Robotic mine vehicles successfully reanimated by UA engineering students

June 2 2011

ENGR 450/550 students from the University of Arizona College of Engineering gather around one of two autonomous mining vehicles at the university's San Xavier Mining Laboratory in Southern Arizona. The students successfully reactivated and tested the vehicles for eventual use in underground mines where conditions are too extreme for human workers. Credit: University of Arizona College of Engineering

In just 10 weeks, a group of University of Arizona engineering students took five crates of surplus hardware and two heavy-duty test vehicles, which didn't run, and mixed them with youthful enthusiasm, tenacity and many long hours to build two robotic vehicles that successfully drove themselves around UA's test mine.

It was no easy task, and predicted by some as too big a project for a one semester course: ENGR 450/550, autonomous vehicle systems. But the

naysayers didn't factor in the can-do attitude of 23 undergraduate and graduate students who were willing to put in late nights following regular classes and daytime jobs.

The autonomous vehicles, which replace human drivers with computer control, satellite navigation and robotic vision, were originally part of a research program at Freeport-McMoRan in Safford, Ariz.

"Their mine technology group has been pursuing autonomous vehicle programs, and they asked if we could use some of the equipment they finished testing in 2008," said Mary Poulton, director of the Lowell Institute for Mineral Resources, which worked with Freeport-McMoRan to set up the equipment donation to UA. IMR is collaborating with the Science Foundation of Arizona, the mining industry and Arizona's universities to build a global center of mining excellence.

Tucson Embedded Systems stepped in and offered space to house the equipment and a place for students to work. Then it was simply a matter of loading five crates of hardware and two 7,500-pound vehicles onto a semi and transporting them to Tucson.

"The vehicles had been sitting for two years, and didn't start or run," said Sean Martinez, a systems engineering master's student and teaching assistant for the autonomous vehicle systems course. "The communications equipment was inoperable. None of the control software was correct for what we were doing. The hardware was all there, but nothing worked." And some important things were missing, such as a complete wiring diagram for the vehicles.

To sort this out, the course combined students from electrical and computer engineering, systems and industrial engineering, and aerospace and mechanical engineering -- teaming students in training to do everything from auto mechanics to software engineering to control

systems fabrication.

"The next goal will be integrating a robot operating system and securing industry partnerships or research funding to fully exploit the research possibilities," Martinez said.

Poulton agrees. "When you have these kinds of test platforms, it's almost that the sky is the limit as far as what we can do with them now." Some mining companies already are using autonomous vehicles and the industry trend is in this direction, she added. Autonomous vehicles can work in remote areas or in underground mines where temperatures approach boiling and are too extreme for human workers.

Autonomous vehicles also are upgrading the skill set for mine workers. Instead of truck drivers, mining companies now need engineers who are familiar with autonomous systems. The two new autonomous vehicles built in ENGR 450/550 can give UA students that kind of experience.

It was a project that never would have happened without close industry support, first from Freeport-McMoRan, which donated the hardware, and then Tucson Embedded Systems (TES), which provided space and other resources. Autonomous Solutions Inc. also donated manuals for their software, and the college's Department of Systems and Industrial Engineering hired one of the company's partners to spend a couple of days in Tucson to get the students over some rough spots.

One of two autonomous mining vehicles reanimated by University of Arizona College of Engineering students -- with strong support from regional industry -- and tested at the university's San Xavier Mining Laboratory in Southern Arizona. The vehicle is traversing a course around the San Xavier mine without human help. There is a driver in the cab as a safety measure, and if you look carefully, he's indicating "look, no hands." Credit: University of Arizona College of Engineering.

TES develops, designs and manufactures a variety of information technology software products for the aerospace, defense and commercial industries. The company specializes in systems design, development, integration and testing of hardware and software systems, and has worked closely with UA College of Engineering on projects in the past, such as the 2007 DARPA Urban Challenge, which called on engineering teams to build an autonomous vehicle that could drive itself through 60 miles of urban traffic.

In 2010, the TES-sponsored team won the best overall engineering design award at UA's annual Engineering Design Day competition. They built a robotic vehicle that could drive itself point-to-point using GPS navigation while avoiding obstacles. This year's senior design team extended that project by modifying the vehicle to deploy a series of sensors that measure temperature, humidity and sound. These sensors

then were linked together in a network. The team also wrote network protocols to allow another group of students to communicate with and drive the robots, and built an android application to go on cell phones.

This application now can be applied to the full-size autonomous mine vehicles.

Provided by University of Arizona College of Engineering