EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

RESEARCHER

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FLYING THE SAFER SKIES

Embry-Riddle researchers are asking questions that will change the future of aviation

FEATURES

Julia DeMarines

Cover photo: Daryl LaBello

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Through Embry-Riddle's S.U.I.T. Lab, researchers including Ryan L. Kobrick (left) and colleague Sarah Jane Pell are testing the technology that will keep future space explorers safe.

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IN EVERY ISSUE

Left and top right: Daryl LaBello; Bottom right: National Aeronautic Association

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Do You Read Me?

Language barriers play a larger-than-expected role in aircraft accidents.

Dear Friends and Alumni,

We don't typically think of safety as a creative process.

"Playing it safe" describes the opposite of innovation.

However, I suggest prioritizing safety can lead us to dig deeper and be more tenacious in asking: Why? What if? What next? Seeking those answers can drive research and new uses for our resources.

To reduce risks, we employ advanced flight simulators, proprietary engineering software and unique facilities, such as our Virtual Aerial Robotics and Virtual Crash Labs (Page 28) and our Spacesuit Utilization of Innovative Technology Lab (Page 16).

These resources are invaluable, but the engine of discovery is our curiosity.

The need to protect children when seconds matter inspired our researchers in the College of Security and Intelligence to test school doors and windows against attacks and develop an emergency response-time analysis model (Page 8). It's groundbreaking work that could have national implications.

Similarly, weather-related accidents prompted a team of professors and students in our Department of Human Factors and Behavioral Neurobiology to survey general aviation pilots on their ability to interpret hazardous weather information (Page 12). Their research results could guide future assessments as well as improved pilot training.

And then there's linguist Elizabeth Mathews. She and her colleagues are taking a closer look at language barriers and miscommunication between aircrews and controllers (Page 20). Their groundbreaking work shows that language plays a much larger role – as a contributing or latent factor – in many more aircraft crashes than previously assumed. Their findings could heighten safety by underscoring the importance of English proficiency among aviators.

Lastly, researchers within the College of Business, supported by Embry-Riddle's Next-Generation Applied Research Lab, are quantifying the economic impacts of the New Space Age on airlines (Page 4).

Our five-year strategic plan prioritizes earning international recognition for leading-edge aerospace/aviation research and innovation, and providing a discovery-driven undergraduate program. I hope you will agree that, with your support, we are well on our way.

Sincerely,

Dr. P. Barry Butler

PRESIDENT, EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

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Daryl LaBello

Reaching New Heights

NEW DATA COULD HELP INTEGRATE SPACEFLIGHTS INTO THE NATIONAL AIRSPACE

For the first time, a team of Embry-Riddle Aeronautical University students has confirmed the accuracy of a component of the Next Generation Air Transportation System (NextGen) at high altitudes using a NASA research aircraft. The results of their research using automatic dependent surveillance-broadcast (ADS-B) technology, which shifts air traffic control from ground-based radar to more precise satellite-derived positions, could help determine how rocket launches and sub-orbital spaceflights best integrate into the national airspace.

Embry-Riddle undergraduates gained real-world research experience aboard a WB-57 high-altitude scientific research aircraft. The findings could someday help planners choreograph suborbital spaceflights with aviation.

Josh Valcarcel

A RARE OPPORTUNITY

Retired astronaut, Embry-Riddle alumna and Board of Trustees member Nicole Stott alerted professors Sathya Gangadharan and Pedro Llanos to a new NASA-sponsored science, technology, engineering and mathematics program to place undergraduate student-designed and -built experiments aboard a WB-57 high-altitude scientific research aircraft. Only seven schools in the country were selected to participate in the program, organized by Johnson Space Center.

Twenty-one students from Embry-Riddle's Daytona Beach Campus in Florida worked on the payloads of two high-altitude experiments for months prior to the flights in November 2017 at Ellington Airport in Houston.

"This was an opportunity rarely given to undergraduates at other schools, to work firsthand with NASA engineers to conduct research for real-world applications," says Gangadharan, mechanical engineering professor and principal investigator.

"SEEING THESE STUDENTS FROM DIFFERENT DEGREE PROGRAMS ... COME TOGETHER AS A TEAM WAS INSPIRING."

COLLECTING DATA AT 50,000 FEET

Aerospace engineering student Ankit Rukhaiyar led the research team as they constructed a test bed for their experiments that could withstand the 60-degrees-below-zero temperatures in an unpressurized cargo area when the WB-57 was flying above 60,000 feet on the four-hour flights. They were supported by Llanos, a spaceflight operations professor, and NASA mentors Kerry Lee and Jacob French in Houston.

"ADS-B equipment had never been tested at the altitudes we were flying," Rukhaiyar says. "We requested specific flight paths during the WB-57's analog suborbital flights to map the proposed ground-based ADS-B transceivers along the Gulf of Mexico, where subsonic and supersonic flights from at least two proposed spaceports would enter already busy flight corridors."

Flight data were collected up to 50,000 feet. The information was shared with and confirmed by NASA's Aircraft Operations group – the mission pilot, Tom Parent, is an Embry-Riddle alumnus – and has been integrated into the university's Suborbital Space Flight Simulator program.

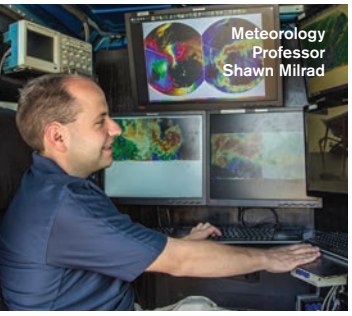
"Seeing these students from different degree programs in the Colleges of Aviation, Engineering, and Arts and Sciences come together as a team was inspiring," Llanos says. "The students also overcame major setbacks with the construction of their payloads. It gives us confidence knowing that when challenging research opportunities are offered, our students will be ready." / JAMES RODDEY

THE FUTURE OF FLORIDIAN HEATWAVES

Temperatures as high as 117 degrees Fahrenheit swept across India in May 2015, causing widespread power outages and killing at least 2,500 people.

By the late 21st century, if atmospheric greenhouse gas concentrations reach worst-case projections, Floridians could experience summer heatwaves three times more frequently, and each heatwave could last six times longer than at present, says Meteorology Professor Shawn M. Milrad of Embry-Riddle Aeronautical University.

"More extreme heatwaves in Florida would have profound impacts on human health as well as the state's economy," Milrad notes.


Meteorology Professor Shawn Milrad

For the time period 2070 to 2099, if atmospheric carbon dioxide concentrations rise two to three times above the current level of 410 parts per million, heatwaves could also get hotter, rising by 7 to 10 degrees F, Milrad reported in a peer-reviewed article, "Floridian heatwaves and extreme precipitation: future climate projections," published in the journal *Climate Dynamics.*

The research — conducted with recent Embry-Riddle graduate Ajay Raghavendra (now at the University at Albany); undergraduate student Shealynn R. Cloutier-Bisbee; and Aiguo Dai at the University at Albany and the National Center for Atmospheric Research — looked at temperatures and precipitation levels at present versus under the highest-emissions scenario set forth by the Intergovernmental Panel on Climate Change for Florida.

In a very high-level CO2 emissions scenario, precipitation would also increase following heatwaves, though this impact might vary from region to region. "A much warmer atmosphere would hold more moisture and bring heavier downpours," Milrad says. / GINGER PINHOLSTER

Rodrigo Firmo, MBA candidate, and Grace McSween, a senior aerospace engineering student minoring in human factors and flight, check out a light-sport aircraft.

Flying the Crowded Skies

RESEARCH CONFIRMS THAT EVERY SPACE LAUNCH TAKES A FINANCIAL TOLL ON AIRLINES

The SpaceX Falcon Heavy — the most powerful operational rocket in the world — streaked across a brilliant blue sky on Feb. 6, 2018, triggering wild applause from spectators lucky enough to witness America's latest aerospace achievement. When Falcon Heavy's two side boosters successfully returned to Earth, proving

Left: Chi-Valry Wu; Right: Daryl LaBello

the potential of reusable boosters, onlookers screamed with joy.

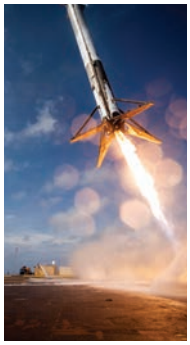
Such breakthroughs inspire people in all types of industries to push the limits of human capability ever higher. Yet every launch takes a financial toll on airlines, and at the dawn of a New Space Age, those impacts are bound to keep rising.

At Embry-Riddle Aeronautical University's College of Business in Daytona Beach, Florida, researchers are calculating the financial impacts of space launches on aviation. Rodrigo Firmo, a graduate research assistant and MBA candidate, presented preliminary results at an international conference at ESTACA University in France.

The research – directed by faculty members Janet Tinoco and Chunyan Yu – looked at two scenarios: a launch by Virgin Galactic from the Cecil Spaceport in Jacksonville, Florida, and an Atlas launch at Cape Canaveral. Virgin Galactic's SpaceShip Two takes off horizontally, whereas the Atlas rockets launch vertically, so they affect the national airspace in different ways.

As a first step, the team captured a real-world snapshot of the national airspace over both locations on a particular day: May 2, 2017. They leveraged special fast-time simulation software – the Jeppesen Total Airspace and Airport Modeller (TAAM) – with help from Carlos Castro and colleagues at the Next-Generation Embry-Riddle Advanced Research (NEAR) Lab.

"We established a baseline, which was a standard day of air traffic," Firmo explains. "Then we simulated it again, but we blocked the airspace for a certain amount of time to see what would happen to flights, based on how the U.S. Federal Aviation Administration (FAA) handles launches."



"AIRLINE FLIGHTS GET DELAYED AND REROUTED. AIRCRAFT SPEND EXTRA TIME IN THE AIR, INCREASING FUEL COSTS."

Generally, two hours before and two hours after a launch, the FAA closes the airspace around the spaceport. "Airline flights get delayed and rerouted," Firmo notes. "Aircraft spend extra time in the air, increasing fuel costs."

Quantifying those costs proved astonishing. "For extra fuel alone, when we ran simulations for Cape Canaveral and Cecil Spaceport, the cost was between $10,000 and $30,000 per launch that airlines cumulatively pay for extra fuel in each of those two locations every time a space launch closes the airspace," Firmo says, assuming a fuel cost of $1.51 per gallon. "Although these results are preliminary, they provide a starting point in determining potential impacts to the airlines."

Based on the current simulation scenarios, by 2027, extra fuel costs could rise to $200,000 per launch, and by 2037, the price tag for airlines could be a whopping $300,000, he says. /GINGER PINHOLSTER

Left: SpaceX; Right: David Massey

Mike Geldart demonstrates the use of the Ascend™ brace.

EMBRY-RIDDLE INVENTOR BRACING FOR SUCCESS

Based on a flexible, aerospace-grade composite material used for aircraft wings and fuselages, an innovative knee brace developed by a recent Embry-Riddle Aeronautical University graduate promises to improve orthopedic rehabilitation.

The key to the lightweight Ascend™ brace is Mike Geldart's patent-pending Varying Radius Spring technology, which provides continuous assistance to the quadriceps and helps strengthen muscles.

Geldart, a mechanical engineering graduate, recently won first prize at the World Congress of Biomechanics in Ireland for his invention. The Ascend™ composite is a carbon fiber more flexible than a metal spring. When the wearer sits, mechanical energy is stored and released back into the leg when the wearer stands.

"When you reduce load on muscles, you reduce contact forces in the joints that are the primary cause of knee pain," says Geldart, who designed his first prototype following a go-kart racing accident and knee surgery.

Twenty student athletes participated in a pilot study to test muscle activity. With the 3D printed brace, which was custom-made to each user, sensors measured a 30 percent increase in muscle activation, according to Geldart and fellow students Tyler Farnese and Walker Hobson. Christine Dailey, a Ph.D. candidate, is pursuing further validation.

Geldart, CEO of GRD Biomechanics, has won two $10,000 prizes – the Cairns Foundation Innovation Challenge and Embry-Riddle's Launch Your Venture competition. /DEBORAH CIRCELLI

EXIT QUICKLY AND QUIETLY: RESEARCH PROMISES SPEEDIER EVACUATIONS

What if a fire or a shooting erupts at an airport and chaos ensues? Now imagine passengers seeing in real time — from their phones or the airport monitors — the fastest evacuation routes and which parts of the airport to avoid.

Three Embry-Riddle Aeronautical University professors and their students are studying how best to reduce evacuation times at airports, schools and other locations during disasters.

Preliminary research results suggest that making evacuation information more readily accessible and establishing policies to put authority figures in charge of directing foot traffic can make evacuations far more efficient.

"If there are real-time instructions to guide people so they know where to go, it will save time and lives because every second counts," says Professor Dahai Liu, aviation lead investigator, who is working

with Assistant Professors Sirish Namilae and Jennifer Thropp; graduate students Pierrot Derjany and Yixuan Cheng; and alumnus Jie Chen.

The team collects data by observing two Florida airports and analyzing 100 evacuation reports worldwide. Thousands of simulated scenarios calculate individuals' ages and genders as well as building structure and other factors that can affect the speed and efficiency of evacuations. Some of the team's mathematical models are processed by Embry-Riddle's Cray® CS™ cluster supercomputer.

Research support has been provided by the Center for Advanced Transportation Mobility, a consortium led by North Carolina Agricultural and Technical State University. / DEBORAH CIRCELLI

Remote Control

WEARABLE CONTROL SYSTEM GUIDES REMOTE VEHICLES INTO THE FUTURE

Someday soon, military personnel and first responders arriving at the scene of an accident or a disaster may be able to swiftly assess damage and casualties by redirecting drones with a flick of their wrists. A group of Embry-Riddle Aeronautical University students is paving the way for this future with their discovery of a new application for augmented reality.

Integrating unmanned vehicles, an augmented reality headset and a neuromuscular gesture recognition armband, the system developed by the interdisciplinary team leads the way for teams on the ground to operate remote vehicles while staying mobile and carrying out additional tasks. The system uses wearable technology that mimics natural human-to-human interaction, such as hand signals, for a human-to-vehicle interface.

"This technology is great for use by first responders and military," says Adam Berlier, team lead for the project. "They don't need to set up an extensive computer control

Left: Shutterstock; Above: David Massey

Student Adam Berlier uses virtual reality glasses and a sensory arm band to operate a remote vehicle.

Right: Daniela A. Cabrera

system because this small, mobile augmented reality headpiece is a computer itself."

Combining a Microsoft HoloLens augmented reality headset – which produces computer-generated content through a small, wearable headpiece – with the gesture recognition armband (dubbed MYO), the system allows users to retain their situational awareness while controlling the remote vehicle. This permits users to stay mobile while simultaneously operating the device and observing feedback from the vehicle, including GPS information.

"The use of the HoloLens is an emerging technology," explains team member Brandon Koury. "Integrating this with the MYO armband is a really new and developmental system."

Plus, the augmented reality device allows users to communicate with each other, eliminating the need for walkie-talkies, Berlier adds. "It is also a system worn by a single individual, allowing it to be programmed to allow users to access only the information they have clearance to see."

In addition to being used at disaster and accident scenes, the technology could prove useful for unmanned inspections of structures, such as powerlines and wind turbines. "It is more intuitive and natural for use with unmanned vehicles and doesn't require massive controls to operate," Koury says.

As the team of seniors prepare for graduation, they plan to pass the torch to the next generation of Embry-Riddle students who will continue to develop and improve the technology. Incoming senior Charlie Pollock will take on the role of principal investigator, forming a team to create a centralized network and allow single users to control multiple vehicles. /KATHARINA LANE

Professor Remzi Seker teaches an aviation-focused cybersecurity camp.

CYBERSECURITY CAMPERS ARE TOMORROW'S WHITE HATS

At any given time, cybercriminals are trying to exploit the vulnerabilities of the aviation industry: connectivity, availability, legacy systems and the constant flow of payment data from passengers.

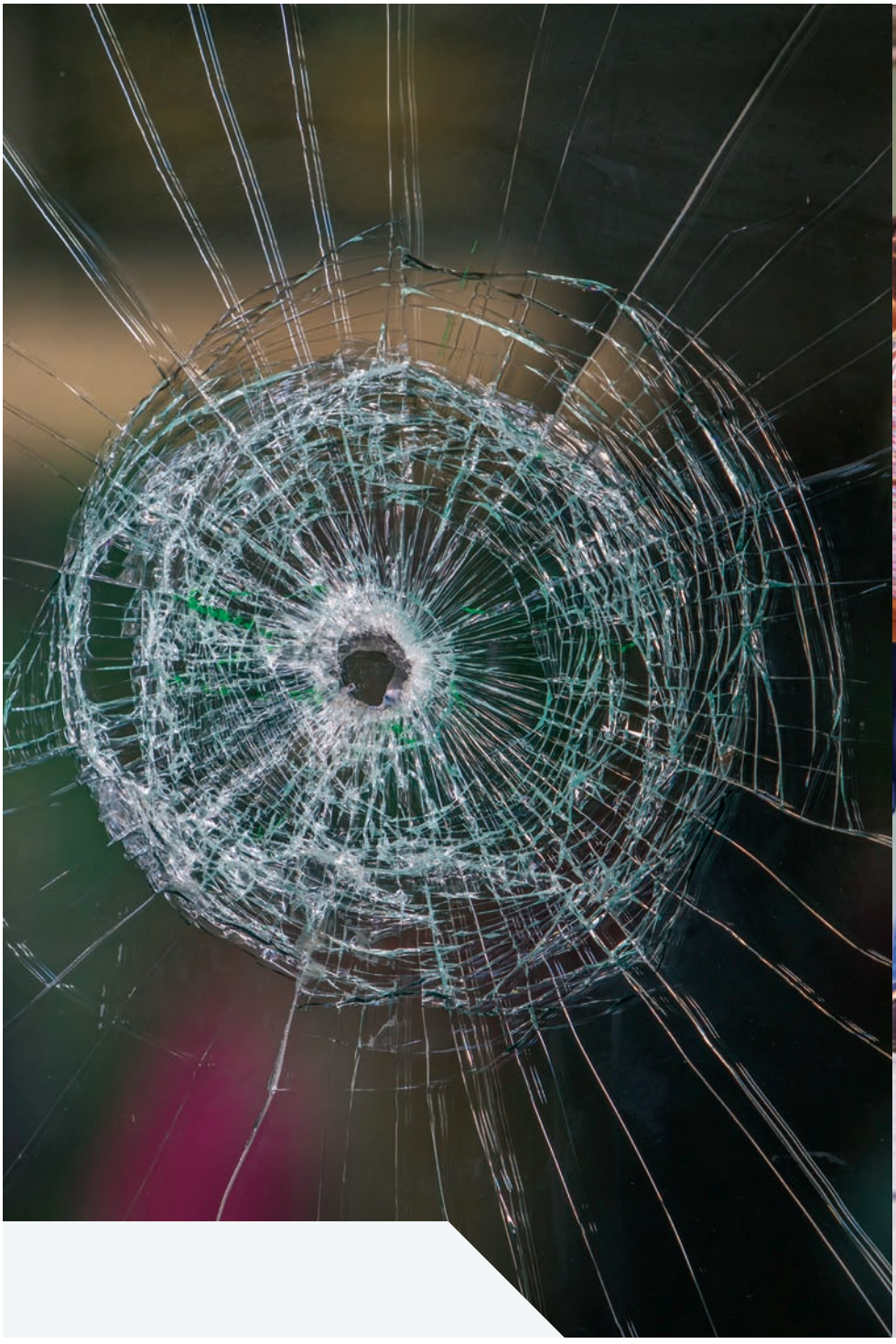
Soon, 17-year-old Antonia Nunley of Columbus, Georgia, might join an army of "white hats" being trained at Embry-Riddle Aeronautical University to protect airports and airlines from cybercriminals. Nunley recently joined 20 other high school students to take part in a unique aviation-focused cybersecurity camp, developed by Embry-Riddle faculty member Remzi Seker and funded by the National Security Agency.

Nunley is mastering the basics of secure programming through Python and JavaScript while learning about the Linux operating system and various vulnerability testing tools. She's also learning to bridge aviation culture and the rapidly changing realities of information technology.

Seker's cyber camp curriculum lets students explore hacking, cracking and digital forensics within Embry-Riddle's Cybersecurity and Assured Systems Engineering (CyBASE) Center, a lab that serves as a safe sandbox for mock malicious attacks. The program builds on Seker's deep experience developing curricula to incorporate systems thinking – a disciplined approach for identifying links and interactions to understand the underlying structure of computer systems and programs.

"Aviation safety and cybersecurity professionals don't share a common base of knowledge. At times, both groups use the same terms with different meanings. The goal is to become bilingual – fluent in aviation safety and cybersecurity," Seker says.

/KIM SHEETER & DEBORAH CIRCELLI



KEEPING SCHOOLS

How many seconds does it take to shoot through a classroom door? New research by Tom Foley (left) and Richard Rodriguez will answer that question.

Right: Connor McShane

SAFER

SECURITY RESEARCHERS LOOK FOR WAYS TO BUY CRITICAL TIME DURING SCHOOL SHOOTINGS

BY BECKY HAM

Students at Northern California's Rancho Tehama Elementary were rushed from the playground into locked classrooms after school officials heard nearby gunshots on Nov. 14, 2017. Minutes later, the gunman rammed through the school gates in a pickup truck and began shooting again.

"The gunman was not able to get into the school because teachers responded immediately to secure all barriers between him and the children," says Tom Foley, an assistant professor of global security and intelligence at Embry-Riddle Aeronautical University's Prescott Campus in Arizona. "He spent about six minutes trying to get in – trying doorknobs, shooting through doors and windows – but he was never able to get into the classrooms, and after six minutes he became frustrated and left the school."

The incident illustrates how a few minutes of delay can save hundreds of lives during a school shooting. Yet, Foley says, schools have been left with little guidance on which kinds of physical barriers can be used to stave off a shooter before the police and other emergency responders arrive on campus. He and a team of Embry-Riddle researchers want to change that with a new project that helps K-12 schools build what Foley calls "security in depth."

He and his colleagues have received a $769,890 grant from the U.S. National Institute of Justice to evaluate the success of physical barriers in delaying an attack and to learn more about parent and teacher perceptions of school security.

The researchers aren't looking for barriers that will stop a bullet, since those kinds of solutions are unsuitable for cash-strapped schools – not to mention kindergartners who can't push open a bulletproof door. Instead, they want to know what kinds of doors and windows are best for keeping a shooter at bay for critical extra seconds.

LAYERS OF SECURITY

Schools can be wrapped in layers of security like an onion, Foley says, where a perimeter fence occupies an outer layer, outside doors and windows form a deeper layer,

Richard Rodriguez, a retired Navy SEAL, and Tom Foley, an assistant professor of security and intelligence, are teaming up to make schools safer.

and so on. "The basic concept is that at each layer, you're creating a little delay, and each layer has a few seconds or minutes attached to it that represent how fast it can be breached," he explains.

"You find out how long it will take the police to get there and engage the shooter, then you design the physical security of the school to keep the shooter away from the children for at least that long," he adds.

But how many seconds does it take to shoot through a classroom door? As the centerpiece of their project, Foley and his colleagues will measure how long it takes a combination of brute force and 5.56 mm, 9 mm and 357 Magnum munitions and 12-gauge 00 buckshot to breach the three most commonly used solid birch and steel clad doors; plate glass, wired glass and tempered glass in classroom doors and sidelights; as well as each type of glass covered in two different thicknesses of smash-resistant film.

The researchers will also measure and make videos of the range and spread of splintering debris from a gunshot through a door or a window. "We want not only penetration times, but also how much fragmentation will come off a specific product and cause injuries," Foley says.

Gearing up to perform the experiments is Richard Rodriguez, a retired Navy SEAL, former SWAT team commander for the Surprise, Arizona, police department and a recent Embry-Riddle graduate. Rodriguez was a heavy weapons machine gunner and platoon chief who breached everything from doors to armored ship hatches during his time as a SEAL, most of which "were done under less than desirable conditions such as hostile ship takeovers and in combat while in Operation Iraqi Freedom," he says.

Rodriguez has three children. "As a parent, I have a personal interest in this study to possibly help out in making future changes to our schools for the better," he says. "As a former police officer and SWAT team commander, I can only see positive things coming out of this research."

"AS A PARENT, I HAVE A PERSONAL INTEREST IN THIS STUDY. AS A FORMER POLICE OFFICER AND SWAT TEAM COMMANDER, I CAN ONLY SEE POSITIVE THINGS COMING OUT OF THIS RESEARCH."

A COMMUNITY EFFORT

The study team is reaching out to 447 Arizona schools in 23 districts for another key part of the project: visiting individual schools to determine their current state of physical security and surveying parents and teachers to gauge their perceptions of security. Participating schools in urban, suburban and rural areas and on Native American reservations will receive surveys at the start of the 2018-2019 school year, when parent interest and engagement with the schools runs high.

As part of their senior-year capstone projects, some of Foley's students analyze the physical security of schools, and he says the experience has taught him that security experts and parents and teachers often have different ideas about school safety. He recalls one school that was proud of its locked-door policy, for instance – until he pointed out multiple doorways propped open in hallways that could have been difficult to close or might be blocked by bodies in an active shooter situation.

"They had just heard that it's good policy to have classroom doors locked all the time, but they didn't really think about what they were trying to accomplish by doing that, and how they can best accomplish it," he says.

INSPIRED BY SANDY HOOK

The team is also putting together a detailed buying guide for doors, windows and window treatments based on its ballistics results. The idea isn't to recommend particular brands, Foley emphasizes, but to provide information on how many seconds a particular barrier can add to a school's security plan.

There is a "moral panic" after each school shooting that can spur financially stretched school districts to spend money on measures that may not add to campus security, Foley notes. "We hope our buying guide will help schools take whatever their limited funds are and spend them on what's most effective."

Foley was motivated to examine school safety in greater depth after the 2012 Sandy Hook Elementary School shooting. At a meeting that year of ASIS International, a global security professionals organization, "we started off the meeting with a moment of silence for the victims, and it occurred to me that we had 500 years' worth of combined work experience in here – I should be doing something other than hanging my head in silence," Foley recalls.

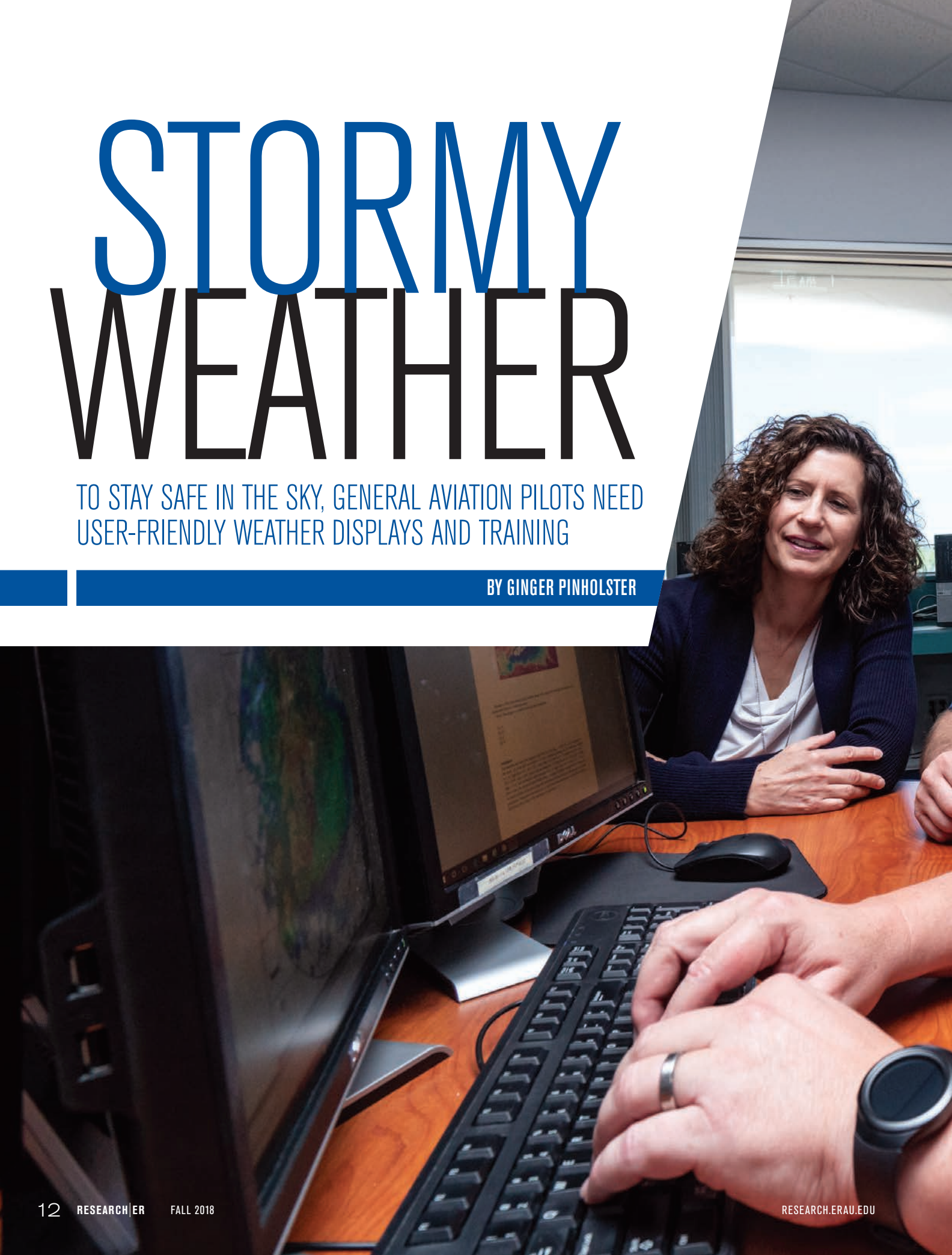
"The Sandy Hook shooting took six minutes from the first to last shot," he says. "In essence, we are figuring out how to enhance security design to give the kids at the next Sandy Hook six minutes before the bad guy can get to them." ER

Connor McShane

STORMY WEATHER

TO STAY SAFE IN THE SKY, GENERAL AVIATION PILOTS NEED USER-FRIENDLY WEATHER DISPLAYS AND TRAINING

BY GINGER PINHOLSTER



From left to right: Elizabeth Blickensderfer, lead researcher; Robert Thomas, assistant professor of aeronautical science; and Thomas A. Guinn, associate professor of meteorology.

Daryl LaBello

ON JAN. 2, 1999, A PILOT FLYING A SINGLE-ENGINE, PISTON-POWERED AIRCRAFT UNDER VISUAL FLIGHT RULES DEPARTED WALGETT, ON THE EASTERN SIDE OF AUSTRALIA, AND HEADED FOR MERRIWA, ON THE CONTINENT'S WESTERNMOST EDGE.

The aircraft never reached its destination. At 3,600 feet above mean sea level, the plane sailed through a cloud base. Without instruments, the pilot was flying blind. Just above the clouds, the plane collided with trees at the top of a ridge and burst into flames, the Australia Transport Safety Board reports. The passenger survived, but the pilot later died from burn injuries.

This situation – a pilot licensed to fly based on visual cues who encounters meteorological conditions requiring instrument-based navigation – is all too common, says Yolanda Ortiz, a graduate student at Embry-Riddle Aeronautical University.

"Clouds blow in and degrade visibility, and that can happen more quickly than you might think," Ortiz notes. "General aviation pilots who are not instrument-rated are incredibly vulnerable in that type of situation."

Making matters worse, Embry-Riddle research shows general aviation (GA) pilots often don't know how to interpret weather forecasts and observation displays. That's why Ortiz and fellow graduate student Jayde King spent nine sweltering days collecting data from GA pilots at the Experimental Aircraft Association's sprawling AirVenture fly-in event in Oshkosh, Wisconsin.

"Rain or shine, Yolanda and I were literally running all around the show with clipboards, test booklets and information scanners," King laughs. "We had to get it done."

Their goal was to give a weather-knowledge exam to as many GA pilots as possible.

The Oshkosh data, combined with additional results collected on Embry-Riddle's campus in Daytona Beach, Florida, paint a grim picture of weather knowledge among GA pilots.

When tested on their knowledge of 23 types of weather information, from icing forecasts and turbulence reports to radar, 204 GA pilots were stumped by about 42 percent of the questions, says lead researcher Elizabeth Blickensderfer, a professor in the university's Department of Human Factors and Behavioral Neurobiology.

Graduate student and researcher Jayde King observes a classmate's experience as he flies through various simulated weather conditions.

The findings, published in the April 2018 edition of the *International Journal of Aerospace Psychology*, are worrisome because GA pilots flying smaller planes at lower altitudes, usually with minimal ground-based support, have higher weather-related accident and fatality rates. The Federal Aviation Administration (FAA) reports that in fiscal year 2017, 347 people died in 209 general aviation accidents. According to the FAA, a failure to recognize worsening weather is a frequent cause or contributing factor of accidents, and most weather-related GA accidents are fatal.

Improved testing of GA pilots is needed, Blickensderfer says, noting that in 2014, the National Transportation Safety Board named "identifying and communicating hazardous weather" a top priority for improving safety. Presently, however, the FAA's Knowledge Exam allows pilots to pass even if they fail the weather portion of the test.

To conduct their study, the Embry-Riddle researchers carefully reviewed what the FAA expects GA pilots to know about weather. Next – in consultation with Thomas A. Guinn, associate professor of meteorology and co-principal investigator, as well as Robert Thomas, a gold seal certified flight instructor and an assistant professor of aeronautical science

at Embry-Riddle – the team developed a 95-question exam aligned with the FAA's expectations, as well as currently available aviation weather technologies.

Four categories of GA pilots scored as follows:

- Instrument-rated commercial pilots achieved the highest scores, with a 65 percent accuracy level.
- Instrument-rated private pilots ranked second, with 62 percent correct responses.
- Private pilots flying without an instrument rating scored 57 percent.
- Students correctly answered only 48 percent of the questions.

Overall, the mean score across all 204 pilots was 57.89 percent.

INSCRUTABLE WEATHER DISPLAYS

Blickensderfer emphasizes, however, that her research should not be interpreted solely as a symptom of faulty pilot training. "I don't want to blame the pilots for deficiencies in understanding weather information," she says. "We have to improve how weather information is displayed so that pilots can easily and quickly interpret it. At the same time, of course, we can fine-tune pilot assessments to promote learning and inform training."

What kinds of questions are asked on the Embry-Riddle exam?

As an example, respondents might be prompted to interpret cryptic METAR (Meteorological Terminal Aviation Routine Weather Report) information, which helps pilots prepare for safe flights: "You notice the comment, 'CB DSNT N MOV N.' Based on this information, which of the following is true?" Pilots should understand the METAR comment to mean, "Cumulonimbus clouds are more than 10 statute [land-measured] miles north of the airport and moving away from the airport."

Jayde King (left) and Yolanda Ortiz quizzed hundreds of general aviation pilots on their weather knowledge as part of the study.

Daryl LaBello

As another example, pilots might be asked to interpret a ground-based radar cockpit display, which would only show recent thunderstorm activity – not current conditions. Or, the survey might ask pilots to look at an infrared (color) satellite image and determine where the highest altitude clouds would most likely be found.

Guinn notes that it's critical for pilots to assess big-picture weather issues before takeoff. In addition, they need to understand, for instance, that radar displayed inside a cockpit shows what happened up to 15 minutes earlier.

"If you're flying 120 miles per hour and you don't understand that there's a lag time in ground-based radar data reaching your cockpit," Guinn points out, "that can be deadly."

GA PILOTS FLYING SMALLER PLANES AT LOWER ALTITUDES, USUALLY WITH MINIMAL GROUND-BASED SUPPORT, HAVE HIGHER WEATHER-RELATED ACCIDENT AND FATALITY RATES.

HIGHER-LEVEL THINKING

All test questions were designed to push pilots beyond whatever facts they had memorized, so "they had to think about it and answer the question using the same thought processes as if they were performing a preflight check," Thomas says.

In other words, these realistic questions are high in "cognitive fidelity," Blickensderfer notes.

A key component of aviation safety is for pilots to integrate weather information and develop a mental model of weather conditions before they leave the ground. This allows pilots to make better flight decisions if they face deteriorating weather in flight, Ortiz and King say. The questions developed by the Embry-Riddle team will help instructors, display designers and researchers understand how well pilots can do that.

The multiyear research program is funded and sponsored by the FAA's NextGen Weather-in-the-Cockpit program, with matching support from Embry-Riddle. Blickensderfer, who is president-elect for Division 21 of the American Psychological Association and leader of the education division of the Human Factors and Ergonomic Society, says the work could help guide pilot training and assessments. She also hopes it will inspire more understandable aviation weather products.

Blickensderfer is continuing to pursue questions about GA pilots and weather knowledge – research conducted in collaboration with Guinn, Thomas, King and Ortiz, as well as former Embry-Riddle faculty member John Lanicci (now at the University of South Alabama) and graduate students Nick Defilippis and Quirijn Berendschot.

A follow-up study, involving about 1,000 GA pilots across the United States, is underway. ER

EXPLORING MARS IN UTAH

By developing better spacesuit designs, Embry-Riddle researchers work to protect space explorers on future missions to Mars and beyond

BY DEBORAH CIRCELLI

Julia DeMarines

Surrounded by deep canyons and rugged, scenic sandstone formations resembling the red terrain of Mars, researcher Ryan L. Kobrick paces himself as he climbs about 200 feet up a steep desert mountain in south-central Utah named after one of the moons of Mars.

Making the climb more difficult, he's wearing unusual equipment, including fans blowing air into an imitation space helmet. Monitors under Kobrick's protective coveralls track and record his body temperature and heart rate as he maneuvers around loose rocks near the top of Phobos Peak.

"It was grueling. I couldn't see properly from the helmet fogging up, and it was really steep," says Kobrick, an assistant professor of spaceflight operations at Embry-Riddle Aeronautical University's Daytona Beach Campus in Florida. Adding difficulty to the trek, his boots ripped apart during the ascent.

In his simplified version of a spacesuit, Kobrick was on a simulated extravehicular activity as mission commander at the Mars Desert Research Station in the rugged terrain of the San Rafael Swell. The isolated, analogue extraplanetary outpost was established in 2001 by the Mars Society, an international volunteer-driven organization of astronomers, scientists, engineers, astronauts, educators and space enthusiasts.

The biometric protocols used to monitor Kobrick's ability to move and work in the simulated spacesuit during extraterrestrial activities were developed in Embry-Riddle's S.U.I.T. (Spacesuit Utilization of Innovative Technology) Laboratory. The work supports NASA's Human Research Program, which includes studying medical capabilities, human factors, behavioral performance, space radiation and human health countermeasures – all considerations for keeping explorers safe in deep space.

This research also continues Embry-Riddle's partnership with Final Frontier Design, a company creating advanced safety garments for space and extreme environments. Their work with NASA includes developing lower-cost, next-generation spacesuits and accessories. The S.U.I.T. Lab's evolving methodologies track the spacesuit validation techniques used by NASA's Johnson Space Center.

Embry-Riddle Assistant Professor Ryan L. Kobrick (left) and colleague Sarah Jane Pell climb to the top of Phobos Peak in simulated spacesuits that track their body temperatures and heart rates.

Ryan L. Kobrick tests a thermal micrometeoroid garment (outer layer space glove) by Final Frontier Design while at the Mars Desert Research Station in Utah.

"A spacesuit is a human's last line of defense against the hostile environments in outer space." – NICHOLAS LOPAC, LEAD TECHNICIAN, S.U.I.T. LAB

Embry-Riddle researchers compiled and analyzed data collected from the Mars Desert Research Station mission, other analogue stations in Hawaii and the Arabian Desert of Oman, and from tests in the S.U.I.T. Lab.

TAILOR-MADE FOR SPACE

As they worked to standardize the tracking of body measurements and calculations, Kobrick and his undergraduate student research team found there were limits to the amount of work that could be conducted on extravehicular activities.

On short-duration missions, for example, a daily extravehicular activity may be feasible. But on longer-duration missions, the workload could cause a strain on the extravehicular activity crew. Real-time cardiac and oximetry data would be useful for a mission flight surgeon or crew trainer who is remotely monitoring heart rates and oxygen saturation levels. Using video and 3D motion capture, researchers have also documented several range-of-motion limitations, with some suits being more restrictive, depending on their construction and fit.

"It's very demanding on the body, even with a simulated spacesuit, to go out conducting work for four hours or longer," says Kobrick, who has been on six analogue missions and serves as principal investigator of the S.U.I.T. Lab.

Back in the lab, the support team also learned that remotely gathering data with a pulse oximeter, Bluetooth wireless thermometers and Hexoskin smart shirts while the explorers were hiking and riding all-terrain vehicles created additional limitations.

"For future studies, the biometric equipment we use will have to be more comfortable and flexible to adapt to the changing environments," says Jenifer Schuman, a S.U.I.T. Lab assistant and Embry-Riddle sophomore majoring in aerospace physiology.

Their findings, presented at the International Conference on Environmental Systems in Albuquerque, New Mexico, in July, describe methods for studying range of motion and tracking and analyzing metrics. The research showed that – for long-duration planetary missions – an

Ryan L. Kobrick

operational protocol for spacesuit performance analysis should be followed on-site. On long-duration missions, Kobrick explains, the complexity of operations means crews won't have time to work with a support team on Earth to diagnose problems with extravehicular activity spacesuits. With advancements in video capture technology and artificial intelligence, range-of-motion analysis could be processed in real time, providing instant feedback to the crew regarding suit performance, Kobrick says.

"A spacesuit is a human's last line of defense against the hostile environments in outer space. While the suit should be able to save a human's life in an emergency scenario, it should also allow them to perform the tasks they need to do," says S.U.I.T. Lab Lead Technician Nicholas Lopac, who is double-majoring in spaceflight operations and human factors at Embry-Riddle.

Preliminary Embry-Riddle results are bound to aid future test protocols and provide participants in upcoming training missions with relevant feedback about the design and function of their simulated spacesuits.

The S.U.I.T. Lab researchers continue to refine their data-gathering capabilities. In-house, the motion-capture system helps create better anthropometric models and virtual environments. Kobrick's research also reaches far beyond campus, into other remote analogue environments across the planet, where Embry-Riddle's work helps set standards for testing spacesuits and providing protocol recommendations for extravehicular activity simulations.

"The better we can make the simulations, the better we can prepare crews to go to Mars and beyond," Kobrick says.

CAPTURING MOTION IN 3D

Inside the S.U.I.T. Lab, four 3D motion-capture cameras, positioned throughout the room, record participants' movements with and without a spacesuit for both intravehicular activities within a spacecraft and extravehicular activities on planetary surfaces.

The lab, fully operational since January 2017, establishes protocols for range-of-motion testing on space and analogue training suits, including testing with Final Frontier Design.

The research-focused goals provide a test bed for industry partners to receive feedback, data and recommendations for spacesuit design, while providing hands-on research opportunities for faculty and students.

For example, engineers at Final Frontier Design, who are developing next-generation spacesuits and other garments for NASA and the commercial space industry, came to the lab in April 2017 because they wanted to have a third party quantify the performance of their suit in a well-documented way. The company later returned for motion-capture testing.

Meanwhile, the lab is involved in more than just spacesuits. For example, Kobrick helped test the durability of new gloves by Final Frontier Design during a recent mission at Mars Desert Research Station.

Kobrick and his student researchers hope to work with additional industry partners and conduct off-site experiments using portable equipment in the coming year. ER

HELPING NASA PREP FOR MARTIAN TRAVEL

Two Embry-Riddle Worldwide Campus students spent 45 days on two NASA simulated space habitat missions, conducting research to support future deep space travel.

The Human Exploration Research Analog (HERA) at NASA's Johnson Space Center is one of several ground-based research facilities where NASA's Human Research Program is preparing to move astronauts from low-Earth orbit to deep space explorations.

Embry-Riddle Worldwide student Chiemi Heil, who is pursuing a master's degree in human factors, was part of the HERA XVII crew, which completed its mission in June.

Karen Brun took part in the HERA XV mission.

Meanwhile, Karen Brun, a Worldwide master's student enrolled in the unmanned systems program with a specialization in space systems, was part of the HERA XV mission, which ended in December 2017.

HERA is a unique three-story habitat designed to serve as an analog for isolation, confinement and remote conditions in exploration scenarios.

Crews participate in behavioral health and performance assessments, communication and autonomy studies, human factors evaluations and medical capabilities assessments. Recent crews conducted plant studies and tested hardware prototypes and applications used on the International Space Station. Crews also simulated traveling to an asteroid to collect samples. Experiments with sleep and circadian rhythms tested their alertness.

Chiemi Heil (second from right) joined the crew of NASA's HERA XVII mission.

"Miscommunication plays a more significant role [in aircraft accidents] than many people realize," says applied linguist Elizabeth Mathews.

Daryl LaBello

LANGUAGE BARRIERS PLAY A LARGER-THAN-EXPECTED ROLE IN AIRCRAFT ACCIDENTS

BY GINGER PINHOLSTER

West of Africa's vast Saharan desert, a bomb explosion on the island of Gran Canaria caused air traffic to be diverted to Tenerife North Airport on neighboring island Tenerife on March 27, 1977.

Jets quickly clogged the airport's only taxiway. KLM Flight 4805 surged for takeoff as Pan Am Flight 1736, obscured by heavy fog, remained on the runway, having missed a turn onto the taxiway.

Confusing dialogue preceded the deadliest aviation accident in history:

KLM: We are now at takeoff.
Tenerife tower: Okay, stand by for takeoff, I will call you.
Pan Am *(simultaneously)***:** No, uh, we're still taxiing down the runway, Clipper 1736!
[KLM's radio emits a shrill noise.]
Tenerife tower: Papa Alpha 1736, report runway clear.
Pan Am: OK, will report when we're clear.
KLM flight engineer to captain: Is he not clear?
KLM captain: Oh, yes.

Seeing the Pan Am jet too late, the KLM crew desperately tried to lift off. The Pan Am crew made a hard left-hand turn, but the two Boeing 747s collided nearly head-on. The death toll was an astonishing 583.

While aircraft accidents usually have multiple causes, "miscommunication plays a more significant role than many people realize," says applied linguist Elizabeth Mathews, an assistant professor of aerospace and occupational safety at Embry-Riddle Aeronautical University.

UNCOVERING HIDDEN PROBLEMS

The Tenerife tragedy has been widely cited as an example of a communications-related failure. A systematic Embry-Riddle global survey of approximately 5,000 aviation accident reports from 1990 to 2012 uncovered many more such cases – at least two dozen in which language played a contributory or latent role in the chain of events leading to disaster – in ways that were largely overlooked by investigators.

Veteran air-safety investigator Anthony Brickhouse says the aviation community should pay close attention to the team's findings. "It's incredibly important work," says Brickhouse, director of the Aerospace Forensics Laboratory and associate professor of aerospace and occupational safety at Embry-Riddle. "It has truly opened my eyes to an area that is critical to aviation safety, yet has been under-researched."

Jennifer Roberts, an aviation English specialist at Embry-Riddle's Worldwide Campus, agrees. "We need to have more of this type of research in hand," she says. "We need to prove that if pilots or air traffic controllers don't have the required level of English proficiency, we run the risk of incidents and accidents occurring."

> "UNDERSTANDING LANGUAGE AS A FACTOR IN AVIATION SAFETY IS INCREASINGLY URGENT AS MULTICULTURAL, MULTILINGUAL CREWS BECOME AN INDUSTRY NORM."
>
> – ELIZABETH MATHEWS

Surprisingly, Embry-Riddle researchers identified certain effects of language proficiency on flight safety not currently addressed within language standards set forth by the International Civil Aviation Organization (ICAO).

For example, Mathews says, the ICAO's language standards make no mention of being able to read English-language operational, safety and training manuals. Other problems include pilots with inadequate English crew-resource management skills; inadequately translated operational manuals; and flight crews and air traffic controllers speaking different languages, she says.

'AUTHORIZED TO TAKE OFF'

On May 25, 2000, mixed English and French communication contributed to a fatal accident at the Paris Charles de Gaulle Airport.

The British mail carrier Streamline Aviation Shorts 330 was cleared to proceed to runway 27. A passenger jet, Air Liberté Boeing MD-83, taxied to runway 27 around the same time. The jet was cleared to lift off: "Liberté 8807, autorisé au décollage [authorized to take off] 27, 230°, 10 à 15 kts." The mail freighter was told, "Streamline 200 line up runway 27 and wait, No. 2."

The British crew didn't realize the jet had clearance to take off. The Shorts 330 captain asked his co-pilot, "Where is the No. 1?" – meaning the aircraft cleared to take off first.

The ensuing collision killed one of the mail carrier's pilots and seriously injured the other.

"Understanding language as a factor in aviation safety is increasingly urgent as multicultural, multilingual crews become an industry norm," says Mathews, a former linguistic consultant to the ICAO, a United Nations assembly that sets forth safety standards. Under ICAO rules, all pilots and air traffic controllers involved in international flights must demonstrate Operational Level 4 English-language proficiency.

Inadequate English may have played a contributory or a latent role in the crash of Air China Flight 129, a Boeing 767-200ER that crashed into Korea's Mount Dotdae, killing 129 people on April 15, 2002. The tower's question to Flight 129 – "Can you landing?" – suggests the controller "may have had inadequate English proficiency," Mathews says.

Similarly, following an April 2, 2012, aircraft accident in Russia, investigators determined that neither pilot demonstrated ICAO Operational Level 4 English-speaking proficiency. Since it was a domestic flight, however, ICAO language standards didn't come into play. The Russian

Jennifer Roberts (left), aviation English specialist, and Elizabeth Mathews, assistant professor.

Daryl LaBello

pilots operating a French-manufactured ATR 72-201 twin-engine turboprop failed to de-ice their wings and crashed in a stall shortly after takeoff. Thirty-three of the 43 passengers and crew on board died.

Training and onboard manuals on the ATR 72-201 were in English – a possible latent factor in the accident, Mathews says. According to the accident report, "The actual English proficiency of the [pilot in command] and [first officer] did not allow them to completely understand training materials presented in the English language."

ICAO language standards don't currently require English-reading proficiency. Embry-Riddle research found a number of instances in which inadequate English-reading proficiency may have played a contributory or latent role in an accident.

MINIMIZING MISCOMMUNICATION

Mathews, who worked with David Williams, professor of aviation and occupational safety, described her global survey during a May 2018 conference of the International Civil Aviation English Association (ICAEA), hosted by Embry-Riddle.

The research – conducted under the auspices of the university's Language as a Factor in Aviation Safety Center, in collaboration with Georgia State University – began with a list of official, English-language reports of fixed-wing, civilian aircraft accidents from 1990 to 2012. Graduate student Steven Singleton took a deep dive into the reports, annotating evidence of language or cultural issues. Ultimately, the team found 24 unambiguous cases of language problems. The findings underscore the need for specialized training.

More research is needed, Mathews says, but the real solution will require academically and operationally relevant teaching materials; support for effective aviation English teachers; and industry adaptation of training to reflect the fact that most pilots, controllers and maintenance technicians now use English as a foreign language. ER

PERSISTENCE PAYS OFF

Snorri Gudmundsson helped develop lifesaving jet technology that overcame failed early designs to earn the world's most prestigious aviation prize

BY MICHAELA JARVIS

"In music, you can let the mind go free. In airplane design, you are always constrained by the laws of nature," says Snorri Gudmundsson, who plays many instruments, including the flute, piano, guitar, bass, drums and trumpet, and has released four CDs.

As a boy growing up in Iceland, Snorri Gudmundsson thought a lot about how airplanes could fly. During many trips to a nearby airport in Reykjavik with his father, he would ask, "How can something made of metal become airborne? It's heavy. How can it lift off?" If he wanted to understand, Gudmundsson's father told him, he needed to read a lot and do mathematics.

"I remember that disappointed me," Gudmundsson says, "because it would take time away from soccer."

Luckily, at age 12, Gudmundsson found a simple book on aeronautics, and the musings of a boy began to transform into understanding and ability. He was fascinated by a basic aerodynamics equation: lift/drag = weight/thrust.

"It's a simple concept," Gudmundsson says, "but it really got me."

Snorri Gudmundsson was part of the team behind the Collier Trophy-winning SF50 Vision Jet, the first single-engine general aviation jet with a self-supporting parachute.

AWARD-WINNING WORK

Some decades later, Gudmundsson's fascination with flying and his considerable skills have led to his being honored, along with a team he worked with at Cirrus Aircraft, with the 2017 Robert J. Collier Trophy, the world's most prestigious aviation prize. Now on the Embry-Riddle faculty, Gudmundsson worked at Cirrus from 1995 to 2009, serving as the chief aerodynamicist on the Collier Trophy-winning plane: the SF50 Vision Jet, a single-engine seven-seater equipped with a parachute capable of lowering the entire plane to the ground.

After the award was announced, former students of Gudmundsson's expressed their pride.

"It truly is a remarkable achievement, awarded only to the biggest achievers in the aviation industry," says Sumit Shibib, who currently works for Rockwell Collins. "To know that someone who taught you face-to-face in college has been a part of the team that designed a Collier Trophy-winning airplane is amazing."

The SF50 Vision Jet is not the first aircraft with a self-supporting parachute, although it is the first single-engine general aviation jet to have one. If an emergency landing is required in the SF50, Gudmundsson explains, the pilot pulls a handle in the cockpit, which ignites a rocket. The rocket shoots out of the back of the fuselage, pulling the parachute with it. The airplane's original design was developed by architect and designer Mike Van Staagen.

"It's not like a magical device that's going to save all situations," Gudmundsson says. Nonetheless, as of May 1, there were 88 parachute deployments on record, with more than 150 people saved.

The chute technology, which was developed at Cirrus for two previous aircraft that were not jets, required considerable trial and error, Gudmundsson says.

To test the forces the chute would be subjected to, a Cirrus team assembled a 3,000-pound pallet of concrete-filled barrels and pushed it out of a military cargo plane with the chute attached. Over and over, the parachute disintegrated.

"It looked for a while like this would be impossible," Gudmundsson says.

It was only after Chief Engineer Paul Johnston developed a solution – a nylon disk on the lines between the plane and the chute itself – that the parachute survived.

"It's a very simple aerodynamic device that keeps the parachute somewhat closed until the plane slows down, and then it slides forward and slowly but surely opens it up," says Gudmundsson, sounding, at age 54, just as excited as ever by aeronautics – and slightly less so about his own achievement.

"I'm of course immensely proud of the Collier Trophy," he says, "but I don't want anyone to think I was the No. 1 person on this. It's Cirrus that received the award for an airplane that I and many other individuals were involved in."

Opposite page: Daryl LaBello; This page: National Aeronautic Association

During Scott Shappell's naval career, he developed the well-known and widely used Human Factors Analysis and Classification System (HFACS). Today, he's helped to build one of the top human factors programs in the country at Embry-Riddle.

FACTORING IN THE HUMAN ELEMENT

Renowned human factors scholar advances safety across the military, aviation and healthcare fields

BY MELANIE STAWICKI AZAM

After joining the Navy, Scott Shappell served as the human factors branch chief at the Naval Safety Center.

While visiting Galveston, Texas, this year for a conference, Scott Shappell reflected on how his life has changed since he last was in the city 27 years ago as a doctoral student.

"I walked on the same seawall I would run on every day when I was younger," says Shappell, now an internationally renowned expert and scholar in the field of human factors. "I remember running along that seawall wondering, 'Should I join the military, should I do a postdoc, or should I do something different?'"

Now chair of Embry-Riddle's Department of Human Factors and Behavioral Neurobiology, Shappell says serendipity played a big role in his life, but he has ended up exactly where he wants to be in his career.

"My career has been everything and more than I ever thought it would be," he says. "I never thought I'd be where I am now."

His experiences led to his most well-known accomplishment – inventing the Human Factors Analysis and Classification System (HFACS), which is widely used and respected across aviation, the military, healthcare and other industries as an essential way to improve safety. The original HFACS pinpoints the role and types of human performance failures that contribute to aircraft accidents. Another version of the framework has been developed to classify workflow disruptions in healthcare settings.

In 2017, Shappell received the Paul R. Chatelier Lifetime Achievement Award for outstanding accomplishments in the field of aerospace psychology, awarded by the Society of U.S. Naval Aerospace Experimental Psychologists.

"Scott Shappell is an internationally renowned author and scholar in human factors," says Douglas Wiegmann, an associate professor of industrial and systems engineering at the University of Wisconsin-Madison, who developed the HFACS with Shappell. "In the 25 years that I've been in the field, I've never known anyone who has been more successful in translating human factors principles into practice. Dr. Shappell's impact on aviation human factors and system safety is truly remarkable."

> "I've never known anyone who has been more successful in translating human factors into practice."
>
> DOUGLAS WIEGMANN, UNIVERSITY OF WISCONSIN-MADISON

Shappell has produced more than 200 publications and presentations covering accident investigation, system safety, behavioral stressors, sustained operations and fatigue. He serves as an elected fellow or member of 10 organizations and was a consulting editor for the *International Journal of Aviation Psychology*, as well as a reviewer for six other journals.

"He is so well recognized in his field that I literally cannot walk into a meeting without people knowing him personally or the next generation of professionals introducing themselves by saying that they have read all of his works," says Karen Gaines, dean of the College of Arts and Sciences at Embry-Riddle's Daytona Beach Campus.

AN UNEXPECTED PATH

Shappell, who grew up on a farm in Ohio, became interested in psychology at Wright State University. After earning his doctorate in neuroscience from the University of Texas Medical Branch, he joined the U.S. Navy "on a whim." The choice led him to work in human factors for the military and develop HFACS. He also served as the human factors branch chief at the Naval Safety Center.

"I was put in charge of human factors of the North Atlantic fleet, so it was really accident investigation," he recalls. "I was the human error guy."

Shappell was a professor of industrial engineering at Clemson University in South Carolina from 2005 until 2012, when he joined Embry-Riddle. With Gaines, he has helped build Embry-Riddle's human factors program into one of the top programs in the country – and the only one to offer an undergraduate degree in aerospace physiology. Shappell helped drive the addition of a doctoral program too.

Alumna Tara Cohen, now a human factors research scientist at Cedars-Sinai Medical Center, says Shappell has been fundamental in developing Embry-Riddle's human factors program into a department dedicated to research and innovation.

"His teaching and guidance pushed me to become an inquisitive scientist with the desire to continuously develop and learn more about the field of human factors," she says.

That is no doubt music to Shappell's ears, who sees the value that the field brings to the world. "I think what we have to offer changes lives," he says. "I know there are people alive today because of what we do."

Opposite page, top left: Nicole Hester

In Embry-Riddle's virtual crash lab, students examine wreckage to determine the cause of the crash.

BRINGING LEARNING TO LIFE

Virtual and augmented reality technologies are giving online students real-world experience

BY JAMES RODDEY

Imagine going through the wreckage of an airliner, looking for clues to determine what caused the accident. Only highly trained investigators ever have a chance to take part in such situations. But thanks to the rapidly developing technology of augmented reality (AR) and virtual reality (VR), Embry-Riddle Aeronautical University Worldwide Campus students can examine crashed aircraft in a simulated environment, searching for clues from their computers, tablets, smartphones or AR goggles.

Scott Burgess, associate professor in Worldwide's College of Aeronautics, has been involved in Worldwide's virtual reality labs since they began. His 34 years of aviation experience includes multiple flight ratings and developing the helicopter flight-training program at the university's Prescott Campus in Arizona. He now teaches aviation safety and sUAS (small unmanned aircraft systems) operations courses for Embry-Riddle Worldwide.

Q: Where did the idea for virtual labs come from?

Around five years ago, we were exploring virtual classroom concepts. Worldwide Associate Professor Katherine Moran wanted to explore the idea of a virtual crash lab. Our Daytona Beach and Prescott campuses have actual wreckage that students can physically examine. Katherine wanted a way to address the academic aspects of accident investigation in plane crashes for Worldwide students that was as close to reality as possible.

Our College of Aeronautics leadership and faculty worked with Chief Information Officer Becky Vasquez's team and development partner Pinnacle Solutions, to create our first virtual learning environment – a computer-generated crash lab where a 737 airliner had skidded off a runway and broken apart. In 2016, this group came together again to develop the Aerial Robotics Virtual Lab, which has enabled us to offer a new engineering degree program, MS Unmanned Autonomous Systems Engineering.

Q: What's the experience like for students?

In the crash lab, students can enter a virtual environment and act as National Transportation Safety Board investigators – walking through the wreckage, zooming in on details. They collect and analyze data and apply what they've learned to determine possible scenarios that led to the aircraft disaster. In the Aerial Robotics Virtual Lab, students can jump online anywhere in the world to design and build an unmanned aerial vehicle (UAV), then test its flight capabilities and analyze the results.

We've now combined both labs into a Virtual Hub, a planning center students can enter to conduct Aerial Robotics Virtual Lab, crash lab or flight activities.

Q: What comes next for Embry-Riddle Worldwide in the world of AR/VR?

We have proposed expanding the Hub's capabilities to encompass maintenance assurance, emergency response and operations, air traffic control and other aspects of airport operations. These enhancements will offer applications for our business, aeronautics, safety, human factors and emergency management degrees and more. We want to continue introducing cutting-edge technology to our students. We want to expand their learning environment and bring Star Wars-like tech to life.

EXCELLING IN INFORMATION TECHNOLOGY

Because of innovations like virtual labs for aerial robotics and aviation accident investigations, virtual classrooms and real-time online collaboration, Embry-Riddle Worldwide has been recognized as one of only three educational institutions globally included in the prestigious 2018 CIO 100, an annual award recognizing organizations around the world that exemplify the highest level of operational and strategic excellence in information technology. "It is extraordinarily rewarding to know we are providing students around the world with a realistic lab environment for both accident investigation and robotics," says Becky Vasquez, Embry-Riddle's vice president and chief information officer. "This brings anytime, anywhere learning to the next level and supports the mission of our Worldwide Campus in delivering accessible learning opportunities."

HELPING BUSINESSES FLY HIGHER

The Center for Entrepreneurship launches new businesses

Aspiring business leaders received inspiration and mentoring at a recent Test Flight Bootcamp organized by Embry-Riddle's Center for Entrepreneurship and led by accomplished entrepreneurs.

The Bootcamp is one of many ways the center marries technological knowledge in aeronautics, aerospace, engineering and computer science with business ingenuity to help entrepreneurs launch high-value, high-growth companies. In partnership with the university's Technology Transfer and Commercialization office, as well as the Embry-Riddle Research Park, the center helps entrepreneurs build businesses.

At a recent Launch Your Venture competition, student inventors described an innovative knee brace, a wearable fitness sensor, technology to save lives at sea and a "gas station in space."

→*Read about the game-changing knee brace on Page 5.*

Daniela A. Cabrera

OTHER EMBRY-RIDDLE RESEARCH CENTERS AND INSTITUTES INCLUDE:

Alliance for Systems Safety of UAS through Research Excellence (ASSURE)
Embry-Riddle is a founding member of the multi-university ASSURE Coalition, comprised of 21 research universities. ASSURE was designated as the FAA's Center of Excellence for Unmanned Aircraft Systems in May 2015.
→*Visit assureuas.erau.edu.*

Center for Space and Atmospheric Research (CSAR)
CSAR investigates planetary atmospheres and near-space environments to understand the neutral and ionized atmosphere as well as the space plasma environment and space weather. The research leverages both state-of-the-art modeling and advanced instrumentation, such as a high-resolution sodium LIDAR.
→*Visit csar.erau.edu.*

Eagle Flight Research Center (EFRC)
The EFRC is helping to shape the future of human mobility, including clean, quiet flight, through research focused on propulsion, unmanned autonomous vehicles, manned flight control and the certification of new technologies.

FAA Center of Excellence for Technical Training and Human Performance
This consortium of 25 universities and nearly 40 industry partners is helping the FAA revolutionize technical training practices and human performance for its workforce. The center is led by Embry-Riddle and the University of Oklahoma.

Center for Wildlife and Aviation
This center collects, maintains and disseminates relevant bird strike data and bird strike research; promotes wildlife mitigation training, policies and plans; and bridges the gap between the scientific community and stakeholders.
→*Visit wildlifecenter.pr.erau.edu.*

Cybersecurity and Assured Systems Engineering Center (CyBASE)
CyBASE leverages academic, industry and government expertise to provide cybersecurity solutions for aerospace, aviation and other enterprises. It investigates high-assurance systems in aviation and aerospace with an emphasis on cybersecurity.
→*Read about a cybersecurity camp on Page 7.*

Next Generation Air Transportation Safety (NextGen) Facility
NextGen is an FAA initiative in which government, industry and academia work to modernize the nation's national airspace, shifting from ground-based radar to satellite-based technology. The FAA has contracted Embry-Riddle to conduct national and international airspace research and operate its Florida NextGen Test Bed facility.
→*See Page 3.*

Robertson Safety Institute
As a professional development, outreach and consulting organization, the Robertson Safety Institute offers opportunities for advanced professional training, consulting on safety projects with corporate partners and applied research activities.
→*Visit prescott.erau.edu/robertson-safety-institute.*

Southeastern Association for Research in Astronomy (SARA)
Led by Embry-Riddle, this 14-university consortium operates 1-meter class telescopes for astronomical research and education in Arizona, Chile and the Canary Islands.
→*Visit saraobservatory.org.*

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MICAPLEX

For a complete list of our leading industry partners, see

erau.edu/micaplex

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