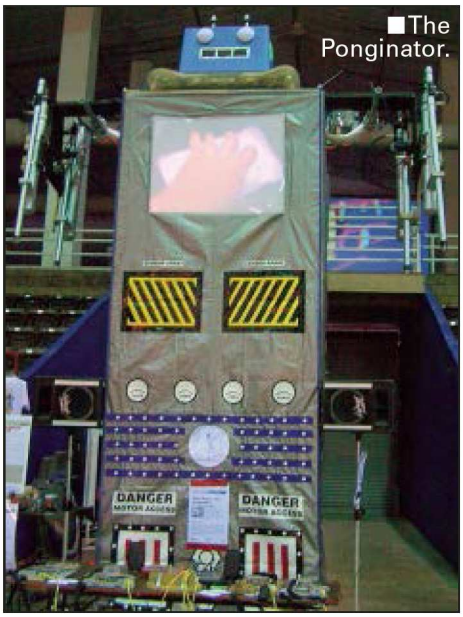


■ BY VERN GRANER

THE PONGINATOR: What's 20 feet tall, blasts smoke, flashes lights, roars air raid sirens, and shoots ping pong balls?



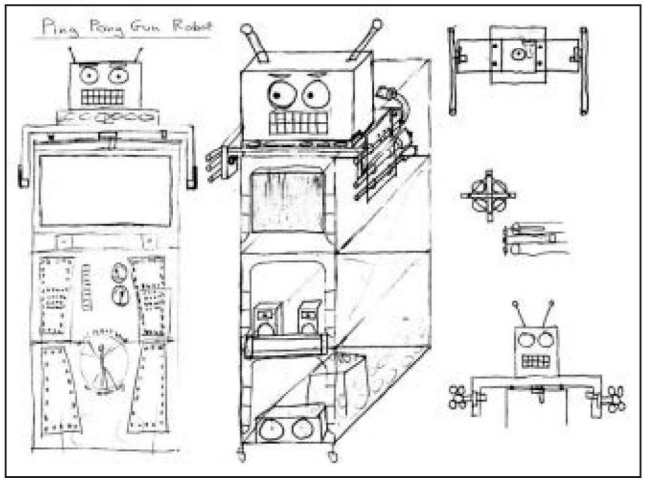
■ The Ponginator.

WHEN WE THINK OF PERSONAL ROBOTICS, we usually think of personal as referring to size, i.e., a personal digital assistant or a personal computer. Things that usually are small enough to fit in a shoe box or at least fit on your workbench. This month, I want to talk about how "personal" can also mean interpersonal. Finding other people to help with your projects and possibly to assist with theirs.

As a member of The Robot Group, Inc., here in Austin, TX, I have been lucky enough to find my evil minion friends right here in town. This is not to say that mailing lists and online forums aren't useful and/or fun, but if it weren't for these local folks and their complimentary and overlapping skills, I would NEVER have been able to complete the number and type of projects I've tackled. A recent example is The Ponginator we created for the MAKER Faire in October.

MAIN SCREEN TURN ON!

The Ponginator was a project that grew from a small need (a place to hang a video projector screen) into the centerpiece of The Robot Group's display at the Faire. We originally thought we would use a PVC pipe frame to hold up a bed sheet to act as a screen for our video projector. About a month before the Faire, some roboteers and I were sitting around my kitchen table sketching up designs for a PVC pipe frame. We decided the screen should be high enough to be visible from far across the arena. An eight foot tall design soon became 16 feet tall, so there would be room beneath the screen to hold the PA system and power amps.



■ FIGURE 1. Original sketches.

By the time the sketching and brainstorming was done, our original PVC frame bed sheet holder had morphed into a 20' tall, 1950's inspired, smoke belching, video screen sporting, microcontroller operated, articulated turret pneumatic cannon ping pong ball shooting robot with LED antennas, servo controlled eyes, and police strobe lights (Figure 1). It's a lot of fun to be around creative people! Now all we had to do was build it. How hard could it be?

A PALLET OF TALENT

I'm lucky in many ways but especially in that I am surrounded by creative, helpful, and talented folks (let's leave crazy out of it, for now!) In order to bring this project to completion, I would need all the help I could get. It was time to draw on the "Pallet of Talent" that surrounds me.

As most of the members of The Robot Group are full-time occupied with work, school, or parenting, 30 days is not much time for a project of this scope. It never ceases to amaze me that no matter how simple a project appears when sketched on paper, it becomes increasingly complicated on the journey to reality! I firmly believe the truism that "inside every little problem is a great big problem waiting to jump out."

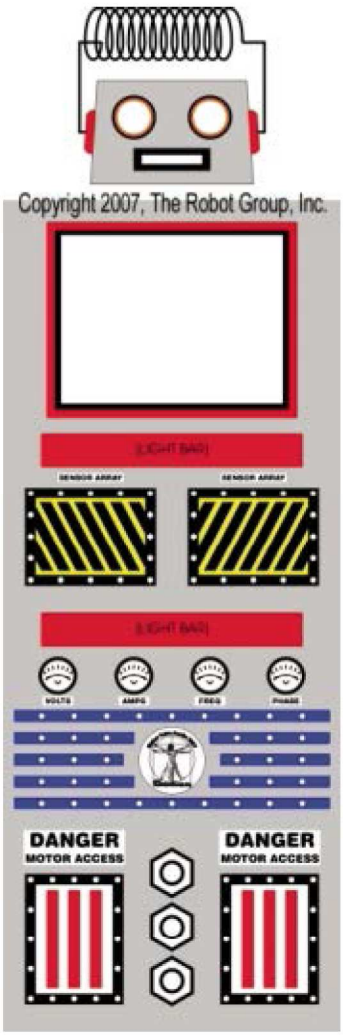
Conversely, it's astonishing how a complicated or difficult project can bring out the best in people while many times uncovering their otherwise hidden talents. I also find it fascinating that I learn SO MUCH simply by making something. For example, did you know that ping pong balls come in two diameters (38 mm "hobby" and 40 mm "professional")?

Most of my projects progress from sketches to "To Do" or "parts" lists, so I began to enumerate all the things I would need. I then posted the listing to our group's mailing list (our mailing list is archived on our website if you want to see all the gory details). Almost immediately I started receiving phone calls and emails from folks saying they could do this part or that part, and we started to schedule times and tasks. In a matter of hours, I had already received an updated version of my sketches done in a CAD program from one of our members (Figure 2). The process had begun.

THE MACHINE THAT GOES PING!

A wide variety of people brought their various disciplines to bear in the creation of the Ponginator. I started out collecting various sirens, Klaxons, and alert sounds, and editing together the "soundtrack" that would alert the crowd to the Ponginator's activities. I then edited various songs to match the length of — and play behind — the sound effects to help build excitement as the robot fired its guns. With about all the desk-based work complete, it was time to start gathering all the major pieces for the Ponginator and evict my car from the garage for another project.

■ FIGURE 2. Ed's CAD drawings.

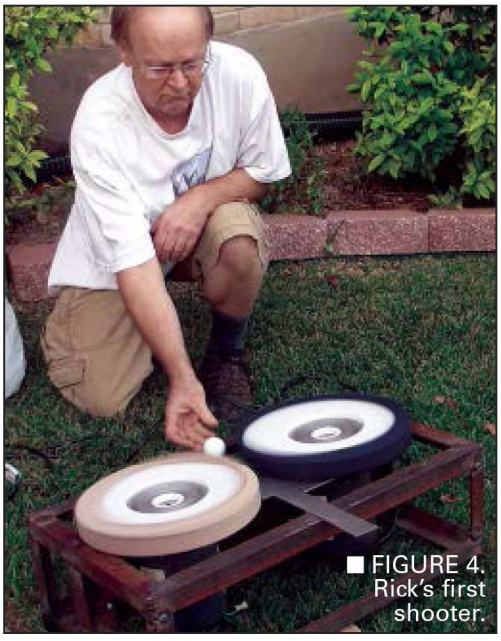


We started by getting two full frames of scaffolding and a large silver-colored construction tarp. We put one layer of scaffolding up in the garage so we could test the gun movement. We then created two gun turrets from 3/4" plywood and used an eight foot 2 x 12 for the "shoulders." Using some L brackets, we hung the two gun turrets and mounted heavy-duty surplus gear head motors to raise/lower the guns.

The motors were originally designed to position satellite dishes so they have lots of torque. So much torque in fact, we ended up using custom machined motor mounts for them as our first torque tests threatened to rip the wood screws free from the plywood! With the motor mounts, we could use bolts and fender washers to firmly attach the motors to the turrets (Figure 3).

The next step was to create the ping pong ball guns themselves. We pondered a number of designs, experimenting with rubber "surgical" tubes that would shoot the balls like a slingshot and one of our members even fabricated a mechanical system that used counter rotating wheels to "throw" the

■ FIGURE 3. Gun turret with motor mount.



■ FIGURE 4. Rick's first shooter.

■ FIGURE 5. Pneumatic Ponginator gun.

■ FIGURE 6. The author loading the guns.

balls like a pitching machine (Figure 4).

We had hoped to make the system auto-loading with some type of hopper to hold the ammo. We sketched up and experimented with numerous different designs with the first requirement being throwing distance (we wanted to be able to hit the middle, if not the end of the arena!) and the second biggest concern being reliability. We had to consider that the end product would be suspended 15 to 20 feet in the air, so it would be difficult (if not down right dangerous) to reach it for diagnostics, adjustment, or repair.

In the end, we settled on a simple design based on one of many pneumatic spud gun plans we found on the Internet. Our final gun consisted of a length of 4" ID PVC pipe configured as an air reservoir, an inexpensive 1" sprinkler valve as a trigger, and a piece of 1.5" PVC pipe as a barrel (Figure 5).

Due to concerns with reliability and the short time we had to build things, we settled on a "muzzle loaded" design using strips of a plastic drinking cup to hold the ping pong ball in place after loading. Because the gun turrets would rotate, we were able to point them down for loading, and then point them almost straight up in order to allow the balls to settle into position for firing (Figure 6).

We wanted the balls to be memorable, so we found a shop that could print our logo onto the ball (Figure 7). We ordered four gross of logo-emblazoned ping pong balls. They were scheduled to arrive just two days before the Faire! In the meantime, we did our testing with some ping pong balls purchased at local sports shops.

FIRST "BUMP" IN THE ROAD

Once we had four pneumatic guns built and tested, it was time to test the shoulder pan motion. The original design called for the 2 x 12 cross plank to rotate to allow the head and shoulders to pan the guns across the arena. This would allow us to shoot ping pong balls both into the arena and also up into the stands. The pan cross plank was designed with outrigger wheels that would carry the weight of the guns so the motor would only have to provide the rotational torque to move the shoulders (Figure 8).

When we got all four guns hung on the turrets, and applied power to the 12V pan motor using a 12V gel cell, the motor made a soft click and did not move the shoulders at all! We removed the guns and the shoulders would pan with ease. Turns out that with the guns mounted, the assembly was just too heavy for the motor to get moving.

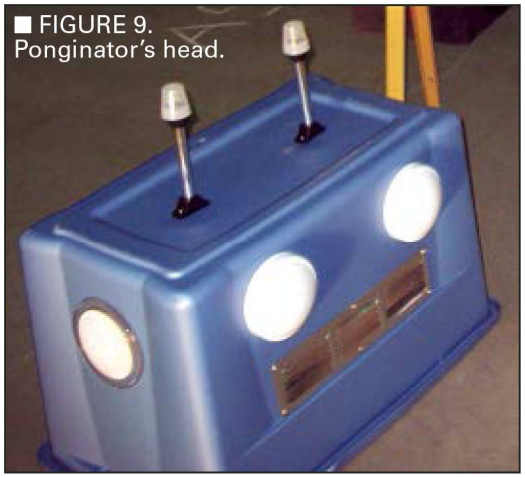
We didn't have time to redesign the shoulders or replace the motor, so I decided to see if a bit more "juice" might make the motor turn. I grabbed a second gel cell and put it in series to get 24V. Again, the motor went click but a bit louder this time. I picked up another gel cell, added it for 36V, and the motor started to barely move, but after a short slow turn, it got stuck. I tried reversing it, but no luck. It stayed put.

Having another gel cell handy, I added it in series as well, and hit that motor with 48V! The shoulders creaked and lurched into action and the shoulders began to pan! Success! But then, a very loud crackling sound came from the motor's gearbox and the shoulders ground to a halt. Turns out 48V is enough to get the motor turning, but the gear train wasn't up to the task and disintegrated into metal shards! Lucky for us, it hadn't frozen up so we were able to manually position the shoulders point-

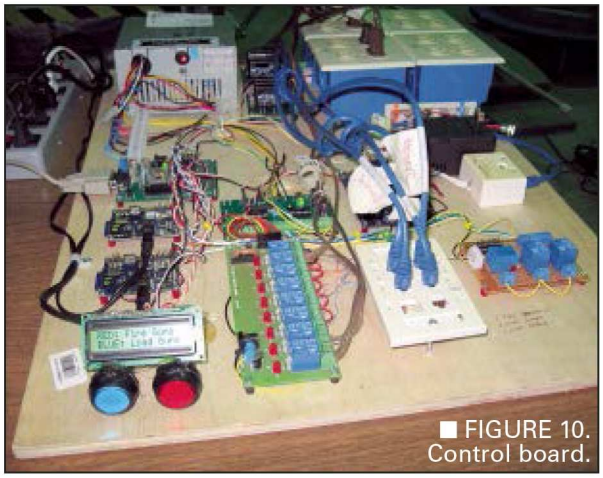
■ FIGURE 7. Ponginator ammo.

■ FIGURE 8. Shoulder rotation cross plank.

ing in a single direction for the show and put the shoulder rotation plans on the back burner for now. We built Ponginator's head from a large plastic storage bin (Figure 9); mounted some boat navigation lights for antennas; some push lights were modified with servos and high brightness LEDs for eyes; some decorative lightning lights were added as ears; and a sound activated CCFL light bar in a box was placed behind a metal screen to act as a mouth. As I knew the controls would all be at ground level but the things being controlled would all be up high, I used RJ-45 jacks on both the motor/head end and also at the control board end. This made it easy to find cables of the proper length to use for the finished project as we could use standard Ethernet cables.



■ FIGURE 9. Ponginator's head.



■ FIGURE 10. Control board.

WE HAVE ASSUMED CONTROL ...

Now that we had gun turret motors and solenoid operated sprinkler valves, I had to have something to coordinate all this machinery. I cut a sheet of 1/2" plywood to about 2' x 3' and then started to gather and attach the microcontroller components I figured I would need to control the show (Figure 10). I ended up using:

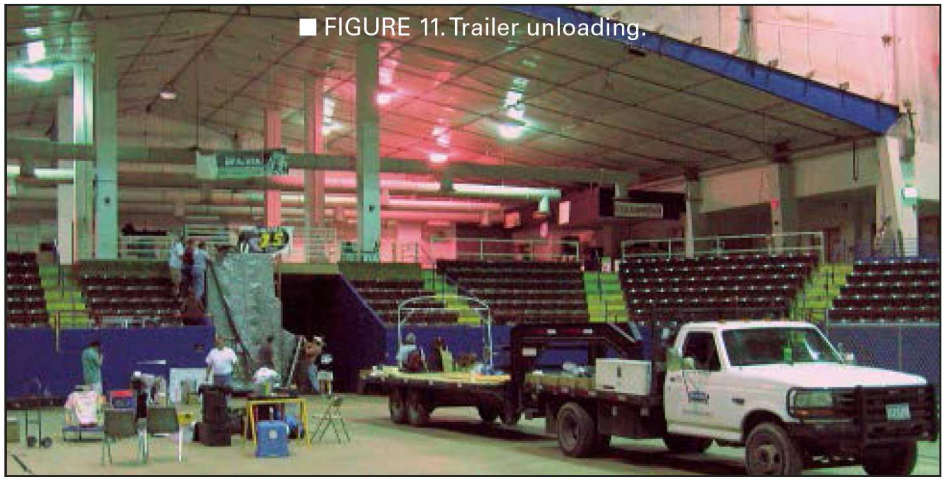
- Parallax BASIC Stamp IIP24
- Parallax Super Carrier Board
- Parallax Serial LCD display
- Solutions Cubed Motor Mind C
- Solutions Cubed Motor Mind C Carrier Board
- EFX-TEK RC4 (quantity two)
- EFX-TEK DC-16
- Circuit Specialists Kit 74 octal relay control board
- Rogue Robotics uMP3 sound players (quantity two)
- Surplus 250W ATX PC power supply

With the control board built, we had the last piece of the puzzle, so it was time to load it all up and truck it about 15 miles to the arena. I borrowed a large truck and trailer from my brother (thanks Walt!) and we loaded the Ponginator and all the other displays for the Faire onto the trailer. (Oh, did I forget to mention that in addition to creating the Ponginator in 30 days, we also had about a dozen other Robot Group created displays we had to set up for the Faire — see Resources. We were a very busy crew.)

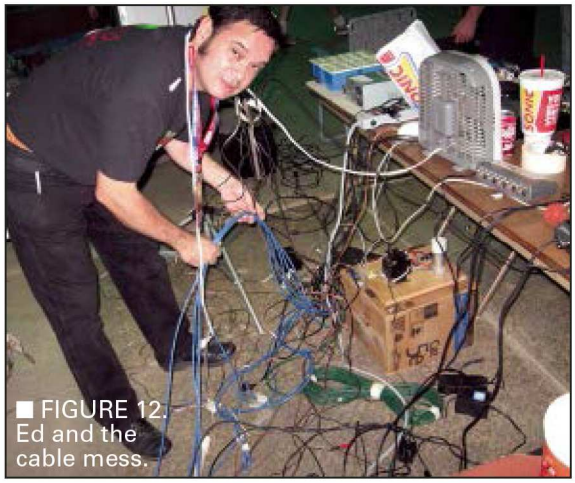
Once we arrived on site, we had to assemble the Ponginator for the first time (Figure 11). We had put up one layer of scaffolding in my garage

READY ... AIM ... PING! (The Ponginator Firing Sequence)

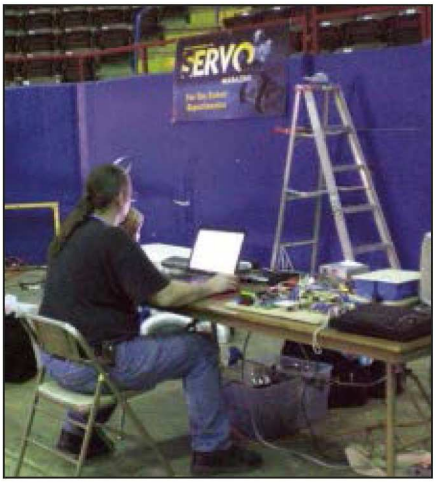
- Press the fire button.
- Parallax BSIIp starts countdown on LCD.
- EFX-TEK DC-16 activates smoke machines.
- First uMP3 player starts sound effects.
- S3 Motor Mind C moves gun turrets into firing position.
- EFX-TEK DC-16 blinks LED eyes, antennas, and mouth.
- EFX-TEK RC4 blinks rope Lights and activates police light bar.
- Second uMP3 player starts background music.
  - EFX-TEK DC-16 fires solenoid valve.
  - Parallax BSIIp pauses 10 seconds.
  - S3 Motor Mind C moves gun turrets to new position.
- Repeat above three actions for next three shots.
- First uMP3 fades out sound effects.
- Second uMP3 fades out music.
- EFX-TEK RC4 and DC16 turn lights out.
- S3 Motor Mind C moves gun turrets into load position.
- Manually muzzle-load the guns for next shot.
- Press button, guns raise to seat ping pong ball ammo.
- Ready to fire



■ FIGURE 11. Trailer unloading.



■ FIGURE 12. Ed and the cable mess.



■ FIGURE 13. Author writing Ponginator code

in the week before the show, but we had never put all the pieces together at full height and with the "skin" fitted. We assembled the two stories of scaffolding, then wrapped the frame in the skin for the first time. We then cut the hole for the video screen, mounted the video projector, and hoisted the gun assembly into place.

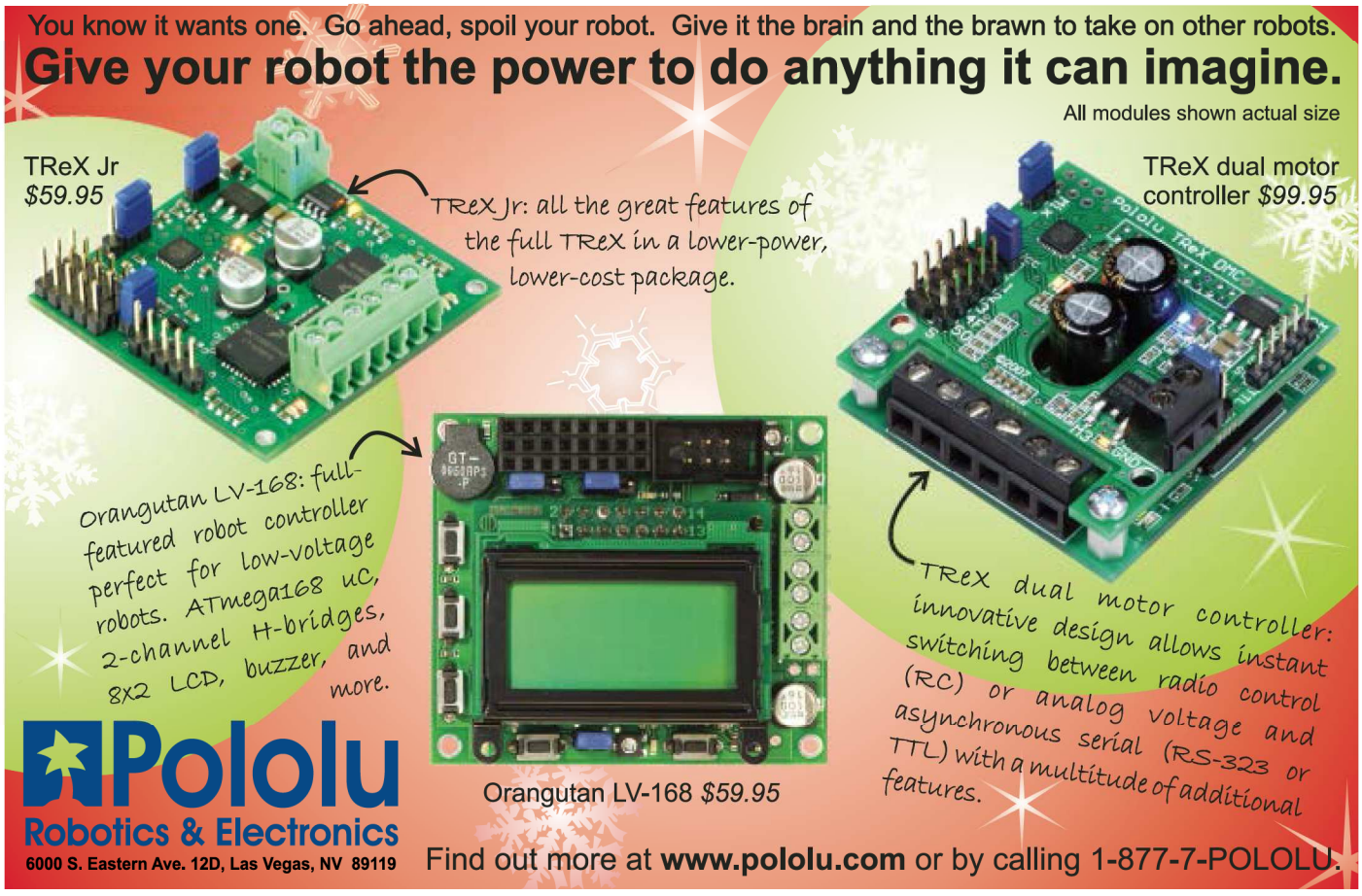
We mounted the smoke machines and screwed the head down to the cross bar, then ran the cables down to the control board (Figure 12). We added the lights and the lighting power lines, as well as the closed circuit video camera that would display a Ponginator's eye view of the crowd as the ping pong balls rained down.

It took us hours to get the Ponginator fully assembled, but when he was finally up and ready to go, there was really only one "little" problem. We had about four hours till the Faire was going to pre-open for the press and I hadn't written the software that operated him yet.

CODE MONKEY LIKE FRITOS

The reason for the lack of code was pretty simple. I had not been able to write code for a device that didn't exist. Now that I had the device fully assembled, I could finally begin to write and test the routines that would control the gun firing solenoids, activate the lights, LED eyes, and police lights, start and stop the music players, rotate the gun turrets, and turn on and off the smoke machines (Figure 13).

Luckily, I had used many of the controllers before so I had some code chunks from previous projects that I could cut and paste together to talk to



PONGINATOR PALLET OF TALENT

Rick Abbott, Alberto Alonso, Paul Atkinson, Brooks Coleman, Bob Comer, David Comer, Tom Davidson, James Delaney, Wolf Dilworth, John Funk, Vern Graner, Kym Graner, Nic Graner, Sami Graner, Ed Xavier Gonzalez, John Herron, Nyssa Hughes, Puiyee Hung, Eric Lundquist, Gary Mack, Marvin Niebuhr, Sonia Santana, Denise Scioli, and Mike Scioli.

RESOURCES

- The Robot Group entries for MAKER Faire:
  - **http://makerfaire.com/austin/2007/tags/indexcsp?tag=The%20Robot%20Group**
  - **http://tinyurl.com/23x444**
- Fox 7 News MAKER Faire Showcases Unique Inventions
  - **www.myfoxaustin.com/myfox/pages/Home/Detail?contentId=4695465&version=1&locale=EN-US&layoutCode=VSTY&pageId=1.1.1**
  - **http://tinyurl.com/3aa23d**
- Video of the Ponginator
  - **www.youtube.com/watch?v=iPSoFYHywJw**

the LCD panel, the uMP3 music players, DC-16 controller, and so on. The final code was rather straightforward as it simply stepped through sequences with timed intervals separating events. The Ponginator firing process is described in detail in the sidebar "Ready Aim PING!."

CAN WE DO IT? YES WE CAN!

What could unite school teachers, plumbers, carpenters, laser technicians, entrepreneurs, software engineers, artists, musicians, photographers, stay-at-home moms, cube dwellers, electrical engineers, students, and kids? A project just like this. We were all working towards a common goal. We knew the result could be wonderful, and it was. The Ponginator was a huge hit! It worked wonderfully, the crowd loved it, the kids loved it, and it drew people to our displays all weekend. It even made the local news cast (see Resources).

I created a short documentary video using photos and video clips collected during the creation of the Ponginator and also during his performance at the MAKER Faire (see sidebar). I encourage you to have a look and to see the type of project you can be a part of if your personal robotics interests are joined with those of others in your home town.

The Ponginator is also a prime example of how the whole really can be greater than the sum of its parts. Some rough pencil sketches, old scaffolding, silver tarp, PVC pipe, sprinkler valves, a storage bin, and some electronics, when mixed with the right people, became a triumph that I don't think anyone involved will soon forget. **NV**