

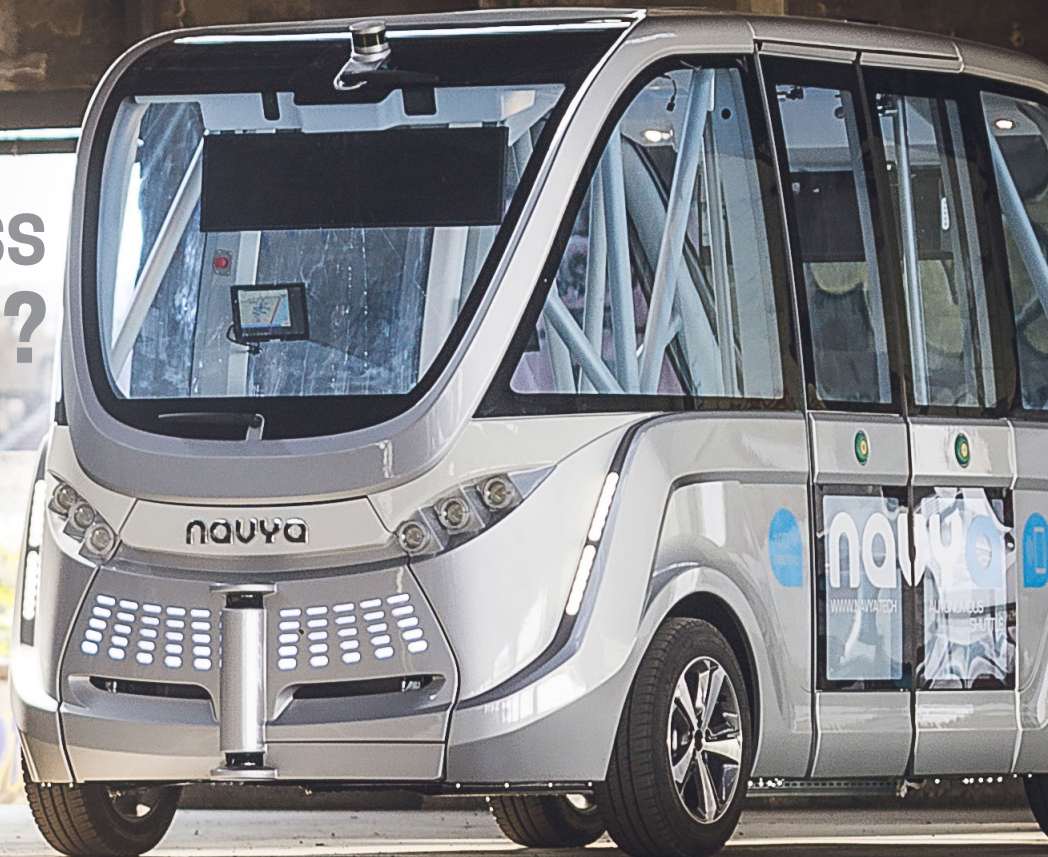
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DRIVERLESS  
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# PILOT PROGRAM PARTICIPANTS SHOWCASE FUTURE OF UAS INDUSTRY

May marked another momentous step forward in the march toward further integration of unmanned aircraft systems into the national airspace system. On May 9, U.S. Department of Transportation Secretary Elaine Chao announced the 10 projects selected for its UAS Integration Pilot Program after unprecedented interest from across the country. The participants represent state, local and tribal government entities that will partner with businesses to conduct research on expanded operations and help shape a national UAS policy framework in the years to come.

This program is the latest example of government-industry collaboration to safely and efficiently integrate UAS into the national airspace. The chosen projects, ranging from mosquito control in Florida to pipeline inspections in rural Alaska, will provide critical research that will allow us to go above and beyond what is permitted under current regulation. For example, medical delivery testing in Reno could lead to more widespread use of UAS for emergency management, and UAS traffic management (UTM) research conducted by the Memphis-Shelby County Airport Authority in Tennessee could pave the way for a nationwide UTM system that can work alongside aircraft traffic control for manned aviation. These small-scale projects may give a glimpse into what the future holds for UAS operations



**Brian Wynne**  
President And CEO,  
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COLLABORATION  
TO SAFELY AND  
EFFICIENTLY  
INTEGRATE UAS  
INTO THE NATIONAL  
AIRSPACE.



around the country. A look at two of the projects, in Oklahoma and Virginia, is contained in this issue, with more to come in future issues.

Notably, the pilot program provides a mechanism for the selected government entities to collaborate with the Federal Aviation Administration while maintaining the U.S. government's jurisdiction over the national airspace. This federal control is a bedrock principle of aviation law that dates back well over 50 years, and is the primary reason the United States maintains an aviation safety record that is the envy of the rest of the world. Program participants will have input into the development of UAS policy without creating a complicated patchwork of local and state laws that could erode, rather than enhance, safety, paving the way for further UAS integration into the national airspace.

Numerous studies have shown the tremendous benefits UAS technology will provide for economic growth and workforce development across the country. Under the right regulatory environment, guided by the findings of the pilot program, there's no doubt the industry will continue to advance with regulations to permit operations over people and beyond line of sight. We look forward to seeing the findings of the program's research and continuing to work with the FAA to tap into the tremendous potential of UAS.

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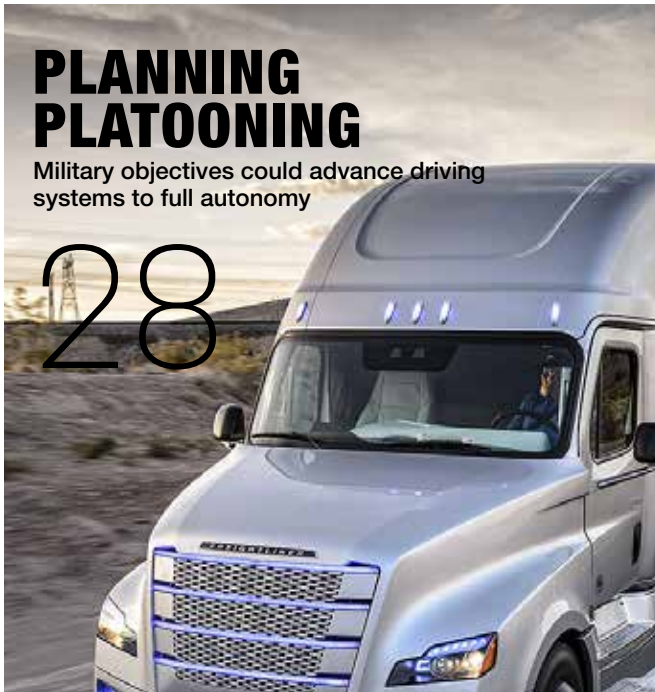


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On the cover: A self-driving shuttle bus built by Navya. Autonomous shuttle buses could be among the first self-driving services on the road. Photo: Navya



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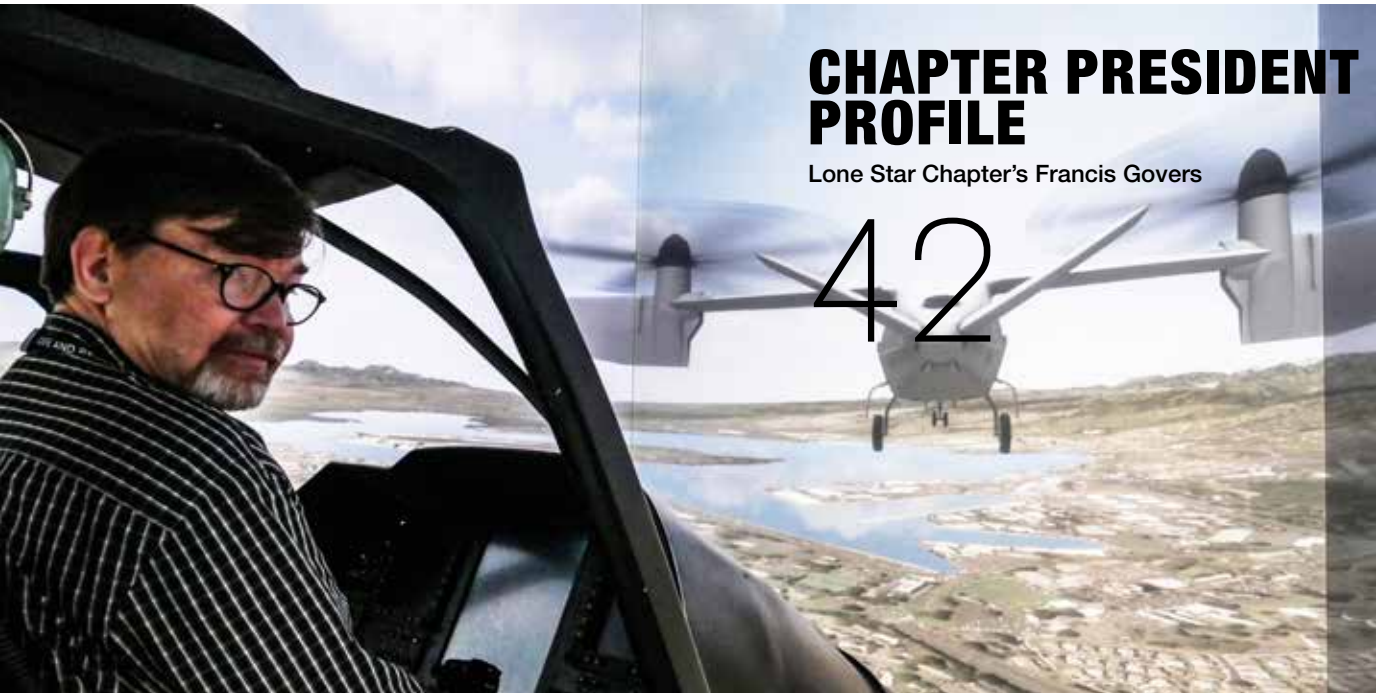
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# ASSOCIATION **EVENTS**



## FEATURED EVENT

### **Automated Vehicles Symposium 2018**

July 9-12

Hilton San Francisco Union Square

San Francisco, California

#### **Auvsi Cascade Chapter: Networking Social Hosted by Perkins Coie**

July 19

4:30 - 6:30 p.m. PDT

Perkins Coie Downtown Seattle  
Office

1201 Third Avenue Suite 4900,  
Seattle

#### **Capturing the Moment: Drones In The Arts & Entertainment**

July 25

3:00-4:00 p.m. EST

Webinar

#### **European Imaging & Sensors Summit 2018**

Sept. 19-21

Grenoble, France

#### **MEMS & Sensors Summit**

Sept. 19-21

Grenoble, France

#### **Robobusiness**

Sept. 25- 27

Santa Clara Convention Center  
Santa Clara, California

#### **AUVSI Hill Day & Science and Tech Fair 2018**

Sept. 26

8:30 a.m. - 5:00 p.m. EST

Rayburn House Office Building  
Banquet Rooms 2044 and 2045,  
Washington, D.C.



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▼ The Mcity Driverless Shuttle launched on June 4 on the University of Michigan's North Campus. **Photo: University of Michigan**



### **Mcity Driverless Shuttle begins operation at University of Michigan**

The Mcity Driverless Shuttle research project at the University of Michigan (U-M) launched on U-M's North Campus on Monday, June 4.

Through the project, Mcity is examining how passengers react to the driverless shuttles, in an effort to measure consumer acceptance of the technology.

During the project, data generated during operation will be captured using the shuttles' onboard cameras and Wi-Fi communications. This is the first driverless shuttle project of its kind in the U.S., according to Mcity Director Hwei Peng, who is also the Roger L. McCarthy Professor of Mechanical Engineering and the faculty lead on the shuttle research project.

"The Mcity Driverless Shuttle is the first driverless shuttle project in the United States focusing on user behavior research and data collection, and we're excited to begin this important work," Peng says.

"The data we collect will help researchers understand user trust over time, as well as how to design safer vehicles and how to operate them more efficiently."

Mcity, a public-private partnership led by the University of Michigan to "accelerate advanced mobility vehicles and technologies," is operating the shuttle in partnership with U-M Logistics, Transportation and Parking.

According to U-M, the Mcity Driverless Shuttle uses two fully automated, 11-passenger, all-electric AUTONOM Shuttles manufactured by Navya. The shuttles will be used to cover an approximately one-mile round-trip route contained to the North Campus Research Complex (NCRC).

The shuttle carries students, faculty and staff to the complex from more distant parking, and provides easy access to the U-M/Ann Arbor Area Transportation Authority bus stop. Future plans include the expansion of the route, and accessibility research.

The shuttles are equipped with a plethora of technologies, including lidar, which uses invisible laser beams to build a view of the surrounding environment, and GPS for localization.

The reactions of riders inside the shuttle will be recorded using interior cameras. This includes using video and audio recordings, and photographs from the videos.

The reaction and behavior of other road users — including other vehicles, bicyclists and pedestrians — will be captured using exterior cameras.

To learn about ridership and usage patterns, Mcity will use Wi-Fi data already collected by the university. Mcity is also working with J.D. Power to survey users about their experience, and Mcity's data protection plan will safeguard riders' privacy.

"The research obtained from our surveys will help the industry understand the rider's experience on the driverless shuttle as well as non-riders who interact with the shuttle as it operates on U-M's campus," says Kristin Kolodge, executive director of driver interaction and human machine interface at J.D. Power.

"Examining the experience from both perspectives will help industry stakeholders better understand consumer acceptance of driverless technology over time."





## In-Flight Data, senseFly partnering on BVLOS UAS operations

In-Flight Data has announced it is embarking on what it calls Canada's largest beyond visual line of sight UAS operations trials to date.

With support from senseFly, this project will seek to "demonstrate that BVLOS UAS flights can be conducted safely and efficiently, to the benefit of all Canadians, while providing cost reductions and/or operational efficiencies for the different use-cases involved."

"We are truly excited to get the go ahead for this ambitious project," says Chris Healy, the owner of In-Flight Data.

"Working closely with senseFly and our 20 partner organizations, we'll be collecting a huge amount of geo-accurate data — across many types of long-range drone applications — which we are confident will help contribute to the creation of pragmatic future BVLOS legislation."

During the trial, which is expected to run until early November, In-Flight Data will look to complete one BVLOS mission per week. The missions, which are defined by the trial's 20 partner organizations, will cover a wide variety of operations, including pipeline surveys, graveyard inventory assessments, and search and rescue applications.

"The reasons we made this trial so large are two-fold," Healy explains. "The more data, the better the risk models Transport Canada can create, which will help them to create safety-focused BVLOS regulations that benefit everyone. And secondly, there are just so many potential BVLOS applications out there, we really wanted to explore a good number of these."

The flight safety data collected during the trial will be provided to Unmanned Systems Canada and Transport Canada to "help define BVLOS risk models for different categories of unmanned aircraft," which will ultimately contribute to the growth of Canada's commercial UAS industry, according to senseFly's Regulatory Project Manager, Samuel Dépraz.

▲ The first two operational MQ-4C Triton aircraft at home in their newly refurbished hangar at Naval Base Ventura County, Point Mugu. **Photo: Northrop Grumman**

## Northrop Grumman, Navy begin MQ-4C Triton flight operations

On May 31, Northrop Grumman and the U.S. Navy officially welcomed the MQ-4C Triton UAS to the fleet during a ceremony to celebrate the commencement of flight operations at Naval Base Ventura County (NBVC), Point Mugu, California.

NBVC Point Mugu is home to the maintenance detachment of Unmanned Patrol Squadron (VUP)-19 DET Point Mugu, the Navy's first unmanned patrol squadron. Maintainers are currently conducting training and tests on the Triton UAS before it deploys to Guam later in 2018. Point Mugu has also completely refurbished an existing hangar that will house up to four Triton UAS. The first two Triton UAS are located at Point Mugu.

"With each new part of the Triton infrastructure that the Navy stands up, we move closer to making Triton operational and showing the fleet what this remarkable aircraft system can do," said Doug Shaffer, vice president, Triton programs, Northrop Grumman. "I look forward to the day when this hangar is full of activity leading up to the Guam employment."

## Mohawk Valley college receives grant to help prepare students for UAS industry

The National Science Foundation has awarded Mohawk Valley Community College in New York a \$557,487 grant to support a project in which MVCC will develop a series of "microcredentials" to increase the number of skilled technicians in the UAS industry, and ultimately address local workforce needs.

Over the next three years, MVCC will develop and implement five microcredentials made up of four courses each, which will provide students with "highly specialized, specific skills" without requiring completion of a full degree. The microcredentials are UAS Components, UAS Fabrication, UAS Operations, UAS Electronics, and UAS Data Analysis.

The grant money will also be used to launch two new degree programs: associate in applied science degrees in UAS Fabrication and UAS Electronics by innovating ways to merge the microcredentials into comprehensive and coherent packages.



▲ Team Polaris' optionally manned MRZR X1. **Photo: Polaris Industries**

## Team Polaris' MRZR preps for year of military trials

The U.S. Army has selected Team Polaris — made up of Polaris Industries, Applied Research Associates and Neya Systems — and its advanced MRZR X multi-mode vehicle platform to be one of the robotic systems used by infantry brigade combat teams for the next year of trials, as part of the Squad Multipurpose Equipment Transport (SMET) program.

Warfighters using the MRZR X are provided with a “modular, multi-mission support platform” that has several modes of operation, from traditional operator driving to multiple levels of autonomy, including the capability for remote control, teleoperation, follow-me, leader-follower and full autonomy.

Different modes of operation allow the MRZR X to “enhance and evolve mobility” in various roles such as, but not limited to, service as a robotic equipment mule, autonomous resupply vehicle, and rescue mission enabler.



▲ One of Waymo's Pacifica self-driving vans. **Photo: Waymo**

## Waymo gets more self driving Pacifica minivans

Fiat Chrysler Automobiles (FCA) and Waymo have announced the expansion of their partnership, with an agreement to add up to 62,000 Chrysler Pacifica hybrid minivans to Waymo's self-driving fleet.

This announcement comes after FCA announced in January that it will deliver thousands of its Chrysler Pacifica Hybrid minivans to Waymo's driverless transportation service. So far, FCA has delivered 600 Pacifica Hybrid minivans to Waymo.

“FCA is committed to bringing self-driving technology to our customers in a manner that is safe, efficient and realistic,” says Sergio Marchionne, CEO of Fiat Chrysler Automobiles N.V. “Strategic partnerships, such as the one we have with Waymo, will help to drive innovative technology to the forefront.”



▲ Aurora's AACUS system makes its first cargo delivery mission. **Photo: Aurora Flight Sciences**

## AACUS system makes its first cargo delivery mission

In early May, Aurora Flight Sciences' Autonomous Aerial Cargo Utility System (AACUS) successfully delivered cargo to U.S. Marines in an integrated training exercise at the Marine Corps Air Ground Combat Center Twentynine Palms, California.

According to Aurora Flight Sciences, AACUS completed its first closed-loop mission from takeoff to landing for its intended purpose of actual cargo resupply to Marines, as it successfully completed an autonomous cargo sustainment

flight delivering more than 500 pounds of water, gasoline, MREs, and replacement communications gear including a packed cooler to represent urgently required cargo such as blood.

Aurora says this was the first “autonomous point-to-point cargo resupply mission” providing critical logistics support to Marines in need.

“Aurora is building autonomous systems that will enable tomorrow's intelligent aircraft,” says John Langford, Aurora's founder and CEO. “Whether it's protecting Marines in combat or providing accessible urban transportation, autonomy is the key to the future of aerospace.”





▲ A photo taken by Airborne Response in the wake of Hurricane Irma. **Photo: Airborne Response**

## Airborne Response boosts UAS pilot ranks

Miami-based Airborne Response, which describes itself as “the nation’s premier provider of high resolution aerial imagery for emergency management and disaster response operations,” is expanding its force of FAA-certified remote pilots for commercial and emergency UAS operations across the United States.

The company is doing this as the 2018 summer storm season started a few days earlier than expected with the

formation of Subtropical Storm Alberto, which made U.S. landfall on May 28.

“Our seasonal ramp-up of UAS operators was already under way,” says Airborne Response President Christopher Todd. “The arrival of Alberto, combined with several new aerial imagery and data contracts, is prompting us to build additional capacity for ‘gray sky’ operations just a bit more rapidly than we had originally anticipated.”

## SeeByte launches tool to improve MCM missions

SeeByte has launched the Area Breakdown Tool (ABT), designed to increase the efficiency of unmanned maritime systems operators as they plan complex mine countermeasure missions.

ABT has been designed to help operators divide large operational areas into smaller sections that can then be assigned to unmanned systems. These areas can be customized for the platform type, the duration of the mission, or the number of vehicles in the squad.

The result is that ABT helps the operator efficiently prepare a “set of sortie plans,” and quickly evaluate alternatives for a complex mission involving multiple unmanned maritime vehicles, the company says.



▲ Lockheed Martin’s upgraded Stalker. **Photo: Lockheed Martin**

## Lockheed’s Stalker UAS gets VTOL upgrade

Lockheed Martin has announced that its Stalker eXtended Endurance UAS has received a vertical take-off and landing (VTOL) capability upgrade, which, according to Lockheed, gives users “greater mission flexibility,” and allows them to operate the system in more “austere locations.”

Aside from featuring a reduced logistics footprint, the new VTOL option also

expands how and where the Stalker XE UAS may operate. Additionally, the company notes that other launch alternatives include a pneumatic rail or a standard bungee launch system.

“By offering three unique launch options, we will support day or night flight operations in a variety of environments, expanding Stalker XE’s ability to do more with less,” says Stalker X Program Manager Russell Coons. “We continue to evolve the system to bring more capability to our system operators.”

## DDC and Toyota subsidiary team for delivery platform

Drone Delivery Canada (DDC) and Toyota Tsusho Canada Inc. (TTCI) have signed an agreement to work together on a UAS delivery logistics platform.

Through the agreement, TTCL, a wholly owned subsidiary of Toyota Tsusho America Inc., will take part in DDC’s commercial pilot program in Canada as an initial stage.

Together, the two entities will look to begin flight testing, and identify other international markets to deploy DDC’s proprietary UAS delivery platform as a transportation option.

“This agreement with TTCL is expected to open international markets for us as a company,” says Tony Di Benedetto, CEO of Drone Delivery Canada.

▼ An unmanned aircraft flies at the MAAP facility in Blacksburg. **Photo: Mid-Atlantic Aviation Partnership**

## MID-ATLANTIC AVIATION PARTNERSHIP TO SPEARHEAD VIRGINIA'S WORK FOR IPP PROJECT

By Brett Davis

Virginia, already home to one of six Federal Aviation Administration test sites devoted to helping integrate UAS into the national airspace, will now continue and augment that work through its selection as host to an IPP site.

“What we’re really focused on is getting to deployable, commercial operations that can be sustained long term,” says Mark Blanks, director of the Mid-Atlantic Aviation Partnership, based at Virginia Tech.

MAAP is the heart of the Virginia test site and will also carry out the day-to-day operations of the IPP work, Blanks says, on behalf of the Center for Innovative Technology (CIT), based in Herndon, which will handle policy recommendations.

The Virginia IPP has identified three use cases it wants to study: package delivery; infrastructure inspection; and emergency management and disaster recovery. Project Wing, part of Alphabet’s (formerly Google’s) X division, worked with MAAP on food deliveries in 2016, and before that the drone company Flirtey delivered medical supplies to then-Virginia Gov. Terry McAuliffe.

MAAP has also worked with Hazon Solutions and Dominion Energy on various infrastructure inspection projects, including using drones to inspect their electrical lines, and with Sinclair Broadcast Group on an aerial journalism training program.

The selected use cases are the ones the state considered to have the greatest economic potential and are also in areas where the “the communities and the public at large are most likely to interact,” Blanks says. “High-potential use cases that will impact people on a routine basis.”

As MAAP has been active for years, some of the projects are ongoing, while “others will be entirely new, from scratch,” he says.



A WHITE HOUSE AND FAA INITIATIVE, THE UAS INTEGRATION PILOT PROGRAM INVOLVES 10 LOCATIONS THAT WILL USE UNMANNED AIRCRAFT IN A WIDE VARIETY OF WAYS. OVER THE NEXT FEW MONTHS, AUVS WILL TOUCH BASE WITH EACH OF THE IPP WINNERS TO LEARN ABOUT THEIR PLANS. FOR THIS ISSUE, WE TAKE A LOOK AT SITES IN OKLAHOMA AND VIRGINIA.



## Insurance

One of the partners on the project is the insurance giant State Farm, which has been working with drones since at least 2011, and is already using them as a safer, cheaper, more efficient way to conduct roof inspections. It was the first insurance company to get a Section 333 exemption and among the first to get waivers from the FAA for expanded flights.

Todd Binion, a section manager who is working to “operationalize” drones for State Farm, says although the company is now using drones in its day-to-day operations for roof inspections, current FAA rules for commercial use are “kind of inhibitors for us.”

“If we had multiple homes damaged ... in the same neighborhood, the rules don’t make it very easy for you to do a larger mission that’s broader than one house,” he says. Limits on beyond-line-of-sight flights and flights over people “are limiters for us.”

After a natural disaster, people tend to be out in the street, so it can be difficult not to fly over them if you’re using a drone, he says. Pushing beyond those limitations is what attracted State Farm to work with MAAP in the first place.

“What we saw was an opportunity to approach the FAA and say, we want to fly beyond line of sight and over people,” he says, and so engaged MAAP “on a research program for exactly that.”

Then along came the IPP, and “it just frankly aligned perfectly with what we were already doing. It was a pretty easy decision for us to join the MAAP [team],” he says.

“We’re not doing the research for the sake of research. We have a practical use case that we’re trying to develop, and as soon as we can get the waivers, we want to go out into the real world and operate in real world scenarios.”

MAAP’s Blanks says Virginia has proposed using airspace across the state, not just in the Blacksburg area that is home to Virginia Tech. Other areas will include central Virginia, five Virginia counties, and more urban environments.

“We’ll be flying all over the state,” he says.

## Emergency response

Another company hoping to push the envelope through flights over people and flights beyond the line of sight is Airbus Aerial, the relatively new division of the industry giant which fuses data from satellites and drones for uses such as storm damage assessment and infrastructure inspection.

“This important work will help the U.S. government to lay a foundation for drone operations in the United States,” says company President Jesse Kallman.

The company plans to fly smaller, fixed-wing UAS to study flooded areas or blocked roadways, then fuse that with the satellite data to give companies such as State Farm “a really broad level of understanding,” Kallman says.

“We’re hoping this allows us to really do the work in a efficient way,” he says of the IPP effort. It will also allow the FAA to have a “sandbox” for testing out operations not currently covered by the rules.

“They’ll be able to start learning” and find that drones are “not as inherently risky as we once thought, there are ways to do it without a completely robust sense and avoid system, and a 100 percent UTM [unmanned traffic management system, maybe there are things now that we can do,” he says.

Airbus Aerial plans to work with both the Virginia and North Dakota IPP programs on infrastructure inspections, but the North Dakota work “will probably be different from what we’re doing with MAAP,” perhaps covering topics such as land use, fire monitoring and other efforts.

## Inspection

Dominion Energy has been working with drones for the last three years, inspecting nearly 10,000 transmission lines and related structures, says Steve Eisenrauch, manager of Electric Transmission Forestry & Line Services at the company.

“Current regulations for our structure inspections using visual line of sight flights seldom impact our inspections unless it is close to an airport or in the no-fly zone around Washington, D.C.,” he writes in an email to *Unmanned Systems*. “Where regulation is hindering us is with BLOS flights. Without the ability to fly BLOS, we cannot realize the true efficiencies that BLOS flights will bring.”

Working with the IPP will enable Dominion to take advantage of expedited waivers from the FAA to conduct those BLOS flights and will in turn provide the agency with some of the data it needs to “help write new rules around BLOS flight that can be implemented across the country, similar to Part 107 rules for VLOS flight.”

Dominion also hopes to “test machine learning algorithms that potentially will achieve automated defect detection of issues on our lines and structures, so that we can proactively correct those issues before they cause outages,” Eisenrauch writes.

## Education

Educating the public about drones and their positive uses will be a big part of the Virginia work, says Blanks.

“I am a firm believer that there a lot of concerns out there that are legitimate, that need to be addressed,” he says. “I’m a big believer that the value has to be perceived in order to tolerate the negative. We tolerate a tracking device in our pocket 24/7, because the perceived value is so high,” he says, referring to cell phones.

“If we succeed in our vision, I see growth in jobs and improved efficiencies.”

# CHOCTAW NATION TO USE PARTNERS, DIVERSE LANDSCAPE TO PUSH FOR UAS INTEGRATION

By Brett Davis

When Secretary of Transportation Elaine Chao announced the winners of the DOT's UAS Integration Pilot Program in May, the first team announced was the Choctaw Nation of Oklahoma.

That effort involves a technology-minded Native American tribe, a multi-billion business incubator, a demonstration farm and a 45,000-acre ranch, as well as nearly a dozen partners interested in pushing the envelope for drone flights at night, package delivery and flights over people.

James Grimsley, founder of DII LLC, a family of technology companies (and a former AUVSI Member of the Year), says the Choctaw Nation contacted him about two years ago to discuss a strategy of getting into aviation, which is a strong point for Oklahoma.

"We literally started from scratch at that point," he says.

When the IPP program was announced in October 2017, they decided to put in a bid for it, relying on Oklahoma's aerospace history, its existing facilities and its varied topography, not to mention its penchant for storms, the study of which could lead to better forecasting.

"I was incredibly impressed and proud of the Choctaw Nation, how they got to the point where they could compete for an IPP," Grimsley says.

Going forward, the nation and its partners plan to focus on weather studies, package delivery, beyond line of sight drone flights, flights at night, crop and livestock management, flights



▲ A drone flies at Green Valley Farms Living Laboratory. **All photos: GVFL**

over people, communications in remote areas, and more.

"The sandbox that they have to work with is exceptional," Grimsley says. "... There's a lot of interest from many different angles."

## The Choctaw Nation

Brian Post, vice president of strategic investments for Choctaw Global, says the tribe is based in 10.5 counties in Southeast Oklahoma, a region that has historically been poor, with high unemployment and low incomes. While the tribe has a successful casino operation, it wanted to go beyond that and attract better, high-paying jobs that would also interest young people in STEM education.

The nation already has its own emergency management team that has been flying drones for a variety of reasons, from search and rescue to tornado and fire monitoring to mapping and monitoring local rivers.

The tribe owns a 44,000-acre ranch in Daisy, home to a few thousand head of cattle and some rugged terrain. "We thought it would be a great place to do some flight testing, beyond visual

line of sight, night testing," Post says.

"It's very remote. If someone crashed or something happened, there are maybe five or six people on the ranch at most at any given time. It's a very safe environment to do that kind of testing."

After this decision was made, the tribe learned about the IPP program and thought, "we're already going down that path, let's get some team members together and make that happen."

## Green Valley Farms

One of the most prominent team members is Green Valley Farms Living Laboratory, a large private farm that's geared toward working with researchers.

It's owned by Warren Thomas, whose family has worked for decades with the Tinker Business Industrial Park, a 70-acre, 50-member cluster of defense and aerospace companies, academics and others located near Tinker Air Force Base. TBIP, as it is known, generates \$3 billion in top-line revenue and works in aerospace and aviation, telecommunications and environmental services.



"We create environments that are specifically targeted to certain types of research and value creation, which then evolves into entrepreneurship and the formulation of companies," Thomas says. "... It's a spawning ground for value creation and entrepreneurship."

More than 11 years ago, Thomas bought the land that is now Green Valley Farms, with an eye toward using unmanned systems for weather science, pipeline surveillance, utility maintenance, disaster recovery, precision farming and others.

That was even before it was a given that the Federal Aviation Administration would allow drones to routinely undertake that sort of work, but "we knew generally speaking where we were heading with these addressable markets," he says.

The farm includes 3,500 acres that is "very biodiverse," including five miles of river and a variety of wildlife, including endangered and protected species, not least of which are resident bald eagles.

Thomas says the linkage between TBIP, with its existing base of heavyweight companies, including General Atomics Aeronautical Systems, GE and others, Green Valley Farms Living Laboratory, with its varied terrain and ties to the University of Oklahoma and other institutions, and the Choctaw Nation, with its extensive ranchlands, is "all interrelated and complimentary."

Companies like General Atomics, GE and CNN get access to venues like TBIP, in the middle of the state's largest metro area, as well as 25 miles of unrestricted airspace over Choctaw land. The Choctaw Nation, for its part, gets access to financial opportunities and industry partners they might not otherwise have.

For kids growing up poor in the nation, it means "their dreams are all of a sudden expanded, and you see the GEs of the world, CNNs and some of these other large institutions, in your backyard, and all of a sudden that becomes very real and you say, 'hey, maybe I could do something like that,'" Post says.

STEM education will be a big component of the program, with outreach to area universities, high schools, trade schools and even summer camps, he says.

"We probably won't do anything like that this summer, but within the next year, we would love to have kids come out, be able to touch, see, feel and get exposed to the STEM opportunities," he says.



▲ University of Oklahoma researchers observe a DJI Phantom 3 UAS in flight at Green Valley Farms Living Laboratory.

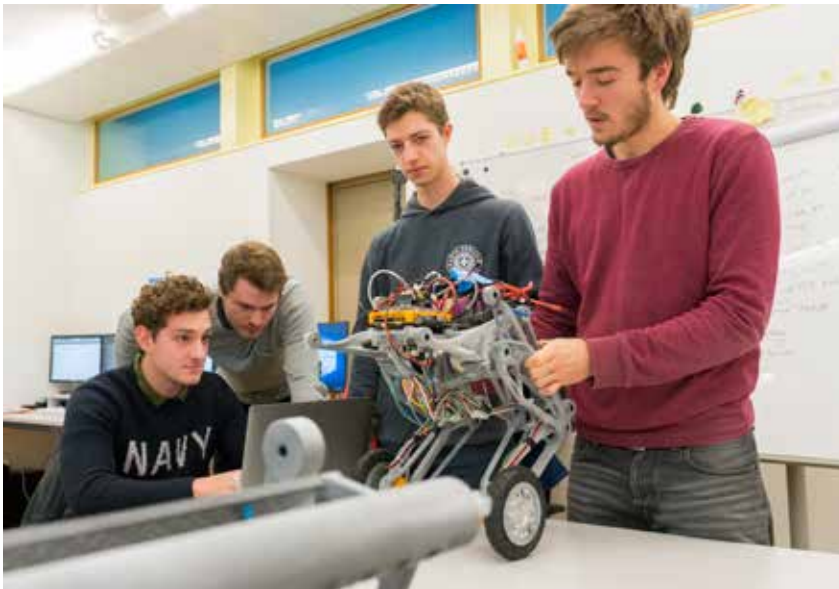


▲ The preliminary infrastructure map for GVFL.

# STEPPING IT UP A NOTCH

By Adrian Venetz

Stairs are still unsurmountable obstacles for many robots. Yet a young team at ETH Zurich is building a vehicle designed to negotiate steps with ease – by hopping.



▲ Maxon Motor's Young Engineers Program supports innovative projects with discounted drive systems and technical advice. **All photos: Maxon Motor**

"Ascento" is the name given to the sophisticated device by its creators, a team of eight students majoring in mechanical engineering and one in electrical engineering. The robot is quite special: It moves and balances on two wheels. From an engineering standpoint, this is significantly more difficult than building a device on four wheels. However, a bipedal robot provides much better mobility and adaptability to different terrain types.

That's not all: The main goal of the nine up-and-coming engineers is to make the robot leap. They want it to be able to jump high, like a kangaroo, and land again safely on its two wheels.

"This would enable the robot to master stairs and other obstacles," student Florian Weber explains.

The Ascento team originated from a focus project. In this type of project, undergraduate students of various disciplines have a chance to apply their knowledge to a concrete project — from the initial idea to a functioning prototype.

The special feature of the Ascento is that it is designed as an inverted pendulum: The center of gravity is above the axis. As a result, the Ascento is able to stand and move only as long as it is powered and actively maintaining balance on its wheels — similar to a standing human, who continuously has to expend energy to maintain balance. This makes the Ascento comparable to a Segway, which is also driven

by two wheels that are on the same axis and requires a controlled drive to maintain balance.

Potential applications for the Ascento are for example building inspections. For example, the vehicle could enter a house that's on fire or in danger of collapse. A built-in camera would deliver valuable information to rescuers outside the building. There are already various robots for these purposes.

However, "Especially when it comes to climbing stairs, many robots reach the limit of their ability," says Marcus Vierendeis, who is also a member of the nine-person focus group.

The goal for the Ascento is to enable it to climb stairs at a human's walking speed. Due to its lightweight two-wheeled design, the Ascento is more agile than other robots anyway.

"On the other hand, larger robots are able to interact with their environment. This is something that Ascento cannot do," adds mechanical engineering student Lionel Gulich.

Equipped with sensors, the Ascento would be able to scout a building and

▼ A closeup of the hopping robot's wheels.





deliver 3-D scans of the rooms in a short time. Of course, the prototype won't be able to scout a whole building by itself yet. However, it will be able to approach a flight of stairs on remote control and then use its sensors to measure and calculate the height and length of the jumps required to climb each step.

"Triggering each jump via remote would be too complicated and slow," Weber says.

This puts the Ascento in the category of semi-autonomous robots.

It is still uncertain whether the focus project and the Ascento prototype will eventually become an inspection

robot ready for commercial production. However, this is not the primary goal. Focus projects serve mainly to let ETH students try their hand at an actual project instead of just cramming theory.

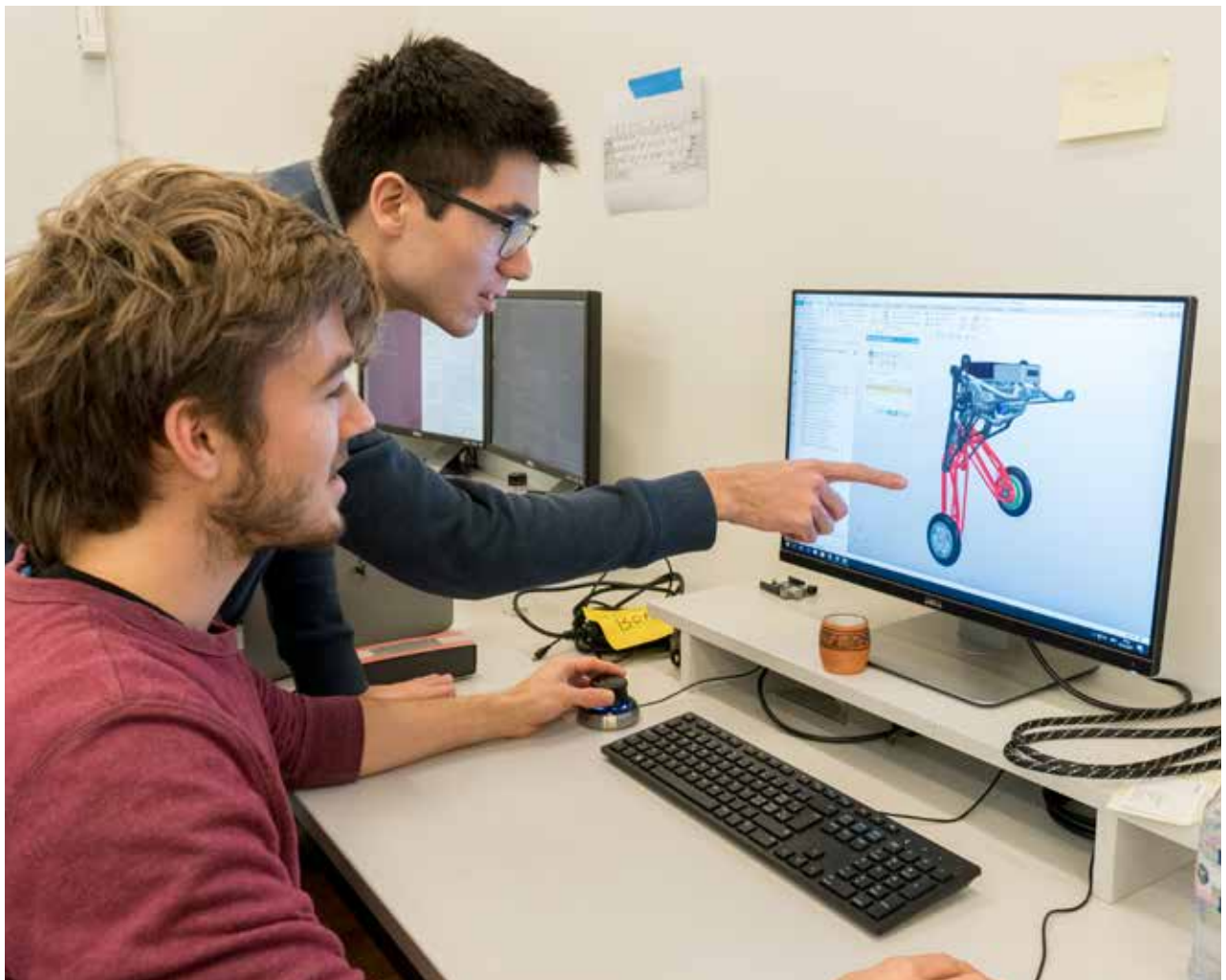
The students are receiving technical and financial support from the drive specialist manufacturer Maxon Motor, as part of the company's Young Engineers Program (YEP). The Ascento's drives include two Maxon EC 90 flat motors. Technically, the torque of 963 mNm delivered by these motors is somewhat over-dimensioned when the robot is moving along a single plane. The drives come into their own when balancing the Ascento after landing on a narrow step, as this requires high

torque and precise control. The ETH students decided to use the frameless version of the motors. Rotor and stator are delivered separately and without an output shaft. The rotor and stator are connected only during the integration into a system.

Especially in robotics, Maxon frameless motors are often the first choice because they enable space-saving and elegant integration into joint structures. Each motor is driven by an EPOS4 module.

*Editor's note: This article by Maxon Motor's Adrian Venetz was first published in Maxon's Driven magazine.*

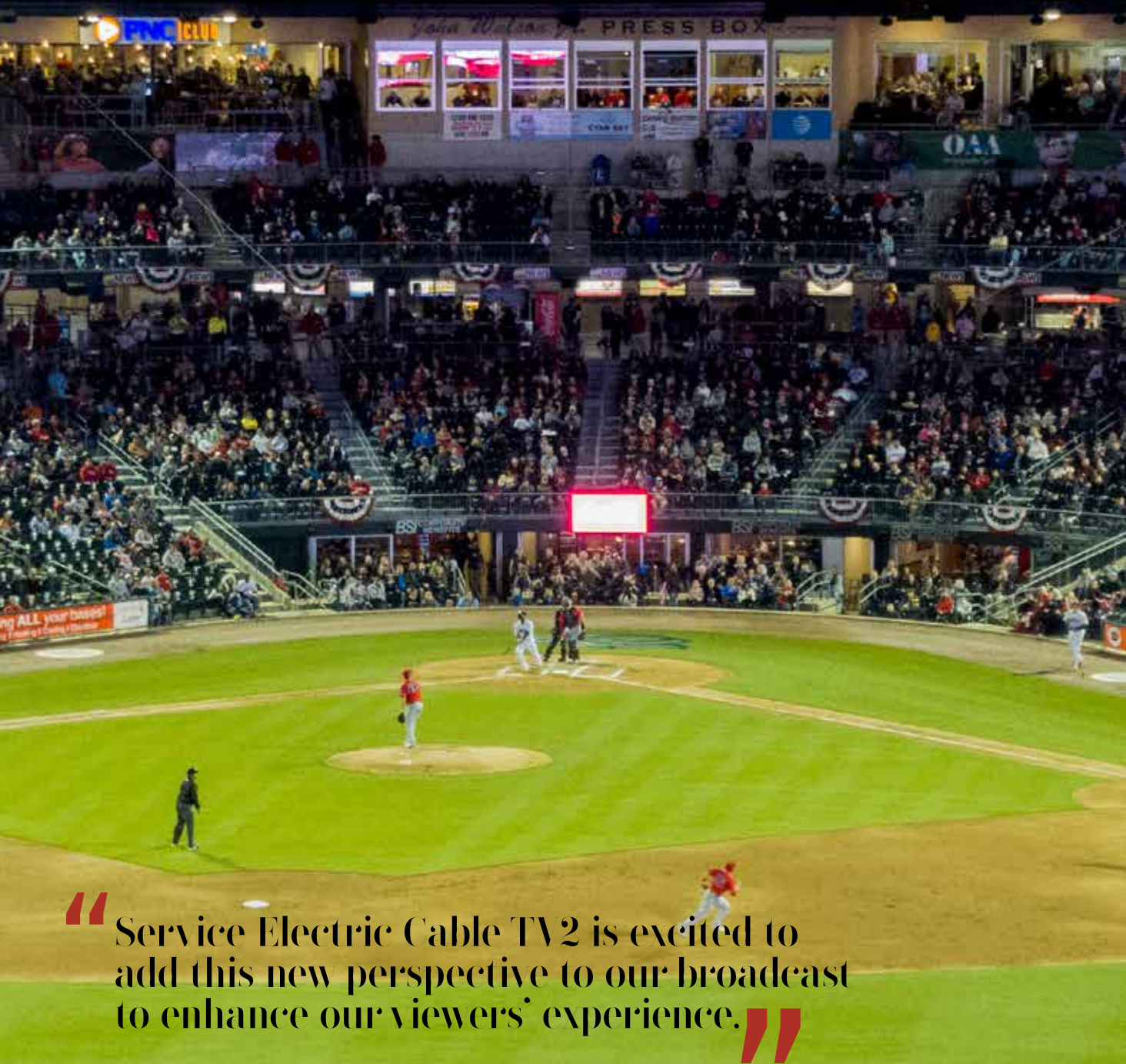
▼ Students at ETH Zurich are building a jumping robot named the Ascento.



TESTING, TESTING

# DRONE PROVIDES 'SPECIAL TREAT' FOR IRONPIGS BASEBALL FANS

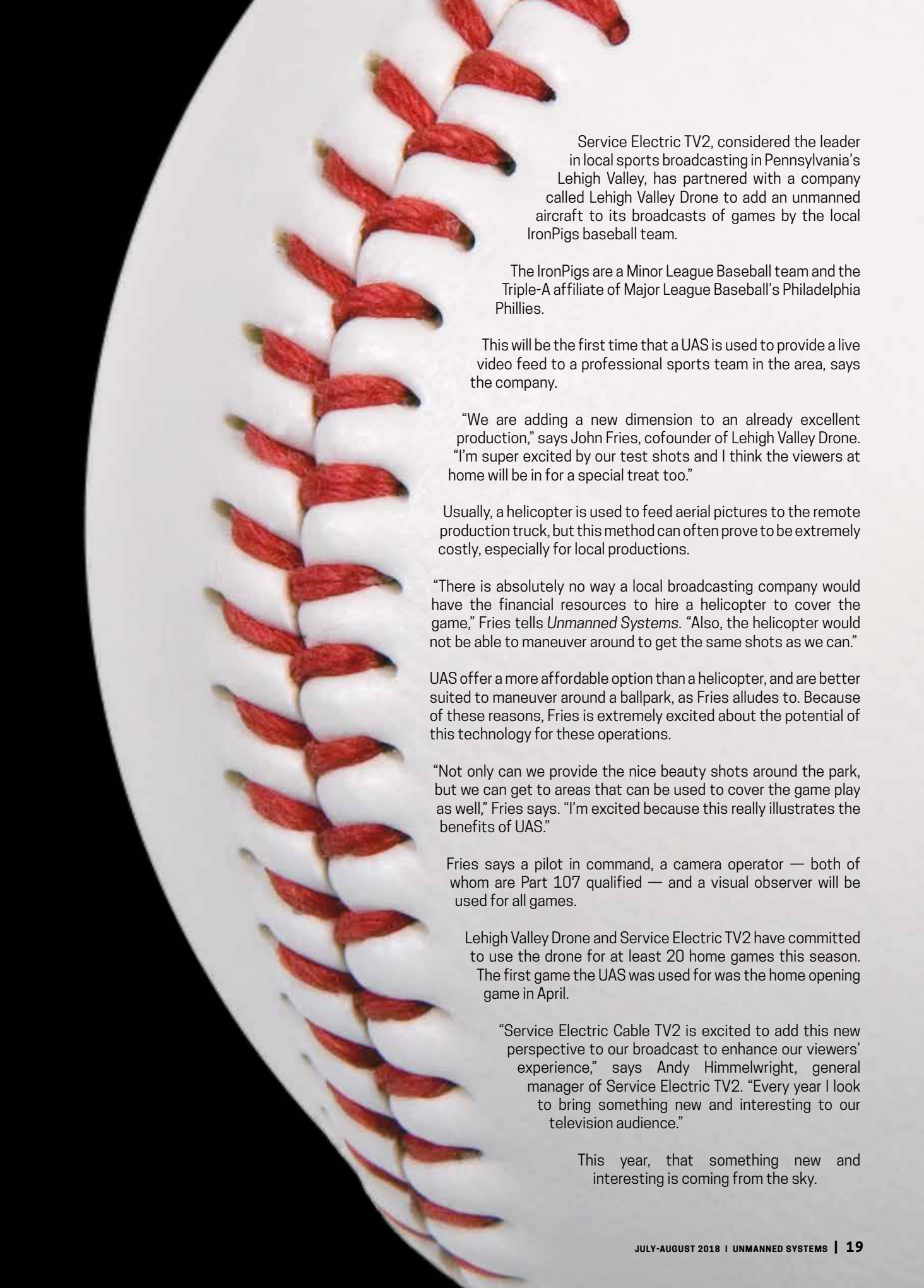
By Brian Sprowl



“Service Electric Cable TV2 is excited to add this new perspective to our broadcast to enhance our viewers’ experience.”

▲ An aerial, drone-shot scene from the IronPigs’ 2018 April opening night. Photo: Lehigh Valley Drones





Service Electric TV2, considered the leader in local sports broadcasting in Pennsylvania's Lehigh Valley, has partnered with a company called Lehigh Valley Drone to add an unmanned aircraft to its broadcasts of games by the local IronPigs baseball team.

The IronPigs are a Minor League Baseball team and the Triple-A affiliate of Major League Baseball's Philadelphia Phillies.

This will be the first time that a UAS is used to provide a live video feed to a professional sports team in the area, says the company.

"We are adding a new dimension to an already excellent production," says John Fries, cofounder of Lehigh Valley Drone. "I'm super excited by our test shots and I think the viewers at home will be in for a special treat too."

Usually, a helicopter is used to feed aerial pictures to the remote production truck, but this method can often prove to be extremely costly, especially for local productions.

"There is absolutely no way a local broadcasting company would have the financial resources to hire a helicopter to cover the game," Fries tells *Unmanned Systems*. "Also, the helicopter would not be able to maneuver around to get the same shots as we can."

UAS offer a more affordable option than a helicopter, and are better suited to maneuver around a ballpark, as Fries alludes to. Because of these reasons, Fries is extremely excited about the potential of this technology for these operations.

"Not only can we provide the nice beauty shots around the park, but we can get to areas that can be used to cover the game play as well," Fries says. "I'm excited because this really illustrates the benefits of UAS."

Fries says a pilot in command, a camera operator — both of whom are Part 107 qualified — and a visual observer will be used for all games.

Lehigh Valley Drone and Service Electric TV2 have committed to use the drone for at least 20 home games this season. The first game the UAS was used for was the home opening game in April.

"Service Electric Cable TV2 is excited to add this new perspective to our broadcast to enhance our viewers' experience," says Andy Himmelwright, general manager of Service Electric TV2. "Every year I look to bring something new and interesting to our television audience."

This year, that something new and interesting is coming from the sky.



## THOMAS B. FENERTY

CEO and president of Navmar Applied Sciences Corp. (NASC)

**The technology I'm most excited about:**

The technology I am most excited about is developing and mastering the full autonomous capability of an unmanned air vehicle. In simple terms, implementing complete artificial intelligence and machine learning.

**My favorite robot movie is:**

I don't purposely watch robot movies, however, in 1971, I decided to watch "THX1138" because I thought it was a WWII German U-Boat movie. It turns out that robots controlled the world government and all citizens. However, two people fell in love and stopped taking their daily control medication pills. The robots outlawed love and sex so the humanoid couple started a civil war. They won the war and the world was all saved. Now you know why I stopped watching robot mov-

ies. Whoever heard of outlawing love? That is really artificial intelligence.

**The best advice I ever got is:**

I was taught at home and in college, "never compromise your moral character or integrity because it is your true identity." I have since validated that all good successful companies are managed, developed and grown by people with character and integrity, not entrepreneurs.

**For fun, I like to:**

Hang out with my grandchildren, play golf and kayak with a camera.

**When I was a kid I wanted to grow up to be:**

When I was a young man I wanted to be a career Boy Scout leader (then I found out they didn't get paid) so I changed my ambition to an astronaut.







**The best part of my job is:**

Working with the many project teams (management, engineers and people) to watch them grow and develop their careers.

**The strangest thing in my office is:**

In my office I display the figurines of three Vietnamese young ladies dressed in traditional dress. They are beautiful and elegant, a gift from a brilliant young doctoral-student teacher whom I had the pleasure to work with at Carnegie Mellon University. We conversed at the Edison Awards ceremony where they (CMU) took first place for advanced optical software development. I received the gifts because I served in Vietnam in the same Province where she was born and her parents emigrated from.



▲ DJI's Matthew Perry, managing director for North America. **Photos: Becphotography**

## NEW XPO AWARDS RECOGNIZE HUMANITARIAN, PHILANTHROPIC EFFORTS WITH DRONES

By Brett Davis

Drones are becoming a critical tool for search and rescue and first responders, says Matthew Perry, managing director of North America for industry heavyweight DJI.

For the first time, at the annual Xponential show in Denver in May, Perry presented the DJI-sponsored Humanitarian Award to five winners that made a significant impact using unmanned systems in humanitarian or philanthropic efforts. The recipients received a total of \$25,000, divided among their organizations.

"Drone innovation is not being driven by the technology itself, but by you, the users," Perry said at the presentation.

DJI became interested in aiding humanitarian causes a few years ago, Perry says, when the company noticed that first responders were increasingly turning to drones as the technology got better and cheaper.

The company approached AUVSI to discuss an award program just when AUVSI was revamping its own award program, so "it was the perfect opportunity to tell a big story," he says. "This is about the industry as a whole and how we make our technology valuable to society."

The winners of the first awards spanned the globe. They are:

- Aeryon Labs, from Canada, for its work in post-hurricane operations in St. Maarten, using its SkyRanger drones
- DroneSAR, from Ireland, for executing autonomous aerial search and delivering live data to augment first response efforts
- ONG DroneSAR Chile, for its work with first responders and humanitarian relief in that country
- Nepal Flying Lab, for its work in the wake of the devastating earthquake that hit its home country of Nepal
- Zipline, for the medical drone delivery operation it set up in Rwanda.

"We have North America, South America, Africa, Europe, Asia, all represented in the five awards," Perry says. "And all of the use cases are different, so you have people creating a volunteer network across Chile. You have a professional team scanning the wreckage after a natural disaster in North America."

The company is also working with humanitarian organizations and first responders, such as the Menlo Park, California, fire and rescue, to help make its hardware and software more useful for them.

DJI issued a report in April that says at least 65 people were rescued with the help of drones in the past year, in 27 separate incidents on five continents. In conjunction with an earlier report released last year, DJI has now counted at least 124 people around the world who have been rescued by drones.

"The new report found drones have dropped buoys to struggling swimmers in Australia and Brazil, spotted unconscious victims in sub-freezing weather in England and America, and found stranded people in fields, rivers and mountains," the company said upon the report's release.



Scan this code to watch a video of the Humanitarian Awards.

▼ DJI's Perry and the winners of the Humanitarian Awards.





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## Coline Ramee

**University Attended:** Georgia Institute of Technology (master's, now Ph.D).

**Estimated graduation date:** 2020

# ONES TO WATCH

### Why did you pursue a career in unmanned systems?

I was interested by spacecraft and satellites. The fact that they have to work for a long period of time while being so inaccessible is a fascinating challenge. It made me want to study aerospace engineering with a focus on control and autonomy, and I realized other unmanned systems were really interesting to work on as well.

### What sparked your interest to be involved in a RoboNation competition?

My lab received a WAM-V [unmanned surface vessel], and one of the research engineers at my lab had done the RoboSub competition when he was in undergrad. I thought it would be a great way to get hands-on experience with robots and apply what I was learning in class to concrete

problems. I got to learn a lot of new skills from manufacturing to managing projects.

### What advice would you give those pursuing a degree in unmanned systems?

It would definitely be to get involved in robotic competitions or robotic projects. It gives a purpose to what you learn in class, you learn how to work in team and it's so satisfying to finally see your robot move or a LED blink!

### What are your future plans?

Right now, I am interning at Staples working on drone deliveries. Then, I need to graduate at some point. I want to keep working on autonomous systems as a research scientist in industry.







## Maryann Owens

**University Attended:** San Diego State University  
**Graduation date:** December, 2015

### Why did you pursue a career in unmanned systems?

I have always been interested in technology so I wanted to be in a field where I would always be challenged and have the ability to learn new things every day. Working on these types of complex systems is exciting because you are constantly thinking about innovative and creative ways to solve problems and it's so rewarding when you are finally able to figure out solutions to these challenges.

**What sparked your interest to be involved in a RoboNation competition?**  
At SDSU, I was a member of the

Mechatronics Club, which is a robotics/engineering organization. We heard about the International RoboSub competition since we are local to San Diego and after visiting the event as spectators we decided we wanted to become competitors the next year. The year after that, with a lot of hard work and dedication we actually were able to win 1st place.

### What advice would you give those pursuing a degree in unmanned systems?

Never lose your passion because it definitely will be tough and at times you may want to give up, but stay

motivated, dedicated, and always give it your best. The possibilities really are endless with what you will be able to do in this field and things that seemed difficult in the past will become trivial to you and you will gain the ability to do even more challenging things that you never imagined before.

### What are your future plans?

I want to continue to grow at my company and stay up to date on all the latest technology, become fluent in Japanese, and hopefully become an executive one day.



# VIEWFINDER

An image of the Helen Madere Memorial Bridge over the Sacramento River at sunset. The photo was contributed by Stan Khlevner/Airzus.com.

Airzus is a portal for video producers, marketing and design firms, advertising agencies and social media managers that want to incorporate aerial photography and videography into their marketing and promotions efforts.

Have a great photo you've taken with an unmanned system?  
Send it to **Brett Davis** at [bdavis@auvsi.org](mailto:bdavis@auvsi.org)





FEATURE

# PLANNING PLATOONING: MILITARY OBJECTIVES COULD ADVANCE DRIVING SYSTEMS TO FULL AUTONOMY

By Jessica Reyes Sondgeroth



▲ Peloton Technology, expected to take its product to market this year, offers a kit to convert trucks to self-driving vehicles. **Photo: Peloton Technology**





**Semi-autonomous vehicles traveling in convoys, or platoons, have the potential to save lives and transport material more efficiently and safely than manned vehicles, but the technology has a way to go before it can be fully autonomous and it's moving at different speeds in the military and commercial sectors.**

**S**emi-autonomous vehicles traveling in convoys, or platoons, have the potential to save lives and transport material more efficiently and safely than manned vehicles, but the technology has a way to go before it can be touted as fully autonomous.

In the commercial sector, the rush to full autonomy is limited by fuel cost efficiencies already achievable with semi-autonomous systems, but the need to protect soldiers on the ground and in war zones may drive the U.S. military to advance the technology into full automation sooner rather than later.

Technology developers and the U.S. military are testing the limitations of semi-autonomous transport vehicles traveling in succession, known as platooning, in conditions similar to those in which the military is currently engaged in conflict. In the military, the partially unmanned technology has the potential to reduce casualties by reducing the number of personnel needed to transport materials from one area to another, limiting human exposure to enemy attacks.

### **Military automation**

With the potential for full automation to give the U.S. the upper hand by preventing the loss of soldier lives, military leadership sees an incentive to further develop the technology. Minimizing the number of drivers means figuring out how the systems work with only one driver in the lead vehicle and no driver in subsequent vehicles until full automation is more tangible.

In testing, the one-driver, semi-autonomous platoon has encountered some problems — detect and avoid sensors and software come with various strengths and weaknesses and, depending on the climate and conditions of the military activity, may not always be as effective as human observation and judgment, says RAND Corp. research Shawn McKay. That's why RAND is recommending continued research on the minimally manned approach, in which "we can keep one soldier in the truck and collect more data to improve the system so we can increase the capability over time."

McKay points to the research that Google's self-driving system Waymo is conducting in California, in which it is collecting data on semi-autonomous vehicle systems. He says Waymo is specifically observing when the driver feels the need to take over the vehicle, and why. These human behavioral observations are critical, particularly in a war zone, to understanding how the technology can better identify and adapt to not only the human operator but to real-time conditions on the road or route.



▲ A vehicle using Lockheed's AMAS system takes part in a convoy demonstration. **Photo: Oshkosh Defense**

Lockheed Martin is one of the contractors working with the U.S. Army to test its own autonomous driving kit on military transport vehicles. Lockheed's Autonomous Mobility Applique System (AMAS) kit provides a retrofit for existing vehicles, allowing for semi-autonomous capability in leader-follower convoy operations. In the "driver warning/driver assist mode," AMAS assists a driver in tasks such as avoiding obstacles and collisions and maintaining a safe distance from the vehicle ahead and a steady position in a driving lane. And "leader-follower mode" allows personnel to link a large number of vehicles together in a convoy so the follower vehicles can operate without a person in the driver's seat.

AMAS logged more than 55,000 testing miles during the U.S. Army Extended Warfighter Experiment at Fort Leonard Wood, Missouri, and Fort Bliss, Texas, last year "in a variety of mission scenarios," says Lockheed Martin Combat Maneuver Systems Director Kathryn Hasse. Testing of the AMAS system during the warfighting experiment involved the use of a "palletized loading system" vehicle convoys in which the lead vehicle was driven by a soldier and three to four vehicles without drivers followed robotically.

"Soldiers operating the AMAS vehicles provided us very positive feedback about how the system freed them up to do the job of a soldier instead of the job of a truck driver," Hasse says.

But the kits are equipped with heavy sensors, cameras and other upgrades that put some limitation on aging military vehicles. U.S. Army Chief of Staff Gen. Mark Milley told the Senate Armed Services Committee on April 12 that the vehicles are "maxed out" and there's little room available to make any additional upgrades. While for the military

that might mean updating the vehicles themselves, for technology developers there's still a lot of prototype testing that will need to be done not just to optimize detect and avoid technology, but to do so while lightening the load to enable a vehicle to operate autonomously, efficiently and safely.

Milley told lawmakers that the military branch is embracing a next-generation fleet of semi-autonomous vehicles.

"Every ground and rotary wing vehicle that the United States Army produces" will be either fully autonomous or semi-autonomous, he said. "We're in a period of changing character of war and [artificial intelligence and robotics], perhaps more than other technologies, will have a fundamental impact," Milley testified.

Milley added that the service branch is also working on different variants of the technology including for tanks and medical transportation. Through the modernization effort, the Army intends to "eventually replace the entire family of vehicles that we have." So it's no surprise Lockheed hopes to steer the AMAS program into new production logistics trucks.

Milley also said the Army is in the process of developing experimental prototypes and expects to deploy the systems by 2028.

The AMAS technology is also being propagated into the U.S. Army's Autonomous Ground Resupply Program, which Lockheed anticipates will extend AMAS into fully autonomous operation. AMAS is also the foundation for other autonomous vehicle products in development by Lockheed Martin for industrial and commercial operations.



## Trucking sweet spot

In the commercial space and across U.S. roadways, semi-driverless convoys can help reduce man hours and accidents and more efficiently transport goods across state lines, but in this sector the fuel efficiency benefits are substantial enough to dampen the transport industry's demand for full automation.

Most of the commercial technology under development is still in the level one phase, meaning a driver is still present in each vehicle. Current testing in platooning of semi-autonomous trucks involves one driver in the lead vehicle and one driver in the follower vehicle.

Technology developers Freightliner and Peloton Technology are expected to take their semi-autonomous driving systems to market this year. The systems include driver-assisted automation equipped with collision avoidance software and vehicle-to-vehicle communication and synchronization to enable the second driverless truck to travel in close succession to the first manned, semi-autonomous truck, allowing for greater realized fuel economy savings.

But there are fundamental differences between the two technologies. Peloton offers a kit that can be equipped in any transport vehicle. Peloton's vehicle-to-vehicle (V2V)

communication system uses the cloud to track V2V-equipped trucks and enable them to communicate with one another and begin platooning at any point that two vehicles find each other. Freightliner, on the other hand, offers a fully integrated Freightliner truck equipped with platooning capabilities, but only with other Freightliner trucks.

Peloton uses the V2V communication to connect the braking and acceleration between the two trucks, allowing the lead truck to control the acceleration and braking of both trucks simultaneously. This allows the vehicles to travel in close proximity, which would otherwise be extremely dangerous, and reduces the aerodynamic drag for both the trailing and the leading truck. Independent fuel efficiency testing by the U.S. departments of energy and transportation as well as the North American Council for Freight Efficiency (NACFE) validate the claim.

"Without question, truck platooning is a valid method of reducing fuel consumption for tractor-trailers engaged in long-haul applications," according to a 2016 report from NACFE. "Once the trucks have moved into close following distances, all of the engaged vehicles receive a significant fuel economy boost thanks to increased aerodynamic efficiencies. The lead vehicle, which bears the brunt of the aerodynamic load, typically sees only a modest fuel economy boost. But the trailing truck in a platoon, which is now

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operating in a low air pressure aerodynamic 'sweet spot,' can see significant increases in fuel economy performance at highway speeds."

In fact, the majority of the monetary benefit of autonomous technology in truck platooning is realized in automating the brakes and throttle, according to industry consultant Richard Bishop of Bishop Consulting.

"You don't get any more, or monetary, benefit if you automated steering, for instance, because it's all about these trucks moving close to each other, following each other closely," Bishop says. "It's just sort of a low hanging fruit."

For Freightliner, that low-hanging fruit focuses on creating the safest and most efficient experience for the driver. Freightliner's highway patrol software processes information from camera and radar technology to enable lane stability, collision avoidance, speed control, braking and steering. The information is distilled and displayed on a dash interface to communicate the truck's performance to the driver, while also accepting commands. And video displays replace exterior mirrors, reducing blind spots.

While semi-autonomy may be optimal in the commercial transportation industry for now, there are other advancements technology developers are exploring, including adding more follower vehicles to the convoy and eliminating the need for more than the one driver in the lead vehicle.

Semi-autonomous platooning is currently legal in at least 13 states, but Bishop emphasizes more are on the way and the industry does not see regulation as a huge hurdle to semi-autonomous commercialization of platooning trucks. <sup>US</sup>



▲ Freightliner allows for autonomous operation with the push of a button. **Photo: Freightliner**

▼ A measurement of how platooning can save fuel and money. **Image: Peloton Technology**



# HITTING THE ROAD WITH FEWER DRIVERS: WHAT A SELF-DRIVING WORLD COULD LOOK LIKE

By Karen Aho



That our future includes self-driving cars is a given. Certainly, every auto manufacturer and urban planner is preparing, or thinking about preparing, for the day. But what form that future will take, and what our daily lives will look like as a result, remains ripe for prognostication.

In an interview with *The New York Times*, Chris Anderson, the former editor of *Wired* magazine, cofounder of 3D Robotics and founder of DIY Robotics — in other words, someone who knows and thinks a lot about the world of autonomous vehicles — said he continues to be confounded by the fact that people so often ask him a question that, to his mind, hardly needs asking: What will people do inside driverless cars?

“We have this world,” he says. “It’s called the back seat of an Uber.” We chat, we nap, we stare at our phone. Paraphrasing Anderson’s explanation, the writer summarizes: “Why should we think that not having a driver will change anything?”

This line of thought, that the future of autonomous vehicles amounts to little more than the removal of the driver, is hardly unique, particularly given the media’s inherent focus on the here, the now, and the potentially dangerous. Much attention is paid to rapidly advancing in-car technology, along with concerns about safety, leaving plenty of people with an image of the autonomous vehicle as just another car in the garage.

But, as this same writer points out, “We miss something when we think of autonomous cars this way, as a difference in degree, not in kind.” What if, he asks, the architectural designer Chenoe Hart is on to something when she writes that, “The elimination of the driver will mean the end of the car as a car.”

▲ A Navya self-driving bus, shown operating in Paris.  
Photo: Michael Gounon





▲ Jacksonville, Florida, is scrapping a little-used monorail in favor of a dedicated highway for automated shuttles.

**Photo: iStock**

The safety and added internal space afforded by automated vehicles will allow for mobile offices, bedrooms, kitchens, gyms, bars. Furthermore, we'll be able to summon the world to come to us, all challenging our conceptions of time and space. Writing in *Real Life* magazine, Hart opines, "If commuting entails being in a space that is functionally equivalent to being at home, one might eventually skip returning home, and commute perpetually."

While clearly theoretical, at root is a practical question that dogs urban planners, environmentalists, and anyone who plans to share the road: What if spending time in cars becomes too enjoyable?

Technology analyst Phil Levin of 99mph, a consultancy trying to predict the effect of autonomous vehicles, used Marchetti's Wall — the rule that cities grow with each new transit technology to the size of a typical one-hour roundtrip commute — to compute how far San Francisco would spread if people were willing to spend 30 percent more time in their cars and if, by eliminating traffic congestion, average speed were improved by 40 percent, to 39 mph.

The result put commuters as far out as Santa Cruz, Napa and Sonoma counties. Globally, it's a phenomenon that would dramatically change suburban and rural landscapes, perhaps making real estate and retail developers the biggest financial beneficiaries of driverless cars.

This has some concerned about increase in inequality that accompanies sprawl, and others about potential traffic. In the United States, as in much of the developed world, privately owned cars currently spend 95 percent of their time parked.

"What we're seeing today does not really reflect our future, in my opinion," says Corey Clothier, a global strategist and a principal at Mobility e3. "The idea that you buy a car, put it in the garage and think that's my car. It may be true to some extent, it just won't be a two, three, four-car family. Other than that, you'll use shared mobility."

## Increasing mobility

Shared or owned, commuting or recreating, collectively we will most certainly log more miles, however, in large part because those who can't or don't drive — children, the disabled, the elderly — will be able to affordably take door-to-door trips. Also, we'll eventually be able to send an empty car to the pharmacy or grocer. Studies by various data scientists have put the estimated increase in total vehicle miles travelled (VMT) at anywhere from 4 percent to 90 percent, depending on penetration rate, public services, and other factors.

In 2017, Joan Walker, a behavioral transportation engineer at the University of California, Berkeley, decided to use a real-world model to gain some insight into AV demand. Working with researchers at three other universities, she provided a chauffeur to three sets of people — millennials, families and retirees — and told them to treat their own vehicle as if it were a self-driving car. Compared to the weeks before and after, the participants' total VMT increased 83 percent during the week they had the chauffeur.

Among the retirees, it more than doubled, on average. One elderly woman, who said she hadn't realized how much she wanted and needed to go places, increased her road miles by 341 percent.

These stories alone may give us a picture of how much different the old open road will look in the future, particularly given the meteoric global growth of the elderly. The United Nations estimates that in most developed regions, where AVs would presumably proliferate, the population of people over the age of 80 will reach 85.2 million by 2030 and 127.8 million by 2050, double the number in 2015. (In North America, the number for that cohort is expected to nearly triple.)

In fact, contrary to common perceptions, it is seniors who seem the most eager to embrace the new technology, reports Walker. "The retirees were really excited about AVs," she told *Science* magazine. "They see their declining mobility and they are like, 'I want this to be available now.'"



The interior of a Navya self-driving bus. **Photo: Michael Gounon**

## Potential ruts

Such a projected traffic increase raises plenty of concerns, right down to the ruts in the road. Or at least that's what John Somers, of the Association of Equipment Manufacturers (AEM), got to thinking about: Will extra traffic, plus GPS accuracy, create well-worn tracks? Human drivers veer within their lanes, but ultra-precise self-driving cars might hew to more precise paths, potentially putting pressure on the exact same tracks.

"Especially if we're talking about some of the platooning semis," he says. "Does that lead to the need to develop different types of asphalt that doesn't wear down to pressure easily?"

Dean Bushey, a computer science professor at Florida Polytechnic University who specializes in automation technology, says any increase in road miles will easily be offset by improvements in traffic flow, with four to six times current throughput levels thanks to car-to-car communication.

"I'm not going to hit a pothole. Traffic lights almost become unnecessary, because all automated vehicles are talking about the flow," he says.

Bushey likes to begin presentations by showing two photos taken on Easter day in New York City. The first, taken in 1900, shows Fifth Avenue filled with horse buggies — and one car. The other, taken in 1913, is the same view, but filled with cars, or "horseless carriages," — and a single horse buggy. In today's iteration of the same phenomenon, Bushey sees the year 2035 as the halfway mark, when developed regions will experience a 40 to 50 percent penetration of AVs.

"Most cities do a 20- or 30-year transportation plan," says Bushey, who serves as a consultant to local governments. "I tell them, you can't do that anymore. You need to do a five-year plan, or a two-year plan. You need to start thinking about it. You can no longer just start building roads."

▶ How would you spend your time in an autonomous car? **Photo: iStock**



Bushey is currently working with the city of Jacksonville, Florida, the first city to convert a rail line — a little-used and costly monorail the city will scrap — into a dedicated highway for automated public shuttles. The plan is to have AVs running on the skyways in five years, to add ramps to ground-level lanes in another five years, and to be merging with other traffic five years after that.

It's a pattern Bushey sees being replicated elsewhere. "I think we're going to do same thing we did with HOV lanes," he says. "If you're Level 3 or 4 capable [using the SAE levels of driving automation], you can go on this lane. Then it will be two lanes, then three. Then it's going to be: You can't drive on this expressway if you're not Level 4 or 5."

## Driverless transit

Tech and auto companies, meanwhile, seeing the high-profit margin potential in driverless transit, are gaming to provide the service, with costs expected to be lower than current public transit offerings.

So while Level 5 AVs, fully autonomous cars akin to that personal chauffeur, could be 50 to 60 years out (one news chart listed the date for Level 5 as "somewhere over the rainbow"), the opportunity to ditch the private car thanks to access to affordable shared transit could be available much sooner. Depending, of course, on where you live. (On a cheery note, you could say goodbye forever to insurance bills. The finance site NerdWallet predicts, based on research from KPMG, that by 2050 personal liability and collision coverage will be a thing of the past.)

What the landscape looks like 20 years out will surely depend on whether you live in a region committed to developing infrastructure for semi-autonomous vehicles and in a nation committed to educating — or importing, via good immigration policy — the computer scientists and technicians needed to build and manage the networks.

"We need to make sure we are educating the next generation of autonomous vehicle engineers. We need to start teaching problem-solving," says Bushey. "Everything is going to be impacted, and I think the number of jobs created is going to be huge." **US**



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# WORKING TOGETHER:

SWARMING PROVIDES BENEFITS FOR MULTIPLE INDUSTRIES, BUT CHALLENGES REMAIN

By Brian Sprowl

Improved flexibility. Redundancy. Increased performance. Recent demonstrations and industry analysis have shown that “swarming” UAS — that is, multiple drones operated by one person, or autonomously — can bring these benefits to almost any mission.

However, many challenges remain, including managing the data from multiple systems and streamlining their communications, as well as increasing autonomy to lighten operator workloads.

## KAIST, UC team

As part of a collaboration with the Korea Advanced Institute of Science and Technology (KAIST), the University of Colorado recently conducted more than 20 hours of swarming-based flight experiments in the Pawnee National Grasslands.

According to Eric Frew, an associate professor of aerospace engineering at the University of Colorado at Boulder, the mission — conducted with approval from the Federal Aviation

Administration — was to use a team of drones to “cooperatively detect and follow” multiple stationary and moving ground targets.

Frew says he believes that ultimately, there are endless benefits when it comes to swarming.

“At its heart, swarming is about improved robustness, safety, and resilience through redundancy. Having multiple aircraft working together increases the system’s ability to respond to unforeseen problems and





**HAVING MULTIPLE AIRCRAFT WORKING TOGETHER MAKES THEM MORE FLEXIBLE AND ROBUST, RESEARCHERS SAY, BUT THERE ARE STILL ISSUES OF DATA MANAGEMENT AND COMMUNICATIONS THAT NEED TO BE ADDRESSED, AS WELL AS A NEED FOR GREATER AUTONOMY.**

disturbances,” Frew explains. “Further, swarming can improve performance by increasing the scope and speed of a given mission. Any industry that needs to gather a lot of information over large areas, or in a timely manner, can benefit from swarming UAS.”

Funding support for the joint project was provided by KAIST, and the KAIST team developed algorithms for coordinating aircraft paths, while the CU Boulder team was responsible for sensor fusion of

radio emitters, as well as designing, implementing, and fielding the UAS performing the flight experiments. Over four days, the University of Colorado and KAIST flew for 26.5 cumulative hours with five different aircraft.

Frew says the objective of the flight experiments was to demonstrate and assess the multi-UAS system the CU Boulder team designed to detect and follow radio emitters moving on the ground.

Frew says the main components of the UAS that they designed included “the aircraft with customized antenna for detecting radio emitters, sensor fusion algorithms that can combine measurements from multiple aircraft of multiple targets, meshed networking between aircraft and the ground control station, coordination algorithms for determining aircraft paths, and a graphical user interface that gave dispersed users situational awareness of the aircraft and targets. ...”

Last but not least, there was “an additional interface for a single pilot to command and control all aircraft.”

“We were successful in demonstrating all the components of the system working together, and were able to find and follow the ground targets,” Frew tells *Unmanned Systems*. “We are continuing to improve the performance of the tracking algorithms.”

During Xponential 2018 in Denver, Colorado, Frew and Cory Dixon, chief technologist at the University of Colorado, presented the lessons that they learned in three topic areas from this experiment.

“The first lesson we learned was the value of a well-trained professional team,” Frew says. “The project was an international collaboration that would not have been successful without the support of the students and professional engineers that conducted the flight operations.”

Frew notes that the Integrated Remote and In Situ Sensing (IRISS) team at the University of Colorado, which has “extensive experience” carrying out these types of field projects, conducted the actual flight testing for this experiment.

Another lesson that Frew and company learned was that since this was a collaborative project, careful design of the networking infrastructure and data interfaces was “crucial” to the team’s success.

“By defining the collaboration architecture, we could easily fly any of our aircraft for any particular mission,” Frew says.

Finally, the experiment highlighted the value of a cloud-computing architecture that can support online autonomy algorithms. Frew says that for these flights, they used a centralized approach to detect and track targets and coordinate aircraft flight paths. Frew adds that they brought their own cloud computing architecture into the field to support these tasks.

Frew says that with a connection back to the internet, they envision “many more applications,” and also says



the cloud computing architecture would let them run various different software modules on the same computer servers, which would eliminate the need to “chain together multiple computers.”

Following their presentation at Xponential, Frew says many of the comments he received had to do with the new FAA certificate of authorization they obtained, which allows them to fly multiple aircraft under a single pilot.

Additionally, they also received “a lot of positive feedback” about the depth of experience of their team, and the complexity of operations that are capable of carrying out. Frew adds that he met several industry members at the session and in the exhibition hall, and discussed collaboration opportunities with several of them.

## **Military swarming**

One industry that will benefit greatly from swarming is the military, according to Matt Dooley, principal consultant for robotics and autonomous systems at JHNA Inc. Dooley says swarming robotics will be “very important” to the future of the military, pointing out that over the years, the military has been very clear in its desire to move from a ratio of one human to one robot, to one controller of multiple machines.

“The reason why is to provide distance in standoff between soldiers and threats and provide commanders with more time to make better decisions with where they deploy human assets,” Dooley says in an interview with *Unmanned Systems*.





to a point of advanced teaming, adding that ultimately, “we have to have clarity of expectations for these systems.”

## Swarming challenges

Also during Xponential, Dooley and Northrop hosted a technical session based on the article they coauthored, which focuses on urban reconnaissance using swarms. Some of the challenges that these operations present are multi-layered, and need to be addressed properly, Dooley notes.

For one, the communications aspect of these operations will be a challenge, as systems that can operate autonomously without continuous control need to be developed so they can operate in terrains and settings that are “non-permissive,” meaning they can be jammed or shot down.

Another issue that has to be addressed is the issue of bandwidth management, Dooley says, because machines right now transmit an industrial-sized amount of data in imagery. Dooley believes that a possible fix to this issue could be showing operators images only when they need to see them, so they don’t get bogged down managing huge streams of data.

Dooley says difficulties in maintaining continuous communications make the argument for why more autonomy is needed, as a team that can make advanced tactical decisions doesn’t need to check in with an operator all the time. Dooley says that ideally, as an operator, he would be able to provide a team with their mission profile, send range and rules limitations, and send the team on its way. **us**


For Dooley, though, swarming isn’t exclusive to just UAS. In fact, in an article authored by Dooley, John Northrop, CEO of JHNA, and B.J. Hennessey — which Dooley and Northrop presented during Xponential — they refer to the systems conducting these swarming efforts as robotic and autonomous systems (RAS), to cover a broader spectrum of technology.

Dooley says UAS are one type of RAS, and the reason they refer to these systems as RAS is because there are many different types of robotic systems, but not all of them are autonomous. By the same token, there are many types of autonomous software, but not all of them may have a robotic form.

“The term RAS incorporates all of that, while UAS is just one domain,” Dooley says.




Another area that the article sought to clarify was the difference between manned-unmanned teaming and advanced teaming. Advanced teaming is much more complicated than unmanned teaming, Dooley says, but offers better benefits because it enables more complex tasks.

Dooley said he believes it’s “very important” to get




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### FRANCIS GOVERS

'REVOLUTIONIZES'  
MEETINGS FOR LONE  
STAR CHAPTER

By Brian Sprowl

When you ask a child what they want to be when they grow up, astronaut is usually one of the top responses, and that was the case for AUVSI's Lone Star Chapter President Francis Govers.

Govers never became an astronaut, but came pretty close by working for NASA on the International Space Station program. During his tenure with NASA, Govers also got involved in space station robotics, and was even part of the design of the large robotic arm on the space station.

From there, Govers' interest in unmanned technologies only grew, which eventually led him to becoming involved with AUVSI, where he has been a member since the launch of Texas' Lone Star Chapter. Around the time that he became a member, Govers was the chief engineer at a company that made unmanned aircraft and ground vehicles, "so having representation with AUVSI felt like a natural thing to do," he says.

More than a decade after joining AUVSI, Govers, now an unmanned systems engineer at Bell Helicopter, was elected the Lone Star Chapter president. Upon his election, he immediately started working on a chapter that he says "needed some energy" around the time he took over.

To infuse the chapter with that energy, Govers began working on uniting two communities in Texas: the commercial drone operators' community and the military community. Govers also acknowledged the importance of keeping local universities involved with all efforts unmanned, which can only yield positive results considering the work being done in the state with unmanned technologies by universities such as Texas A&M.



In his quest to unite all these moving parts, Govers credits AUVSI headquarters with helping move his mission forward.

"It's been delightful to work with Brian [Wynne] and Amanda [Bernhardt]," Govers tells *Unmanned Systems*. "The amount of support that the chapter has been getting from AUVSI is amazing."

### Streaming meetings

Perhaps Govers' most notable achievement since becoming chapter president has been "revolutionizing" Lone Star's chapter meetings by making them available through online streaming, so members from across the state could attend, at least virtually.

This was really done "out of desperation," Govers says, because of how large a state Texas is. Ultimately, Govers and the chapter want to have involvement from everyone interested in participating in this industry, so making these meetings available through online streaming was the most logical way to go about doing this.

"Doing it online was the only way to unite the group," Govers says.

Feedback from members about this innovative way of having meetings has been "very enthusiastic," Govers says. Additionally, this option has created the ability to tie in groups from other chapters, making it a success inside and outside of the chapter.

### Texas 'at the forefront'

Over the coming years, we can expect to see the continued "exponential growth" of unmanned vehicles, Govers says confidently. Specifically, for the state of Texas, Govers says he expects drone and unmanned technologies to have a role that is "quite extensive" in the state.

Govers notes that one benefit of UAS for the state will be in the agricultural sector, as the technology is capable of providing up to the minute surveys, lidar scans and data, something especially useful for a state with as much open land as Texas. Govers also says UAS will play an important role in Texas when it comes to responding to significant weather events, as evident by last year when the state was ravished by Hurricane Harvey.

When speaking about Texas' standing in the unmanned systems' industry, Govers does



not mince words about where he feels the state is in terms of this technology, and where it is headed.

“Texas has always been at the forefront of the unmanned vehicles industry, and that’s just going to continue,” he says.

Govers is equally optimistic in his outlook for the Lone Star Chapter, and has laid out some goals that he wants to see the chapter accomplish to maximize its standing in the industry.

For one, he wants to see the chapter get young people interested in unmanned technologies. He also wants to connect people who are just getting started in the industry — such as the young people whose interests he’s hoping to capture — with those who have a plethora of experience with these different technologies, in an effort to provide benefits to, and for, everyone.

Ultimately, Govers boils down his “mission statement” for what he wants to see the Lone Star Chapter accomplish to one very simple message:

“It’s connecting the dots between members and their needs and interests, and what’s going on with the national organization,” he says.

Aside from that, Govers adds that in the future, he wants to see the Lone Star chapter become a “forum of ideas for smaller operators and larger operators.” This shouldn’t be too difficult of an ask, considering the level of innovation that has already started at the very top of the chapter.



▲ This page and previous: Govers in a flight simulator.  
**Photo: Francis Govers**



# Das Servo.



# INDIANA CHAPTER

## Chapter history

Gary Bullock of Indiana State, formerly of Crane NAVSSEA, was instrumental in the first efforts in the state of creating the local chapter.

## Chapter activities

AUVSI Indiana Chapter meets quarterly with a rotating roster of private, state, military, university and national speakers. Speakers include: LiftWorks' Adam Morrison, Chris Chance from Aerotronic and Jeremy Webber, a research scientist and chief SUAS pilot with the Indiana University Purdue University (IUPUI) SUAS initiative.

LiftWorks provides robust and optimized propulsion systems for the commercial small UAS industry; its strength is leveraging over 60 cumulative years of aerospace propulsion systems development experience to cater to those applications that require a higher level of robustness and a smooth path to certification. Aerotronic makes a single-rotor unmanned system with two large, climate-controlled payload bays. IUPUI is predominantly focused on imagery acquisition, data processing, and algorithm development with data collected by SUAS to advance a variety of research applications in remote sensing.

## Chapter officers

President: Parker Hall  
Vice President: Neerav Shah  
Secretary: Gary Bullock  
Treasurer: Jan Eglen

## Chapter goals

In 2019, we would like to host a regional summit, regarding issues in the unmanned space that we all share.

## Area supporters

The chapter is working with parties from Indiana's UAS Integrated Pilot Program (UASIPP) application, including the state, to continue the efforts. Members such as Jesse Carlton at the NCCO and Danielle Chrysler and the Indiana Office of Defense Development led the charge on the UASIPP application and are continuing to work on issues such as autonomy.



Chris Chance of Aerotronic, one of the speakers at Indiana Chapter meetings this year. **Photos: Indiana Chapter**

Adam Morrison of UAS propulsion systems maker LiftWorks, another chapter event speaker.





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# CHAPTER NEWS

## USA - OK

In May, Oklahoma State University (OSU) held SpeedFest 2018, where engineering students from universities and high schools come together to demonstrate their knowledge and enthusiasm for aviation and aerospace. SpeedFest is an exciting, high-speed aircraft design, build and fly competition, proven to be the most challenging hands-on design competition in the world.

There are two flight competition classes. Alpha Class is the advanced class where collegiate-level teams design a high-speed, unmanned stealth jet aircraft capable of evading Doppler radar and deploying two payloads accurately into a designated area. India Class is the invitational class consisting of high school student teams and K-12 teacher teams competing to design and build pylon-racing aircraft based on a 2-stroke OS.46 AX11 glow fuel engine.

There were four Alpha Class (university) teams competing including teams from OSU, the University of Kentucky and St. Louis University. Thirteen India Class teams competed, in which one consisted of NASA Oklahoma Space Grant Consortium pre-service teachers. The motivation for creating teacher teams is to give the teachers hands-on experience and knowledge they can take back to their classrooms.

New in this year's Speedfest was an additional class, Charlie Class, consisting of college-level teams showing their skillset with autonomous cars.

"This project was great for our students, in that it showed them how hard it is to nail the final details of a project," said Aaron Alexander, mechanical engineering technology professor at OSU. "They thought they had it mastered when they were at 90 percent completion, only to find out that most of the real work consists of the getting the last bits to work out right. This insight, along with the importance of testing, will be their most valuable lessons as they leave their capstone class to start their careers."

Over 184 students, 12 college faculty, 4 university teams and 17 high school teams participated in this year's SpeedFest events. Also on display were Aerospace Expos from industry sponsors that featured multiple static displays and flight demonstrations. Nearly 1,000 spectators attended the event.

The event was supported in part by OSU, USSOCOM, Oklahoma Space Grant, NASA EPSCoR, Boeing, and USA-OK, the Oklahoma AUVSI Chapter.

## Saguaro

American Airlines and the Saguaro Chapter held a "May the 4th be with you" event to celebrate drones and their uses and to educate the American Airlines Technical Operations employees about the many good things drones are used for. This event came a day before International Drone Day.

DJI Arizona/Innovative UAS provided a pop-up drone cage and DJI products for employee hands-on experience at the Phoenix Sky

Harbor International Airport American Airlines Technical Support Hangar Facility. They demoed a DJI Matrice 210 that showcased the potential for exceptional imagery around an Airbus aircraft. Other events were held at American Airlines facilities in Dallas, Texas and Tulsa, Oklahoma simultaneously.

Monica England, AUVSI San Diego Lindbergh Chapter, provided contacts for resources in Tulsa and Dallas. Drone demos and presentations by Gabe Graveline, Tulsa Fire and Midwest Regional Director of Drone Pilot Inc., Jackie Smithson, Broken Arrow Police Department, Gene Robinson, Bryl Garrett and Jonathan Jacobs were some of the many speakers that volunteered their time to offer insights and priceless knowledge share into the drone industry.

After the event, AUVSI Saguaro sponsored a DJI Tello giveaway for an American Airlines Technical Operations IT employee.

Coming up, AUVSI Saguaro, Aerospace Arizona and ASU ASSURE are partnering for the Aerospace Arizona UAS Summit 2018, Nov. 7-9. Join industry leaders and innovative users from both defense and commercial sectors of the aerospace to gain access to the latest updates in policy, technology applications and the most promising developments in the industry. Register now and save at [www.aerospacearizona.org/summit2018](http://www.aerospacearizona.org/summit2018).

## Wright Brothers

The Engineers Club of Dayton, in collaboration with the Sinclair College National UAS Training and Certification Center, and supported by the Wright Brothers Chapter, announced the establishment of the Charles F. Kettering "Bug" Award to coincide with the 100th anniversary of its first flight.

The award is named in honor of Mr. Kettering, who, in partnership with Orville Wright, was the driving force behind the design and successful flight testing of the U.S. Army Signal Corps' first aerial torpedo, known today as UAS. This seminal achievement represents the dawn of aerial autonomy, which has become so ubiquitous today.

Upon annual evaluation by a committee of experts, the Kettering "Bug" Award will be presented to the nominated individual or organization selected for making the greatest improvement or advancement in UAS technology or systems and meeting all other award eligibility criteria.

The call for nominations opened on June 1, 2018, with submissions due to the Engineers Club of Dayton by July 15, 2018. The nominations will be evaluated by volunteering experts by Aug. 15, 2018 and the formal announcement made by Sept. 1, 2018. The inaugural presentation will be made on Oct. 2, 2018 coinciding with the 100th anniversary of the "Bug's" first flight.

The point of contact for the Engineers Club of Dayton is Mr. Ted Fecke ([ted@treble-one.com](mailto:ted@treble-one.com)) or USPS Engineers Club of Dayton, Attn: Mr. Ted Fecke, 110 East Monument Ave., Dayton, Ohio, 45402.



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# AIDBOTS' NEO ROBOT

IS SO MUCH MORE THAN A COMMERCIAL CLEANING TOOL

By Brian Sprowl



▲ Avidbot's flexible, floor-cleaning Neo. Photos: Avidbots

A robotics company called Avidbots has developed Neo, which the company describes as “a purpose-built, floor-scrubbing robot that integrates state-of-the-art navigation technology with hardware designed for ease of use, longevity, serviceability, safety and high productivity.”

Designed to clean large hard-surface areas safely, Neo is an autonomous robot that learns about its environment and adjust to changes. Neo starts this process by scanning the layout of the environment and creating a map during its initial walk-through with a human.

In the event that an obstacle pops up, such as a temporary display or booth in the scanned area, Neo has the ability to reroute. If that obstacle moves, Neo will sense that the space is open, and will go back to cleaning the area.

Avidbots, which was founded in 2014, believes Neo's intelligence will be beneficial to customers by improving efficiency and productivity. The company says that the robot can also ease issues with labor costs or low-employment markets.

While primarily a cleaning machine, Neo is more than that, according to Avidbots. The robot is supported by an easy-to-use web portal that provides real-time and historical

reporting and remote troubleshooting, ultimately offering greater visibility into operations for cleaning teams.

“We're a robotics company first,” says Cameron Waite, director of sales, via Engineering.com.

“We're not a big cleaning company that's trying to figure out robotics. We give the intelligence to the system. We allow it to make its own decisions to move through the space.”

At this time, Avidbots' robots are being used on five continents in various locations including airports, hospitals, shopping malls and manufacturing facilities. The company isn't resting on its laurels, though, as it has plans to develop a robot for carpet cleaning.

The company, originally formed with the idea of exploring snow-clearing robotics, is also looking into additional uses for its robots and the data they collect.

“We are working on making it even smarter,” says Pablo Molina, co-founder and chief technology officer.





# AUTONOMOUS VEHICLES



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