Tinkerer's

The Rube Goldberg Machine Contest

When I was a kid, if you asked me what I wanted to be when I grew up, I always said, "an inventor." I was always putting things together in new ways to make other things. Watching my mom struggle to reach stuff in tall cabinets, I used a bent coat-hanger, a toilet paper roll, and masking tape to make her a "grabber." At my grandparents' house, I hid my toys in a bucket that could be hoisted up to the rafters with a pulley system. So in high school, when I learned there was a Rube Goldberg Machine Contest, I was interested.

The competition is named after engineer Reuben Lucius Goldberg, who is known for drawing outrageously complicated contraptions as a way of poking fun at increasingly complex machines. Contestants construct machines that use as many steps as possible to complete an annual task, such as assembling a hamburger, squeezing toothpaste from a tube onto a brush, and watering a plant.

My junior year, I put together a team. Although we didn't win any competitions, I learned how to pace the building process, what qualities make a good team member, and what kinds of steps will generally be successful. In my senior year, I decided to try again. The challenge: to inflate a balloon and pop it. The winner of my high school contest in February would advance to the state competition. But first, I needed a team.

Fundamental Parts and Random Trinkets

Teams are limited to 12 members. I needed people who not only are intelligent but also work hard consistently, work well with others, and have practical skills that they apply to a variety of jobs. I began by recruiting a couple of students from my previous team, including one who would become my co-leader, Anthony.

By October, our team—four girls and eight guys from my school—was ready. We met at my house every Sunday to figure out how to approach the project. We started by deciding on our machine's theme. It's usually what spectators remember a machine

Team members Alex Zaug, Christian Owen, Renee Kumon, Matt Sherbahn, Casey Bryniarski, Nicole Johnson, Colton Cannon, Lauren Pentz, Lawrence Whitney, and Anthony Groenewold.

by Christian Owen

Dream

by, and it accounts for 10 percent of the overall score. After a vote, we chose an office theme.

Supplies grew as team members contributed various items: ball bearings, wood scraps, adhesives. Over winter break, we built the base of the machine—a cubicle—and decorated it with pens, pencils, coffee mugs, binders, calendars, and mock diplomas. As we sketched step designs and built prototypes, my basement became increasingly messy. It was a good messy, though, consisting of random trinkets that helped inspire steps—such as the stapler that connected a circuit when closed—even when our imaginations seemed drained.

Building a Machine, Step by Step

The competition required at least 20 steps; we were aiming for 40. By the time winter break ended, though, we'd built only 15, several of which were simple transitions between more interesting steps—those that make an impact on spectators and judges. A good machine is determined not only by the number of steps it contains, but also by the level of entertainment the steps provide. One of our most interesting steps was a fan that, when turned on, caused a ping-pong ball to accelerate up a transparent tube.

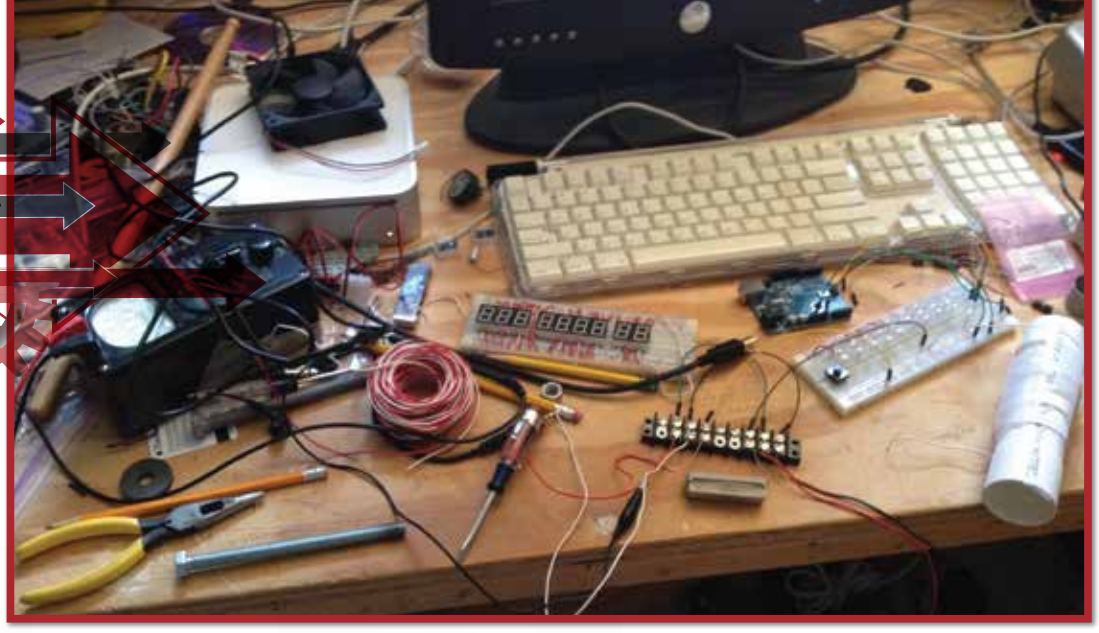
Several weeks later, we had built and connected all the steps except the final one, which we had yet to determine. Since most of the steps hadn't been tested in conjunction with other steps, though, it was time to do a full run-through.

After all the steps were in place, Anthony started the machine by placing a sheet of paper in a paper shredder. The first error occurred immediately when the shredder failed to pull the piece of paper all the way through—which would have rotated a dowel, which in turn would have caused a plastic finger to hit the return key on a typewriter. Still optimistic, I poked the return key, which sent the carriage crashing into the open stapler. The machine ran smoothly for the next few steps, and I began to hope that the first step failure would be the only one. I was wrong. A water wheel failed to spin after water was poured on it; a ball got stuck in a wooden ramp. But while the problem-filled run was discouraging, it helped us see what we needed to fix.

A Perfect Run

Figuring out how to inflate the balloon was harder than we thought: a homemade pump proved unreliable, and our second idea, using gas-producing chemical reactions to inflate the balloon, was unsuccessful. It was a week until the competition, and we were still trying to figure out our most important step!

Two days before the competition, I thought of using dry ice as a means of filling the balloon. It seemed like a long shot: dry ice might be hard to get, and it sublimates at any temperature above -80 degrees Celsius. But ideas—and time—were running short. While two team members went to find dry ice, the rest of us explored how we would get the CO_2 gas (from the sublimation) into the balloon. We sketched out a plan, and an hour later had built a system consisting of two chambers, one containing water, and the other, dry ice. The chambers were



A good kind of messy.

connected by a one-way valve in series with a ball valve. When we tested it, the one-way valve didn't work properly: pressure backed up into the water chamber instead of filling the balloon.

For our next attempt, we half-filled an air container with water and connected it to the balloon with an air hose. A magnet on top of the container suspended a metal cage inside the container; in the cage was a small piece of dry ice. When the magnet was removed, the cage dropped into the water, causing the dry ice to sublimate rapidly. The CO_2 gas traveled through the hose, filling the balloon.

The night before the competition, the team watched as Anthony put the paper in the shredder. We held our breath as step after step worked flawlessly. Nearing the end, the CO_2 quickly built up in the container, causing the balloon to inflate, which set off another step that sent a pen flying down a tube. The pen's point hit the center of the overstretched balloon, and with a loud bang, the run was complete. The team erupted into cheers. Tired but excited, we packed up the machine. The competition would take place after school the next day.

A Strong Tradition

We got up early to take the machine to school. When you disassemble, transport, and reassemble any machine, things get out of alignment; you have to recalibrate them for the machine to work properly. Thankfully, no major problems arose, and we were able to get the machine assembled before school started.

After school, the competition classroom was crowded with the five competing teams, their machines, and many spectators. Our school has a strong tradition of excelling at Rube Goldberg competitions, so the pressure was on.

The rules are simple: Two members from each team have 15 minutes to prepare their machines, making sure each step is ready. Then, each team's spokesperson explains to the judges how their machine works. Each team runs its machine twice. If any steps fail during a run, one of two designated resetters may touch the machine to get it going again.

When I saw that there were no weak machines at the competition, I grew nervous. We had 40 steps—and they were generally pretty complicated—but would it be enough to beat the competition?

On the first run, our machine required two touches. We watched anxiously as the other machines ran. They all performed well; one team had a perfect run. On our second run, we again had two touches. After all the teams had finished their second runs, the judges went off to decide the winner. When they returned, the head judge congratulated everyone on their machines. When he announced the second place team, it wasn't us. After the applause died down, the room fell silent. The judge cleared his throat and said, "The winner of this competition is…the office-themed team!" We were ecstatic.

The victory gave us a spot at the Illinois state competition two weeks later. Other than a few minor tweaks, we didn't mess with the machine's mechanics. Instead, we focused on making it look nice, adding carpet to the cubicle floor and painting the walls and desks. At the state competition, we competed against 11 other teams. We finished second, with two good runs—one touch on each—and we were proud of our machine and of what we had accomplished as a team.

Participating in these competitions has shown me that failure and adversity are better teachers than success. Working as part of a team to build a Rube Goldberg machine is the closest I've come to a real engineering job, and it affirmed my desire to become an engineer. i

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For information on this and other Rube Goldberg competitions, go to www.rubegoldberg.com.