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November 2009

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Der Magnetfelder
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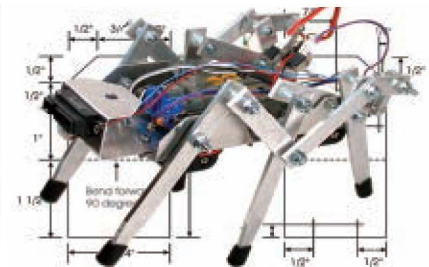
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- Ultrasound Bat Detector
- Flashing Light Alarm
- Cylinder Head

Temperature Measurement



■ BY VERN GRANER

TRY, TRY AGAIN

"I have not failed. I've just found 10,000 ways that won't work."
— **Thomas Alva Edison**

IF AT FIRST YOU DON'T SUCCEED ... DON'T TAKE UP SKYDIVING! Yes, I know "try again" has to be one of the oldest work-related clichés. However, many times if you turn over a dusty old cliché, you find a kernel of truth nestled under it. In this particular case, that kernel is persistence pays. My direct experience has taught me that nothing is ever as easy as it looks.

Experience has also taught me that when things get complicated, a methodical and consistent approach is typically the best course of action. Problems seem to be a natural part of development, so encountering them should come as no surprise and you certainly shouldn't let possible (or actual) problems stop you from building. If you've started building, it means you have something to work on, something to improve.

YOU MAY ASK YOURSELF HOW DID THIS GET HERE?

Sometimes, when we see a finished project, we can only picture it in its finished form. It seems as if it sprung fully-formed from the mind of the creator directly into being. In my career, this has never been the case. I have to design, then prototype, then test (lather, rinse, repeat!). I evaluate what works in the prototype and what doesn't. I then revisit the design and make changes. Sometimes the creation and testing of a prototype reveals better ways that the idea might be implemented. Other times, things just don't work no matter how the diagrams, datasheets, and experts insist it should!

In this month's article, I'm going to give you a behind the scenes tour of the more notable projects I've been involved with and the hidden problems we encountered along the way. I hope to document how these projects would never have come to fruition if not for many people's tenacity in overcoming problems and improvising solutions. I'll begin with one of the single biggest projects upon which I've worked, The Ponginator.

THE PONGINATOR MK-I

Back in the December '07 issue of *Nuts & Volts*, I introduced The Ponginator MK-I, a 20 foot tall smoke-spewing, light-flashing, music-playing, siren-wailing robot with quad-barrel

pneumatic ping pong ball cannons. It was the centerpiece of The Robot Group's presentation for the very first Maker Faire in Austin, TX. In the days leading up to that event, we had struggled with various issues including multiple prototype ping pong ball propulsion systems, leaky air lines, and a stripped cannon pan motor.

In spite of those challenges, the Ponginator was assembled on-site the day before Maker Faire opened and performed much more smoothly than anyone could have imagined. The Ponginator was an unmitigated success. It operated amazingly well for something that, in only 30 days, went from a pencil sketch to towering over the arena floor. This was just the beginning of the Ponginator's career, and more problems would present themselves as we tried to adapt it to changing requirements.

THE PONGINATOR MK-II

When it came time for the next event, we figured it would be easy to just bring out the Ponginator and set him right back up. Unfortunately, when we visited the proposed site, we discovered that we would be in an outdoor area. In the original design, we hadn't considered the challenges an outdoor venue would pose. For starters, the MK-I used a two-story construction scaffolding as a frame and was wrapped with a tarp. There was concern over how we would keep the whole thing from toppling over if the wind picked up. To be safe, we needed to redesign the frame and find something fairly substantial to use as an anchor. Time to put on the thinking caps!



■ FIGURE 1. The Ponginator MK-II frame test-fit on the van.



■ FIGURE 2. Testing the pneumatic cannons on the new frame.



■ FIGURE 3. Test-fitting the Ponginator MK-III on the new bucket lift.

As we would need transportation to and from the event anyway, we decided my full-sized Ford van could act as both the frame and the anchor. We fabricated a new PVC-pipe frame from scratch that mounted to the top of the van (**Figure 1**). We then mounted the crossbar and hung the pneumatic cannons to make sure they could still move properly (**Figure 2**). Though we still had the original Ponginator "skin," we discovered we would need to make a new one as the old one had both a hole cut for a video display (not practical in the MK-II design) and was also about five feet too big for the new frame.

In spite of having to do a thorough retrofit, on the day of the show we managed to assemble the Ponginator for the first time in downtown Austin without any major issues. The MK-II was a smash hit, thrilling crowds with his siren wail and catchy dance tunes. This event also saw the unveiling of the Ping Pong Printer, which didn't exactly go as planned either (are you seeing a trend here?), but we'll touch on that in a bit.

THE PONGINATOR MK-III

After this last show was done, the Ponginator again went into a storage shed until the next big event: Maker

■ FIGURE 4. The Ponginator MK-III towering 30 feet up in the air.



■ FIGURE 5. The Ping Pong Printer with plastic water jug hopper.



Faire Austin 2008. By the time this event rolled around, I had sold the van so we no longer had our "base." However, as luck would have it, my brother Walt had recently purchased a 30 foot hydraulic bucket-lift for his construction company and was happy to let us use it.

We brought all the parts out of storage and mounted them on the lift bucket (**Figure 3**). After fabricating new brackets, adding shelves for the speakers, and mounting the air compressor, we towed the lift out from under the trees and extended it to its full height of 30 feet (**Figure 4**). It looked AMAZING!

When it was time for the event, we trucked the lift out to the Maker Faire show but on the way, one of the gear motors that positions the cannons stripped due to stresses on the mounts created by the movement of the trailer while being towed. We had to quickly swap motors out on the show floor when we arrived. As before, we put all the new electronics and pneumatics together for the first time right there at the show. Once again, the Ponginator lived up to its reputation, not only earning us another Maker Faire "Editors Choice" Blue Ribbon, but also being immortalized on a MAKE poster, and then to headlining on the GeeksAreSexy.com website, among others.

This is a perfect example of how a project can still enjoy continuous success in spite of changing circumstances if the people involved persist. Which brings us to the Ping Pong Printer — a rather problem-plagued device that grew out of the Ponginator project.

PING PONG PRINTER PROBLEMS

The Ping Pong Printer was featured in my February '08 column and was basically a solution to an economic problem. Turns out the Ponginator uses up lots of ping pong balls when it's in operation. As we wanted the ping pong balls to be souvenirs (and not just trash), we had some custom-printed ping pong balls created for the MK-I. Though these worked fine, they turned out to be very expensive (on the order of about .60 cents each!).

The Ping Pong Printer was designed to allow us to create our own "ordnance" for the Ponginator. It was built by a team of folks from The Robot Group including myself (programming), Rick Abbott (metal/plastic fabrication), and Marvin Niebuhr (carpentry).

THAT JAMMED JUG!

When I first designed the Ping Pong Printer, a five



DER MAGNETFELDER DETEKTOR: DAS BLINKENBOARD!

by Nyssa Hughes and James Delaney

As promised, we continue our series on new uses for Das BlinkenBoard. This month, we feature an amazing and simple mod from the "UnfocusedBrains" of James Delaney and Nyssa Hughes. By adding a Hall-effect sensor and a 2K resistor, they have turned the mild mannered Das BlinkenBoard into a magnetic field detector! It uses the LEDs as a bar-graph to display both relative field strength and magnetic pole polarity of magnets held near the sensor. In their own words, here's how James and Nyssa did it:

Because our home laboratory was without a way to measure relative magnetic field strength, we figured it was time to build a simple Gauss meter. Turns out it was really easy! We started by reading a few datasheets, then settling on a Honeywell SS49 analog position sensor (which is a type of Hall-effect sensor). By connecting the part to a voltmeter, we were able to detect magnetic fields from various magnets and read voltage levels from the SS49 to determine the field's relative strength.

Not wanting to stop there, we decided to build a steam-punk inspired "prop" version of a magnet detector. Fortunately, we had a Das BlinkenBoard on hand, so James built a cable to connect the SS49 to the BlinkenBoard (FIGURE A). When it came time to program the microprocessor on the BlinkenBoard, James ran into some challenges when he discovered that the datasheet for the SS49 sensor was very confusing. Our friend Paul Atkinson came to the rescue (he always seems to be helping us out!). He read the datasheet and told James that a 2K ohm "load" resistor would be needed to make the SS49 work according to specifications. We simply added the resistor and Der Magnetfelder Detektor (DMD) was born.

Now that we had the unit working, the final step was to build a snazzy case in which to place the electronics. Since this is a prop version of a magnet detector, we decided to build it as a piece of

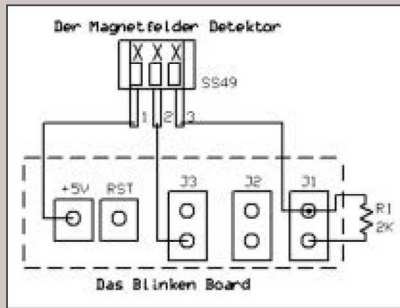


FIGURE A. Schematic showing how to connect the SS49 to the Das BlinkenBoard.



FIGURE B. The printed cover for "Der Magnetfelder Detektor."

foam covered in an ink jet color-printed "skin." Nyssa cut two pieces of foam into a 3" x 5" rectangle to make the case deep enough. She then cut a BlinkenBoard-sized hole in both pieces. As James designed the custom graphics

FIGURE C. The Das BlinkenBoard mounted in the foam enclosure.



for the skin, Nyssa glued the two pieces of foam together. The graphic was printed, sprayed with a layer of protective acrylic, and cut out (FIGURE B). The SS49 sensor was taped to the back of the paper, with the sensor facing up (FIGURE C).

Next, Nyssa stuffed the BlinkenBoard into the foam frame with the circuit. This allowed room to run all the cables for the LEDs in the space beneath the circuit board. She pushed the SS49 sensor cable into a gap between the circuit board and the foam, and plugged it into the circuit board.

Then, it was time to glue the graphic to the foam and drill the holes. The graphic was glued only to the face of the DMD. Using a drill press made quick work of the eight holes. With the holes drilled, Nyssa was about to stuff the LEDs through, but first needed to figure out which LED was "South." The first LED in the series is the one that goes into the South hole. The eighth LED is the one that goes into the North hole.

The LEDs were poked through the holes in sequential order. After some adjustments, the LED cables got organized, plugged in, and taped down. Nyssa poked a hole into the side of the paper-



FIGURE D. The Cables and foam feet on the bottom of the foam case.

covered foam through which to run the power. She glued the sides of the DMD and added some foam feet (FIGURE D).

Now it was time to play with magnets! By holding a magnet to the DMD's printed button, you can determine the general strength (i.e., one LED versus eight LEDs) and the alignment of the magnet. If the bar graph starts on

the North side, you are holding the North pole of the magnet to the sensor and vice-versa.

Please let us know if you configure your Das BlinkenBoard as Der Magnetfelder Detektor. Also, please let us know if you do something fun and interesting with your own Das BlinkenBoard. You can send your emails to vern@txis.com.

DER MAGNETFELDER DETEKTOR RESOURCES

Honeywell SS49 Sensor from Mouser
www.mouser.com/ProductDetail/Honeywell/SS49?qs=sGAEpiMZZMvhQj7WZhFIALYB7HV1zJHhKzTnhQJMM%252bM%3d

James Delaney's Blog
www.unfocusedbrain.com/

Nyssa Hughes' Blog
[www.nyssa.com/http://en.wikipedia.org/wiki/Hall_effect](http://en.wikipedia.org/wiki/Hall_effect)

Das BlinkenBoard Web Page
www.DasBlinkenBoard.com

Source Code
www.nutsvolts.com/index.php?/magazine/downloads/

gallon water jug was sitting on a cooler by the kitchen table where I was sketching. I envisioned the jug filled with ping pong balls (like a gumball machine) and a motor "stirring" the balls to make sure they flowed down the bottle neck to the printer. I figured that would make a simple and easy "hopper" to feed blank ping pong balls into the printer. It looked good on paper and once built, it worked fine with a handful of ping pong balls. However, once we

filled up the entire water jug, the first problem appeared.

At the beginning of the print cycle, the stirring rod system would activate as designed but, instead of the balls mixing around, they would "stack up" and stick to each other. This would cause the stirring rods to bind and resulted in the motor attempting to back spin, twisting and eventually tearing up the motor wires.

Upon closer inspection, we discovered that — unlike

the smooth-surfaced gumballs I used for inspiration — ping pong balls are created with an abrasive surface so they can get traction on the ping pong paddle and table. Unfortunately, this extra friction caused the balls to stick together in the jug, jamming the stirring rods. The only way to un-jam the system was to fill the jug to less than 10% of its capacity (**Figure 5**) which really defeated the purpose of the jug itself. This was about the time we noticed a second problem with the design (insert deep sigh here).

It seems that rotating the ping pong balls inside the plastic jug caused them to build up a static electric charge! This would cause the ping pong balls to cling tenaciously to the sides of the jug making the stacking/jamming problem worse and, of course, stopping them from dropping down through the indexer to the print pedestal (insert second deep sigh here).

DOES SIZE REALLY MATTER?

As we were pondering what to do about the sticking, stacking, and static problems, our bulk-order of blank white ping pong balls arrived. We were excited by this good news and dumped a bunch of these new balls right into the jug in the hopes they would be smoother and might alleviate the jamming. No such luck. These new balls jammed the exact same way. We weren't getting off that easy! We then dumped out the jug and put just a handful of these new balls back in for testing. We activated the printer and the first ball dropped right onto the pedestal for printing as expected (**Figure 6**). When the printing was done, the "indexer" (**Figure 7**) started to cycle, then jammed without releasing the second ball. We removed the jammed ball and tried again. Same thing, the indexer was stuck and would not release the second ball. A lot of head scratching later, we discovered the root cause of the indexer jams.

It turns out that there are two "types" of ping pong balls. The first type is "professional" 40 mm balls and the second type are "hobby" ping pong balls that are 38 mm. We had started buying the test balls from local sporting goods stores and they were of the 40 mm variety. Subsequently, when Rick had machined the parts, he had used 40 mm as his reference size. When the indexer would try to cycle, it would bump into the bottom edge of the next ball in line to be printed and stall without completing the cycle. Rick took the

printer back to his shop and reworked the indexer push-bars to accommodate the 38 mm balls. Once this was done, the bulk purchased balls worked fine but we still had the existing multiple water jug issues to contend with.

CHANGE TO CHAIN DRIVE

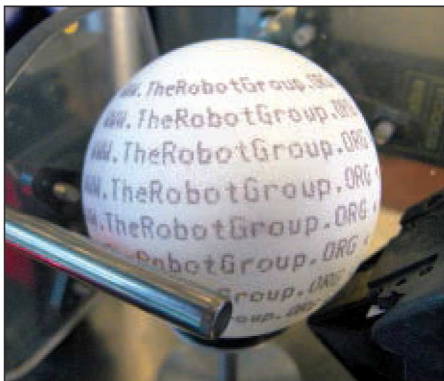
When Rick had the Ping Pong Printer at his shop to re-engineer it for the 38 mm balls, he also took time to look at the plastic jug and try to come up with a new way to serve ping pong balls to the printer. After a few different designs were tossed around, he settled on an ingenious chain drive belt-scoop feed system which he then fabricated from aluminum, polycarbonate plastic, and steel (**Figure 8**). This new system would ferry the balls up to the top of the Ping Pong Printer, then let them roll down a ramp and drop into the indexer. This new design solved both the static problem as well as the stacking/sticking problem, but at the cost of a bit more software complexity. I had to figure out how to sense when to run the motor and — more importantly — when to stop it. To deal with this, I added an IR beam-break detector to determine when a ball was rolling down the ramp. A bit of coding had the software turning on the belt drive motor, waiting for a ball to occlude the sensor, then switching the motor off. With these modifications, the new and improved Ping Pong Printer was all ready to go.

Since then, we've used the Ping Pong Printer not just to make "ammo" for the Ponginator, but to create souvenirs for many events such as movie premieres (**Figure 9**), South By South West Austin, and multiple Dorkbot events. Around this time, the video of the Ping Pong Printer in action (with its original water jug) was picked up by a number of tech-blogs and ended up with over 30,000 views (and counting)!

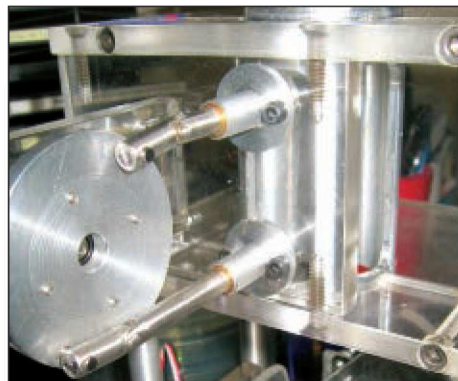
NOTHING EVER GOES AS PLANNED

The point I'm trying to make with all this detail on what went wrong and how it was overcome is that we have yet to encounter a problem that could not be bested with the proper amount of perseverance. As the above examples show, given the right motivation and the right people, you can overcome just about any engineering challenge. Just expect that Murphy is alive and well and living in your

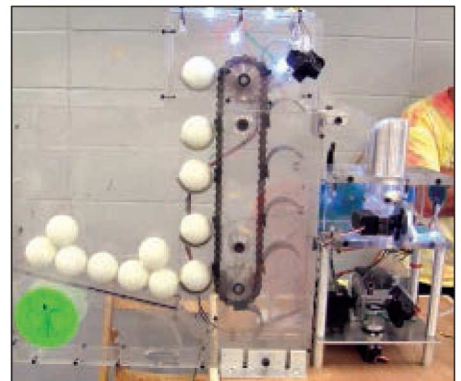
■ FIGURE 6. A ping pong ball on the print pedestal after printing.



■ FIGURE 7. The indexer stage that controls the fall of balls into the printer.



■ FIGURE 8. The new chain-drive ping pong ball hopper.





■ FIGURE 9. The Ping Pong Printer at a movie premier in Austin, TX.

projects, but with the right team, and/or the right attitude, he can be evicted. You just have to learn to manage the stress.

HOW DO YOU SPELL "SUCCESS?"

For many of us (me included!), success is spelled "S-T-R-E-S-S." When a deadline is looming, you're staring down the throat of a killer problem, and you have no idea of how to solve it, it's time to try and regain perspective. Take a deep breath and a step back. Look at what you're doing, what you've accomplished, and envision how you would like things to come out. Remember the bottom line: Making things is supposed to be fun! Unfortunately, the price of this type of fun is sometimes a bit of stress (okay, sometimes more than a bit!). Being nervous, feeling pressure, getting headaches, lack of sleep, worrying, and then worrying some more, then worrying about worrying ... The point is to "keep your eye on the prize."

Bear with me as I wax a bit philosophical here; projects like these are supposed to be the events that — when you look back on your life — clearly stand out as landmarks along the twisted path of this mortal coil (hmm ... I wonder how many uH a mortal coil has ... but I digress ...). I don't know about you, but when I turn around and examine my life there are long gray blurs of continuous, monotonous, "work." Swaths of the regular "nine to five" stuff that consumes much of my life. Honestly, I can't tell you what I was doing at this time and date exactly 10 years ago, or even 10 months ago! However, I can tell you all about my first Maker Faire in San Mateo, CA and going out to San Francisco to attend RoboGames. I can tell you about the first First Night Austin, and the second First Night Austin, and I can also tell you all about the first Robot Group meeting I attended. I can tell you all about the first article I had published in this magazine (yes, writing can be a project!).

For me, these projects really stand out when I look back on my life. I can also tell you that each and every one of these memorable events was surrounded by stress. It was the price of admission. The interesting part is that each of us gets to set that ticket price. If we choose to relax, take the long view, and realize this isn't rocket

RESOURCES

Maker Faire Austin
<http://makerfaire.com/pub/e/2097>

Ponginator in *Nuts & Volts*:
<http://nutsvolts.texterity.com/nutsvolts/200712#pg84>

The Robot Group
www.TheRobotGroup.org

The Ping Pong Printer in
Nuts & Volts
<http://nutsvolts.texterity.com/nutsvolts/200802#pg14>

The Original Ponginator Video:
www.youtube.com/watch?v=iPS0

FYHwJw

The Ponginator featured on
 GeeksAreSexy.com:
www.geeksaresexy.com/2009/02/10/feature-the-ponginator-a-robotic-combination-of-king-kong-and-ping-pong/

The Original Ping Pong
 Printer Video:
www.youtube.com/watch?v=8Ep5OC3E02I

The Ping Pong Printer on the net:
<http://tinyurl.com/161>

The Creation of the Thereping
<http://nutsvolts.texterity.com/nutsvolts/200604#pg50>

science (well ... maybe in some cases it is), it might help to reduce that price.


Remember: ELECTRONICS IS SUPPOSED TO BE FUN! Treat it accordingly. Build a project, draw a drawing, create a monster, find a team, form a team, do something that challenges you. Take some chances. But for cryin' out loud, HAVE FUN with it! And please, PLEASE take care of yourself so you can be healthy and ready to PLAY! If you have questions, comments, or would like to share your project experiences, feel free to drop me an email. As always, I can be reached at vern@txis.com. **NV**

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