Safeguarding the Nation's Ports

When a tiny helicopter flew over the Port of Catoosa, OU engineers were demonstrating part of an innovative new system to monitor maritime cargo.

By Connie Cronley

Photo provided

Usually, the successful conclusion of a research project is publication in an academic journal or presentation of a paper at a conference.

One University of Oklahoma research project finished with a bigger bang—a full-scale media event. Newspaper reporters and television cameras attended. So did an Oklahoma Congressional delegation, authorities from the Port of Catoosa, representatives from the U.S. Coast Guard, academic and private sector researchers, and members of the Oklahoma Department of Transportation. Oklahoma Educational Television Authority produced a 30-minute documentary about the project.

The newsworthy event at Tulsa's Port of Catoosa in October 2008 was a demonstration by OU-Tulsa and Norman campus researchers of a $12 million, five-year project to create a security system for inter-modal, containerized freight. A lot was riding on the demonstration. If it worked, the security system could be replicated at ports around the world. It could safeguard ports against terrorism and enhance commerce. It could save money and revolutionize shipping worldwide.

The research project was funded by the Federal Highway Administration and administered by the Oklahoma Department of Transportation. Phase One began in 2005 on the Norman campus when Tom Landers, dean of the College of Engineering, as the principal investigator, began assembling a research team of academic, government and industry experts.

They studied port vulnerabilities, freight movement pat-

Robert Taylor

The computer-controlled mini-helicopter, with its six-foot, rotary wingspan, pays a visit to OU's Devon Hall from its home base in Tulsa where it was designed to provide aerial surveillance of the Port of Catoosa.

terns, risk analysis and assessment, and more. They created encryption software and state-of-the-art, interoperable tracking systems. A prevailing focus, Landers says, was keeping the system affordable, whenever possible using off-the-shelf technology. Then the federal government wanted to see if the system worked.

"Oklahoma is leading the way in protecting our homeland and worldwide commerce."

—Dean Tom Landers
OU College of Engineering

The pilot demonstration at the Port of Catoosa was the climax of Phase Two—the systems engineering piece—led by James Sluss, director of the School of Electrical and Computer Engineering, and Robert Huck, senior research associate, and involving more than 30 other specialists. Phase Three is further refinement and testing.

Beyond the importance of the project—combatting international terrorism's threat to world commerce—what attracted the crowd to the demonstration were the sophisticated gadgets involved: sensor devices, software infrastructure, global positioning systems (GPS), infra-red cameras, radio frequency identification (RFID) and more. The technological stars were two robot systems: a computer-controlled, mini-helicopter and an automated all-terrain vehicle, both equipped with high-definition video cameras. As Huck says so succinctly, "We had all the toys."

The "toys" demonstrated the value of aerial and ground video surveillance of vast staging and storage areas, saving both time and money. If R2D2 from "Star Wars" had progeny, they would be OU's small helicopter (six-foot rotary wingspan) and the ATV These two robots, however, did not carry a Hollywood price tag. Sluss and Huck used a building-block approach, starting with off-the-shelf products and loading on other technology. The mini-helicopter cost less than $38,000 and the ATV $5,000.

At the demonstration, the OU team had the added gratification of seeing their research in operation. "Systems engineering was a key aspect of the project," Sluss says. "It has been a lot of fun—getting to design and build it, then see it work in the end. We got to see the fruits of our labors."

Sluss and Huck are a complementary team for the project. Sluss is a quiet-spoken man from West Virginia who holds a Ph.D in electrical engineering and recently filed his 11th patent. "I've always been interested in designing and building things," he says. "As a boy, I liked to take things apart to see how they

Photo provided

The potential for video surveillance of the vast staging and storage areas at the nation's ports is demonstrated here by the Unmanned Ground Vehicle interrogating an opened shipping container

worked. Then I often built something else from the parts."

Huck is engaging but more military-brisk in manner and speech, befitting a man who followed a father and grandfather into the Air Force and retired after 20 years of service. In that career, he was a computer maintenance specialist, working on weapons systems in the Air Force's E-3, B-2, F-22 and B-1 aircraft. Now he is completing his doctorate in engineering.

Working with the Numbers

After the terrorist attacks of September 11, 2001, the United States government took a long look at the vulnerability of the nation's ports. Goods and merchandise are transported globally in large containers by sea, truck and rail. Consider the magnitude and complexity of the worldwide shipping industry:

The U.S. has 360 ports of entry.

20 million containers enter the country every year.

90 percent of world trade uses maritime cargo containers.

95 percent of overseas trade passes through 36 U.S. public ports.

21,000 containers arrive daily at U.S. ports and most are parked in a container yard awaiting the next leg of transportation.

Only 3 to 5 percent are spot-checked upon arrival.

Obviously, a large security risk looms. Physically inspecting every container at every port is impossible. Some megaports such as Long Beach and Philadelphia have sophisticated security including gamma-ray scanning systems, but smaller ports inspect the old fashioned way—manually and randomly. Standard security at many port facilities depends on foot patrol, video surveillance, vehicle detection, fences and gates. What is needed is a comprehensive security system to monitor shipyards, warehouses and other cargo areas—an advanced system of creative and technological innovations. Furthermore, such a system must be affordable. Enter OU researchers.

But why Tulsa's Port of Catoosa? Simply because Catoosa is the largest inland port west of the Mississippi River. It sits at the head of the 440-mile staircase of locks and dams that comprise the McClellan-Kerr Arkansas River Navigation System. This navigation system took almost 30 years to build—three decades of planning, negotiating, politicking for funds and, finally, construction by the U.S. Army Corps of Engineers at a cost of $1.3 billion. Officially opened in June 1971, it links Oklahoma and five neighboring states to the nation's 25,000-mile inland and global deepwater shipping waterway system and the Gulf Intracoastal Waterway.

The economic impact to the Oklahoma area is enormous, $3.2 billion annually. For shippers, transporting cargo by water is economical—one-third the price of rail and one-fifth the cost of truck transportation. Every year, barges move at least 13 million tons of cargo on the McClellan-Kerr en route to domestic and foreign ports by way of New Orleans. That cargo includes wheat, raw steel, refined petroleum products, sand and rock, fertilizer and equipment.

One towboat pushes eight barges lashed together. Each barge holds about 1,500 tons of materials, the equivalent of 480 semi-trailer trucks. Barge cargo is packed into containers, and each container might generate as many as 40 enabling documents. By sea, a ship full of containers might require as many as 100,000 documents.

The smallest unit of this massive transportation system—the containers and their contents, their condition and their delivery progress—is the focus of the OU research project. *continued*

Quick Facts

The OU-Tulsa School of Electrical and Computer Engineering, directed by James J. Sluss Jr., holder of the Morris R. Pitman Professorship, has an enrollment of 45 graduate students. "The electrical and computer engineering job market is very strong," Sluss says. "We have placed all of our graduates."

Historically the field, like other areas of engineering, has been male-dominated, but in the last 10 years a concerted effort has been made to encourage young women to pursue electrical engineering. "We have to start that process in middle school," Sluss says, "a critical time when kids are looking at career fields. High school is too late."

Photo provided

The research team used a building-block approach in creating the $38,000 mini surveillance helicopter, starting with off-the-shelf products and adding other technology.

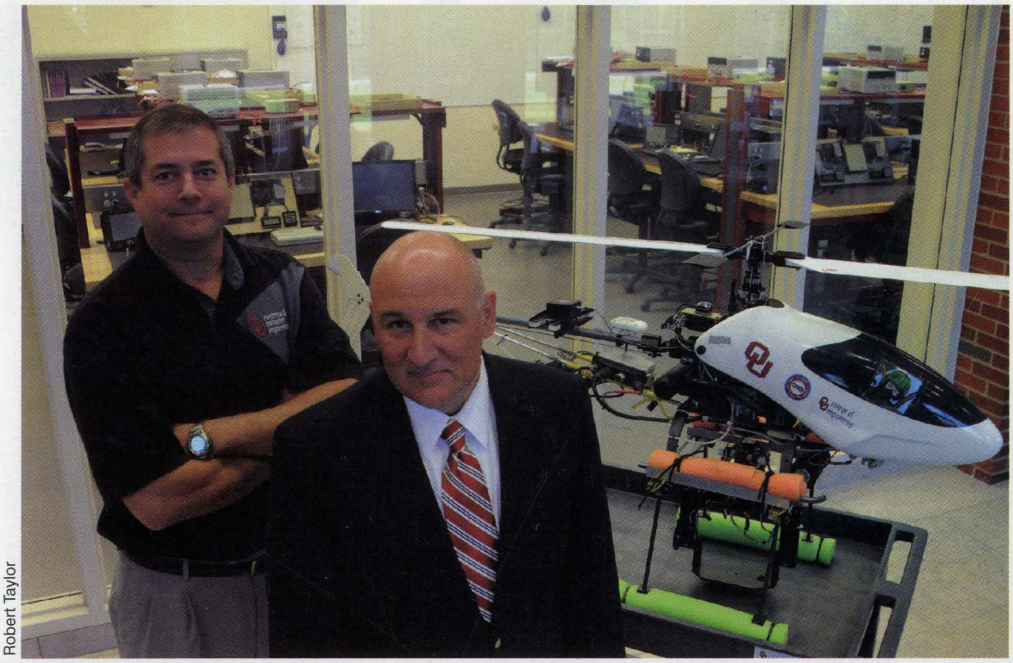
Photo provided

Tulsa's Port of Catoosa, the largest inland port west of the Mississippi River, offered OU researchers based at OU-Tulsa and in Norman a real-life laboratory for the development of surveillance technology to safeguard national and global waterways.

Protecting Commerce

With the constant risks of terrorism and piracy, port security is vital for detecting bombs, drugs, weapons, disease contamination and illegal goods that might be transported in the containers. In addition to homeland security concerns, advancing commerce is a prime objective; nearly all of the nation's commercial supply chain rides in these containers. Shipment delays or content losses could be financially disastrous.

With the OU prototype security system, once a container is sealed, it is monitored throughout its journey for routing, content stability, tampering and changes in temperature, light, chemicals and air pressure.



Robert Taylor

Robert Huck, left, and James Sluss are leading the research team assembled by OU Engineering Dean Tom Landers to address the challenge of protecting U.S. ports.

Directing the Catoosa Project

The OU Research Team consists of Robert C. Huck, James J. Sluss Jr. and Thomas L. Landers of OU's College of Engineering and School of Electrical and Computer Engineering, working with more than 30 researchers and other experts. Participating institutions and companies included Oklahoma State University, West Virginia University, the University of Pennsylvania Wharton School of Business, the private sector and Lockheed Martin Mission Systems & Sensors.

Photo provided

The demonstration in 2008 of security system technology was a full-scale media event. Here Robert Huck is interviewed by OETA.

Huck illustrates the importance of these measurements to the commercial industry with the following questions:

On its journey, was the container opened and something surreptitiously added or removed?

Did the interior temperature change, which could spoil a shipment of produce?

Was the container dropped, which could damage sensitive or fragile contents? If so, where was it dropped, which could affect insurance claims?

What is the container's location? Is it on schedule? When will it arrive in port?

Once it is on land, exactly where is it in the storage yard? Can a truck drive to the container directly, or must the truck meander among acres of container storage?

In addition, the monitoring system must guarantee that information gets only to the right people. One shipper must not be able to tap into another shipper's information.

These examples raise other alarming questions: Is WalMart's warehouse inventory control more sophisticated than worldwide shipping yards? Can security be breached and a shipment of sand be replaced with illegal drugs? Or, like a scene from "The Sopranos," could hijackers pluck out the single most valuable container among thousands?

OU researchers believe their security tracking system will go a long way toward dealing with all these important questions. Still, Landers says, freight security has been inadequate for a very long time. What his team has so successfully demonstrated is that there are viable ways to safeguard shipping for the future.

Connie Cronley is a freelance writer living in Tulsa.