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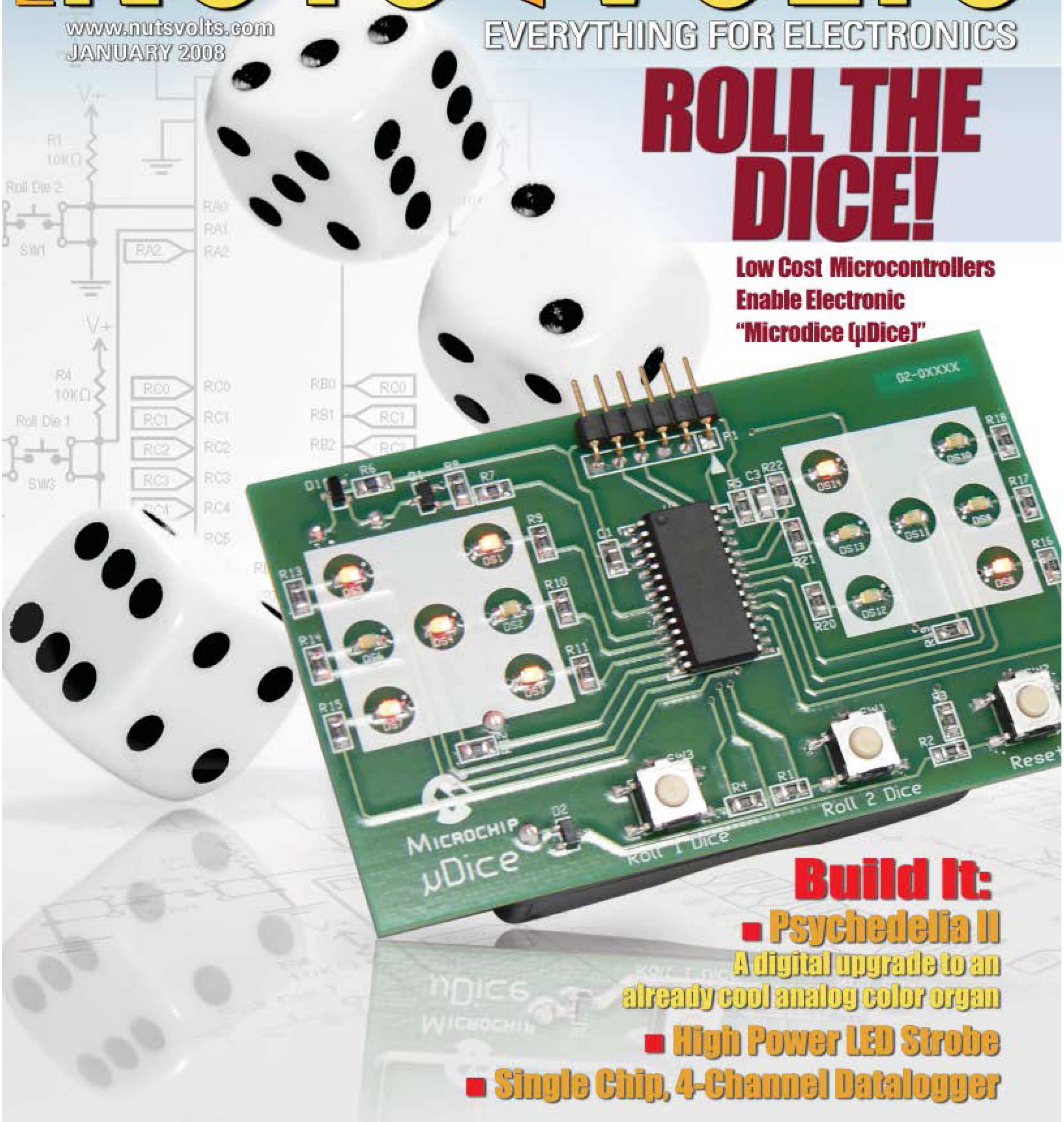

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PROJECTS and FEATURES

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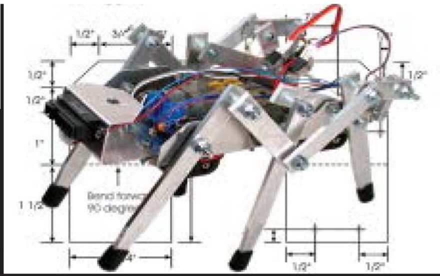


■ BY VERN GRANER

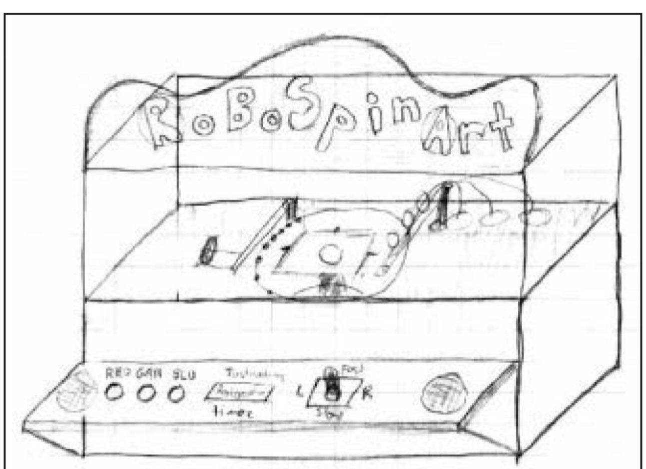
ROBO SPIN ART — Retro Art Meets the Joystick Generation

THE VENERABLE SPIN ART MACHINES popularized in the 1960s and 1970s created funky, psychedelic artwork many of us remember from the carnivals and county fairs of our youth. Simply put, "spin art" is created when paint is dropped on to a rotating paper, allowing centrifugal force to make streaks of color. The RoboSpinArt machine updates this concept by making spin art attractive to the so-called "joystick generation" of today while also adding on features to the original design.

REELING IN THE YEARS

When I was about 10 years old, a Halloween carnival came to a park near my house, and they had a spin art booth in their Midway. The spin art machines they used were the pinnacle of simplicity — a table with a hole cut in it for a bucket, and a motor in the bottom of the bucket with a small bracket to hold a paper card. The operator would turn on the motor, and the kids would use various ketchup bottle type containers to drip different colors of paint on the card as it spun. After a few minutes, the operator would turn off the motor and hand you the finished "painting." At 10 years old, I thought this was amazingly cool!

Flash-forward a few years (okay, more like decades) and I'm in my garage cleaning up a bit with my 10-year-old son Nicholaus when I came across a box with various relics of mine from that time. One item was a slightly faded cardboard card with the classic spin art swirls on it. I showed it to my son enthusing about how it was made, how much fun it was to make, and how cool it looked. Giving me the patented "uh ... sure Dad" look, he said it sounded "okay but kinda boring." I wrote off his disinterest at the time, but his reaction stayed in the back of my mind. What was it that made the difference? Why was it interesting to me at 10 years old, but not to him?



■ FIGURE 1. First sketch of the RoboSpinArt machine.

LIVING IN A DIGITAL WORLD

After the thoughts incubated in my head for a bit, it occurred to me that my son isn't used to dealing with devices that don't have some type of digital user interface. Video games, the TV remote, microwave oven, computer, cell phone, and MP3 player ... all the things he uses daily and understands thoroughly have some version of a digital user interface. Buttons and joysticks are usually accompanied by sound effects, LCD displays, voice prompts, and in many cases, a rockin' stereo soundtrack. Although as a kid of 10 I was fascinated by the simple spinning colors of the spin art machine, my 10-year-old son was not nearly so impressed. On reflection, I wondered if it was the spin art that failed to ignite his interest or the interface to the spin art that was a barrier. If we updated the interface, would the spin art suddenly become interesting again?

Coincidentally, all this occurred about the same time that First Night Austin (a local, family-oriented New Year's celebration) started soliciting artists for proposals for their annual

First Night Austin street celebration. Thinking this the ideal venue for such an amalgam of retro art techno geekdom, I spoke with a few of my regular cohorts at The Robot Group and decided to propose "Robo SpinArt" for First Night. Since I'd already been thinking about making a spin art machine of some type, I sketched up some plans and features (Figure 1) and sent in a proposal.

After weeks of waiting for an answer, I just decided to go ahead and start on the machine myself. I figured if First Night did say yes, I would need to have a good head start to ensure the unit would be ready by New Year's Eve. If they didn't approve the proposal, at least I would be on my way to having a cool new project.

MAKING A LIST ... CHECKING IT TWICE ...

Using the notes from my sketches, I outlined the functions of the machine. I started by going over the things the original old style spin art machine had and compiling a list of the things I needed to do to "update" the machine for the "Joystick Generation."

• *Limit the ammo:* One of the first things to do to improve the machine would be to limit the amount of paint available (i.e., 30 drops or shots of paint). By making sure the kids only had a limited amount of paint ammo, I could eliminate paper saturation as a problem and have a much better chance of the finished piece having that classic spin art look. Not only would this reduce the chance of someone making a mess of their paper, it would also cut down on the amount of paint consumed by the device in the course of its operation, thereby keeping operating costs down. This approach had the added advantage of reducing the amount of time kids had to wait to use the machine since once your ammo was gone, your turn was over.

• *Limit the time:* By putting a count-down timer on the machine, a sense of urgency is created. If you only have, say 30 seconds, you need to start painting quickly. This not only makes it exciting, it helps with the throughput of the machine. Kids who carefully place their shots would know exactly how much time they have to aim and fire their paint. I could also use this as a way to calculate the maximum throughput when trying to determine how many kids could be served and how much paper should be brought to a given event.

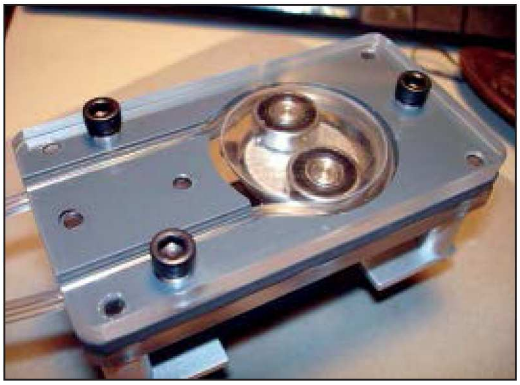
• *Arcade style controls:* The paint firing would be controlled by a series of arcade quality buttons that could be used to fire the paint shots. An arcade style joystick would be used to aim where the paint would fall. Not only would arcade-style controls make the machine more robust, they would also be familiar to the kids and give them an intuitive interface to operate the machine. Each of the buttons also had a colored cover that would light up to indicate the pump was on and what color of paint would dispense when a given button was pressed. A paint gantry (reminiscent of a record player tonearm) would move in an arc over the bucket to allow the kids to aim at different parts of the paper.

• *Speed control:* As a new twist on the old spin art design, I thought that since I had both UP/DOWN and LEFT/RIGHT controls in the joystick, I could use the UP/DOWN motion to control the speed of the motor that spins the paper. Pushing UP on the joystick would accelerate the paper causing the paint tendrils to become thinner and the colors could become more translucent. Pushing DOWN would make the tendrils appear to be thicker and the colors more vibrant since less paint would be thrown off the paper. Also, accelerating and decelerating the motor right as you drop a paint shot could alter the paint trajectory as it moved outward on the paper. This would cause effects such as swirling or bending paint tendrils. Having this sort of hidden functionality was reminiscent of special combo moves in video games.

• *Freeze frame:* Another common problem with the older spin art machines was the inability to see your artwork until the motor stopped spinning the paper. By the time the motor had stopped, it was too late to add paint to a blank portion of the paper or add a few more paint drops that might improve the final piece. To allow the kids to preview their work, I planned to add high-intensity white LEDs pointed down into the bucket to act as strobe lights. These lights would be timed by an encoder on the motor shaft that, when activated, would blink the LEDs one time per rotation of the paper. This would freeze the image and let the progress of the painting be inspected while it was being made.

• *Video broadcast:* As an added touch, I thought it might be interesting to have a video camera in the top of the machine pointing down into the bucket so people in line could watch as the spin art was being made. This would also help them understand the operation of the machine, reducing the amount of instruction required when it was their turn.

• *Card logo and inscriptions:* When I was a boy, it was a standing rule in my household that when we attended an event and the event offered souvenirs, we were only allowed to choose one that had the event or location written on it. As it was likely that the spin art machine would be taken to various events, I thought it would be neat if I could continue this tradition by inscribing text and placing a graphic logo on each card. By limiting the travel of the paint gantry, I could protect the center of the card from being painted, thereby leaving space for this inscription. It would then be a simple matter to pre-print cards for an event with a logo and some descriptive text. However, there was always the problem of printing too few or too many cards for a given event (leading to wasted cards). To mitigate this, I planned to print some cards with a generic graphical logo (i.e., a birthday cake), and then add text to the logo at the time of painting (i.e., "Happy Birthday Sami!"). This would make creating custom cards easy and



■ FIGURE 2. Peristaltic pump prototype.

■ FIGURE 3. Final peristaltic pump design; loaded and ready to paint.

reduce wasted cards. Parallax had recently made available a serially controlled ink jet kit that, when placed on a movable arm, could be lowered into the bucket just before painting to inscribe text around the logo.

• *Sound and music:* Lastly, the machine would need a pair of stereo speakers and a nice, powerful audio amplifier in the box so that sound effects and the rockin' stereo soundtrack would accompany each turn on the machine. This would help to complete the arcade experience, entertain the person painting, and also draw in a crowd to see what all the excitement was about.

WHERE TO START?

So, now that the requirements were all lined up, it was time to start making things. The first item we attacked was the method for dispensing paint. In a traditional spin art machine, the kids are handed a ketchup-style bottle full of paint. Most children will simply dump as much of it as they can on to the paper resulting in a soggy, saturated, monochromatic mess. In order to alleviate this problem, I needed to have a pump that could be triggered to dispense a precisely controlled amount of paint. I explored a number of pump systems but finally settled on the peristaltic pump design.

Peristaltic pumps work by using a roller bearing to pinch a section of flexible hose (creating a movable "seal") and then moving the pinch point away from the source of the liquid and towards its destination. This creates pressure in front of the pinch point and a vacuum behind it. This style of pump is commonly used in food preparation and the medical industry because the pump does not come into contact with the liquid being moved.

This is also perfect for pumping paint because, not only can you very precisely control the amount of paint moved, but you would not have to clean paint out of the pumps at the end of the day. It seemed a peristaltic pump would be perfect for operation by a microcontroller as I could deliver a precise shot of paint with each press of a button.

To make the peristaltic pumps, I turned to Rick Abbott, a talented "old school" machinist and long-time member of The Robot Group. He hand-built a prototype peristaltic pump out of clear Lucite with aluminum pinch rollers and a continuous motion servo motor. Although beautiful to behold, this first pump didn't work well at all.

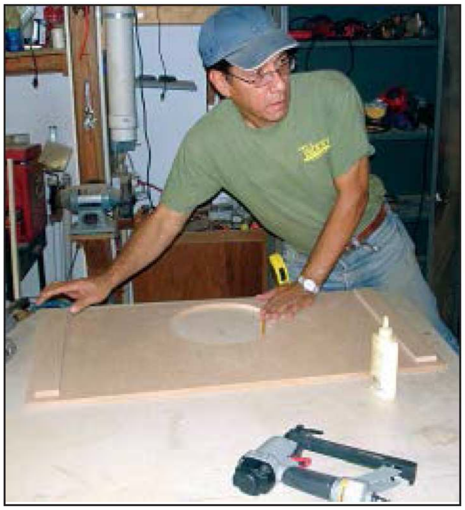
Upon careful observation, a number of things were apparent. First, the shaft of the servo motor was plastic, and as the pinch roller went past the unsupported section of the hose guide (Figure 2), the servo shaft would bend and the lack of pressure by the roller against the tube would cause the pinch seal to fail. When used to pump water, this prototype would draw the water about a quarter inch up the tube; then, when the seal broke, the water would fall back down.

After some head scratching, Rick went back to his shop and emerged a few days later with a new design that had three pinch rollers, a solid steel shaft to support the rollers, and dual bearings to keep the rollers square in the housing. This way, the servo motor only had to provide rotational torque, and the dual bearings kept the pinch rollers in constant pressure against the tube. He brought the new pump over to my house and we tried them out on a cup of water. They worked beautifully! He then set to work making a set of four matching pumps for the machine (Figure 3).

With the pumps finished, Rick designed a bracket to hold the paper in the bucket. He re-purposed an old pump motor and machined an aluminum frame to hold the paper. We tested this first design and discovered that when paint is applied to the top of a paper card, the pulp expands and the card can bow upwards. This

■ FIGURE 4. The "spinner" frame with snap-down PVC cover to hold paper.

■ FIGURE 5. Old cabinet becomes a spin art base.



■ FIGURE 6. Bruce Tabor working on the top for the box.

turns the card into a rudimentary wing which made it fly right out of the frame! (See the Resources for a video about the RoboSpinArt machine that includes the paper launching into the air!).

This was one of many lessons we learned while building this machine. Rick re-designed the aluminum frame to have a snap-down PVC plastic cover to hold the paper in place and in testing, the paper stayed put for painting (Figure 4). So, now we had the basic mechanical parts for the machine. We just needed something to put them in.

BOXING DAY!

As I'm not too handy in the woodworking arena, I reached out to another friend of mine who does carpentry for a living. I went out to see Bruce Tabor. Bruce has a fully-equipped carpentry shop and he said he could help out with the project. I brought my sketches and hoped he would be able to help convert them into reality. Bruce happened to have a cabinet base left over from a project and offered to convert it into the chassis for the RoboSpinArt machine (Figure 5).

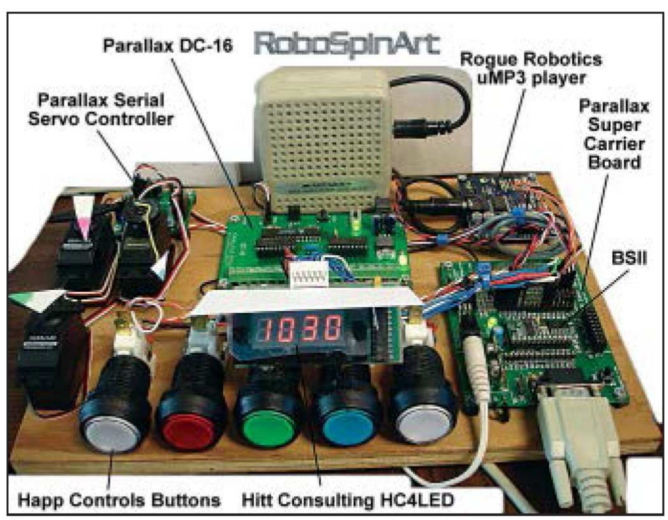
After a number of hours cutting the slanted top, adding some channels for the Plexiglas, and cutting a hole for the all-important bucket, a spin art machine began to take form. (Figure 6). I brought the raw wooden box home and placed a few parts in it. It was really beginning to look like a cool vintage arcade game (Figure 7)! Before I started permanently mounting the controls, it would need a bit of decorating. I contacted Denise Scioli, a local Austin artist (and of course, fellow Robot Group member) and she took control of the decorating. With the help of some friends, she sanded, painted, and decorated the box with a cool, retro-tech, pseudo steampunk finish (Figure 8).

HELLO WORLD!

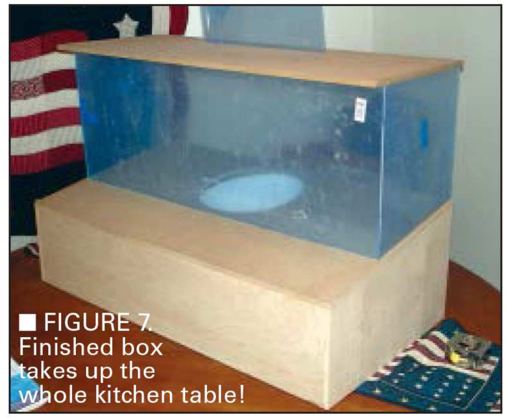
Now that I had the box all ready, I mounted the bucket, the controls, and the pumps. With most of the hardware done, it was time to get busy bringing the monster to life by writing some software. I started small, first building a prototyping platform that would allow me to start writing and testing software for the various component parts (Figure 9). This small board had all the systems I expected I would need including:

- Parallax BASIC Stamp II
- Parallax Super Carrier Board
- Parallax Serial Servo Controller
- Rogue Robotics uMP3 Player
- EFX-TEK DC-16
- Hitt Consulting HC4LED display
- RadioShack audio amp
- Arcade buttons from Happ Controls

I wrote some general code blocks that would let me read the buttons, run the servos, change the values shown on the LED display, turn the button lights on and off, and trigger sound effects. I spent lots of time getting the logic straight, which for me means building flow charts of different programming methods to track the logic (Figure 10).



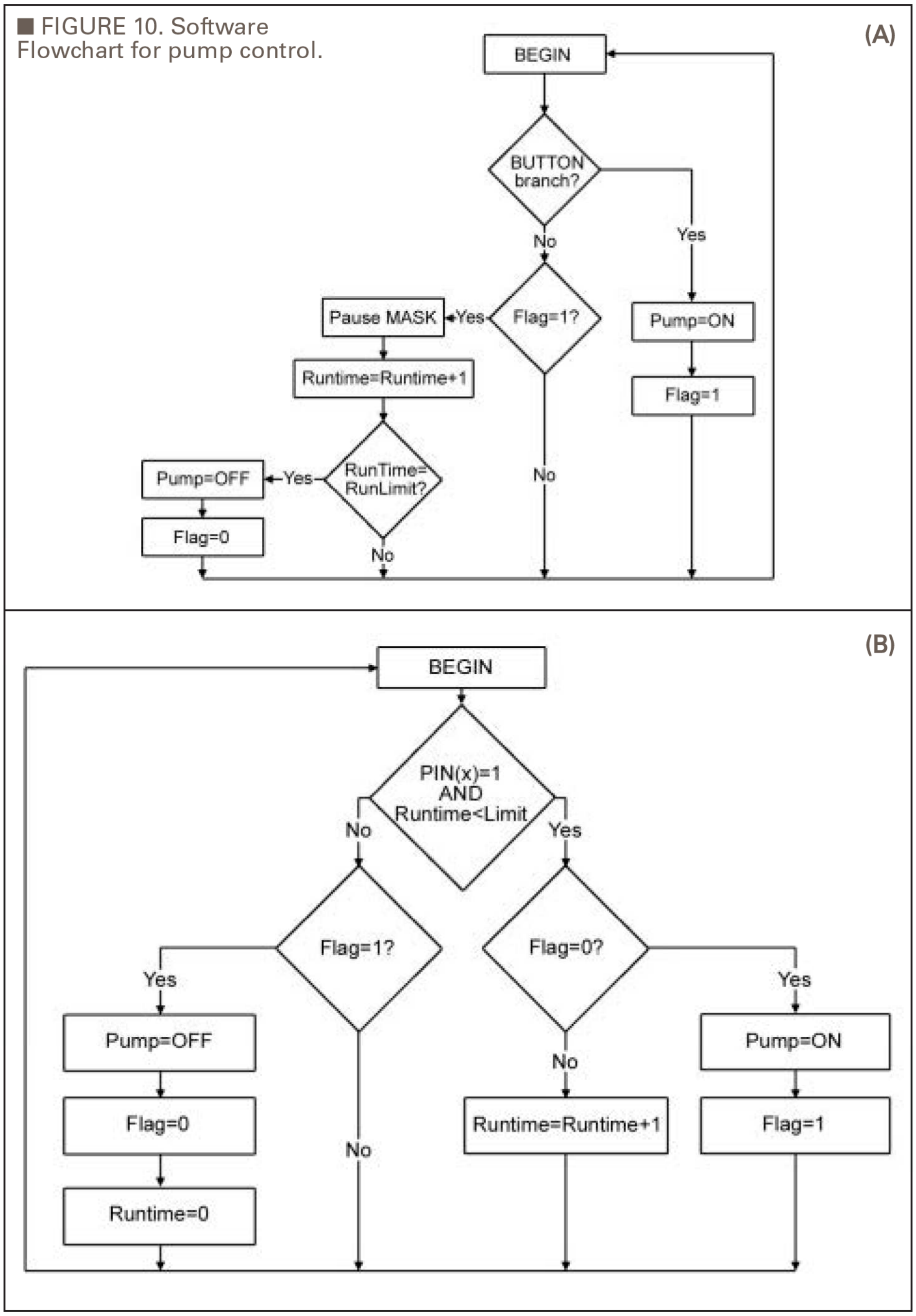
■ FIGURE 9. Software prototyping board Rev 1.



■ FIGURE 7. Finished box takes up the whole kitchen table!

■ FIGURE 8. The box after paint and decorations.

Once I had the basic functionality, I brought the board out to Dorkbot Austin (see Resources section for more info on "Dorkbot — People doing strange things with electricity") for a bit of a preview (Figure 11). The reaction was wonderful! The kids enjoyed playing with the board, even though all it did at the time was blink lights, make sounds, and spin servos! Lots of people were very interested in seeing how the final product would turn out.



■ FIGURE 10. Software Flowchart for pump control.

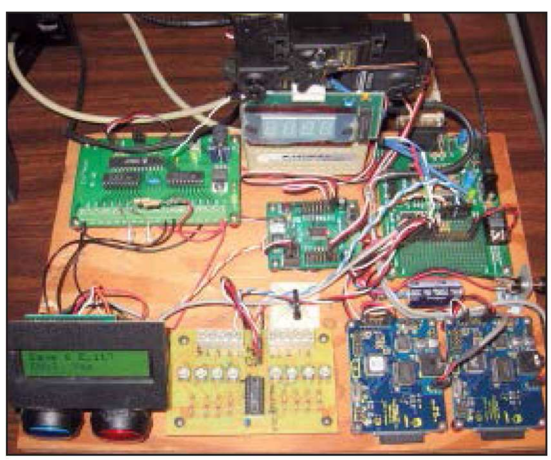
IF IT DON'T FIT, DON'T FORCE IT

Now that I had the basic building blocks of code, I started to try and string them together to get true game-style operation. For starters, I needed to track four paint shot buttons, four joystick directions, the number of paint shots remaining, how long the pumps ran, which pumps were on, when they should be turned off, what sound effects were playing, and how much time was left before the game was over! I very quickly realized I was not going to make all this fit in my trusty BASIC Stamp II chip.

Luckily, I had a Parallax BSIIp24 chip. This chip has eight memory slots. I could fit eight times the code into this chip and it was three times faster than the BSII. It would be even better at handling all the complex tasks that had to happen (in what appeared to the end user) as being in parallel. This turned out to be a very good choice as I soon discovered that, not only did I need to make the game work as described above, I had to build other modes of operation such as "Game Over," "Maintenance," "Setup," and "Attract" modes. In my final design, each of these options received its own slot in the BSIIp24.

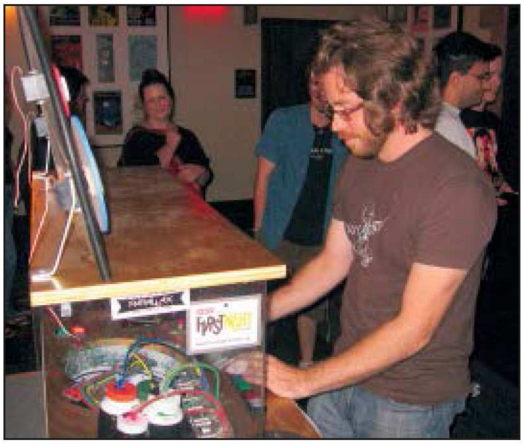
Though the BSIIp24 had more memory than the BASIC Stamp II, it still had the same number of pins. With all the features I was adding, I was rapidly running out of I/O on the chip. I turned to my friend Paul Atkinson (yet another Robot Group member) to help with the overhaul of the prototype board. Paul designed and etched a PCB to hold a 74LS165 input multiplexer to handle

■ FIGURE 11. RoboSpinArt designs and software prototype board presented at Dorkbot Austin.



■ FIGURE 12. Software prototyping board Rev 2.

■ FIGURE 13. Jonathan Coulton making a RoboSpinArt — In September 2007, we brought the RoboSpinArt machine to the Jonathan Coulton concert at the Cactus Cafe in Austin. The fans waiting in line got to make spin art and then Jonathan came out and made one himelf while the machine blasted Code Monkey! A link to a video is in the Resources section where Jonathan makes a spin art and then talks about the machine while onstage!



■ FIGURE 14. P.Y. Hung and Denise Scioli at the "build party."

the pump buttons and the joystick switches, and we added a Parallax Serial LCD display to show menus and settings in the Setup and Maintenance modes. We finished up by adding a second Rogue Robotics uMP3 player so we could have music and sound effects happen at the same time (Figure 12).

MUSIC TO MY EARS

Now that the demo board had proven successful, I needed to start on the sound effects. I contacted a good friend of mine, John Richter, who is (among other things) a rather talented composer. He has some very cool digital keyboards and he agreed to make some "sci-fi" sound effects to accompany the actions of the machine. Over a course of a few days, John sent me about 60 different sound effects from which I pulled 16 to use for the final sounds. Now, I just had to find that rockin' stereo soundtrack.

I had recently discovered Jonathan Coulton (some of you may be aware of his hit song "Code Monkey"), a musician with a huge online following and some very rockin' quirky tech-oriented music that I had listened to rather extensively while I worked on the software for the machine. I sent him an email asking if I could use his music for the soundtrack part of the project and included some details about the machine. Surprisingly, I received an almost immediate reply that not only gave me permission to use the music but declaring the RoboSpinArt machine "so awesome!" (Figure 13).

IF ONE IS GOOD ...

Now that I had the soundtrack done and most of the code written, it was time to put the parts into the actual machine and start testing. I had a build party at my house one weekend and invited some of the roboteers from The Robot Group (Figure 14) over to assist in putting together the prototype. We spent the afternoons transferring the parts from the proto board into the actual machine and I spent the evenings building and soldering the custom wiring loom (Figure 15). By the end of the weekend, I had a baseline operational RoboSpinArt machine with all the parts mounted (Figure 16). Which is good because about that time we finally heard from First Night Austin.

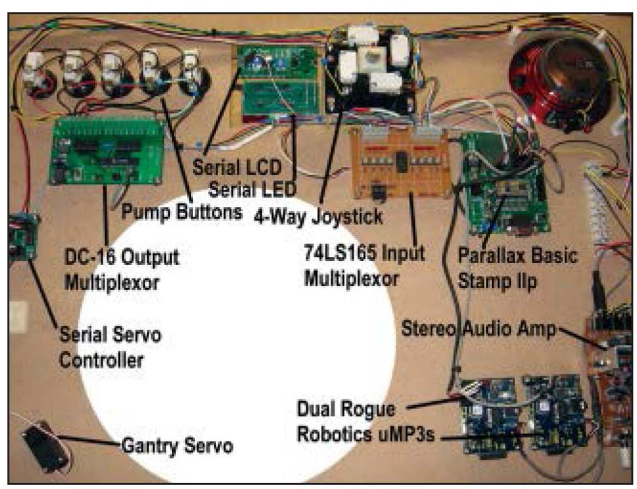
Seems they really liked the idea of a RoboSpinArt machine. In fact, they liked the idea so much that they wanted to know if we could build two of them for First Night! Oh, and while we were at it, could we bring a machine down for a little PR event at city hall where the mayor of Austin would be announcing First Night Austin at a press conference ... this weekend? Lucky for us, we had started early so we were able to show off a fully operational RoboSpinArt machine (Figure 17). At the press event, several people took turns

■ FIGURE 15. The author building the wire loom.

making spin art while the cameras rolled (Figure 18), and I had the opportunity to describe the machine for some reporters (Figure 19).

ON YOUR MARK, GET SET ...

The next weeks were spent pulling late nights and building as much as we



■ FIGURE 16. Parts layout after mounting.

RESOURCES

■ RoboSpinArt website
www.RoboSpinArt.com

■ The Robot Group
www.TheRobotGroup.org

■ First Night Austin
www.FirstNightAustin.org

■ Dorkbot Austin
http://DorkbotAustin.org

■ Jonathan Coulton on RoboSpinArt video
www.youtube.com/watch?v=WcovKOzvRTc

■ "RoboSpinArt — Concept to Concrete" video
www.youtube.com/watch?v=bEKPDoNCyZk

■ "Ink jet gantry — proof of concept" video
www.youtube.com/watch?v=1VzIrBQeaQ0

■ FIGURE 17. The Robot Group with the RoboSpinArt machine at Austin City Hall.

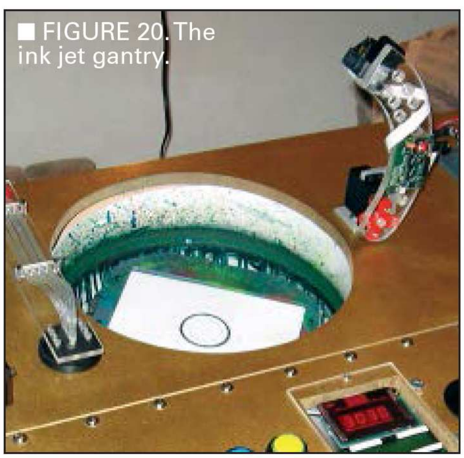
■ FIGURE 19. The author interviewed by KUT radio.

■ FIGURE 18. The press had fun shooting the spinning colors.

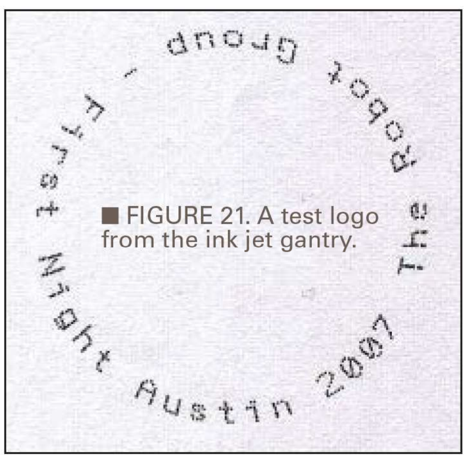
could as quickly as we could trying to make a complete second RoboSpinArt machine from scratch. Rick made a second set of peristaltic pumps (again all by hand) and another spinner for the bucket in record time. Paul photo-etched more custom printed circuit boards. Many other roboteers stepped in to help with woodworking, decorations, painting, circuit board preparation, and all the other bits needed to finish the machine.

In the end, we only ended up with two unrealized features: the strobe light sync circuit and the ink jet painting gantry. Though we did get the ink jet gantry mounted (Figure 20) and in preliminary tests we could get it to print the circular logo (Figure 21), we found we would need a more precise motor speed controller to make sure that the ink jet wouldn't underwrite or overwrite the text due to variations in speed of the motor that spun the paper. The solution (a feedback enabled motor controller) would require us to rework the shaft sensor to provide the feedback. Unfortunately, it would also require a reworking of the strobe light timing circuit to process this new signal. There just wasn't time to get it done, so the strobe effect and the ink jet would have to wait.

For all intents and purposes, when the day arrived, we had two fully operational RoboSpinArt machines (Figure 22) ready for First Night. We set up on the day of New Year's Eve in front of City Hall at 10:30 a.m. By 11:00 a.m. we had a line of people waiting, so we fired up the machines and started painting. We had a steady line of folks till 11:30 that night (Figure 23)! The machines ran non-stop (only changing out the operators) for a full 12+ hours, going through well over 1,600 cards without a single system failure. It was an amazing success! Little children, older folks, parents — everyone loved making spin art!



■ FIGURE 20. The ink jet gantry.



■ FIGURE 21. A test logo from the ink jet gantry.

■ FIGURE 22. The author with two working RoboSpinArt machines.

ROBOSPINART OPERATION

To operate the RoboSpinArt machine, a person behind the unit (the operator) will place a piece of paper on the turntable. Once the paper is in place and an artist is ready to begin, the operator presses a start button on the back of the cabinet. At this point, the RoboSpinArt machine will drop a print head down onto the paper and inscribe a circular message onto the paper. After the inscription, the turntable will spin up to the accompaniment of music. Once up to speed, the artist will be verbally signaled with a countdown of "three ... two ... one ... PAINT!" At this point, they may choose to:

- Move the paint gantry left or right with the joystick.
- Increase or decrease the speed of the turntable with the joystick.
- Dispense paint using the pushbuttons.
- Activate the strobe light.

Once 30 paint shots or 30 seconds has elapsed (time and paint shot values are adjustable by the operator), the turntable will spin down and the operator is signaled to remove the painting.

The operator unloads the finished art and then reloads paper for the next artist. When not actively painting, the RoboSpinArt will revert to "attract mode" where sounds and lights will entice people into trying their hand at creating art.

With a typical turn-around time of 1.5 minutes per artwork (20 seconds to load the paper, 20 seconds to inscribe the message, 30 seconds for the artist to paint, and 20 seconds to remove the paper and hand to the artist), each RoboSpinArt machine can entertain approximately 40 people per hour.

AND ... WE'RE BACK!

Since that night, the RoboSpinArt machines have been a staple at Robot Group events. We even had one of them up and running during Maker Faire Austin (Figure 24). The folks at First Night were also very happy with the RoboSpinArt performance. In fact, they've booked us for a return engagement! At this year's First Night Austin, our two RoboSpinArt machines will flank The Ponginator (see *Nuts & Volts* December '07) which will be making its inaugural outdoor appearance. We plan to have the strobe light function and the ink jet gantries added to the RoboSpinArt machines by then so, if you're in Austin on December 31, 2007, feel free to come by and make some RoboSpinArt with us! **NV**

■ FIGURE 24. The RoboSpinArt machine at Maker Faire Austin.

■ FIGURE 23. The crowd formed two lines at First Night Austin.

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