

New technologies help robots make inroads on daily life

July 6 2012, By Jon Swartz

Notre Dame came back from an early deficit and took the lead over Ohio Northern University on a pass. Its defense stiffened in the second half, and it stymied ONU, 26-7.

But these weren't student athletes on the gridiron in a spring scrimmage in late April. Eight robots about the size of big printers slugged it out for each side in the world's first intercollegiate football game with robots on Notre Dame's campus in South Bend, Ind.

Organizers are comparing the historical significance of the so-called Mechatronic Football Game with the first [collegiate football](#) game between Rutgers and Princeton in 1869. "A lot of robots were injured," said Bill Hederman, who helped organize the competition. "This was a serious bang-up game."

The student-designed robots performed well on the basketball court-size field, and organizers hope to create an intercollegiate mechatronic football league that accelerates innovation in robotics in the same way that the DARPA Grand Challenge accelerated self-driving vehicles for the military, or the [X-Prize](#) has for private space activity, Hederman said. Brian Kelly, Notre Dame's real football coach, attended [robot](#) practices.

Robots, it seems, are everywhere - ranging from microbots, which are tiny black dots to the naked eye, to bots that resemble bees and bats, to gigantic models.

Titan, a 9-foot rental robot, is being carted out at marketing events, even a Rihanna concert, to mingle with the masses. New York University graduate student Marko Manriquez recently built a robot that makes burritos. And scientists at University of Tokyo's Ishikawa Oku Labs designed a [robot that specializes in, and wins, rock-paper-scissors games](#).

Experts predict that within 10 years, general-purpose robots - at \$25,000 to \$30,000 per unit - will perform house chores while consumers are at work; or serve as butlers at cocktail parties. "We are putting robots into people's lives," said Sarjoun Skaff, co-founder and [chief technology officer](#) of Bossa Nova Robotics, which is developing a robot maid modeled after Rosie of TV show "The Jetsons" for less than \$5,000.

The mechanical march is gaining steam. To date, robots have mostly been used by automakers and semiconductor firms to produce goods in high volume. They're also in vogue at some warehouses. Amazon.com in March plunked down \$775 million to acquire Kiva Systems, a maker of squat, cube-shape robots that move products around shipping centers.

But that was just the start. Cheap, powerful cameras, advanced sensors and other electronics now form the basis of robotics projects. In the 1990s, technology was pricey and limited to industrial settings where large companies could afford to make the necessary investments.

"It sounds like 'Star Wars,' but it's coming," said Bill Vass, a former Sun Microsystems executive who is CEO of Liquid Robotics, maker of a surfboard-like device for underwater research.

"A perfect storm of technology is occurring" for robotics, he said, ticking off the convergence of technologies such as GPS, advances in cell and wireless communications, nanotechnology, Wi-Fi, satellite technology, open-source software and new ARM processors on smartphones.

It's hard to gauge the commercial potential for robotics, as the technology is in its infancy and, once ready, the bots could do just about anything. What's certain, though, is that bots will be ubiquitous in all shapes and sizes for:

-Industrial use. Factory robots, once confined to cages so as not to harm humans with an inadvertent swing of a steel arm, are now commingling with people because of cheaper and more advanced sensor technology.

Japan's Kawada Industries, Switzerland's ABB and other companies are developing dexterous robots capable of assembling smartphones and working safely in close proximity to people. Kawada's \$90,000 NextAge bot, which could pass for the robot character WALL-E in the animated film of the same name, is one such model. ABB is designing a humanoid-like robot with "dual-arm" that can assemble consumer-electronic products.

Heartland Robotics, run by iRobot co-founder Rodney Brooks, plans to introduce affordable robots for small manufacturers.

At Carnegie Mellon in Pittsburgh, researchers are working on software that enables a robot to determine which parts to choose and assemble properly. These more efficient tools for repetitive tasks could slice labor costs of consumer-electronic products makers, and free up humans for other jobs.

-Military use. Within 10 years, squadrons of unmanned planes will swarm enemy sites like killer bees, launching missiles and avoiding detection with sophisticated jamming devices.

Self-programmed submarines will replace dolphins to detect and disarm mines. Robotic mules the size of pickups will haul ammunition, medical supplies and food. Drone ambulances will load wounded soldiers and

cart them to hospitals. Crablike robots will crawl into buildings to sniff out chemical stashes.

The transition to mechanized weaponry is key to the military's transformation from heavy ground forces to smaller human units fortified with robotic weapons.

-Search-and-rescue missions. The palm-size winged schematic sitting on a table at Carnegie Mellon's robotics lab isn't from the forthcoming "The Dark Knight Rises," but a "vampire bat" bot for above-the-fray surveillance of action scenes, and search and rescue. The 100-gram, foot-wide bot, made of inexpensive molding, is propelled from the ground by an internal spring.

Once airborne, it glides with the wind and would be part of a "swarm" of bots that communicate with each other. The devices are cheap to produce - \$40 each - even cheaper if mass produced. They're loaded with a motor, camera, sensors and battery. "Think of the swarm of bats as the equivalent of an (expensive) satellite," said Matthew Woodward, a doctoral student in Carnegie Mellon's nanorobotics lab who developed the mechanical vampire bat.

A few feet away, the wings of "the flapper," a bee-size bot that can get into small crevices such as a mine shaft, beat 45 times a second.

-Research. Liquid Robotics makes a surfboard-shape device for collecting data underwater, such as ocean depth, post-hurricane damage, fish density populations, weather forecasting and shark surveillance. The service would be sold to researchers. Wave Glider is its first marine robot. "It operates in environments where you don't want to send people," Vass said. "Our bots go out in 35-foot waves and 100-mph winds."

David Hanson has been pushing the frontiers of android making for years. The chief scientist at Hanson Robotics helped design an android replica of the head of science-fiction writer Philip K. Dick ("Do Androids Dream of Electric Sheep?", "The Minority Report"), which answers questions as the author would. "We think we can change the face of entertainment," Hanson said. "Facial expression technology is very life-like, and we can advance socially intelligent, compassionate computers (androids) as characters."

America's fascination and, occasionally, guarded fear toward robots runs deep. It dates to 322 BC, when Aristotle alluded to the "need either of apprentices for the master workers or of slaves for the lords." In the 15th century, Leonardo da Vinci designed a mechanical device that looks like an armored knight.

"A robot is the interface between the information world and physical world," said Richard Mahoney, director of the Robotics Program at think-tank SRI International.

Though robots have been portrayed as sinister, as in the movie "Terminator," they have also sparked delight in the guise of C-3PO and R2-D2 in "Star Wars," Optimus Prime in "Transformers," WALL-E and other famous mechanical creations.

"People like robots; it's in our psyche and culture," said Skaff, whose company hopes to offer a \$5,000 robot within a few years. "The canvas is there. It is our opportunity to paint on it."

"It was amazing how people gravitated to it," said Chris Barbin, CEO of Appirio, which used Titan at a cloud-computing conference in London in May and drew 1,000 people. "It was our biggest event of the year."

Robots are becoming de rigueur as populations age and working couples

look for help while at work. Toyota and Honda (maker of the Asimo) are building robo-servants to help Japan's aging population. IRobot's Roomba vacuum already does some of that. And experts expect dog-walking bots and driverless cars in the near future.

It's probably not surprising, then, that people increasingly are more comfortable with walking, talking machines, said Eric Schweikardt, design director of Modular Robotics, which makes robot-construction kits for use in gaming and education. He points to newfangled dishwashers and refrigerators as entry-level household robots powered by microprocessors.

"Robots will be bigger than the PC in 10 to 20 years, but it will be linked to your computing device either in the cloud or on your person," said Paul Berberian, CEO of Orbotix, which makes Sphero, a robot ball controlled by smartphones.

Like others in the industry, Berberian envisions affordable toy robots for the mass market first, followed by larger devices. "While specific-task home robots are cool, the big play will be entertainment," he said.

"Tons of technology starts out in the game/entertainment sector and then migrates to performing common tasks."

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Citation: New technologies help robots make inroads on daily life (2012, July 6) retrieved 10 May 2024 from <https://phys.org/news/2012-07-technologies-robots-inroads-daily-life.html>

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