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Team 122 member Grant Weinmann signs his name to the shipping container holding the robot at the New Horizons Regional Education Center in Hampton. The team packed the robot and shipped it to Washington, D.C., for an upcoming competition.

Quest completed

After six weeks of hard work, the NASA Knights ship off their robot for a competition in D.C.

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Two teen-age kids lie on the floor next to their nearly finished robot, peering and poking tools into its open chassis like mechanics working under a car.

Out stretches a toe as Juliana Wu, 16, works to maintain her balance while reaching in toward a particularly inaccessible spot. Teammate James Burton, 18, who's sprawled out on the other side, looks even more like a contortionist as he attempts to push a wrench in, then up and around the side of a sheet metal cover.

A few awkward turns of their tools may be all it takes before each of them can withdraw their arms and toss another tiny metal fastener into the piles sprouting up around them on the floor. But already they've been at work a long time — and many more of these elusive "T-Nuts" must be retrieved to make sure the NASA Knights' machine meets the weight restrictions of the 2009 FIRST Robotics competition.

"When we first starting building the robot, we put these sliders everywhere because we didn't know exactly where we were going to need to attach things to the frame — and now we're taking all the ones we're not using off," says Burton, a member of the award-winning team based at the New Horizons Regional Education Center in Hampton.

"And that means all of them — or at least all the ones we can get to," Wu adds. "They don't weigh very much by themselves. But when you add them all up, it's a lot."

Wu and Burton's labors marked just one of many last-minute tweaks completed in the waning hours of the national science and technology competition's strictly enforced, six-week-long design and fabrication period.

In some previous years, the NASA-sponsored team has pushed their deadline down to the wire, working overnight in the center's machine shop and robot room in order to get the complicated job completed.

But this season, the group of some 40 students — whose hometowns range from Smithfield to Gloucester — toiled alongside a dozen adult mentors to stay ahead of the curve. So instead of having to play a last-minute game of catch-up they've spent most of their final week making improvements.

"We're just so lucky. Our robot is completely functional already," says Team Leader Joanne Talmage, an electronics instructor at the Butler Farm Road campus.

"So all we're doing now is fine-tuning."

Among the team's most critical changes is a complete revision of the hopper needed to hold, then dump a series of balls scooped up by the robot as it wheels across a playing field with an ultra-low friction surface.

Instead of forcing the balls out of the front of the hopper by raising its inclined floor, the team decides to substitute a much simpler mechanism that will use a motorized roller to spit them out.

"It was just too complicated. We couldn't find a way to make the rising blocks move in parallel with one another — and at the same speed — without a lot of unwanted structural support," says Julia Thompson, 16, of Gloucester, describing the balky lifting mechanism.

"So now the balls just roll down the inclined floor — and the roller spins around and pops them out."

Still dissatisfied by the mechanism's lack of speed, however, the team tries a second tweak designed to make the balls shoot out faster. Pulling the roller motor apart, they rework its gears, increasing its speed from less than 100 to 1,800 rpms.

"Before, the balls just sort of oozed out," says Thompson, as she attaches a brace below the hopper. "Now they really pop out with some force — about a foot or so — and that will make it a lot easier to put them into our opponents' trailers."

Inside the glass-walled cubicle overlooking the team's slick-floored practice space, mentor Chris McMahon and his team of programmers have been hard at work, too, perfecting the computer commands crucial to the robot's success in the low-traction game.

Instead of sticking with the single code that made the machine's hopper roller and conveyor belt move at the same time, they split these commands into two, then refined the roller code so it could spit the balls out at various speeds. They also added a reverse motion to the conveyor code, giving the team a way to unclog the robot's long, floor-to-hopper conveyor chute if a ball gets stuck after being scooped up.

Additional work smoothed out some bumps in the robot's accelerometer code and straightened out its tendency to track to one side. Both problems had been making the already difficult task of driving the robot even harder.

Though FIRST's organizers named this year's competition "Lunacy" because of the way its low-friction playing surface mimics low-gravity conditions on the moon, they also wanted to underscore how that slippery environment would make any wheeled vehicle handle like crazy.

"Because of that low-friction floor, the wheels are already spinning as soon as it gets the power to move," Thompson says. "So you can't just gun it whenever you want to go."

Indeed, each of the 12 teens who competed for the team's driver, operator and coach's spots ran into problems controlling the robot during a tense afternoon of trials.

Talmage and her mentors made their difficult task still harder by turning a radio up full blast, then instructing everyone else to jump and yell — and that filled the room with the same kind of noise and distractions the team will face in its upcoming competitions.

"We need people who do well under pressure. It's a test of nerve and communications as well as driving skill," Talmage says.

"And Julia showed that she was the smoothest and the quickest."

Mentors Tony Smith and Joanne Talmage look over shipping instructions as they wait for the robot to be picked up.

From left, James Burton, mentor Joanne Talmage, Grant Weinmann, Matt Reno, Lawrence Agee and Elizabeth Murray wave goodbye to the robot.

Online extra

Go to dailypress.com/first robotics to find a gallery of previous stories, pictures and videos about the NASA Knights and their 2009 robot.

The series

This is the third in an occasional series of stories following the NASA Knights robotics team as they create a robot for the 2009 FIRST Robotics competitions.