RESEARCH AT EMBRY-RIDDLE AERONAUTICAL UNIVERSITY ■ SPRING 2010

strata

NextGen Testing Takes Flight

pg. 08

Alternative Energy and Vehicles ■ Simulation and Gaming ■ Human Factors ■ UAVs

The First Word

The sky is the limit.

That phrase conjures up possibilities, new ideas, breaking from the past, and defining the future.

At Embry-Riddle Aeronautical University, it's a phrase that has literal meaning.

If you want to glimpse the future, I invite you to take a look at research being conducted at Embry-Riddle.

You'll find engineers designing alternative vehicles and energy systems for air, land and sea.

Research teams are testing advanced air traffic management systems for the FAA's NextGen program, which will transform air travel for all of us.

Human factors researchers are devising better ways to board airliners, perform surgeries, and conduct military operations.

Scientists are taking the pulse of Earth's atmosphere with sounding rockets and sensing stations in Antarctica and Greenland.

Two new Ph.D. programs at Embry-Riddle – in Aviation and Engineering Physics – also promise to make our research program even more robust. I am impressed by the caliber, energy, and intellectual depth of the first cohort of students we have admitted to both doctoral programs.

Being headquartered in central Florida, just 60 miles from Kennedy Space Center, Embry-Riddle is also actively concerned about the future of the space industry. We are working to help the industry move from the Space Shuttle as space transportation to the innovative, efficient alternatives that can result from partnerships between NASA and aerospace corporations.

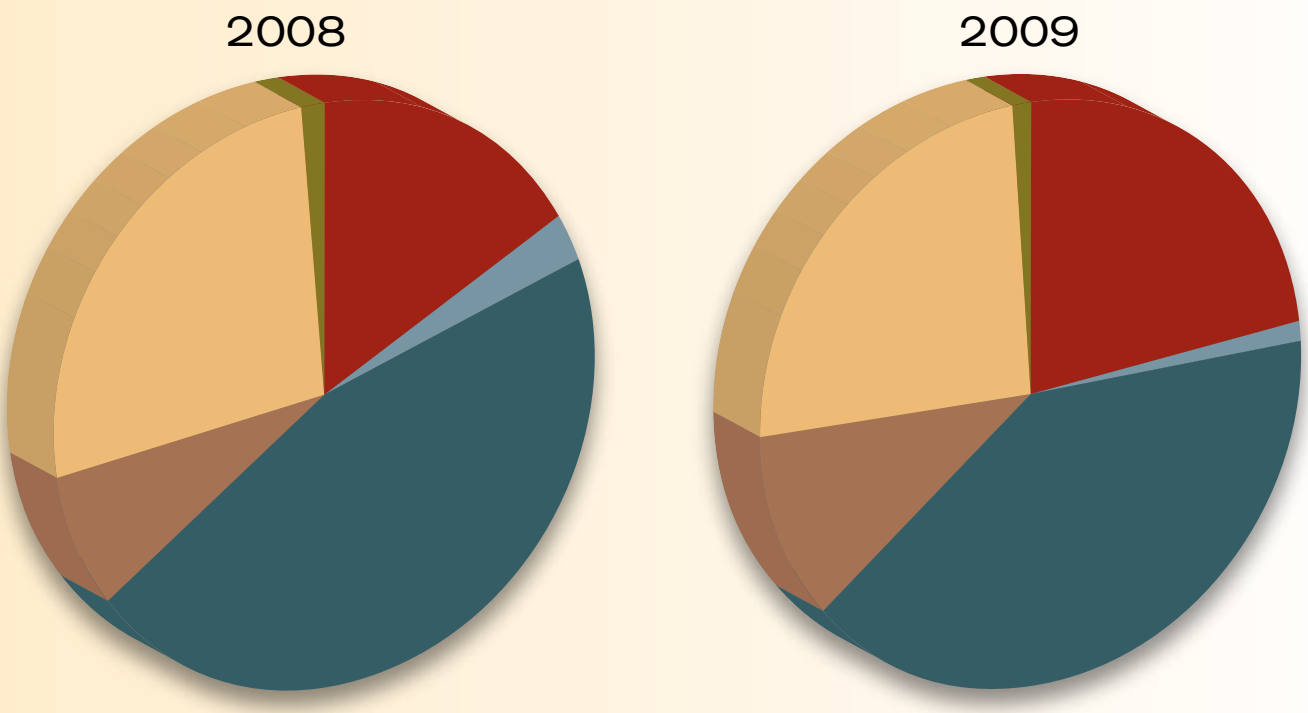
Our own research ties with government agencies and corporate partners continue to thrive. And our faculty researchers are attracting a growing number of honors, awards, and increased support from esteemed organizations such as the National Science Foundation, the Society of Automotive Engineers, and the Boeing Company.

Embry-Riddle itself was honored in 2009 with a prestigious Boeing Performance Excellence Award. To be one of only 14 recipients from among Boeing's 10,000-plus suppliers to receive this award is an honor of the highest degree. It is a testimonial to the strength of our partnership and the value of our faculty's research.

As you read about research at Embry-Riddle in the following pages, I invite you to consider how we can help your organization define the future.

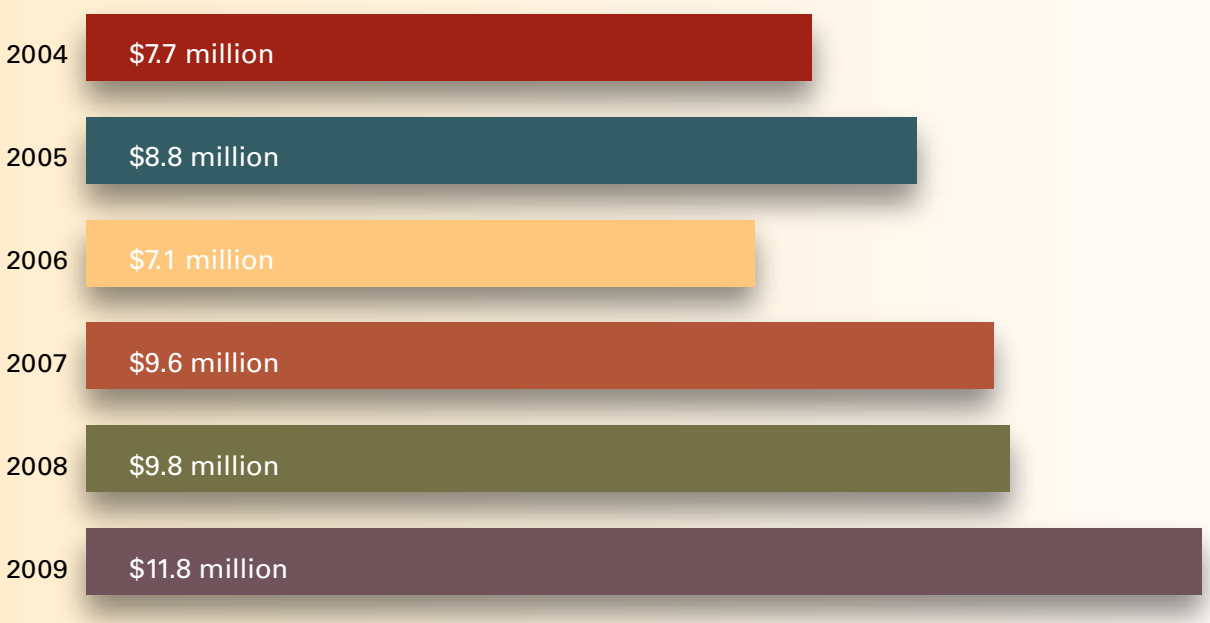
Christina Frederick-Recascino
Vice President for Research

Sources of Research Funding



Source	2008	2009
Industry/Private	16.88%	23.30%
Foundations	2.60%	0.97%
Federal/national	45.45%	39.81%
State/local	7.79%	10.68%
University	25.97%	24.27%
Other	1.3%	0.97%

Total Research Funding



Space physicist Katariina Nykyri wins prestigious NSF grant

Embry-Riddle scientist Katariina Nykyri has received the National Science Foundation's prestigious Faculty Early Career Development grant to support her continuing research into space plasma that may improve our understanding of plasma heating and transport through magnetic boundaries.

Nykyri, an assistant professor at the Daytona Beach campus, will receive $483,699 over the next five years from the NSF award program that supports teacher-scholars who are judged likely to become leaders in academic research and education.

"We're proud that Katariina is the third professor at our Daytona Beach campus to receive the highly competitive NSF Career Award in the last four years," said Christina Frederick-Recascino, vice president of research at Embry-Riddle. "The NSF is clearly impressed by the research capabilities of our faculty, students, and state-of-the-art facilities."

As a faculty member in Embry-Riddle's new Ph.D. program in Engineering Physics, which begins in August 2010, Nykyri will teach space plasma physics and develop a course on spacecraft data-analysis methods. She currently teaches advanced space physics and basic physics courses. She plans to use much of her NSF funding to involve students in her research project and sponsor a Ph.D. student in the doctoral program.

Nykyri's research has shown that giant space hurricanes measuring more than 14,000 miles across can form next to our planet's magnetic shield. These space hurricanes can break the magnetic shield through a process called magnetic reconnection, allowing solar wind to enter Earth's magnetosphere. During the next five years, she and her collaborators will study space hurricanes by using spacecraft observations of these cosmic whirlpools compared with numerical simulations.

NAA honors Tom Connolly for achievements in aviation

The National Aeronautic Association (NAA) has honored Thomas Connolly, professor of aeronautical science and presidential endowed chair of aviation at Embry-Riddle, with its Wesley L. McDonald Elder Statesman of Aviation Award.

Connolly has spent more than 36 years dedicated to the education and training of thousands of aviation professionals at Embry-Riddle. Since joining the faculty in 1973, he has chaired the aviation education design, flight, and aeronautical science departments and served as dean of the School of Aviation and interim chancellor of the Daytona Beach campus. In 2001, he was appointed the university's first endowed chair in aviation and in 2005 chancellor of Daytona Beach campus.

Connolly is past president of the University Aviation Association (UAA) and the Florida Association of Aerospace Education. He has chaired visitation teams for the Council on Aviation Accreditation (CAA) and served as an elected trustee of CAA, UAA, and Women in Aviation International. He was national winner of the FAA Administrator's Championship Award for Excellence in Aviation Education and a recipient of the National Congress on Aviation and Aerospace Education Crown Circle Award, NAA's Brewer Trophy, and the United Airlines/UAA Wheatley Award for outstanding contributions to aviation education.

He has published numerous articles on aviation education and served as an international visiting professor in aviation at Massey University in Auckland, New Zealand.

SAE honors Darris White as top faculty advisor

Darris White, an associate professor of mechanical engineering at Embry-Riddle, has received the prestigious Faculty Advisor Award from the Society of Automotive Engineers at SAE's 2009 World Congress and Exhibition.

The annual award honors university faculty who have advised students in SAE design projects and helped them develop as future engineers.

Since 2004, White has been faculty advisor of the SAE chapter at the university's Daytona Beach, Fla., campus, where he advises student design teams for the Baja SAE, Formula SAE, Formula Hybrid, SAE Aero Design, and EcoCar Hybrid vehicle competitions. Under his guidance, the chapter has become one of the world's largest and won eight design awards.

White was recruited to Embry-Riddle to help develop a mechanical engineering degree program, which began in 2005. The ABET-accredited degree includes a concentration in high-performance vehi-

cles, which often uses aspects of the SAE projects. White teaches courses in vehicle dynamics, control systems, senior design, and hybrid and hydrogen vehicle systems.

An expert in modeling, simulation, and control of dynamical systems, White works closely with the U.S. Department of Energy on wind energy research and with students and colleagues to promote clean energy systems.

White received his B.S. and M.S. degrees in mechanical engineering from Virginia Tech and his Ph.D. in aerospace engineering from the University of Colorado-Boulder in 2003.

White worked for Volvo Trucks North America for three years, where he earned five U.S. patents and was active in the 21st Century Truck Project. He also conducted research at the National Renewable Energy Laboratory on Wind Energy before joining Embry-Riddle.

Boeing award honors Jonathan French for aircraft passenger flow model

The Boeing Co. has honored Embry-Riddle with a prestigious Boeing Performance Excellence Award for 2009. The award recognizes outstanding performance by organizations selected from among the company's 10,000-plus suppliers.

Edward Winkler, a technical fellow at Boeing, said the company selected Embry-Riddle largely because of research that was conducted by Jonathan French, professor of human factors and systems at the Daytona Beach campus.

"Dr. French's recent effort on our Enplane/Deplane Aircraft Passenger Flow Model was a great success and was considered key to receiving this award," Winkler said. "He invented an outstanding analytical tool that gives Boeing a method to analyze various passenger constraints and interferences while boarding an aircraft."

Winkler said Boeing has submitted the model for a U.S. patent, listing French as one of the inventors.

Cutting the ribbon at the new Green Garage: Embry-Riddle President John Johnson (center) and Volusia County (Fla.) councilmembers Joie Alexander (L) and Patricia Northey (R).

EcoEagles park experimental car in "green garage"

The EcoEagles, a team of Embry-Riddle student engineers at the Daytona Beach campus who are competing to design a car of the future, marked two milestones in 2009.

In September, they took delivery of a hybrid vehicle donated by GM, which they will reengineer to further minimize fuel consumption and reduce emissions while retaining the vehicle's performance and consumer appeal. Embry-Riddle is one of 17 U.S. and Canadian universities taking part in EcoCar: The Next Challenge, a three-year competition sponsored by the U.S. Department of Energy, GM, and other organizations.

In December, they opened a new engineering laboratory, dubbed the Green Garage, which is equipped for the task they are undertaking. The lab includes a rotary vehicle lift, dedicated high-voltage room, and integrated hardware-in-the-loop laboratory donated by National Instruments. It also showcases the Embry-Riddle College of Engineering's environmental focus. Every component in the lab was chosen to reduce environmental impact, including the floor covering, which is made from recycled tires.

FAA certifies Embry-Riddle lab to modify King Air for mosquito spraying

The Federal Aviation Administration has approved and certified Embry-Riddle's modification of a Raytheon Beechcraft King Air C90 to enable the installation of an aerial spray system. The system was designed and prototyped by the university's Applied Research Center, formerly known as Eagle Works. Researchers at the lab modified the airplane for Hillsborough County, Fla., which plans to use it to prevent the spread of mosquitoes.

Wildlife risk mitigation center created to improve air safety

The Jan. 15, 2009 ditching of US Airways Flight 1549 in the Hudson River vividly illustrated the dangers of midair collisions between birds and aircraft. But what precipitated the "miracle on the Hudson" happens more often than the public realizes. Bird and wildlife strikes cause more than a half-million hours of aircraft down time and cost U.S. civil aviation more than $500 million annually, according to the U.S. Department of Agriculture. And the threat to air safety is on the rise with the expansion of many wildlife species that are hazardous to aircraft.

To help manage this growing hazard, Embry-Riddle has launched the International Center for Aviation and Wildlife Risk Mitigation (wildlifecenter.pr.erau.edu) at its Prescott, Ariz., campus. The center brings together top aviation wildlife experts to share and develop new research and management solutions to reduce the dangers and serve as a resource to airports around the world.

The center is an initiative of national wildlife expert Archie Dickey, dean of arts and sciences and associate professor of aviation environmental science at the Prescott campus. Dickey created and managed the FAA's online database on aircraft and wildlife strikes around the country for more than 10 years.

The new center develops and promotes solutions for managing wildlife around airports and training pilots and airport personnel to avoid aircraft collisions with wildlife. Some approaches already show promise, according to Dickey. For example, certain marine radar has been modified to detect birds near airports, and the mowing of airport-area grass to a height of six to 12 inches deters the presence of larger birds.

The center works with bird strike committees in North America and abroad to collect, maintain, and disseminate relevant data and research. The center's goals are to develop training programs, management policies, and operational plans regarding aviation and wildlife risk mitigation to effectively and accurately facilitate communication with the scientific community, public, media, and government organizations.

Embry-Riddle to collaborate with FAA on space transportation research

With the Space Shuttle nearing retirement, Embry-Riddle and the FAA have agreed to explore research opportunities in commercial space exploration. The university's agreement with the FAA's Office of Commercial Space Transportation identifies five space transportation topics that can be tackled by faculty and student researchers:

- Special Activity Airspace Standards: Develop airspace design and risk determination standards for Special Activity Airspace during nominal and non-nominal space flight operations.
- Critical Spaceport Infrastructure Needs: Assess infrastructure requirements for commercial human spaceflight operations to mitigate safety, schedule, and program risks.
- Space Launch Operations Issues and Anomalies: Quantitative and qualitative analyses to gain a better understanding of credible failure modes for launch systems.
- Uncertainty Risk Study: Develop a mathematical method for comparing space transportation risk factors.
- Spaceport Capacity Study: Identify capacity "breaking points" for specific spaceports and their surrounding airspace for current and future air/space traffic densities.

The university is also exploring ways to integrate space transportation information and scenarios into its air traffic management training and curriculum and to educate air traffic leaders about integrating aviation and space transportation operations.

"This effort is a timely one, now that a blue-ribbon panel has finalized its report to the White House on the future of U.S. space exploration," said Christina Frederick-Recascino, Embry-Riddle's vice president for research. "Pointing to similarities with the early days of the aviation industry, the panel says it is now appropriate for NASA to start turning to the commercial sector for transporting crew to the International Space Station."

The FAA, which already regulates commercial rocket launches and several spaceports nationwide, is watching closely as U.S. companies make progress on crew-carrying rockets and reusable space planes. These vehicles will present unique challenges for the FAA with their high-speed flight through the airspace during their ascent and descent from space.

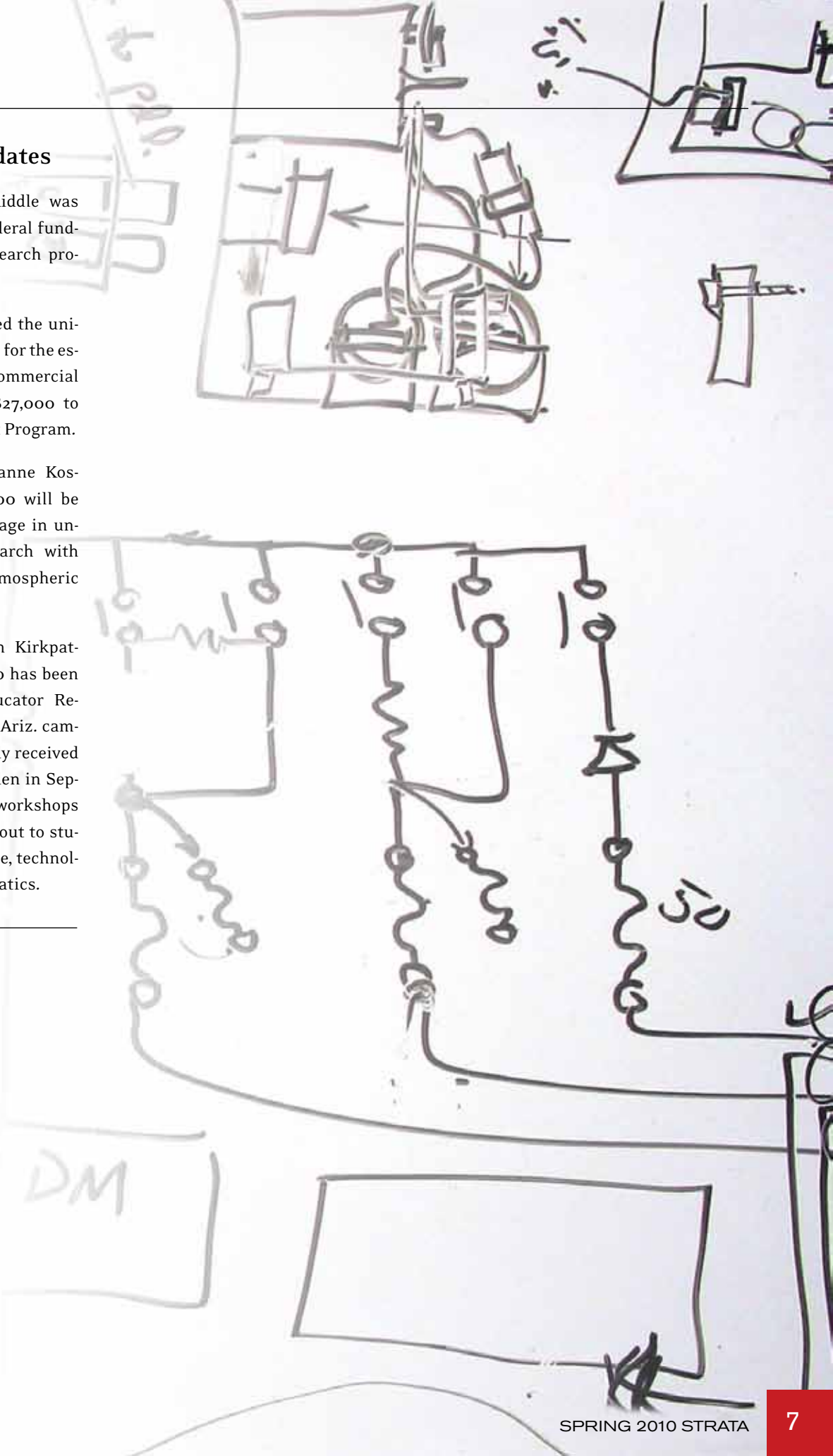
Research funding updates

In December 2009, Embry-Riddle was notified that it will receive federal funding for several important research programs.

Sen. Bill Nelson (Fla.) informed the university it will receive $974,000 for the establishment of a Center for Commercial Space Transportation and $827,000 to support the Integrated Airport Program.

Florida Congresswoman Suzanne Kosmas announced that $300,000 will be awarded Embry-Riddle to engage in unmanned aerial systems research with the National Oceanic and Atmospheric Administration.

Arizona Congresswoman Ann Kirkpatrick announced that $200,000 has been set aside for the NASA Educator Resource Center at the Prescott, Ariz. campus, adding to $299,314 already received by the center from NASA-Dryden in September. The center conducts workshops for K-12 teachers and reaches out to student to build interest in science, technology, engineering, and mathematics.



Researchers test Aviation's Next Generation

In the United States, flights are expected to jump from 769 million in 2007 to one billion in 2016. In 2007, delays cost airline passengers more than 320 million hours and more than $41 billion in airline costs and lost productivity and business opportunities. Safety also is a serious concern. The nation's air traffic handling system is straining to meet these challenges today and is likely to fall short in handling the growth that lies ahead.

The solution proposed by the Federal Aviation Administration (FAA) is NextGen, an ambitious program to transform the nation's air traffic control from today's ground radar-based system to a satellite-based system designed to let aircraft fly shorter, more direct routes. The system would use GPS for navigation, enabling airlines to reduce flight distances and use runways more efficiently.

The new satellite-based technologies can greatly improve safety on the ground and in the skies and they also promise more environmentally friendly flight procedures that would reduce fuel burned, carbon emissions, and noise. According to Randy Babbitt, chief of the FAA, NextGen could save carriers a billion gallons of fuel a year.

Embry-Riddle, the nation's leader in aviation and aerospace higher education, is one of the FAA's key partners in this exciting multi-year, multi-million dollar effort.

With support from the FAA, Embry-Riddle's NextGen program manager, Wade Lester, is leading a group of aerospace and high technology companies in an initiative to model and test these technologies at the Daytona Beach NextGen Test Bed. The facility is located at Daytona Beach International Airport, adjacent to the university's Florida campus. Other companies involved in the effort are Lockheed Martin, Barco, Boeing, CSC, ENSCO, Frequentis, Harris Corp., Mosaic ATM, Sensis, GE Aviation, NATS UK, and Volpe Center.

"The new satellite-based technologies can greatly improve safety on the ground and in the skies and they also promise more environmentally friendly flight procedures that would reduce fuel burned, carbon emissions, and noise. **NextGen could save carriers a billion gallons of fuel a year."**
[Randy Babbitt, chief of the FAA]

Embry-Riddle has a long history working with the FAA. For more than 30 years the FAA has relied on the research expertise of Embry-Riddle faculty, and in 2001 the agency tapped the university to lead its Center of Excellence for General Aviation Research.

In the United States, flights are expected to jump from 769 million in 2007 to one billion in 2016. In 2007, delays cost airline passengers more than 320 million hours and more than $41 billion in airline costs and lost productivity and business opportunities. Safety also is a serious concern. The nation's air traffic handling system is straining to meet these challenges today and is likely to fall short in handling the growth that lies ahead.

The solution proposed by the Federal Aviation Administration (FAA) is NextGen, an ambitious program to transform the nation's air traffic control from today's ground radar-based system to a satellite-based system designed to let aircraft fly shorter, more direct routes. The system would use GPS for navigation, enabling airlines to reduce flight distances and use runways more efficiently.

The new satellite-based technologies can greatly improve safety on the ground and in the skies and they also promise more environmentally friendly flight procedures that would reduce fuel burned, carbon emissions, and noise. According to Randy Babbitt, chief of the FAA, NextGen could save carriers a billion gallons of fuel a year.

Embry-Riddle, the nation's leader in aviation and aerospace higher education, is one of the FAA's key partners in this exciting multi-year, multi-million dollar effort.

With support from the FAA, Embry-Riddle's NextGen program manager, Wade Lester, is leading a group of aerospace and high technology companies in an initiative to model and test these technologies at the Daytona Beach NextGen Test Bed. The facility is located at Daytona Beach International Airport, adjacent to the university's Florida campus. Other companies involved in the effort are Lockheed Martin, Barco, Boeing, CSC, ENSCO, Frequentis, Harris Corp., Mosaic ATM, Sensis, GE Aviation, NATS UK, and Volpe Center.

Embry-Riddle has a long history working with the FAA. For more than 30 years the FAA has relied on the research expertise of Embry-Riddle faculty, and in 2001 the agency tapped the university to lead its Center of Excellence for General Aviation Research.

How NextGen Will Change Flights

On the Ground – New airport surface monitoring systems that combine radar and the Global Positioning System (GPS) will extend monitoring beyond runways and taxiways to the ramp areas. This shared awareness among the airport control tower, airline ramp management towers, and airline operations centers will improve safety on the ground and improve the management of aircraft.

After Take Off – Most aircraft flying in the United States are tracked by radar. But because ground-based radar stations can send incomplete signals, or in rugged terrain and over water no signal at all, controllers keep aircraft farther apart in the air to ensure they are safely separated.

A new system called Automatic Dependent Surveillance-Broadcast (ADS-B) uses satellite signals to more accurately identify an aircraft's location during a flight. With ADS-B, controllers will be able to reduce the distance needed between aircraft and allow more flights in the skies. The fatal accident rate for aircraft equipped with ADS-B, which gives pilots cockpit displays showing the whereabouts of other planes, bad weather, and terrain, dropped by 47 percent.

Embry-Riddle's 100 training aircraft have been equipped with ADS-B since 2003, giving the university preeminent experience with a technology that is planned for the entire nation by 2013.

Another new tool is Traffic Management Advisor, a software program that helps controllers sequence aircraft through high-altitude space and into airspace around major airports by calculating their precise routes and the minimum safe distances between aircraft.

Over the Ocean – New satellite-based systems use cockpit digital communication, instead of voice, and satellite data link communication for transoceanic flights, allowing aircraft to fly the most efficient routes and altitudes. In 2008, seven test flights saved 330 gallons of fuel and 6,730 pounds of carbon dioxide.

On Approach – New software called Tailored Arrivals lets controllers tailor an aircraft's final 200 miles to avoid conditions that might slow it down, such as bad weather and restricted airspace. In 250 arrivals by Boeing 747s and 777s into San Francisco since Dec. 2007, 27,350 gallons of fuel were saved using the new software.

When aircraft land make a longer, smoother descent to an airport (a method called Continuous Descent Arrival), rather than the stepped-down approach currently required, it saves time and money and reduces carbon emissions and noise. Delta saved 10 to 60 gallons of fuel and 200 to 1,250 pounds of carbon per arrival into Atlanta using this method in May 2008.

NextGen Project Tasks

Embry-Riddle faculty researchers are collaborating with their peers at aerospace companies to develop and test these new technologies at the Daytona Beach NextGen Test Bed. A major resource in this joint research is the university's Next Generation Advanced Research (NEAR) Lab, which makes use of sophisticated simulation technology that cannot be found anywhere else. By combining its experienced faculty, ambitious students, and robust NEAR Lab, Embry-Riddle brings unparalleled depth and breadth to the complex NextGen endeavor.

Several important tasks have already been completed successfully.

In early 2009, two demonstrations showed how integrating a four-dimensional weather system and a transoceanic flight trajectory display system on controllers' computers allowed them to better manage flights around current and forecasted severe weather.

Dawna Rhoades, associate dean of the College of Business and professor of management, marketing and operations, worked with Embry-Riddle researchers Todd Waller, John Pesce, Mohammed Mahmoud, Carlos Castro, and Sean Lewandowski on the weather project. Industry partners included representatives from the FAA, Lockheed Martin, Mosaic ATM, and Sensis.

On the flight trajectory project, Embry-Riddle researchers Waller and Pesce collaborated with representatives from the FAA and Lockheed Martin.

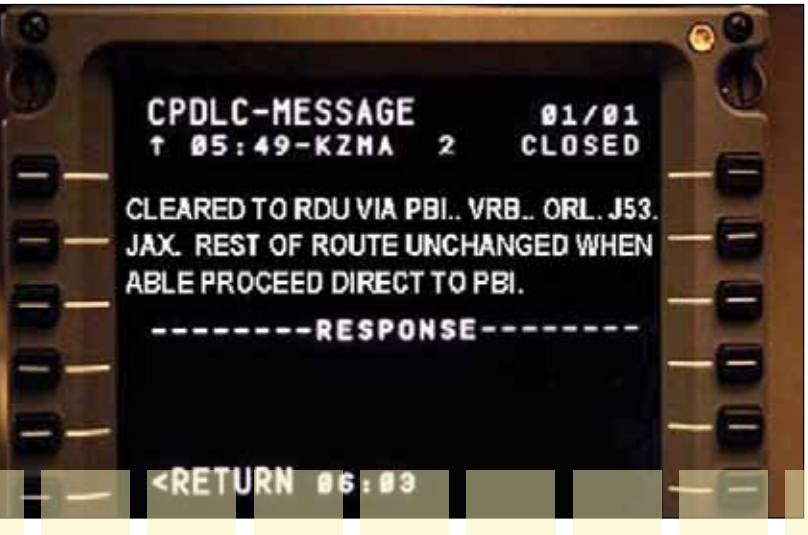
In late 2009, a demonstration showed how the new technology makes it possible to monitor aircraft and other vehicles on airport surfaces for more efficient and safer operations. Embry-Riddle researchers were Waller, Pesce, Mahmoud, and Castro. They collaborated with representatives from the FAA, Lockheed Martin, Mosaic ATM, and Sensis.

Another project is underway to plan for the integration of unmanned aerial systems (UAS) in the national airspace when the NextGen environment is established. In 2010, after examining challenges and writing protocols for allowing UASs to join existing air traffic, researchers will conduct several live test flights of unpiloted air vehicles.

On the UAS project, Embry-Riddle researchers are Ted Beneigh, professor of aeronautical science, and Kelly Neville, associate professor of human factors and systems, assisted by a team of student researchers. Industry participants include researchers from the FAA, GE, and Lockheed Martin.

Work has also begun to explore and demonstrate new procedures that would let aircraft glide from high altitude to landing, which promises to be a smoother, quieter, cleaner, and more fuel-efficient process. These tasks involve Embry-Riddle researchers Massoud Bazargan, chair and professor of management, marketing, and operations, and his team, along with Keith Garfield, assistant professor of computer and software engineering, Neville, Waller, and Pesce. They are working with researchers from the FAA, GE, and Lockheed Martin.

Next up, researchers will test and demonstrate the integration of departure and arrival management systems into a system-wide information system.



Simulation Gets Real

Simulation has revolutionized aviation by reducing the risks, costs, and hours spent learning to be a pilot, air traffic controller, and maintenance technician.

As an early adopter and innovator of simulation, Embry-Riddle makes use of 36 flight simulators and training devices, three air traffic control simulation labs, and a High Altitude Normobaric Lab that teaches pilots the symptoms of air sickness induced by loss of oxygen in the cockpit.

But Embry-Riddle researchers are also developing new uses for simulation, ranging from flight training to role-playing by teams in separate locations. They are even creating touch-free, interactive applications for teaching, playing games, and operating equipment.

Researchers Justin Westbrooks and Tom Haritos test SAFTE-VATS, a pilot-ATC simulation tool.

Simulator teaches pilot-ATC teamwork

In partnership with Frasca, Embry-Riddle is developing SAFTE-VAT, an air traffic control simulation tool that will relieve flight instructors from having to play air traffic controller in addition to teaching flight procedures.

Using speech recognition technology, SAFTE-VAT parses the pilot's spoken words and responds with appropriate air traffic controller messages and instructions.

For example, "Daytona Tower, Riddle 345 is 25 left, ready for departure" contains at least five key words – Daytona, Tower, Riddle, 25, and left – that can trigger a response. The new program's virtual air traffic controller may reply with "Riddle 345, Daytona Tower. You are cleared for departure 25 left, maintain runway heading."

The program's software also recognizes non-spoken triggers such as altitude, time, and waypoints.

Frasca built SAFTE-VAT, and Embry-Riddle researchers are developing the content for it. Principal investigator is Dan Macchiarella, chairman of aeronautical science at the Daytona Beach campus. The university will be the first user of the program before Frasca puts it on the market.

> There's a need for brevity. In a congested airspace, it sounds like an auction sometimes. **We want to optimize communication between ATCs and pilots."**
>
> [Dan Macchiarella, Embry-Riddle chairman of aeronautical science]

In a spinoff project, also led by Macchiarella, Embry-Riddle researchers are defining synthetic speech for cockpits in the FAA's planned NextGen environment, where aircraft will have a digital link with air traffic controllers.

"We're examining how much of the message traffic with ATCs should be displayed to the pilot visually or conveyed by synthetic speech," Macchiarella explains. "There's a need for brevity. In a congested airspace, it sounds like an auction sometimes. We want to optimize communication between ATCs and pilots."

Researchers in the FAA-funded project are also exploring ways of presenting air traffic information on cockpit displays and how pilots could respond using a touch screen, buttons, or a keypad.

Simulated flight for the Airbus 320

Ray Bedard, assistant professor of aeronautical sciences at Embry Riddle's Prescott campus, is the principal investigator on "A320 Computer-Based Training and Virtual Qualification," a research project to develop simulation training for the Airbus A320.

Bedard and Jack Panosian, also an assistant professor of aeronautical science, began by developing a desktop learning module that trains users how to operate the Airbus A320. Their next step is the creation of Microsoft Flight Simulator missions that reinforce the learning objectives accomplished. The researchers are also creating a virtual airline pilot qualification for the A320 that uses the scores from the test missions.

In creating this simulated learning template, Bedard and his team are facilitating the learning process of many other complex training systems. Their work takes advantage of an already operating simulator system, the soon-to-be-released Microsoft Flight Simulator, Airbus A320.

Several students on Bedard's research team are designing a new scoring system for the flight simulator missions, a website to host the results of that scoring system, and several flight training missions to support the course.

The Airbus A-320 is one of the most advanced and popular jets flown by airlines today.

Airport operations analyses, human factors studies, and fast-time simulations are among the projects conducted in the NEAR Lab.

NEAR Lab

On the Daytona Beach campus, Embry-Riddle's Next Generation Advanced Research (NEAR) Lab conducts cutting-edge research on problems of safety, control, capacity, and efficiency in the national airspace. The lab also contracts with outside clients to carry out applied research that solves practical problems in aviation.

In the lab, multidisciplinary teams of faculty, research staff, and students conduct research in fields such as cost-benefit analysis, data warehousing, fast-time simulation, real-time distributed simulation, probabilistic weather forecasting, metrics and methodologies, and human factors modeling and analysis.

NEAR's aviation clients include air traffic management, the avionics industry, aircraft manufacturers, communications providers, commercial airlines, and governmental agencies such as the FAA, NASA, and Volpe Center.

Facilities:

- **16 air traffic control** positions equipped with unique software developed at Embry-Riddle. Each position also contains software required for controller-to-controller and controller-to-pilot communications.
- **Four electronic pseudo-pilot** positions that interact with the controller positions. These pilot positions and cockpit displays give flight students unparalleled opportunities to actively participate in the air traffic control environment, complementing the actual flight line and ATC instruction they receive in the classroom.
- **Three powerful workstations** that run the Total Airport and Airspace Modeler (TAAM) software that Embry-Riddle uses in an exclusive arrangement with Preston Aviation Solutions, a Boeing Co. subsidiary.
- **The AviationSimNet Sim Center**, a distributed simulation bridging environment for voice and data communications that uses open standards to allow multiple facilities to share assets and conduct large scale distributed simulations. AviationSimNet partners include Boeing, FAA, Lockheed Martin, MITRE, NASA, Raytheon, and UPS.

Machine Vision Lab

The Machine Vision Laboratory (http://vision.pr.erau.edu/) is a state-of-the-art facility at the Prescott campus directed by Tarek El Dokor, assistant professor of electrical engineering.

The lab conducts research on 3-D technology, advanced machine perception, and robotics applications, ranging from video games and unmanned aerial vehicles to training programs and outdoor signage. Several interactive holographic interface stations demonstrate the limitless educational and commercial potential of 3-D vision technology.

The lab's researchers have the ability to design solutions for highly complex vision and artificial intelligence problems. Through its proprietary design approaches, the lab has helped industry partners bring products to market more quickly and at a lower cost.

Projects completed in the Machine Vision Lab include:

- **Interactive 3-D LCD:** A technology that controls and manipulates projected 3-D images.
- **Virtual Book:** An engaging medium of interactive textbooks that feature projected interactive content in the form of figures; interaction with the book is natural and intuitive, solely based on gestures.
- **Virtual Glove:** A 16 degrees-of-freedom virtual hand that can be manipulated by the user's hand. Machine training is utilized to recognize the various hand gestures.
- **Interactive Space Station:** A virtual reality space station where a user can navigate using only hand gestures. Translation of the user's hand positions controls the movement of the virtual camera. The user's left hand serves as a depth reference for the right hand.

By making technology more intuitive, this system, called In Touch 3-D, has many possible applications, including: outdoor signage, automobile dashboards, training programs, aerobic video games similar to Wii gaming station, video games, and unmanned aerial vehicles. The system also offers a sanitary substitute for devices with touch screens, such as automatic teller machines, grocery store checkout devices, and casino gaming machines.

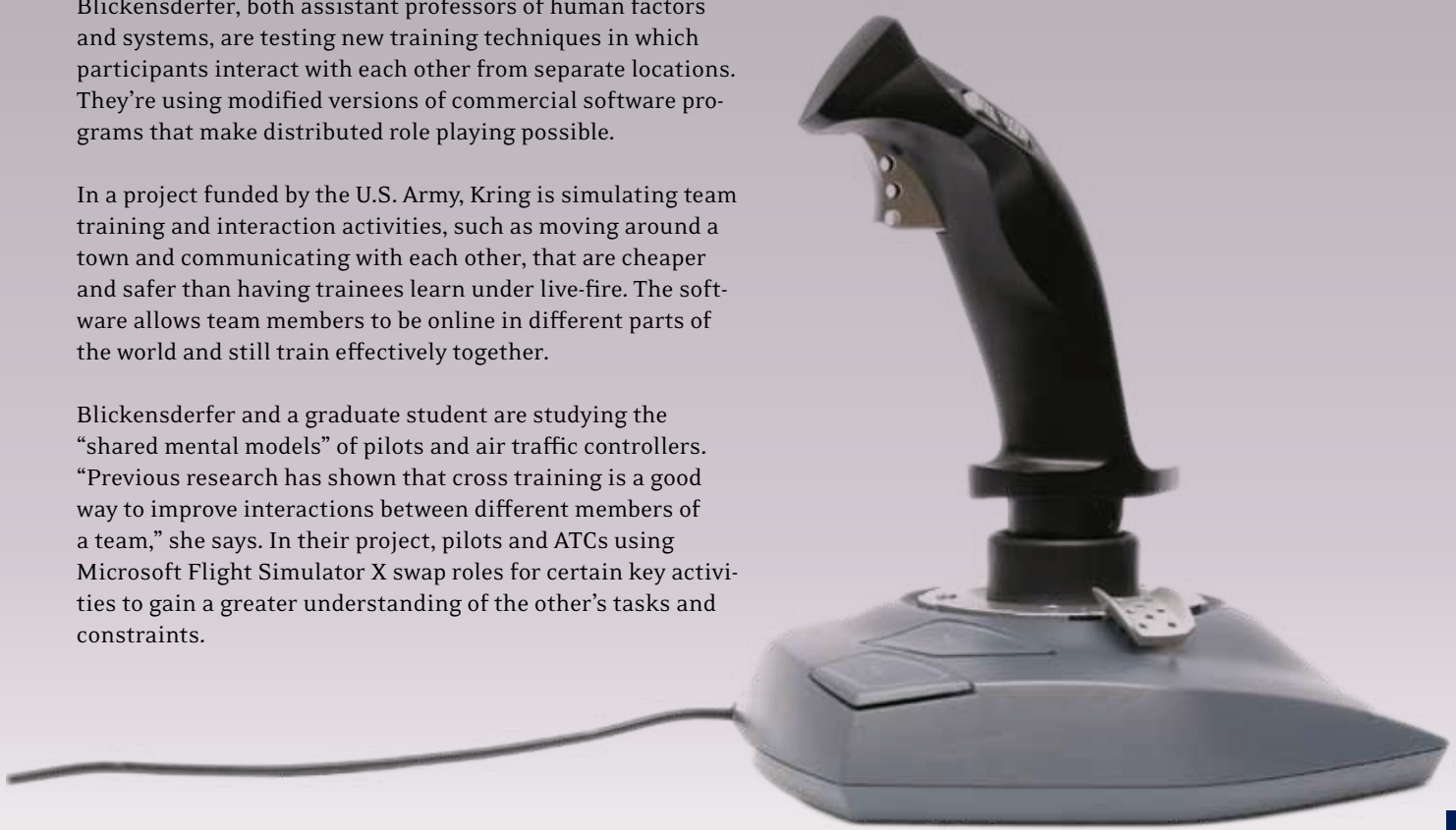
According to El Dokor, the system also provides "another critical link in our quest for a better understanding of the underlying neuronal mechanisms of learning in the visual pathways and the impact of such learning on the science of machine vision."

Team Simulation and Gaming Lab

In two separate projects in the Team Simulation and Gaming Lab at the Daytona Beach campus, Jason Kring and Elizabeth Blickensderfer, both assistant professors of human factors and systems, are testing new training techniques in which participants interact with each other from separate locations. They're using modified versions of commercial software programs that make distributed role playing possible.

In a project funded by the U.S. Army, Kring is simulating team training and interaction activities, such as moving around a town and communicating with each other, that are cheaper and safer than having trainees learn under live-fire. The software allows team members to be online in different parts of the world and still train effectively together.

Blickensderfer and a graduate student are studying the "shared mental models" of pilots and air traffic controllers. "Previous research has shown that cross training is a good way to improve interactions between different members of a team," she says. In their project, pilots and ATCs using Microsoft Flight Simulator X swap roles for certain key activities to gain a greater understanding of the other's tasks and constraints.



Researchers talk about

Joe Schoolfield, Project Engineer Government Communications Division Harris Corp.

■ Harris has worked with Embry-Riddle for several years, most recently doing integration work in support of the NextGen project.

■ Embry-Riddle's objective academic leadership helps foster collaboration among corporate partners.

■ Embry-Riddle has a wide breadth of knowledge in the areas of airline, aircraft, and airport operations.

■ Another advantage is that students are involved, and the academic atmosphere is relaxed. Industry schedules can be cramped, but Embry-Riddle is more available for new research.

Doug Sweigard, Senior Program Manager Transportation Group at Lockheed Martin

■ Lockheed Martin cofounded the Integrated Airport Initiative with Embry-Riddle to do R&D for NextGen air traffic management and attract other industry collaborators. Because that was successful, Embry-Riddle received an OTA from the FAA to co-lead the Integrated Airport team.

■ Lockheed Martin wanted a liaison with Embry-Riddle, because they're better suited to do independent research. Every company comes with its own commercial interest, but Embry-Riddle brings an unbiased perspective. That independence is very important.

■ Embry-Riddle has a long history of educating aviation and aerospace professionals, plus expertise with technologies like ADS-B. It's a combination of academic and practical.

■ We're now starting to leverage the university's real assets – students – in the NextGen tasks. They're young, exuberant, and interested in the research.

Dieter Eier, Vice President for Business Development Frequentis USA

■ Frequentis provides an electronic flight strip system for the Integrated Airport Initiative that is part of the NextGen program. It automates the final non-computerized part of aviation, the paper flight strips used by air traffic controllers.

■ Frequentis chose to partner with Embry-Riddle because the university is a leading independent research institute with a high reputation internationally in air traffic management. As a research and education institution, Embry-Riddle has so many possibilities. They can do independent, fundamental research that is not possible for a corporation to do. They can think outside the box and get new things going. It's an asset they bring to the table.

Mark Lyden is a recruiter for Boeing. He graduated from Embry-Riddle in 1989 with a B.S. in aerospace studies and in 1995 with a master's degree in aeronautical science.

■ "When you're from the number one aviation and aerospace school and you go to work for the number one aviation and aerospace company, it's a great partnership, because we have the same passion. You can't teach passion. You either have it or you don't. Boeing recruits Embry-Riddle students from all of the disciplines. I see them match up with interns from other schools, and I watch as their careers progress. Embry-Riddle's best can compete with the best from any college in the United States."

Mitchell Serber, who earned an aeronautical science degree from Embry-Riddle in 1984, analyzes aircraft health and performance data at the Mitre Corp. to help prevent future accidents. He is also serves as an advisor to Embry-Riddle on its new Ph.D. program in aviation. He previously worked as an airline pilot and conducted safety studies for the Airline Pilots Association.

■ "I'm impressed by how Embry-Riddle adapts and leads, how it is giving students the tools they need for success in the industry. They're staying ahead of the curve. The Embry-Riddle name is valued in the industry."

Chris Hemerly, who earned B.S. and M.S. degrees in aerospace engineering from Embry-Riddle, is a mechanical engineer at Rolls-Royce, where he designs the compressor sections of gas turbine engines for the civil and defense aerospace and energy sectors.

Embry-Riddle research

I would not be in the role I am in without my master's degree; it is a prerequisite to be in a highly technical area, such as the compressor aerodynamics group. The ability to dissect an engineering problem is vital. It is necessary for a student to struggle with a problem at first try. They should be taught what to do, but also what not to do when given a task. Embry-Riddle gives preparation in this area and a good background for engineering judgment.

I was fortunate enough to have Dr. Magdy Attia for AE408 and AE440, which gave me a good technical understanding of gas turbine engine, specifically axial compressors.

Embry-Riddle's aerospace engineering graduates are coming from a program that has been ranked #1 for the past 10 years. The mechanical engineering program is on the rise and shows great potential in the gas turbine industry – a mechanical engineer with aerodynamic knowledge or vice-versa. The research is closely related to the aerospace industry and has potential of being published by ASME or AIAA. Also, some of the professors in the College of Engineering are well known in the engineering community.

Han Wu, who earned a master's in aeronautics from Embry-Riddle, is Latin America manager at Sagem Avionics, where he helps customers use the company's hardware and software for the recording and analysis of recorded flight data. He also is involved in research applying flight data to flight safety and the operation of aircraft.

Embry-Riddle brings together people from all sectors in aviation, resulting in an extremely saturated learning environment for areas such as flight safety, air accident investigation, or aviation business. The university's facilities, focus, and reputation in the industry are immediately recognizable throughout the world. The people I've met and the research I did while a student prepared me well for my duties today.

Embry-Riddle is replete with knowledge in every facet of areas such as safety, human factors, accident investigation, maintenance, and aircraft design – areas that the field of flight data analysis often involves.

Moriba Jah is director of the Advanced Sciences and Technology Research Institute for Astrodynamics (ASTRIA) for the Air Force Research Laboratory. Previously, he was a spacecraft navigator at NASA's Jet Propulsion Laboratory in Pasadena, Calif. He earned a bachelor's degree in aerospace engineering at Embry-Riddle's Prescott, Ariz., campus.

When I was a student, I participated in the NASA-Arizona Space Grant program, where I did research on simulated lunar trajectories and presented my work at two conferences. I did research about 20 hours a week on top of my full class schedule. It was very hectic, but it exposed me to the top folks in the field of astrodynamics and solidified my desire to go to graduate school. Dr. Ron Madler was a great mentor.

The experience gave me insights into real-world problems and helped me understand what successful research can be.

Mark Talaga, who earned his MBA at Embry-Riddle, is an operations analyst at United Airlines. He recently led research aimed at reducing arrival fuel weight, which translates to less in-flight burn.

In my business research methods class, I was on a team that analyzed potential marketing expansion of AeroLift Company's aircraft lift product in the United States. We designed a survey, analyzed the data, and produced a final report recommending expansion. A second project involved discrete simulations for Air Tran, using Arena to analyze the potential of a super tug purchase in Atlanta. I designed the model, validated the results, and ran simulations to quantify the financial benefits. Air Tran used this research and purchased super tugs for the operation.

When I arrived at United, the statistical and operations methods we were taught in class and later used in the real project far exceeded the expectations for the job. In the data-rich environment of the airline business, the skills I gained at Embry-Riddle helped me to smoothly transition into the job and create value.

When a company such as United needs to run short-term projects but lacks human resource, Embry-Riddle is a great fit. We can initiate projects quickly because the university is so close to the industry. Embry-Riddle also has software and simulation tools, such as TAAM, which United lacks and could take advantage of.

Alternative vehicles and energy research

Student Mark Trussell and faculty advisor Darris White peer under the hood of the EcoEagles' hybrid vehicle.

Green Means 'Go' for EcoCar Designers

In the heart of car-racing country, a team of Embry-Riddle student engineers at the Daytona Beach campus is helping to "green" Detroit's best effort with a powertrain design that is similar to that of the Chevy Volt and an engineering process borrowed from the aerospace industry.

The students, who call themselves the Eco Eagles, are designing and building an Extended Range Electric Vehicle that will be fuel efficient, environmentally friendly, and high performance. They are one of only 17 university teams selected to compete in the three-year EcoCar Challenge sponsored by the U.S. Department of Energy, General Motors, and other government and industry leaders.

Their car will have a hybrid-electric powertrain with both an all-electric driving capability and a diesel engine/electric motor combination that can extend the electric range of the vehicle using biofuel stored on-board.

The Embry-Riddle vehicle will be drivable in three modes – electric-only, series hybrid, and parallel hybrid – for city and highway driving, according to Vince Sabatini, a graduate student in mechanical engineering and the team's leader.

The control system makes use of GPS, traffic information, and terrain maps which, combined with the multi-mode power system, can deliver more than 40 miles per gallon and give the car a range of about 300 miles before refueling.

The Eco Eagles are employing a design process called hardware in the loop (HIL), which the aerospace industry has used for years to develop new aircraft, says Darris White, associate professor of mechanical engineering and the team's faculty advisor.

The EcoCar's supervisory control system will be programmed onto this sbRIO hardware from National Instruments.

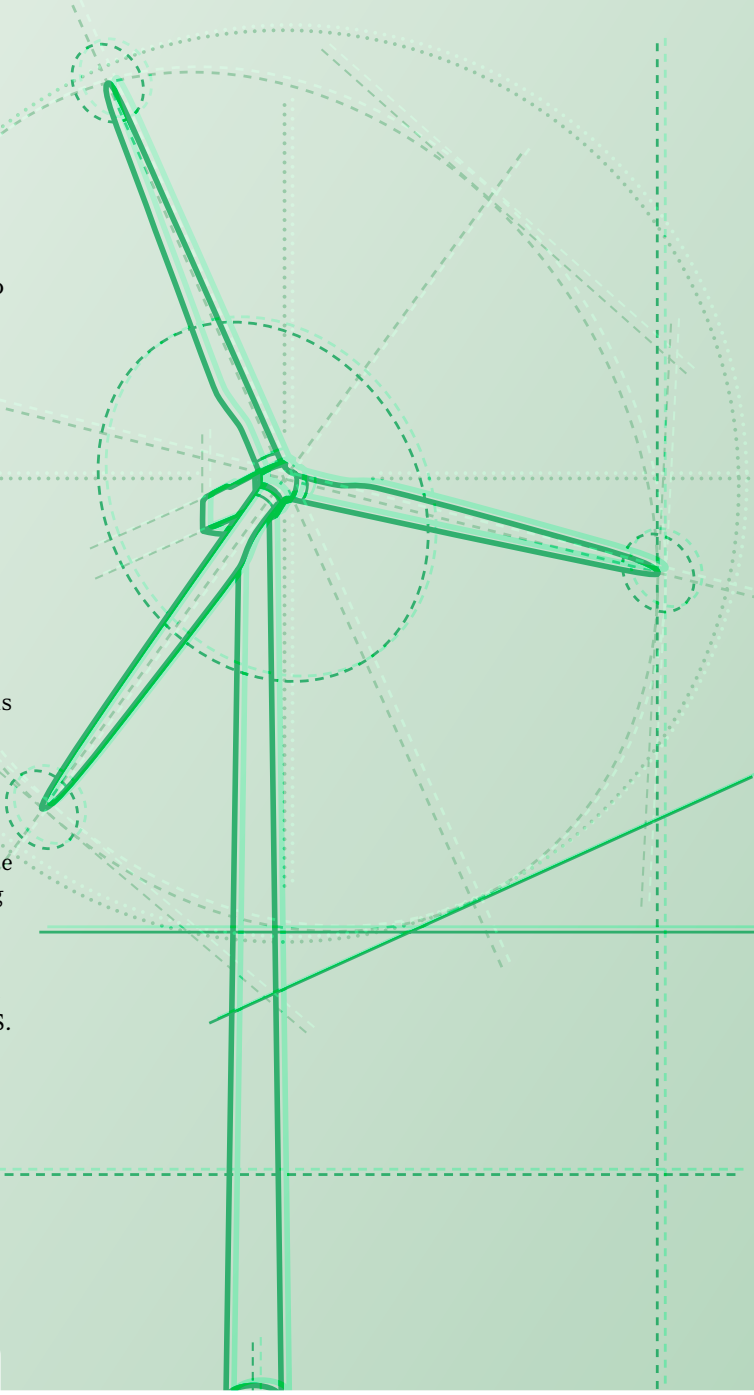
In the first year, the team built a simulated model of the vehicle on a computer, wrote control algorithms for it, and then programmed them onto the supervisory control unit (SCU) that will be installed in the car. The SCU will control the car's many components, ranging from the engine transmission to the wheels.

In the second year, the team is modifying their donated vehicle. "Our car will have to be plugged in to get electric power, and the GM car was not designed to be pluggable," White says, "so we're going to rip out the car's existing brain and install the one we developed."

The team has written mathematical simulations of all the car's parts as they would respond when controlled by an SCU. To test and refine the software and algorithms, the team will connect the SCU to their simulated car. "So if the car runs off the road, it's only a simulation, not a real car," White says. "It used to take four years to introduce a new car. But GM is now able to go from concept to production in 22 months. HIL is a big part of that."

The Eco Eagles team consists of students from the disciplines of aerospace, civil, computer/software, electrical, and mechanical engineering, as well as aviation, engineering physics, and human factors. Business students will examine how intellectual properties derived from the project could be licensed by the university.

Harnessing Renewal Energy



Darris White, associate professor of mechanical engineering at the Daytona Beach campus, continues his efforts to engineer new ways to harness sustainable energy from wind, which is capable of meeting 20 percent of U.S. electrical energy demands, and from water currents.

Assisted by a team of graduate students, he is working with the National Renewable Energy Laboratory (NREL) to develop a new fatigue testing system for large composite wind turbine blades. His system, which has spun off three patent applications, would determine frequencies at which the blades vibrate and flutter, allowing engineers to design blades that can last more than 20 years and operate at lower wind speeds.

White is also expanding his expertise with wind turbines to an exciting new project to convert the kinetic energy of water currents into electricity. "We're working on a control algorithm to allow autonomous turbines to float in formation – a swarm – in the Florida Gulfstream," he says.

Although the Gulfstream, a narrow channel between Florida and Bermuda, varies by only a few kilometers, the turbines, which would be tethered to the ocean floor, must be able to move into the ever-shifting "sweet spot" of the current. White is looking to NREL for funding.

Embry-Riddle is also one of 14 universities that are collaborating with NREL on a plan to create a center for oceanic energy funded by the U.S. Department of Energy. The center would develop an advanced water power system capable of producing electrical power from the Gulfstream.

Embry-Riddle researchers, who have extensive expertise in fluid dynamics, turbine design, and control systems, will develop a prototype hydrokinetic turbine to be installed at an oceanic research center on Florida's coast for data collection and control system testing

Green Flight Challenge

A team of students and faculty at the Daytona Beach campus is designing an aircraft that could average at least 100 m.p.h. at 4,000 feet on a 200-mile flight, while achieving more than 200 passenger miles-per-gallon. Those are the metrics of the Green Flight Challenge, a contest they have entered, which is funded by NASA and the Comparative Aircraft Flight Efficiency Foundation.

Thirty universities and experimental aircraft makers have entered teams in the competition, which will award a $1.5 million prize in 2011 when the planes are to be flown, says Pat Anderson, associate professor of aerospace engineering and principal investigator for the Embry-Riddle effort.

Noting that a gas-powered Cessna 172 engine converts only 30 percent of energy to thrust, while an electric engine converts 85 to 92 percent, Anderson says the team will probably put an electric motor in a sailplane, whose longer wings and smooth composite surfaces make it more aerodynamic.

"Our biggest challenge will be weight," Anderson says. "We'll use high-performance batteries or hydrogen fuel cells to make electricity to drive the engine. But batteries are heavy. It will be a challenge to store enough electricity at a weight that can go in a sailplane."

The Embry-Riddle team is multidisciplinary. The airframe will be designed by aerospace engineering students, the electrical work will be done by electrical, mechanical, and aerospace engineering students, and fundraising for materials and equipment is the task of business students.

Human Factors Looks for the 'Better Fit'

By Jim Hampton

The world in all its complexity is the laboratory for faculty and student researchers in Embry-Riddle's human factors department, who look at existing systems with an eye toward creating a "better fit" between humans and their equipment.

The human factors mission involves incorporating human capabilities and limitations into the design of systems, ranging from simple tools to complex workplaces. Human factors research is needed whenever human beings come into conflict with their surroundings and every time an invention, innovation or system changes the way things have been done before.

> **Our laboratory is the real world.** Much of what we do is operationally based. How does it work on the airplane, on the train, in the controls of a car, in the air traffice control tower?"
> [Jonathan French, Embry-Riddle Human Factors research director]

"Our laboratory is the real world," says Jonathan French, the department's research director. "Much of what we do is operationally based. How does it work on the airplane, on the train, in the controls of a car, in the air traffic control tower?"

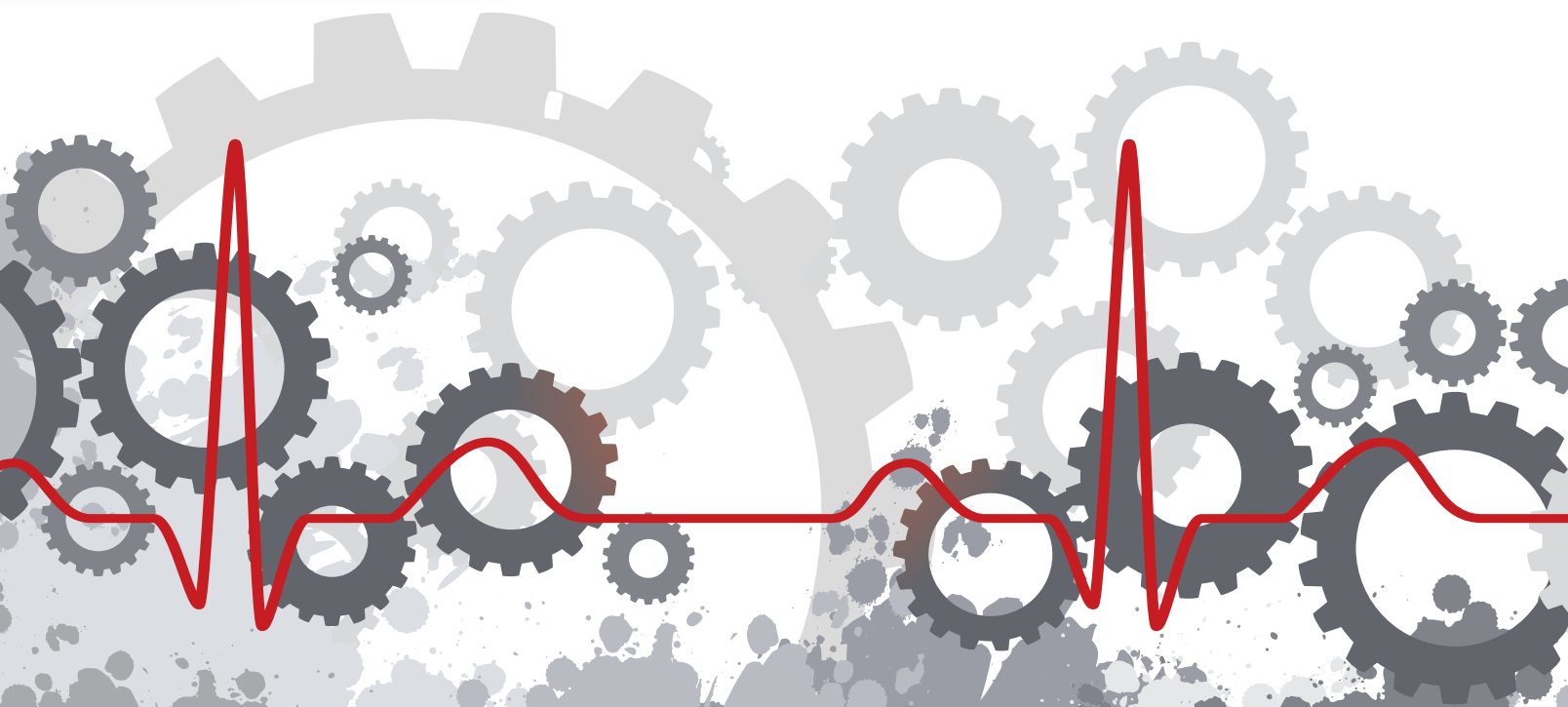
French is especially vocal on the subject of student research. He says he cannot imagine a program anywhere that gives students the research experience they receive at Embry-Riddle.

One project, for Boeing, looked at strategies that would allow airlines to improve the turnaround time for aircraft. "My students got on a plane and went somewhere like Chicago, New York, Washington, D.C., or Atlanta and observed how people board airplanes," French says. "As passengers are loaded, they watched how the different boarding strategies work or don't work."

French's efforts led to his invention of an analytical tool that Boeing can use to analyze various passenger constraints and interferences while boarding an aircraft. "It was a great success," said Edward Winkler, a technical fellow at Boeing, adding that the company has applied to patent the Enplane/Deplane Aircraft Passenger Flow Model that resulted, listing French as one of the inventors.

The human factors department has also submitted a grant proposal to NASA to look at the effects of motion sickness in space flight.

"Sometimes fatigue is the only symptom of low-level motion sickness from a vibrating, oscillating space craft," says French, who has a background in the pharmaceutical industry. Judging by the remedies touted for motion sickness - "everything from magnets to ginger root" - he says it's clear that not much is known about the ailment.




Sacha Duff

Selected human factors projects

Sacha Duff, a graduate student in human factors and systems, is studying workflow disruptions in a hospital operating room.

Her research project was conducted as part of her master's thesis. "It was spurred by an oncology surgeon who had become aware through published journal articles of the increasing application of human factors in health care," Duff says.

Duff and her thesis chair, Albert Boquet, associate professor and chair of the human factors department, worked with physicians, nurses and other operating room staff on this innovative project. Duff was granted access by a local hospital to videotape medical procedures, specifically laparoscopic removal of the gall bladder and open hernia repair.

Interruption and distraction is detrimental to performance in any undertaking, but in the operating room it can be especially devastating. At least seven percent of deaths of hospitalized patients are related to surgical procedures in the operating room. Results of Duff's study should prove invaluable in tracking potential problem areas.

Rafael Patrick, a graduate student in human factors and systems, is studying the conduction of sound through bones. Collaborators on the project are the U.S. Army Research Laboratory, Human Research and Engineering Directorate, Aberdeen Proving Grounds, and Embry-Riddle.

Bone conduction of sound would allow soldiers to keep their ears free to receive messages from multiple sources in combat, when it is important to hear what is happening around them, and also receive messages from a distant command post.

"Bone conduction technology allows listeners to maintain two-way radio communication without severely impeding their situational awareness," Patrick says.

He is evaluating four bone conduction headsets using 20 volunteers with normal hearing. Patrick says of the potential value of this study, "Having the latest in effective two-way communication gives our soldiers the upper hand in any potentially unsafe environment."

Bone conduction technology could also conceivably be built into the "bite bar" that scuba divers hold between the teeth, allowing them to hear what people are saying on the surface.

Jason Kring, assistant professor of human factors and systems, is working on two projects that examine small team performance in simulated search-and-rescue exercises.

In one project, funded by an internal award from Embry-Riddle, Kring and his team are using heart rate variability to monitor individual and team reactions to varying task loads in team coordination and cohesion.

"Beat-to-beat variations in heart rate are tied to activity of the sympathetic and parasympathetic branches in the heart that are related directly to the autonomic nervous system which is related to human responses to stress," Kring says.

According to Kring, NASA has identified specific risks that must be addressed before humans venture beyond Earth's orbit: performance errors due to poor team cohesion, inadequate team selection and composition, inadequate training, and poor psychosocial adaptation.

Kring says he intends to use the studies as groundwork for future research proposals to NASA to study small teams and crews. The study is taking place at the Team Simulation and Gaming Laboratory, of which he is co-director. His collaborators are Albert Boquet, associate professor and chair of human factors and systems at Embry-Riddle, and Kenneth Cohen, a researcher with NASA's KSC Biomedical Research Lab.

In another research project, funded by the U.S. Army, Kring is simulating team training and interaction activities, such as moving around a town and communicating with each other, that are cheaper and safer than having trainees learn under live-fire. The software, which the U.S. Army provided for the study, allows team members to be online in different parts of the world and still train effectively together.

Kring's collaborators are principal investigator Donald Lampton, a researcher from the U.S. Army Research Institute, James Bliss and Karen Orvis, researchers from Old Dominion University, and Glen Martin, of the University of Central Florida.

Space Science research

For most at Embry-Riddle, the sky is "home," but for the university's physicists, space is the place to be.

At the Daytona Beach and Prescott campuses, researchers are exploring space weather and measuring massive stars, sampling and analyzing the chemical makeup of the Earth's upper atmosphere, and designing better space vehicles. And a new member of the faculty is developing structures that one day could be used to make electronic devices smaller than the width of a human hair.

Super Stars and Solar Winds

Katariina Nykyri, assistant professor of physics, is studying how the disruptive force of 24,000-mile wide "space hurricanes" can allow solar wind plasma to penetrate the Earth's magnetic field. Understanding these hurricanes and how to prevent their formation could one day help in the development of fusion energy. In other research, she is studying how particle acceleration occurs in the Earth's magnetosheath. High-energy particles can be harmful to spacecraft, satellites, and astronauts. Nykyri was honored in 2009 with a Faculty Early Career Development Award from the National Science Foundation, making her the third Embry-Riddle faculty member to receive the prestigious award. [NSF]

Jason Aufdenberg, assistant professor of physics, is working on a project to gain a better understanding of the radiuses, temperatures, luminosities, and masses of the biggest stars. "For the super giants, the most luminous stars, our results will ultimately contribute to the three-dimensional map of our Galaxy," he says. "Future observations will also help put our Sun in better context with other stars, and we will better understand the evolution of the Sun relative to other stars." [NASA, JPL-Caltech]

At the Sondrestrom Research Facility in Greenland, Embry-Riddle scientists use an interferometer and spectrometer to gather data about the effects of aurora and the solar wind on the Earth's upper atmosphere.

A Sense of Atmosphere

Abas Sivjee, professor of physics, directs Embry Riddle's Space Physics Research Laboratory (SPRL), which investigates disturbances in the near-Earth space environment that are triggered by solar electromagnetic and particulate radiations. These disturbances impact the orbits and systems of satellites and the International Space Station, which orbit the Earth in this region. The lab works to quantify the disturbances and explain the physical processes involving the solar-terrestrial interactions.

SPRL (http://www.sprl.db.erau.edu/site/) operates advanced electro-optical remote-sensing research facilities at six stations worldwide. In the high latitude Arctic region, the stations are in Longyearbyen in Svalbard, at Sondrestromfjord

in Greenland, and at Resolute Bay in the Canadian Arctic. At mid-latitudes, SPRL's stations are in Daytona Beach, Fla., and Adelaide, Australia. In the Antarctic region, the station is located at the Geographic South Pole. The researchers also conduct short-duration special research projects with scientists at other remote stations.

Talented undergraduates and graduate students assist SPRL with the design, construction, testing, and deployment of sophisticated equipment at the remote stations. They also make measurements, analyze the data in a quantitative manner, report the results at conferences, and publish their findings in refereed journals. The lab also employs post-doctoral fellows for research work. In addition, the lab provides new faculty members, such as John Hughes and Mathew Zettergren, with ample opportunities for space research and mentoring for proposals to federal agencies for national competitions to win research funding. [NSF, NASA, other federal agencies]

Peter Erdman and John Olivero, both professors of physics, have been conducting measurements of the light emitted by chemically excited hydroxyl radicals in the Mesopause region of the atmosphere 90 kilometers above the Earth. Their team spent two years developing 10 new photometric instruments, which flew aboard a sounding rocket from White Sands Missile Range in late 2009 and transmitted measurements to the ground during flight.

Hydroxyl radical light emissions are observed from the ground by instruments all over the globe (Abas Sivjee has several) and are used as measures of atmospheric gravity wave activity and of temperature in the Mesopause region. The latter is considered a sensitive "canary" for global warming, because temperature variations at this altitude will be much greater than at the Earth's surface.

Erdman also directs the university's Atmospheric Physics Research Laboratory (http://aprl.db.erau.edu), which designs, assembles, and tests payloads for upper atmosphere research. The lab collaborates with NASA's Wallops Flight Facility, Utah State University's Space Dynamics Laboratory, New Mexico State University's Physical Sciences Lab, and others. [NASA]

NASA engineers prepare a sounding rocket payload designed by Peter Erdman's group for pre-launch stress tests.

Remote Controls

Mahmut Reyhanoglu and Sergey Drakunov, both professors of physics, make use of mathematical theory derived from physical principles to solve problems in robotic, automotive, and aerospace systems. Reyhanoglu has addressed the control of constrained mechanical systems such as wheeled mobile vehicles, the reorientation of space multi-body systems, and the attitude control of rigid spacecraft, as well as underactuated mechanical systems and the control of flexible robotic manipulators, autonomous marine vehicles, and space vehicles.

In recent research, Drakunov developed techniques detecting anomalies in tests of the engine of the J-2X rocket that will be used when the Space Shuttle retires, data processing techniques to describe and predict human decision making, and control algorithms for autonomous vehicles and small satellites. [Florida Space Grant Consortium, GrayMatter Inc., NASA, Florida Institute for Human and Machine Cognition]

A Growth Spurt for Nanotech

John Mathis, associate professor of physics, recently brought to Embry-Riddle his program of research using lasers to grow tiny structures composed of complex metal-oxide rods that are no larger than 100 nanometers. A human hair is about 100,000 nanometers wide. The results from his research could be applied towards developing improved electronic devices such as computer memories, chemical sensors, solar cells, and superconductors. Making nanorods that consist of one more than material can also lead to a better understanding of the quantum properties of these materials at the nano-level. [Oak Ridge National Laboratory]

Unmanned Vehicle Research Takes Off

Can UAVs Share the Air?

Although drones are being used extensively by the U.S. military in the wars in Iraq and Afghanistan, unpiloted aircraft are scarce in American domestic airspace because the current air traffic management system cannot ensure the separation of manned and unmanned aircraft.

Nonetheless, the demand to open the airspace to unmanned air systems (UAS) is growing, because they can perform certain tasks longer, more safely, and for less money than piloted aircraft. These tasks include collecting weather information inside hurricanes, tracking wildfires, and monitoring borders and traffic congestion.

At Embry-Riddle, researchers are laying the groundwork to train future UAS operators and testing concepts for integrating UASs into the nation's airspace.

In the university's Next Generation Advanced Research Lab, researchers led by Ted Beneigh, professor of aeronautical science, are designing computer simulations that merge UAVs with other aircraft in the nation's airspace.

"By using flight simulators, our researchers have fused live real-world air traffic with that of simulated UAS operations," Beneigh says. "We can transfer the training and testing of UASs from the sky to the simulator while maintaining a level of realism to prepare UAS operators of the future."

Playing a crucial role in this research are Embry-Riddle aircraft equipped with ADS-B, a satellite-linked system that lets aircraft, surface vehicles, and fixed ground locations share information and actively tracks the aircraft on a graphical overlay of the airport and airspace. By giving the UAS pilot live aircraft traffic and weather information, the operator can see 3-D graphics of the aircraft, airport, and surrounding area.

"This new research product will allow us to train our students in UAS flight operations without actually having an unmanned aircraft," Beneigh said. "The student will achieve the same skills of flying an actual unpiloted aircraft for a fraction of the cost."

At the conclusion of the project, their simulations will meet reality when actual unmanned aerial vehicles are flown in a series of tests to see how well they integrate with other air traffic.

Also involved in the project is Kelly Neville, associate professor of human factors and systems. With a team of graduate students, she is devising criteria for assessing the challenges of allowing unmanned aircraft in an already busy airspace. For example, is a system resilient enough for human UAS pilots to jump in and perform a task that automation can't handle? And are pilots and controllers aware enough of other elements in the system to rule out gaps or oversights?

The research is funded by the Federal Aviation Administration as part of its NextGen program to update U.S. air traffic control technology. Embry-Riddle's collaborators include Lockheed Martin and Harris Corp.

Eyes in the Sky

Can unmanned aerial vehicles be taught to "see" what's around them or "think" for themselves? Those are some of the questions Charles Reinholtz, director of the Robotics and Unmanned Systems Laboratory at Embry-Riddle's Daytona Beach campus, is trying to answer.

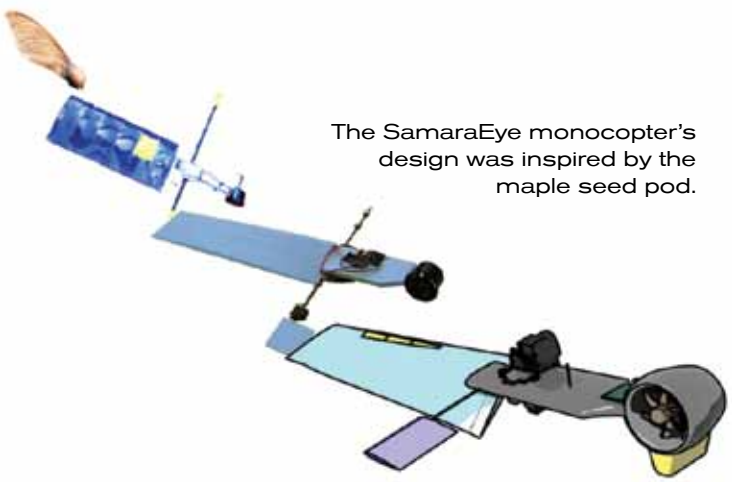
> **It's based on the maple seed pod.** When it falls from a tree, the air causes the pod to rotate and that creates lift."
> [Charles Reinholtz, Embry-Riddle Robotics and Unmanned Systems Laboratory director]

Reinholtz's research team is exploring how to get a small, single-winged helicopter, dubbed SamaraEye, to fly through an open window, search inside a building, and send back photos – all without an operator's control or input. The craft is being developed as an autonomous search-and-rescue vehicle.

The concept for the unique copter, which was designed by Embry-Riddle students, was borrowed from nature. "It's based on the maple seed pod," says Reinholtz, a professor and chair of mechanical engineering. "When it falls from a tree, the air causes the pod to rotate and that creates lift and permits the seed to fly a long way. Our 'seed pod' is a ducted fan that spins the wing up so it can fly."

Lessons learned from SamaraEye could address the problems of flying in a crowded airspace. "If we're going to have autonomous vehicles in the air, they'll need to be able to sense and avoid other aircraft," Reinholtz says.

He speculates that their research could also lead to the development of an autonomous control system that would fly an aircraft to safety if the pilot were unable to operate it due to injury or damage.



The SamaraEye monocopter's design was inspired by the maple seed pod.

Robots to the Rescue

Massood Towhidnejad, professor of computer and software engineering, and Richard Stansbury, an assistant professor, are teaching an unmanned aircraft and several unmanned ground vehicles to work together as teammates. The project takes them one step closer to the day when robots perform rescues that are too dangerous for humans.

Towhidnejad says their aircraft, which they built for a previous UAV project, would transmit a "God's-eye view" of a location under surveillance, including its GPS coordinates, to a remote station. Unmanned vehicles on the ground would then negotiate with each other to determine which one is closest and should move in on the target. The ground vehicles would be equipped with temperature sensors that could determine if the victim is still alive, and an audio system would allow a remote operator to ask questions and gather more information from the person.

The researchers have their work cut out for them. "Our biggest challenge is the negotiation among ground vehicles," Towhidnejad says. He adds that debris in the search area will also require a lot of obstacle avoidance. In their tests, the researchers are using Power Wheels mini-vehicles they purchased at a local toy store. In the real-world, much-larger ATVs would do the job.

The researchers are being assisted by 20 students who have taken on the project for their senior design course. The research is supported by funding from Rockwell Collins and Embry-Riddle.

Students Show Prowess in AUVSI Contests

In 2009, Embry-Riddle became the only university to compete in all five annual contests organized by the Association for Unmanned Vehicle Systems International (AUVSI). Student teams from the Daytona Beach campus demonstrated their teamwork and skills in designing, building, and operating aerial, ground, and underwater unmanned vehicles. The student teams expect to repeat their success in 2010.

"Our students' performance at AUVSI competitions showcases Embry-Riddle's growing strength and diversity in this exciting new arena," said Charles Reinholtz, professor and chair of mechanical engineering and advisor of several of the student teams.

strata

Embry-Riddle Aeronautical University
600 S. Clyde Morris Blvd.
Daytona Beach, FL 32114