Machinations

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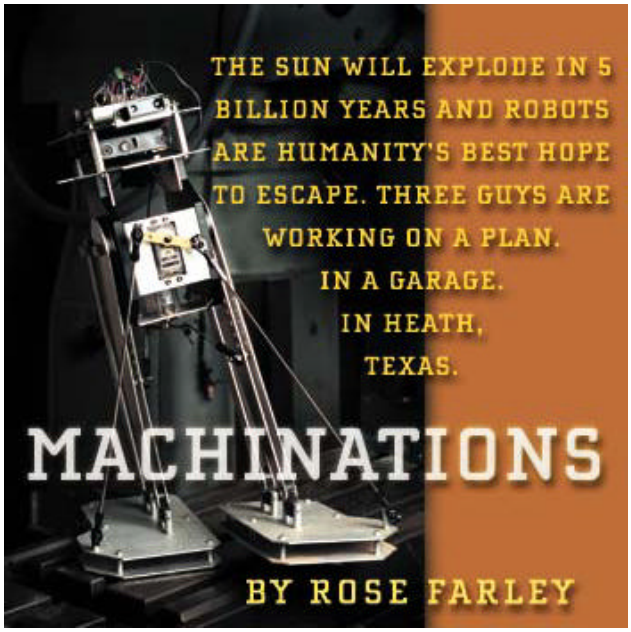
BY ROSE FARLEY



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The sun will explode in 5 billion years, and robots are humanity's best hope to escape. Three guys are working on a plan. In a garage. In Heath, Texas.

By Rose Farley

A few miles east of Lake Ray Hubbard, deep in the heart of the orderly suburb of Heath, a halogen beam cuts into the darkness surrounding Barry Jordan's two-car garage. There, amid the glow, Jordan hosts another session of Robot Builder's Night Out, attended, as usual, by his partners Eric Yundt and Kip Moravec.

The men are three of the more committed--or some might suggest, committable--members of the Dallas Personal Robotics Group, the oldest robot builders club in the nation, which operates by the motto, "It's a lot harder than it looks."

Lately, robots have been attracting a new generation of admirers, thanks in part to the popularity of shows like *BattleBots*, in which remote-controlled metal monsters, bearing names such as "Your Worst Nightmare," beat each other's batteries out for prime-time audiences. Jordan's garage represents the less flashy but more authentic side of a boting--an interdisciplinary hobby carried out by self-admitted geeks and mechanical wizards who strive to create robots that can survive independently of humans.

These botters revile the mindless destruction of *BattleBots*, choosing instead to embrace the ethics of science fiction authors, namely Isaac Asimov, who laid out a vision of a future in which dangerously superior robots work for the benefit of mankind.

Nerds they may be. Ninnies they are not.

By day Jordan is a structural engineer, whose best-known contribution to commercial architecture was to design the first rapid oil change building. Dressed in a pair of Wrangler jeans, Jordan hoists a boot up on a workbench and explains why his garage resembles a high school shop class.

"Before I got married, I raced dirt bikes," Jordan says. "When I got married, my wife said, 'You're not riding dirt bikes anymore.' So I traded in those toys for these toys."

Jordan is talking about the industrial-sized lathe that consumes one-half of the back wall. There is also a brake, which Jordan describes as a "giant paper cutter for metal."

"Barry's got the undisputed best toys," says Yundt, a tech-support guy by trade, whose contribution to this group is his computer programming skills.

Tonight's task is making "bot bones," which, like human bones, create a sturdy frame that protects the sensitive electronic brains that bring robots to life. Ultimately, the trio hopes to mass produce these aluminum bones and sell them via the robot hobbyists' handbook, *Nuts & Volts* magazine. The bones will be part of a bigger robot builder's kit, which will come complete with gears, encoders and motor mounts, all made right here in Jordan's garage.

At the moment, the enterprise is ground to a halt because the drill Yundt has been using is mysteriously stalled. That the 4-foot-tall contraption even works is a feat of engineering. Originally, it was a commercial-grade microscope, salvaged by another group member whose wife ordered it removed from her garage. Brought here, Jordan hacked off the lens and replaced it with a drill, attaching it to the machine with a thick rubber band Yundt lifted off his wife's vacuum cleaner. The group then wired the machine to an old computer, which Yundt uses to program the drill.

"A big part of boting is making tools you need to make what you want to make. It's like the old days, when the blacksmith made his own nails," Yundt says.

Moravec, an electrical engineer, wants to use the lathe to drill a hole into the center of his robot's battery, but he can't plug the machine into Jordan's power box because it lacks an outlet. Moravec started building a new outlet, only to discover he needs parts. Time to go to Home Depot. At 10 p.m., it's past normal business hours, but that's OK. Moravec says, "We know where the 24-hour ones are."

Jordan, meanwhile, is about to attach a pair of jumper cables to a plastic bucket that's lined with a lead plate and filled with sulfuric acid. "You might want to step back," he says.

A pipe is laid across the bucket and from it a bone hangs into the acid. Jordan attaches one of the cables to the pipe and the other to the lead plate. He clamps the other ends onto a power supply, which he rescued from a burning building and nursed back to life.

If everything works, Jordan will send 12 volts of electricity through the cables and into the lead, causing the acid to peck away at the bone, like a woodpecker on a tree. Later, he'll dip the bone in a vat of dye. The acid holes will absorb the dye, changing the bone's color to an eye-pleasing red. This is called anodizing, normally the last step in the bone-making process. Jordan is skipping ahead, mostly because anodizing is fun.

"It's like coloring Easter eggs," he says, "once you get past the dangerous part."

Jordan flips a switch, and soon the acid begins to bubble.

Then it begins to smoke.

"That's hydrogen sulfide gas coming off there," he says, reaching for a fan. "Not too good to breathe."

Behind him, Yundt pumps his fist and emits a victorious hoot. After three hours of futzing, he has figured out why the "page up" key on his keyboard is having no effect on his drill. Now he hits the key and the machine groans, lifting its bit into drilling position, which is the same position it was in the last time Yundt had it working.

Yundt promptly puts on a pair of safety goggles. "One time," he says, "I got a metal splinter in my eye. Believe me, one time is plenty."

Jordan, standing before his smoking acid vat, his arms folded across his chest and a smile planted on his face, nods his head in agreement.

"This," he says, "is not kid stuff at all."

Jordan's garage is one of several hideouts in which members of the Dallas Personal Robotics Group gather. Another is The Science Place in Fair Park, home of the IMAX Theater and the DPRG's increasingly popular robot contests.

On this Saturday morning, some 50 robot enthusiasts have emerged from their respective garages and arrived here, armed with pens, screwdrivers, laptop computers and the large plastic bins in which they store their robots.

The bots come in all shapes and sizes. Some are made from LEGO MindStorm kits, a retail sensation that has created a new breed of robot enthusiasts since it appeared in toy stores a year ago. But most robots, like Frank Elia's "Viperbot," are made from parts that would otherwise wind up in dumpsters.

"I was wondering what to do with all those AOL discs you get in the mail. That's the result," Elia says, pointing to Viperbot, whose brains are sandwiched between a pair of discs that Elia painted gray and blue in honor of his favorite car. "I always wanted a Dodge Viper, and that's the closest I got."

Scavenging is a key aspect of a robot builder's life.

"I would be willing to bet," says R. Steven Rainwater, a computer specialist who hosts the DPRG's Web site, "that every member of the DPRG has gone dumpster diving in the Richardson technology corridor at one time or another. You can find hundreds of dollars of pretty good stuff."

In the wake of the smash-hit Comedy Central show *BattleBots*, in which remote-controlled robots destroy each other using "killsaws," "ramrods" and giant metal sledgehammers, the DPRG has found it necessary to adopt a new definition of a robot--which is *not* a BattleBot.

A real robot, says DPRG President Robert Jordan, is known as an ALaN, an acronym that applies only to robots that have "autonomous locomotion and navigation." In other words, the robot must be able to move around and complete tasks without the use of a remote control.

"We've refined the definition of a robot to be more along the lines of what Asimov wrote about as a device that interacts with people," Jordan says.

Jordan, of course, is referring to the late science fiction writer Isaac Asimov, author of *I, Robot*, the groundbreaking 1950 novel that might well be the DPRG's bible. The book, which laid out a future in which robots are used to benefit mankind, introduced the "Three Laws of Robotics." The first and most important law states that robots must never be used to harm a human being.

DPRG members are typically strict adherents to Asimov's laws, which explains why some feel somewhat conflicted every Tuesday at 9 p.m., when they, like rubberneckers at a car wreck, faithfully tune in to *BattleBots.*

"There's the people among us who like the battlebots, and there are those of us who think it's an abomination of robotics," says Bill James, the group's vice president. "I watch it every Tuesday. I love it. I'd make one if I could afford it."

"I think it's a perversion," says Ralph Tenny, 70, the group's oldest member. Tenny's raspy voice makes him sound like Marlon Brando in the *Godfather*. "For one thing," he says, "battlebots are not automotive. That immediately removes them from *this* arena."

In this arena, which consists of a large rectangle of black paper rolled out on the floor and surrounded by an ankle-high wooden fence, brains are favored over brawn. What the contest lacks in oil-letting collisions, it makes up for in creativity.

Today, a dozen robots will compete in four contests, the most popular of which is "quick trip." The goal of quick trip is to see which robot can rip down the 16-foot-long course and return in the shortest amount of time without hitting any walls. How they complete the course is a matter of design.

Most of the robots in this contest are equipped with microchips, the same kind used in cell phones, which are programmed to instruct the robots to go 16 feet forward, stop and return in reverse. A good example is Sugar Eater 2, designed by 11-year-old Harrison Massey, who constructed his robot from a LEGO kit he found under the Christmas tree.

Within the DPRG, LEGO bots are often the target of jokes among the traditionalists, who argue that snap-together robots are inferior to those made from scrap. Massey, who describes himself as a "technophile" and says there's "no doubt" he'll be a scientist when he grows up, puts that debate to rest. Although his kit came with a set of blueprints for a flipping robot called "Acrobot," he created a racecar.

"Their design doesn't have any gearing on it at all," says Massey, who explains that he attached small gears to the wheels to increase velocity. "It has to do with the gear ratio. The smaller gears rotate faster than the big gears."

Other robots, like John Drummond's Blip, are wall followers that use sonar to navigate. Drummond sets Blip down and turns it on. Like a toaster on wheels, Blip begins slowly rolling, guided by a series of bleeps that bounce off the wall and ricochet back to another set of sensors, which calculate the time lag and thus enable it to measure its distance from the wall. When Blip approaches the rear wall, its sensor will tell it to turn, allowing it to stay parallel to the wall without hitting it.

The more sensors a robot has, the smarter the robot is, explains David Anderson, creator of SR04, the undisputed smartest robot in the group and the reigning "can can" champion. In this challenge, six soda cans are placed on the course. The robots get points for locating and retrieving the cans.

Today SRO4 has one new opponent, a duo of LEGO robots that look like miniature forklifts. They are connected by wooden slabs, designed to sweep the cans off the course. Unfortunately, a faulty steering mechanism sends the contraption rolling into a wall, causing it to fall to pieces.

It didn't have much chance against SR04, anyway.

The product of several years of labor, SRO4 sits on two bagel-sized wheels protected by a piece of clear plastic that works like a bumper. Its "brains" sit like a glob of noodles atop an electronic board. Its showstopping technology includes an "infrared collision avoidance" system, a shaft-encoder odometer and a rarely seen motion detector. SRO4 also has two sonar "eyes," made out of the auto-focusing mechanisms that Anderson pried off a Polaroid camera.

Stepping onto the mat, Anderson turns SRO4 on with a laser gun. It promptly beeps and begins scanning the course, turning left and right. A red light soon pops on, indicating that its infrared sensors have "seen" the cans. Using its sonar eyes, which emit a series of clicks, SRO4 closes in on the nearest can. Once in range, it clasps the can with a pair of grippers installed beneath the bumper. Then it whirs around and heads back to the starting line, where it sets the can down and promptly begins the process anew.

Around the race course, jaws collectively drop.

James whispers, "We're, like, all jealous."

A week after the contest, Anderson talks about robotics from his office at Southern Methodist University. A self-described "systems philosopher," Anderson's position is funded under the Comprehensive Nuclear Test-Ban Treaty. His job is to monitor the planet for atomic blasts, using a laboratory filled with computers linked to seismographs, which are buried in the earth at various remote locations.

To Anderson, a true test of a robot's design is not a race course or a well-lit arena surrounded by top-heavy cheerleaders, but inside a room in an ordinary home. Or, in the present case, an office.

"From the very beginning, we decided we wanted the robots to survive on their own without us watching 'em all the time, which is a huge challenge," Anderson says. "At a minimum, it should be able to survive in your own home. Every time I have to get up and save SR04 from ripping itself apart, that's a failure."

To demonstrate his point, Anderson plants SR04 on the floor and sets him free, letting him rely on his sensors to navigate the office.

"It'll turn toward the bright light," Anderson predicts. "It turns out that is a great way to navigate in a lot of human spaces because we tend to light passages."

Anderson programmed SRO4 to seek out open spaces using a combination of "path seeking" and "obstacle avoiding" sensors. After rolling about the room, carefully checking out the dark spaces beneath several chairs and a desk, SRO4 comes to a halt next to Anderson's chair. Like a dog pricking its ears up to detect the arrival of its master, SRO4 raises its motion detectors into the air and silently waits for a disturbance.

"Ooh," Anderson says, "I like the fact that it came and sat by me."

Anderson, like most robot enthusiasts, is driven by a powerful desire to tinker with electronics. His hobby presents a unique challenge because it requires a blending of three disciplines. They are mechanical engineering, needed to build frames; electronic engineering, for wiring the brains; and computer programming, for programming the brains.

Many robot enthusiasts, visions of Rosie from *The Jetsons* planted squarely in their heads, have a habit of predicting, falsely, that robots will soon be serving people cocktails and sweeping their floors. Others, namely the "transhumanists," believe robots will ultimately surpass humans and replace them as the most intelligent creatures on earth. Anderson prefers to think of robots as "smart tools," similar to the robots already deployed in the nation's automotive industry. To him, the Jetsons are still a long way off.

To give an idea where modern robot technology is, Anderson uses the following analogy: Imagine a football coach trying to communicate a play to a team of robots. To do so, he would have to write a computer program that would give step-by-step directions to every muscle in the bodies of every player for the entire play.

"None of our robots," Anderson says, "are as sophisticated as a cockroach."

Still, it is a mistake to think that robots are not already a part of our society or that they won't play a greater

role in the future.

"The robots already surround us. We already have a robot that washes your dishes," Anderson says, adding, "Here we are sitting at the end of 100 years of industrial revolution. It's given us the hands, the arms, the legs and the bodies. All we need is the brains."

Those brains, which consist of microchip technology, are getting rapidly smarter. In fact, it is only a matter of decades in which the microchips will match the human brain in terms of intelligence, according to Hans Moravec, a research scientist at Carnegie Mellon University, home to one of the nation's leading robotics institutes.

In a 1997 paper, Moravec traced how computers are rapidly becoming more powerful, shrinking the time it takes to "double" their capacity from every 18 months in the 1980s to every 12 months in the 1990s. At that rate, Moravec wrote, computers suitable for "humanlike robots" will appear in the 2020s, while personal computers that match humans in brain power will arrive in homes before 2030.

On a recent Saturday afternoon, inside a classroom at the Bill Priest Institute just south of downtown Dallas, a couple of dozen DPRG members are getting an update on a new microchip, developed for Motorola by a Dallas company called New Micros. Randy Dumse, a company representative, tells the group the chip's advanced capacity is so exciting it drew him out of early retirement.

"When I heard about this one I said, 'Boys, this is gonna hit like the HC11 [another chip],'" Dumse says. "I see it plugging square into the robotics market. I see it taking robotics to the next level."

Later, David Martineau lays out his robotics vision, influenced heavily by Asimov, as he digs through a large cardboard box filled with the parts of a pinball machine he found at Salvation Army and promptly disassembled.

"After Mary Shelley published *Frankenstein*, it went all downhill. Until Asimov," Martineau says, adding, "I would like to see a world in which robots and humans live together in harmony, rather than the Frankenstein complex."

Nonetheless, Martineau says he loves to build robots, like his dog-shaped LEGO bot called "Hexadog," because he likes the feeling of controlling his creations. "Everybody wants to be gods," he says. "This is a way of creating your own life."

Asked whether he believes robots are capable of replacing human society, Martineau promptly stops digging through his wire-filled box.

"That's a loaded question," he says. "In 1950, people thought we'd have cities on the moon, and we don't yet. People tend to think things will happen sooner than they will. Still, we are now capable of creating something that can surpass us. Whether it does depends on how we handle it. Will it destroy us, or will they save us?"

Inside Barry Jordan's garage, Kip Moravec says he believes robots and the inevitable ethical dilemmas they present are something people need to think seriously about now, while there's still time. As he carefully screws a wire into an outlet, Moravec quotes a recent statement from science's leading mind, Stephen Hawking, as a reference.

"He basically said we better start using DNA to advance the human species or the robots will pass us," Moravec says. Seated at his computer, Yundt adds, "You know, like *Terminator*, where all the people were living in the sewers with rats."

Hawking, the author of *A Brief History in Time* who holds the Cambridge University chair once held by Sir Isaac Newton, made his comments during an interview with *Focus* magazine in September. During it, he said that while the task of "improving" human beings with DNA is still a long way off, it is a path humanity must embark upon because of the rapid rate at which computer technology is growing.

"The danger is real that they could develop intelligence and take over the world," Hawking is quoted as saying. "We must develop as quickly as possible technologies that make possible a direct connection between the brain and computer, so that artificial brains contribute to human intelligence rather than opposing it."

During an earlier public lecture titled "Life in the Universe," Hawking said that, on the other hand, robots might be humanity's only chance for survival 5 billion years from now. That's when the sun is scheduled to explode and, in the process, destroy Earth. If humans hope to survive, they must be able to relocate themselves on planets out of the sun's reach--a distance that far exceeds the human life span. In short, people must find a way to upload their brains onto microchips and install them in robots.

"These machines would be a new form of life, based on mechanical and electronic components, rather than macromolecules," Hawking said. "They could eventually replace DNA-based life, just as DNA may have replaced an earlier life form."

To Hawking, computer viruses, such as the Nimba virus that recently wormed its way through the world's computer systems, already constitute a new life form. That's because they, like all basic life forms, are capable of reproducing themselves, albeit in an electronic rather than biological way.

"Maybe it says something about human nature, that the only form of life we have created so far is purely destructive," Hawking said. "Talk about creating life in our image."

Hawking's machines aren't likely to be made inside Jordan's garage, but the place does illustrate that 5 billion years isn't as far away as it sounds.

Yundt switches on his microscope-turned-drill, and it emits a wicked howl as the spinning bit bites into aluminum. A cloud of silver flakes floats into the air like a metallic blizzard. It is well after 10 p.m. The trio is supposed to adhere to a strict no-drilling-after-9 p.m. order, but Moravec says, "We usually let the wife remind us."

After neatly severing the stick's rugged end, Yundt switches the machine off, realizing his code is off by a few thousandths of an inch.

"Shoot," he says, "that's not where it's supposed to be at."

Behind him, Jordan notices that the arrow on the power supply has dropped down to zero. "Oops," he says, "we blew a fuse." Moravec, meanwhile, wrestles with a stubborn wire inside Jordan's power box. "I hate these tight boxes," he says.

A quiet settles over the garage as Yundt, Moravec and Jordan troubleshoot their respective problems. Out in

the yard, the sprinkler system automatically kicks on and goes about its nighttime watering chore. The neighbor, a doctor, returns home from making his evening rounds at the hospital. He walks his dog, then shuts his lights off for the night.

Beneath the halogen glow, the men continue their slow march toward progress. Soon, the clock strikes 12 and a new day is marked by the screams of Yundt's machine. An hour later, he triumphantly presents Jordan with a completed bone.

"Preeeeety cool," Jordan says with a whistle. He glances up at the clock and ends this session of Robot Builder's Night Out on a factual note.

"It always takes longer than you think," he says. "*Always*."
