Suddenly Someday: Driverless cars, pilotless planes about to change how we work, travel

By John Pastor

Imagine unmanned aerial vehicles searching for missing hikers or scanning acres of farmland to detect threats to crops. Or picture a day when a car can get passengers to their destinations without any assistance at all.

Unmanned and autonomous vehicles are about to move into safe public use, and Virginia Tech innovators are showing the world how to do it. Faculty members across colleges and institutes are developing new research strategies, creating new technology for rescue or environmental missions, and changing the way people and products get from place to place.

**Leave the driving to us**

Today's teenagers may be perfect candidates for driverless vehicles. "A driver's license does not represent freedom for young people to the extent that it did for their parents," said Myra Blanco, a research scientist with the Virginia Tech Transportation Institute. "It's a new generation. Teenagers get feelings of freedom when they are texting with friends or posting to Facebook. If mom and dad can drive them from Point A to Point B, that's a great convenience."

Imagine the convenience if the car could do the driving for mom and dad.

Blanco is at the Virginia Smart Road in Blacksburg with officials from Google Inc. and more than a dozen journalists. In the distance, a modified Lexus carrying U.S. Rep. Bob Goodlatte, U.S. Rep. Morgan Griffith, and two Google engineers turns at the far end of the two-mile circuit, brakes for another car, and parks.

Nothing unusual, except the Google car is driving itself.

During the ride, the vehicle's brakes, accelerator, and steering wheel were untouched by humans — conditions described as Level 3 self-driving automation.

"It's one of those futuristic types of things that you knew would happen someday, but you didn't realize it was happening now," Griffith said.

**Look, Ma: No hands**
Research with Google and General Motors is part of a National Highway Traffic Safety Administration study about how driverless technology should evolve from a user's perspective.

Ultimately, at Level 4 automation, "drivers" will be free from routine driving obligations. They'll hop in the vehicle, pick a destination, and — as Blanco said — send messages or post to Facebook to their heart's content.

Virginia Tech researchers are writing the next chapter in a story as old as history.

After more than 5,000 years of civilization, early humans tamed the horse and acquired speed, range, and the ability to haul goods. After another 5,000 years, humanity mastered the internal combustion engine and sent modern automobiles rattling down the road.

Engineers added throttles, transmissions, shock absorbers, and electrical parts, and with each new innovation, the old ones, like hand-cranks to start the engine, were forgotten.

Above ground, planes went from open cockpits to pressurized cabins, autopilot became a lifesaver, and the airspace filled with jets, helicopters, and even unmanned aerial vehicles, commonly called drones.

First in flight

Orville and Wilbur Wright took turns piloting the 1903 Wright Flyer, the first heavier-than-air machine to achieve controlled, sustained flight with a pilot aboard.

In 2003, pilot and mechanical engineer Kevin Kochersberger, an associate professor in the College of Engineering, re-enacted the flight for its 100th anniversary. Preflight jitters? None.

"I had mentally made that flight a thousand times," Kochersberger said.

Now, 10 years later, Kochersberger feels butterflies. This is a vastly different mission, using a 250-pound helicopter Kochersberger engineered to fly autonomously — a drone.

Nor is the site the familiar Kentland Experimental Aerial Systems Laboratory, which serves as the base for the Virginia Center for Autonomous Systems, a research arm of the Institute for Critical Technology and Applied Science and the College of Engineering.

Kochersberger's flight team of mechanical engineering students is alone in a distant valley near the Roanoke River, disconnected from power, except for a portable generator.

Justin Stiltner, of Grundy, Va., is the ground station operator; safety pilot Kenneth Kroeger, of Hunt Valley, Md., is ready to take remote control of the helicopter at the first sign of trouble; Donny Rogers, of Winchester, Va., programs in the navigation and payload information; and Gordon Christie, of Morgantown, W.Va., serves as an official observer, continually scanning the ground and sky for hazards.

Drones, crops, and cameras
The team is working with David Reed, an Extension agronomist at the Virginia Tech Southern Piedmont Center in Blackstone, to determine whether unmanned drones can gather data useful for managing crops.

By designing and building sensing systems — called payloads — and integrating them into the autonomous helicopter, researchers are perfecting technology that can be used to record images of crop stress, to deploy on search-and-rescue missions, or to monitor blast areas and conservation sites.

The work could lead to a vital new industry. Integrating drones into the national airspace could add more than $13.6 billion to the nation's economy by the end of the decade, reaching as high as $82.1 billion by 2025, according to the Association for Unmanned Vehicle Systems International.

The chopper rises and the autopilot activates. Infrared, long-wave infrared, and ultraviolet cameras whir to life. In aerial images, green represents growing plants and conveys information about crop health. Yellow provides information about when and where to harvest.

"I don't always sleep well the night before a flight operation, especially one in a remote location with no power, but absolutely nothing went wrong," Kochersberger said. "The helicopter started, the flight control system worked, we didn't have wind issues, the batteries were charged when we started and still charged when we landed, the images were all taken, the exposures were all correct. All of the systems we rely on, every one, worked perfectly. That's because our students are as good at unmanned flight operations as any team from any large corporation out there."

**Into the mainstream**

"As we gain experience with landowners, neighbors, the Federal Aviation Administration, and the aviation community, the more comfortable everyone will be with autonomous flight, and that will lead us to commercially available products and services," said Craig Woolsey, an associate professor of aerospace and ocean engineering with the College of Engineering, and the director of the Virginia Center for Autonomous Systems. "Not only will use of the airspace change, but unmanned systems will transform public roads and waterways. Virginia Tech has faculty members across colleges and institutes who are moving autonomous vehicles out of niche applications and into safe public use."

The changes ahead may have as much impact as the smart phone, which revolutionized communication and productivity, but created problems as well, such as privacy breaches and distracted drivers.

This time, researchers are anticipating the outcomes, Woolsey said.

"We are creating technologies that could transform personal transportation, agriculture, emergency response — a wide variety of activities," Woolsey said. "When people realize what they will gain through autonomous technology, we are going to see a drastic paradigm shift in the way we approach these activities. As happened with cellular devices, new industries will crop up, new infrastructure needs will evolve — the economic impact will be enormous."

**Growth industry**
"We expect unmanned aircraft systems will be extremely useful for utilities — pipeline inspection, for example — search and rescue, disaster response, agriculture, wildlife management, and, most likely, a number of applications we haven't even considered," said Jon Greene, the associate director of strategic planning and development at the Institute for Critical Technology and Applied Science.

The Association for Unmanned Vehicle Systems International believes the marketplace for drones and related products will double in size within three to six years.

The association ranks Virginia eighth among the states with the most to gain from unmanned aircraft systems. By 2017, unmanned aircraft systems-related work is expected to add $463 million to the commonwealth's economy, produce $4.47 million in additional tax revenue, and add more than 2,300 jobs.

Whether remote-controlled or autonomously operated and guided by GPS, unmanned aircraft will keep tabs on storm systems, search for disaster victims, watch for wildfires, track wildlife, monitor power lines, and deliver cargo.

From predicting crop health to old-fashioned cropdusting, farm uses for unmanned aircraft abound. Police, firefighters, and emergency responders are also eager to try the technology for search-and-rescue operations or to keep an eye on dangerous neighborhoods.

Economically, it makes sense. Drones cost less than $100,000 each and can do much of the same work as a police helicopter, which costs more than $1.5 million. But surveillance opens issues beyond safety. Privacy is a concern, although unlike with smart phones, which were in wide use before privacy was addressed, unmanned aircraft can't be used for commercial purposes without Federal Aviation Administration approval.

**Point A to Point B**

"Drivers were texting and emailing on their phones before anyone thought about the hazards of distracted driving, a very real problem that Virginia Tech brought to the nation's attention," Greene said. "Virginia Tech and its partners are anticipating the safety and privacy issues, and we will provide data to inform the discussion in advance."

The Federal Aviation Administration (FAA) was charged by Congress to identify six test sites to determine how to safely integrate unmanned aircraft systems into the nation's airspace by 2015.

Virginia Tech, which is among the primary institutions in the United States seeking FAA permissions to launch unmanned aircraft, also leads a Virginia-New Jersey consortium called the Mid-Atlantic Aviation Partnership, which unites academic, industry, state government, and economic development organizations.

The partnership, which includes Rutgers University, proposed to operate one of the test sites, as did a similar consortium led by the University of Maryland.

"It became clear to all concerned that we would benefit by working together," Greene said. "Virginia Tech has one of the most robust unmanned aircraft systems research programs of any
university in the United States. With our partners, we think we can help introduce this new technology the right way."

In late September, Gov. Martin O'Malley, of Maryland; Gov. Chris Christie, of New Jersey; and Gov. Robert McDonnell, of Virginia, expressed their commitment to jointly support test site infrastructure in a letter to the Department of Transportation and the Federal Aviation Administration.

'Legacy' vehicles

"Ultimately, the role of the pilot is going to change," Greene said. "Look at the way we fly today — a lot is on autopilot. Planes can land themselves. Likewise, we are going to see more and more driver aids, where the driver does less to control the vehicle. That means on the roadways we are working toward a day where a vehicle can completely get passengers to their destinations without any assistance at all."

The hard work comes in getting from Point A — where people are doing the driving — to Point B, where people can instead devote themselves to more productive or entertaining pursuits.

"We need to fully understand the interaction of automated vehicles with 'legacy' vehicles," said Blanco, who works with the Google car. "But just think — all of the mobility issues we can solve. The older generation may have been passionate about driving, but with the new system, they can get to the hair salon or the barber shop and they won't need to ask anyone to take them. They will still be able to go where they want, when they want. It helps them stay independent, it helps them stay aware, and it helps their health."

As for Blanco, when she's not studying the behavior of people in automated cars, she can sometimes be found behind the wheel of a 1974 Mercedes 280 with an odometer reading that is inching toward 300,000 miles.

"It is my dad’s car that he bought and restored for me — I love driving it."

They can't drive themselves, but legacy vehicles will always have their charm.