

The future workforce: Autonomous & robotic mowers

By Dillon Stewart



The landscape industry isn't alone in its labor woes; golf course superintendents fight to find good people, too. So in the midst of a worker shortage, Santaluz Club Superintendent Jeff Miller decided to hire a robot for his operation in San Diego.

Last year, [Cub Cadet](#) released the RG3 robotic greensmower after its parent company acquired Precise Path Robotics in 2014. Miller was sold on it as soon as he saw it demonstrated. He started with one unit to test its efficiency. Soon, he'll buy three more, which he says will save him nearly six figures.

He operates the RG3 on five greens; it can be programmed to mow up to 30,000 square feet. Each morning before golfers get on the course, a crew member—the RG3's wingman—hauls it to the first hole and leaves it on the edge of the green. He situates four beacons around the outside of the green in a pattern specific to that hole. The beacons and the mower exchange ultrasonic sound waves, which tell the mower what green it's on and that green's cut specifications. Once they're set and the wingman pushes start, the mower cuts the green on its own.

A smarter version of this technology could be coming to the commercial landscape market soon, if a 67-year-old landscape industry veteran and a robotics research center in Pittsburgh can find an investor.

"The hypothesis is if you can make a two-man crew into a one-man crew or a three-man crew into a two, it reduces the cost of labor," says Dana Lonn, managing director of The [Toro Co.'s Center for Advanced Turf Technology](#).

More than a decade ago, Toro dabbled with autonomous mowers to the point of producing a functioning prototype, before abandoning it due to cost. All parties believe there could be a market for the technology in a labor-starved green industry—eventually. But taking a theoretical piece of equipment and bringing it to market in a way that is affordable and practical for end users has been decades in the making.



NREC is housed in a 118-year-old ex-foundry building on the shore of the Allegheny River.

Dabbling with technology

[The National Robotics Engineering Center](#) (NREC) is a developmental wing of the renowned Robotics Institute at Carnegie Mellon University's School of Computer Science in Pittsburgh. The 1,000-person Robotics Institute is one of the largest bodies of researchers studying the technology in the world. These minds are so coveted that last year Uber poached 40 of its scientists to work on an autonomous cab, leaving NREC with a \$5.5 million donation as reparation.

About 50 percent of NREC's budget comes from partnerships with the U.S. government. The largest fraction of that comes from the U.S. Department of Defense, for which NREC builds autonomous military vehicles and robotic systems. NREC also has industrial partners, like [John Deere](#). Its agriculture division isn't selling driverless equipment yet, but products like the NREC-developed Active Fill Control and the Deere-developed AutoTrac system guide tractors to harvest crops, lay seed and perform general tasks at an efficiency rate unmatched by human control. All the while the operator, or supervisor, sits back and monitors data on a video screen. The Washington Post even called Deere more progressive on autonomous technology than Google.

Jeff Legault, NREC's director of strategic business development, says its purpose is to turn the Robotics Institute's research into something tangible that its partners can bring to market.

"We're trying to solve problems for clients instead of doing research of our own," he says. "The problem is solved when we find the lowest cost solution."

Currently, John Deere's only foray into the robotic mower market is its Tango, a Roomba-vacuum-style mower for consumers that sells in England. [Other mower manufacturers have gone down this road, too.](#)

Toro experimented with the idea of an autonomous mower more than a decade ago. In 2002, the company partnered with NREC to build an autonomous mower for the golf market. [Toro](#) built NREC two mower platforms for the prototypes: a Greensmaster 3100 for greens and a Groundsmaster 3500 for golf course roughs and sports fields.

NREC and Toro were successful in building a functioning prototype. Unlike a Roomba-style robotic mower, the autonomous mower did not need beacons or guide wires to operate. Instead, it used pose estimate technology, like lidars, which emit

lasers to measure distance, and GPS. This technology gave the mower the ability learn its position, surroundings and terrain and react to them. It also gave it pinpoint accuracy and the ability to stop if a human or object got too close.

Though it worked, this technology wasn't cheap enough yet. NREC and Toro couldn't produce the equipment affordably, which Toro defined as about double the cost of a commercial mower. So Toro abandoned the project. The two organizations keep in touch, but they haven't actively worked together since 2013.

Swan song

Rick Cuddihe is president of Rick Cuddihe & Associates, which operates [Lafayette Consulting Co.](#) and Let's Be Green Landscaping in Prospect, Ky. While on assignment for a client of his consulting firm, Cuddihe was researching the commercial mower market and mostly found what he calls "varying degrees of good."

"Companies are basically making the same product in different colors," he says. "They take what they sold last year, manufacture it at a slightly lower cost and sell it to the consumer for more."

Upon further research, Cuddihe stumbled upon NREC's website detailing the project with Toro. He was enamored by the idea. Deeper investigation convinced Cuddihe that autonomous technology had advanced and could be produced affordably.

Cuddihe knows the mower market. He's been all over the industry, starting with selling Bob-Cat snow blowers. In 1983, Dane Scag, who owned Bob-Cat, started Scag Power Equipment and asked Cuddihe to follow him.

As Cuddihe puts it, Scag was an inventor, not a businessman. So Cuddihe's business acumen made him Scag's right-hand man. He stuck with Scag as he created Great Dane in the mid-1990s and followed the brand to John Deere, which purchased it in 2000. Later, he worked with Husqvarna.

Though he's proud of what he's done, Cuddihe still has energy to do more. So in 2013, Cuddihe started Robotic Turf Equipment, reached out to NREC and embarked on a quest to produce a viable autonomous mower.



Toro also has built an autonomous utility vehicle prototype. Below: Toro's

autonomous Greensmaster.

“It doesn’t interest me to do the same thing everybody else is doing,” Cuddihe says. “What excites me is bringing something new and different to the market.”

Since the Toro project stalled, the technology became cheaper and more accurate. In the first run, GPS technology was too inaccurate. RTK base stations had to be used to bolster GPS strength within a certain proximity. Today, new algorithms and lower sensor costs enable alternate solutions for pose estimate, and more robust pose estimate systems will allow operation with poor or no GPS signal. Lidar is also cheaper now and can be coupled with or even replaced by cameras that can sense objects and the surrounding area in 3D and discern between grassy or nongrassy areas.

With a lot of money invested in confidential equipment, the barbed-wire-fence-surrounded NREC can be a secretive place, so it was difficult for Cuddihe to get in touch. But after four months, NREC staff realized who was calling and hashed out a deal to get him on board.



Birth of zero-turn

Most landscape companies have the desire to grow and many have the sales potential to do so—but staffing is holding them back. A survey conducted by the [National Association of Landscape Professionals](#) showed approximately 60,000 professional-level positions and nearly a quarter million labor positions needed to be filled industrywide in 2015.

To Cuddihe, this environment calls for an innovative product that changes the way contractors do business. It reminds him of the era when Dane Scag invented and started testing hydro-drive, walk-behind zero-turn mowers in the late 1980s. Dealers said contractors would never buy the product because it cost \$1,200 more than the standard gear-drive mower.

So Cuddihe drove from northern Massachusetts to southern Florida, hauling the mower with him. He would pull up to an operation, ask for an owner or foreman and let them test the mower. Operators loved it because of how much less physical exertion it required. Employees didn’t need to be as big and strong to operate the machine, opening job opportunities up for even more people.

Contractors ran to the same dealers who said it would never sell to request it for their

operations, Cuddihe says.

“What I learned working with (Dane Scag) is that landscape contractors were starving for ways to produce more work with the same amount of labor, increasing the productivity of their employees,” he says.

Cuddihe believes an autonomous commercial mower could have an effect similar to what Miller, the superintendent, has seen with his RG3. He reports his operation runs more efficiently than ever and the robot hasn’t erased his human workers. In fact, he hasn’t let anybody go and doesn’t plan to. Instead, he reallocates the labor to other tasks. Where he used to send a three-man crew, he now sends one crew member and the robot. While the mower cuts, the wingman performs other tasks on the green. The RG3 cuts his average green of 7,000 square feet in about 50 minutes, giving the wingman a specific time frame for completing his end of the work.

“We do so much work by hand, like raking and rolling, that it just fit our operation perfectly,” Miller says. “When I put the robot out there, I free up three guys in the morning.”



“(Once there is a prototype), Everyone is going to want a piece of this technology.”
—Rick Cuddihe

Chicken and the egg

Again, Cuddihe is crisscrossing the country trying to sell an innovative product. Again, people are having a hard time accepting new technology and its cost.

If the autonomous mower hits the market, there might be sticker shock initially. Cuddihe estimates the entire system’s price tag at \$25,000. But with the labor it could save an operation that uses the wingman approach on a commercial property, he says it will be worth the investment.

For Cuddihe, the difference this time is twofold. First, instead of contractors and dealers, he’s trying to convince an investor. Second, he doesn’t have a prototype yet. Cuddihe expects a \$2.5 million to \$4 million investment for a completed project, which, to him, means getting a product on the market.

Furthermore, the technology is vast. To come up with the most affordable solution, NREC engineers want to build a mower specific to the needs of a customer, which hasn’t been defined yet.

"Does it need to work at night? Does it need to work in the rain?" asks Legault. "Maybe, maybe not. But the next step is engineering the system for a particular market and a particular application."

Cuddihe is targeting manufacturers with stakes in the golf and landscape markets, like John Deere and Toro. Once the product hits one market, he expects it to organically evolve into the other.

Companies have met with Cuddihe and are interested in the technology, but they're turned off once they find out there's no prototype. It has created a chicken-and-an-egg scenario. To get an investor to believe in the product, he needs a prototype. To get a prototype, he needs an investor.

"Just come to NREC," Cuddihe says to nonbelievers. "Once people see what's going on here, they'll know it's possible. And once a prototype is built, everyone is going to want a piece of this technology."

Why? Consider Miller. His robotic mower cost \$45,000, plus another \$10,000 for programming, installation of a perimeter wire around the collar of the green and a custom trailer. But he says the machine will pay for itself within two years. On a daily basis, one mower saves him six to seven labor hours, which he equates to \$5,000 per green and \$25,000 per year. He's buying three more, which should give him an estimated \$86,000 to \$113,000 in savings per year.

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