EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

AERONEWS

Department of Aerospace Engineering at Embry-Riddle Aeronautical University — Daytona Beach

DECEMBER 2017

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Message From the Chair

AEROSPACE NEWSLETTER

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Dr. Tasos Lyrintzis

It has been another very exciting year! The Aerospace Engineering Department continues to be the largest in the country with 1,402 B.S., 101 M.S., and 32 Ph.D. students as of fall 2017. It should be noted that about 13.3 percent of our undergraduates are honors students, while the rest of the Embry-Riddle Daytona Beach Campus has 5.2 percent honors students. In addition, we continue to have numerous design/build/test projects at both undergraduate and graduate levels.

This fall for the second time *US News & World Report* ranked the Department of Aerospace Engineering in the Ph.D.-granting category, which includes the most elite universities in the Nation. In this new category our undergraduate program moved up to No. 13 (tied) 1st in the State of Florida. This is up three spots from last year when it was ranked No. 16 (tied). Last spring our Graduate program was ranked No. 35 (tied) 2nd in the State of Florida. Our program moved up one spot, as last year it was ranked No. 36.

In a special *USA Today* edition (Back to the moon, Fall 2017) Embry-Riddle was identified as one of the top five colleges for aerospace careers.

Our research expenditures have increased significantly. Some notable current and recently awarded funded projects are:

- NASA NIAC (NASA Innovative Advanced Concepts) program, Phase I and II "Virtual Flight Demonstration of Stratospheric Dual-Aircraft Platform" PIs: Engblom, Moncayo, and Barott.
- DARPA, SBIR Phase I and II, "Low-Cost Miniaturized Control System for Autonomous Flight" PIs: Prazenica, Moncayo, and Henderson.
- NASA SBIR Phase I and II "Integrated Structural Health Sensors for Inflatable Space Habitats," PIs: Kim, Namilae.
- AFOSR YIP (Young Investigator Program) "Exploiting Non-linear Interactions within Wall Turbulence for Flow Control" PI: Gnanamanickam.
- Department of Transportation "Multi-scale Models for Transportation Systems under Emergency", PIs: Liu (Aviation), Namilae.
- U.S. Army/NASA/ONR Penn State Vertical Lift Research Center of Excellence "Fidelity Requirements for Ship Airwake Modeling in Dynamic Interface Simulations" PIs: Leishman, Gnanamanickam.
- AFOSR YIP (Young Investigator Program) "Investigation of Load Path Based Topology Optimization" PI: Tamijani.
- ONR. DURIP (Defense University Research Initiative) program, "Time Resolved PIV System for High Resolution Flow Measurements", PIs: Leishman, Gnanamanickam, and Zhang.

Currently, researchers at the Eagle Flight Research Center (EFRC) are working on hybrid and full electric airplanes and have started the Embry-Riddle Hybrid Consortium to focus on hybrid electric airplanes. The consortium now includes Airbus, Textron, Rolls-Royce, P&W, Hartzell and GE. This consortium's vision is to explore the design space for turbine/electric aircraft propulsion systems. In addition, Embry-Riddle is now a Charter Member, and the only university, in GAMA (General Aviation Manufacturers Association) under the new EPIC (Electric Propulsion Innovation & Competitiveness) program for electric and hybrid propulsion innovation.

Finally, the Department has a significant presence in the new John Mica Engineering and Aerospace Innovation Complex including a new state-of-the-art wind tunnel with construction scheduled for completion in spring 2018.

Best Regards,

A Lyrintzis

Dr. Tasos Lyrintzis
Distinguished Professor, Department Chair

New Facilities

Engineering Building and Wind Tunnel

Embry-Riddle Aeronautical University has completed construction of the John Mica Engineering and Aerospace Innovation Complex.

The 50,000-square-foot, $26 million building features 10,000 square feet of flex lease space to meet the needs of future tenants, and includes the following college-led facilities:

- Advanced Dynamics and Control Laboratory
- Circuits, Sensors and Instrumentation Laboratory
- Computational Sciences Laboratory
- Composites Laboratory
- Materials Laboratory
- Robotics and Autonomous Systems Facility
- Radar and Communications Laboratory
- Space Technologies Laboratory
- Structures Laboratory
- Thermal and Energy Laboratory
- Unmanned System Testing Facility

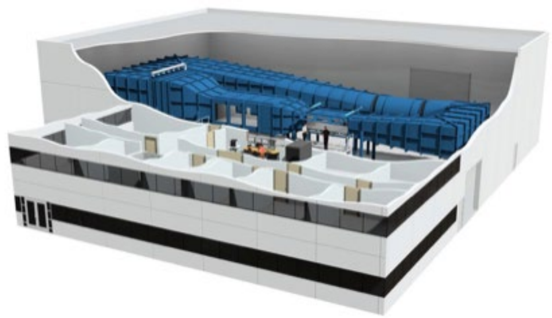
This is the first building of Embry-Riddle's 90-acre research park, which will include offices, laboratories and direct taxiway access to Daytona Beach International Airport.

Tenants of the Research Park, including established industry leaders and burgeoning enterprises, will have access to the facilities provided within Embry-Riddle's continually expanding areas of research.

A new state-of-the-art subsonic wind tunnel will be located in an adjacent building. The wind tunnel was designed by Aero Systems Engineering (ASE). This tunnel will be focused on supporting the education and research needs of the Department as well as commercial applications. The tunnel will have a 4 ft. x 6 ft. x 12 ft. test section, optimized for the use of advanced optical flow measurement techniques such as particle image velocimetry. The 12 ft. long test section can be replaced with a 20 ft. section when required. The tunnel will also have a secondary 10 ft. x 14 ft. upstream test section. The primary test section will have a flow speed capability up to 230 mph with exceptional flow quality. A six-component balance is used for force and movement measurements, complemented by a comprehensive multi-channel pressure measuring system. The wind tunnel is scheduled for completion for Spring 2018, with commissioning expected in the Summer of 2018.

Finally, (just next to the wind tunnel) construction will begin in Fall 2018 for a new hangar and offices for the Engle Flight Research Center.

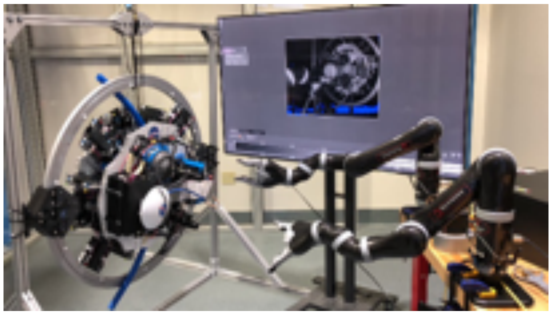
Artist rendering of the wind tunnel



John Mica Engineering and Aerospace Innovation Complex

Advanced Dynamics and Control Laboratory (MicaPlex)

(Drs. Moncayo and Prazenica)



Off-Loading System for On-Orbit Servicing Missions

At ERAU MicaPlex, the Advanced Dynamics and Control Laboratory (ADCL) is a research laboratory for the development and implementation of guidance, navigation and control of aerospace systems and research on a broad range of topics focused on flight dynamics. The ADCL supports activities aimed at advancing aviation and space technologies through the development of concepts, implementation and demonstration of solutions with research efforts that span several areas, including but not limited to: Investigation of technologies to integrate UASs into the National Air Space; design of intelligent systems to increase aviation flight safety; application of robotic technologies for future space missions, such as servicing of existing and future observatory class scientific satellites; fundamental and applied research in manned and unmanned aerospace systems including avionics and payload systems design, aircraft modeling and parameter identification, multiple sensor fusion, vision-based navigation, constrained motion planning, formation flight control, human-machine interface, and remote sensing.

The ADCL is a facility that features unique equipment at Embry-Riddle to support a diversity of advanced research topics. The equipment includes:

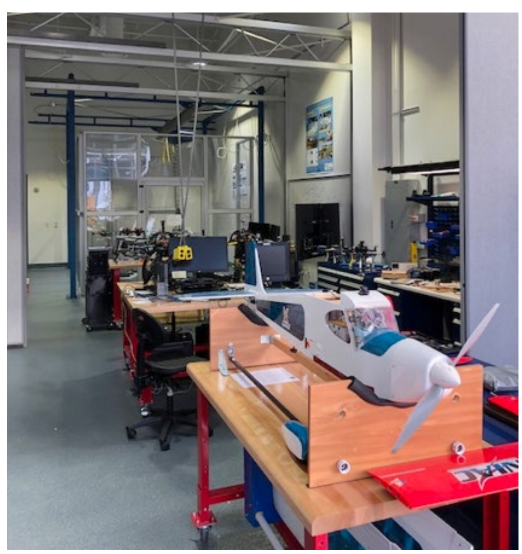
- An Integrated Gravity Off-loading Robotic (IGOR) system that enables simulation of partial gravity environments. This system supports the development and testing of spacecraft technologies such as autonomous control and stabilization, fault tolerant control systems, formation flight and station-keeping, and autonomous docking.

- ADCL provides direct access to a UAS Indoor Testing Facility that features a VICON Motion Capture system. This system provides 12 cameras to track and represent in-motion objects with a high degree of fidelity. The UAS Indoor Testing Facility provides substantial footprint and technology for use in GNC (Guidance Navigation and Control) development and testing of formation flight, UAS sense and avoid in complex environments, and cooperation between multiple autonomous agents. The ability to perform indoor free flight testing enables researchers to implement and test guidance, navigation, and control algorithms on small to medium-sized UAVs within a safe, controlled setting.

- ADCL also features advanced sensors and high performance computing resources to support the development, simulation, and testing of intelligent, autonomous flight vehicles. The lab has 2 Velodyne VLP-16 Puck 3D LIDAR sensors, which can be deployed on autonomous UAVs or spacecraft for feature and obstacle detection as well as mapping unknown environments.

- ADCL has 5 high performance computers, capable of supporting computationally intensive tasks such as GNC algorithm development, processing of large data sets, and vehicle and sensor simulation.

Relevant current projects at ADCL include: *1.) The World is Not Enough (WINE): Harvesting Local Resources for Eternal Exploration of Space, sponsored by NASA Phase II SBIR with Honeybee Robotics; 2.) Low Cost Miniaturized Control System for Autonomous Flight, sponsored by DARPA Phase II SBIR with Creare LLC; 3.) Free-Flying Unmanned Robotic Spacecraft for Asteroid Resource Prospecting and Characterization, sponsored by NASA Phase II STTR with Honeybee Robotics; 4.) Virtual Flight Demonstration of Stratospheric Dual-Aircraft Platform, sponsored by NASA Phase II NAIC; and 5.) Development of Control Laws for an Integrated Gravity Off-loading Robotic System, sponsored by Embry-Riddle Aeronautical University.*



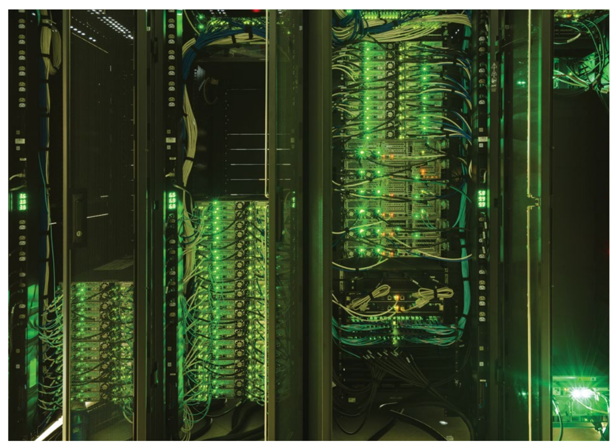
The Vega Supercomputer: Embry-Riddle's Newest Research Star

Named after the fifth brightest star in the sky, Embry-Riddle Aeronautical University's new supercomputer is enhancing faculty, student and industry research.

Dubbed Vega because of its massive amount of power, the Cray® CS™ cluster supercomputer in the Lehman Engineering and Technology Center on the Daytona Beach Campus is ushering in a new era of competitive research.

University leaders touted the new research tool at a ribbon cutting ceremony following the announcement in August of the installation.

The four-cabinet Cray CS400™, which offers 3,024 of the latest-generation of processing cores has an estimated performance of 3 Tera FLOPS. It will support research at Embry-Riddle's Daytona Beach; Prescott, Ariz. and Worldwide campuses and applied research with industry partners at the John Mica Engineering and Aerospace Innovation Complex (MicaPlex) at Embry-Riddle's Research Park.



Research News

Time-Resolved PIV Measurements for High Resolution Flow Measurements

(Drs. Leishman, Gnanamanickam & Zhang)

A $590,000 Defense University Research Instrumentation Program (DURIP) award to the Aerospace Engineering Department at Embry-Riddle will be used to fund the acquisition of a state-of-the-art, large field of view, high-speed particle image velocimetry (PIV) system for use in Embry-Riddle's new wind tunnel. This advanced flow measurement system, which uses high-powered lasers and special high-speed digital cameras, will be used to better understand the underlying physics of various aerodynamic problems that are driven by unsteady, three-dimensional separated flows. The system will be used in multi-camera, multi-resolution, time-resolved forms, as well as in a stereoscopic time-resolved configuration, and will significantly augment the PIV instrumentation that is currently available. The combination of the new PIV system with the custom infrastructure of the new wind tunnel will provide measurement capabilities that are unique in terms of quality as well as the broad range of new problems that can be studied. An initial application of the PIV instrumentation in the new wind tunnel is to study the three-dimensional, turbulent downstream airwake produced by the superstructures of Navy ships, which will be used to better understand how the airwake contributes to the adverse flow environment encountered by landing helicopters. The instrumentation will also be to understand and exploit the interactions within turbulent boundary layers for reducing skin friction drag. Several full-time graduate students in Aerospace Engineering will use the new instrumentation to accomplish their M.S. and Ph.D. research.

Pedestrian Movement During Emergencies

(Drs. Namilae and Liu - College of Aviation)

Sirish Namilae of Aerospace Engineering Department and Dahai Liu of College of Aviation are part of Embry-Riddle team that is a member university in a Department of Transportation Tier-1, University Transportation Center (UTC), led by North Carolina A&T University. The Center for Advanced Transportation Mobility (CATM) led by former Embry-Riddle professor Maranda McBride focuses on two themes of (a) Enabling safe and efficient mobility for vulnerable road users and (b) Optimizing mobility in emergency situations, and has an annual budget of $1.4 Million, renewable for five years.

The research, education, workforce development, and technology transfer activities that take place within the CATM are designed to identify and disseminate solutions that address mobility challenges associated with the movement of both people and goods as well as other critical transportation issues. As an integral part of CATM, Embry-Riddle faculty associated with the center actively participate in the center research and education goals.

Namilae and Liu will use particle dynamics and queuing theory based methods to study pedestrian movement and safe evacuation methods in case of emergencies. The research will tie up into an emergency decision support system being developed by collaborators at NC A&T University. The work has been funded at $450,000 for the first two years and extensions of the research are expected to be funded for three years. Embry-Riddle sponsored a part of the research budget through cost share.

Related work by Namilae on a multiscale model for pedestrian and infection dynamics suggesting transportation policies that mitigate disease spread have received wide media attention and were reported by 75 news outlets in four continents. The emergency response research builds upon the pedestrian dynamics part of that research.

The range of emergencies that can affect transportation networks varies from foreseeable weather related events (e.g., severe storms), to man-made disasters (e.g., terrorist attacks) to epidemics (e.g., 2014 Ebola disaster). Over the past decade, the frequency and intensity of these disasters has increased, causing significant disruptions in local and regional transportation systems, e.g. airports. The research team is investigating and modeling pedestrian movement during emergencies and evacuations. The impact of panic on human behavior during emergencies is examined and mathematical models to incorporate such behaviors into pedestrian movement are developed. The models will be used to develop and assess the policies to be followed during emergencies and will be integrated into a decision support framework developed by the collaborating teams. Three graduate students in aerospace engineering and aviation are working on this research.

Computational Models to Reduce the Spread of Infectious Diseases on Commercial Airliners (Dr. Namilae)

When Embry-Riddle Aeronautical University's professor Sirish Namilae travels for pleasure or for work, his eyes are focused on how people are boarding the plane and move through security and other areas of the airport.

It's become second nature for the Daytona Beach Campus assistant professor of aerospace engineering and his Ph.D. student Pierrot Derjany as part of research that could have a worldwide impact on reducing the spread of infectious diseases in congested places such as airplanes, airports and even other gathering places.

Results from the research published in *Physical Review E* (S. Namilae, P. Derjany, A. Mubayi, M. Scotch and A. Srinivasan, Multiscale Model for Pedestrian and Infection Dynamics During Air Travel) were covered in about 60 international news outlets in four continents, including newspapers and magazines such as *The Economist*, *Fox News*, *Economic Times*, *Readers Digest*, and *India Today*. National Science Foundation has covered the research in a video feature.

Namilae adapted concepts of molecular dynamics and Monte Carlo methods from his background in materials modeling to pedestrian dynamics and infection spread during air travel. The research, funded by $240,000 National Science Foundation grants included computational allocation on National Center for Supercomputing Applications, supercomputer Blue Waters.

The research was applied to the spread of Ebola onboard an airplane. The concern over Ebola and plane travel dominated the airways in 2014 and 2015 with cases of people being diagnosed with Ebola soon after flying commercially, putting an unknown number of people at risk. In September 2014, a man who flew from Liberia to New Jersey was soon found to have Ebola marking the first case in the U.S. A nurse who cared for him also flew on two commercial flights shortly before she was diagnosed with the deadly virus.

The investigation suggested transportation policy that could mitigate disease spread. For example, changing the current multiple zone boarding to a system where passengers board in a random manner between two large airplane sections reduces new casual contacts and reduces disease spread. Simulations indicate smaller airplanes are more effective in controlling disease spread.

Namilae was the primary author on the two initial research papers that included collaborators from Arizona State University and Florida State University. The work utilized parameter sweep simulations that utilized 60,000 processors on the Blue Waters supercomputer. The research team is also using the new Cray supercomputer at Embry-Riddle for extensions on this work.

The methods developed as a part of this work could be adapted to other directly transmitted diseases and could affect a large number of travelers. The International Air Transport Association predicts 7.2 billion passengers traveling in 2035, almost double the 3.8 billion air travelers in 2016. International passenger traffic rose 6.7 percent in 2016 compared to 2015, while domestic air travel rose 5.7 percent. Travel restrictions due to epidemic spread have major economic impact and this research suggests aerospace policies that help in such circumstances.

Nanocomposite Sensors for Orbital Debris Impact

(Drs. Kim and Namilae)

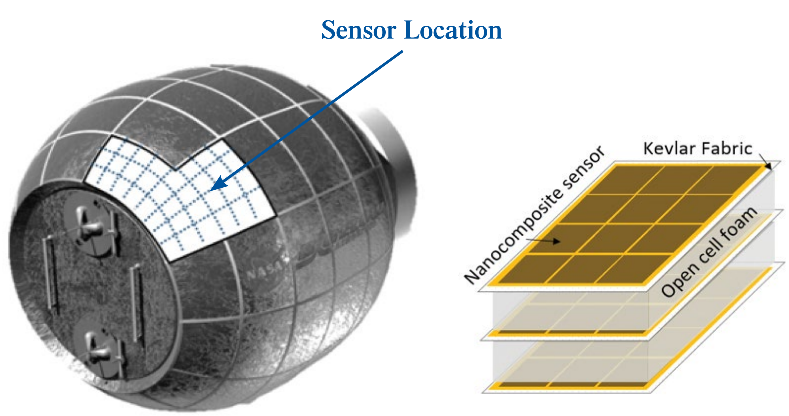
Aerospace Engineering faculty Daewon Kim and Sirish Namilae are working on sensors to detect orbital debris for inflatables space structures. The research is funded by NASA through Small Business Innovation Research phase I and II grants. The research team is working closely with an R&D company Luna Inc based in Blacksburg Va. NASA has funded the project to the tune of $875,000 for phase I and II of the project.

Current development of the space program is moving toward inflatable habitat structures like those developed by Bigelow Aerospace. Inflatable structures for space habitat are highly prone to damage caused by micrometeoroid and orbital debris (MMOD) impacts. The size of orbital debris varies from few microns to meters but the probability of an impact increases significantly for particle diameter size of 0.001 cm to 1 cm due to their high flux. The velocity of these debris particles is extremely high, with average velocity of about 9 km/s in lower earth's orbit and a speeds can go up to 15 km/s. Due to the high momentum even soft materials such as foams can cause damage and rupture of the structure. Depending on the size of the colliding particle, the induced damage may vary from micrometer size hole to rupture of whole structure.

The disaster of the space shuttle Columbia is an example of such case where a piece of insulating foam damaged the wing of the orbiter. After the loss of Columbia, the Space Shuttle Orbiter was equipped with WLEIDS impact detection system to qualitatively estimate the impact and location of damage for a limited period of time. Currently the techniques used by NASA and other space agencies to detect the damage occurrences vary from pressure sensors for leak detection, monitoring cameras to inspect the damage through images, ultrasonic testing to other NDE techniques. There is a great need for innovative structural health monitoring system that can detect impact damage, such as its location and severity, and keep the crew updated with the health of the structure.

The researchers on this project are developing a unique impact detection system based on hybrid nanocomposite sensors composed of carbon nanotube sheet and coarse graphene platelets. These conductive composites exhibit change in resistance when loaded or damaged. An array of sensors made from this material sandwiched between soft good layers in a space habitat can act as a damage detection layer for inflatable structures. Preliminary results indicate that the system is capable of detecting 3mm impacts within five square cm range. Current work is underway in developing rugged sensor system and to test it at high velocities that mimic space conditions. The team is also developing modeling techniques to optimize the nanocomposite microstructure and fabrication methods using 3D printing technology.

The nanocomposite impact sensors will be used in conjunction with fiber optic strain sensors developed by the industry partner, Luna Inc. The research team additionally includes Aerospace Engineering Ph.D. student Audrey Gbaguidi and M.S. student Anees Mohammad.



Nanocomposite sensor proposed location and a schematic

Active Control of Fluid Flows - Accelerated Research Initiative (ARI) grant

(Drs. Gnanamanickam, Balas and Prazenica)

Aerospace Engineering faculty members Dr. Ebenezer Gnanamanickam, Dr. Richard Prazenica, Dr. Mark Balas and PhD student Nicodemus Myhre have been awarded an Embry-Riddle Aeronautical University Accelerated Research Initiative (ARI) grant entitled Adaptive Control of Fluid Flows. The objective of this research is to investigate reduced-order modeling and adaptive control methodologies to better understand and control the physics of turbulent boundary layers.

Turbulent boundary layers are the thin layers of fluid which are formed between a solid boundary and a moving fluid or vice versa. These flow fields are encountered in everyday instances such as airplanes/birds/insects in flight, wind blowing over the earth's surface, airflow over an automobile, blood flow in arteries, ships moving in water, etc. The primary challenge in understanding turbulent boundary layers is that they encapsulate flow features spanning several orders of magnitude, which leads to difficulties in carrying out measurements as well as in modeling these flow systems. Beyond understanding turbulence, most practical applications require that turbulent flow be controlled with a certain goal, which compounds these challenges. For example, controlling turbulence can lead to the reduction of drag over objects such as airplanes, cars, ships etc. that are moving in a fluid.

As part of this work, the investigators seek to control turbulent boundary layers in a new manner drawing from recent advances in control theory. The proposed work applies an advanced technique, namely adaptive control, from the field of non-linear control theory to control turbulence using a feedback loop (referred to as active flow control). Specifically, adaptive control involves the use of a control strategy wherein the controllers, as the name suggests, adapt to an evolving system with very little prior knowledge of the system dynamics. This effort is significant as even a small reduction in drag can lead to several billions of dollars in fuel saving with a concomitant reduction in greenhouse gas emissions.

Design and Analysis of Wireless Smart Sensors for In-Situ Structural Health Monitoring of Composite Structures - ARI grant

(Drs. Al-Haik, Kim, Namilae, Barott, Brown, Barsoum)

The stiffness and strength of laminated, fiber-reinforced plastic composite materials have made them an appealing replacement for metal in aircraft such as the Boeing 787 and in civilian infrastructure. Unfortunately, composite layers can pull apart, crack, or otherwise fail as delamination occurs, raising safety concerns. Some traditional technologies for monitoring the structural health of composites are bulky and expensive, while others, such as fiber-optic sensors bonded into composites, can reduce the strength of the material.

Marwan Al-Haik, a professor of aerospace engineering, teamed up with College of Engineering colleagues Dae Won Kim, Sirish Namilae, William Barott, Jeff Brown and Fady Barsoum to propose a different approach to monitoring composite materials. They will incorporate wireless smart sensors into composite materials by growing nanoscale zinc-oxide nanowires directly onto carbon fibers. Due to the nanowires inherent "piezoelectricity," they will generate an electrical charge in response to mechanical stress, acting as embedded sensors to provide structural information in real time. The nanowires will also help strengthen the material.

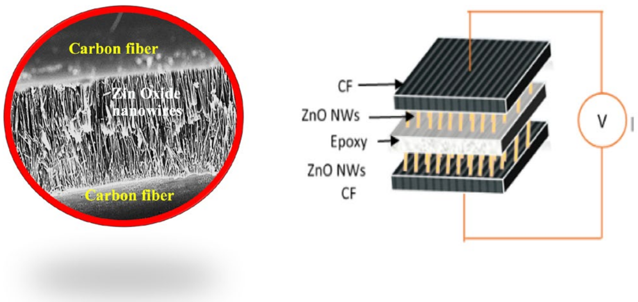


Figure (a) Electron scan microscope image of Zinc Oxide nanowires (ZnO NWs) SEM grown on the surface of carbon fibers (CF), (b) Proposed route for fabricating structure health monitoring sensor based on ZnO islands grown over carbon fiber fabric.

Eagle Flight Research Center, Innovation and Entrepreneurial activities

(Dr. Anderson - Center Director)

The Eagle Flight Research Center's R&D areas have, as of late, converged into new and exciting vehicle developments and links to tech transfer. The Center has been known for research in the areas of hybrid and electric propulsion, manned fly-by-wire technology, unmanned aerial vehicles, and FAA certification In each of these areas, large-scale research initiatives have stood on their own. Now, however, we see that these stand-alone lines of research are rapidly combining to support emerging financial models for new transportation system vehicles.

In hybrid and electric propulsion research, the Center is preparing to fly the "eSpirit of St. Louis," a manned electric aircraft based on a Diamond HK36 airframe donated by Lockheed Martin's famous Skunk Works. The development of this aircraft has included the development of our own battery packs, battery management systems, and battery cooling systems. The National Park Service has provided significant funding to demonstrate low-noise flight of small aircraft. With low-noise aircraft, the Park Service can provide access to the parks for aircraft while maintaining an atmosphere of peace and tranquility for other visitors. This project has allowed the Center to develop substantial noise-mitigation strategies for propeller-driven hybrid and electric-propulsion systems.

Regarding manned fly-by wire, the Center has partnered with Flight Level Engineering, which has procured Princeton's old Navions that worked in analog in-flight simulation modeling for years. Flight Level has updated these aircraft to glass-panel and digital flight-control systems based on MATLAB and Simulink. This partnership supports research into making it easier to fly Part 23 airplanes. The FAA is interested in this philosophy and has supported new research into modern flight controls for light aircraft. This development has yielded new and unique methods of aircraft model development from parameter identification and learn-to-fly like control laws that can be deployed to novel aircraft configurations.

In UAV development, the Center has supported Heurobotics and its twin-engine, tail-sitting electric Vertical Takeoff and Landing (eVTOL) aircraft. This development is part of an innovative tech-transfer arrangement made with the University. The aircraft is now flying well with patent-pending new control laws and drag-reducing algorithms. A conformal production vehicle is expected in the first quarter of 2018. The vehicle's mission capabilities and unique flight dynamics have garnered interest from major aerospace companies due to the generation of significant understanding into the applications of prop-rotors for thrust, vehicle control, and noise mitigation.

In other work, the Center is focusing on various certification projects, with real strength in the advocacy of new rules to stimulate innovation while improving safety. To that end, Embry-Riddle has hosted several meetings on changing current small airplane certification rules to consensus standards. In addition, the Center has several members in leadership roles on the national stage who are assisting certification reform and serving on industry innovation committees.

All of these activities have led to a convergence of technology and entrepreneurial activities in the Center. It was thought, until recently, that the only successful business model for aircraft manufacturers was larger airplanes and larger turboprops. While there are still small airplane manufacturers in existence, the number of aircraft they produce is a fraction of the number produced in the heydays of the 1970s and early 1980s. These companies are a shell of their former selves as they rely on the owner-operator model. That financial model cannot support large-scale production.

This is all changing. The confluence of the Uber financial model, eVTOL technology, modern flight control implementations, and the modernization of the regulatory environment is creating a new area of vehicle design. The Eagle Flight Research Center is taking advantage of existing research lines to develop a prototype "flying car." This is what the news media are calling vehicles that are designed to replace cars. It does not mean an airplane that can drive down a road. The enabling technology in its simplest form is the ability for a flight vehicle to operate quietly in an urban setting. The reason for this is clear: public acceptance. These Uber-like missions could be flown using existing helicopters, but they are too loud for 24/7 operation in urban areas. In fact, a helicopter after tens of years of optimization is a very efficient VTOL. Some of this efficiency will have to be given up in the pursuit of mission- enabling low noise.

The technology that enables low noise is electrified and distributed propulsion with high torque capabilities at low RPM. The low RPM with high torque will allow low tip Mach numbers while preserving thrust capabilities. This is further aided by new control algorithms for active ground noise mitigation and transition dynamics between hover and forward flight.

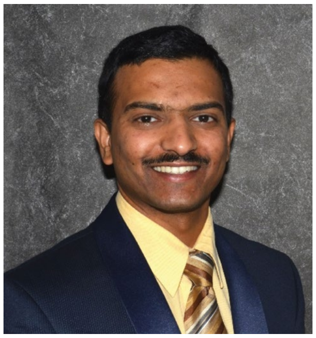
The emergence of this enabling technology and the acceptance by venture capitalists that the business model works have stimulated a flurry of activity in this area. The Center has been actively researching in all these areas.

Because the Center is charged with bringing technology to market, it has attracted multiple new tech companies to be used as conduits toward commercialization. Two of these companies have been previously mentioned: Flight Level Engineering and Heurobotics. A third is now developing in the Center: Verdego Aero. Verdego is a flying car company lead by Erik Lindbergh, Charles Lindbergh's grandson.

These intersections have been good for the Center. The technology used by each of these external companies forms an ecosystem of novel enabling technology in the Center that is shared, within IP constraints, with the others. In addition, the companies perform fundraising activities that continue to support more basic research within the Center. This effect is close to critical mass and it is hoped that several of these companies will survive and thrive with their headquarters in the MicaPlex and payroll in Daytona Beach. This is how the Eagle Flight Research Center is approaching research funding, innovation, tech transfer, and growth of the local economy.

Faculty & Student News

New Faculty



Dr. Mandar Kulkarni was a visiting assistant professor in the Department of Aerospace Engineering from August 2016-17. He finished his Ph.D. from Virginia Tech in 2016 and B.S. and M.S. from Indian Institute of Technology, Bombay. His areas of research are aircraft structural analysis, multidisciplinary design and optimization and impact behavior of ceramics and composites. Mandar has also worked for Airbus and MSC Software. Mandar loves to do amateur astronomy and is a ham radio operator.

Dr. Morad Nazari is a new assistant professor in the Department of Aerospace Engineering. Previously, he was a research associate in the department of Aerospace and Mechanical Engineering at the University of Arizona. He received his Ph.D. in Aerospace Engineering from New Mexico State University (December 2013). His research interests include spacecraft control, geometric mechanics and fractional order systems. He has published/co-authored two book chapters and 15 journal articles in *Journal of Guidance, Control, and Dynamics*, *Acta Astronautica*, and *Nonlinear Dynamics*, among others.

Faculty Awards

Dr. Mark Balas received the AIAA Guidance Navigation and Control Award in January 2018. (currently on leave at University of Tennessee Research Institute).

Dr. Snorri Gudmundsson received the 2017 Embry-Riddle Aerospace Engineering undergraduate teaching award.

Dr. Laksh Narayanaswami received the 2017 Embry-Riddle Aerospace Engineering graduate teaching award.

Dr. J. Gordon Leishman was featured in the January/February 2017 issue of *Vertiflite* with a leadership profile.

Dr. Tasos Lyrintzis completed his term as a Chair (2015-17) of the ADCA (Aerospace Departments Chair Association). He was also the lead organizer for the AIAA/CEAS 23rd Aeroacoustics Conference, Denver Colo., June, 2017.

AIAA News

The Embry-Riddle American Institute of Aeronautics and Astronautics student branch hosted and attended many events throughout the Fall 2016 and Spring 2017 semesters. The goal of the organization is to develop its student members to prepare them for their future careers in the aerospace industry.

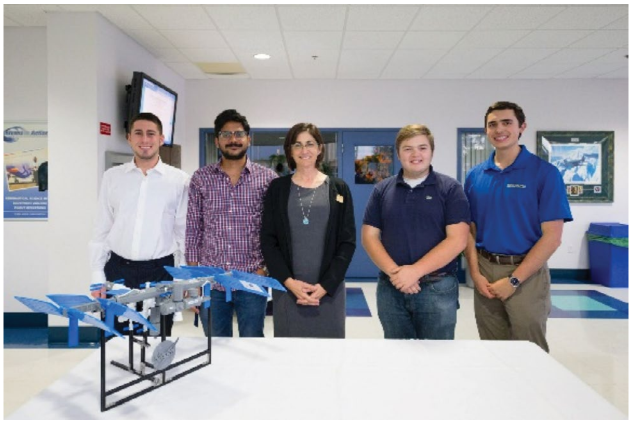
Volunteering is a large part of the organization, and the branch volunteered at Embry-Riddle Open House, Embry-Riddle Preview Day and Kennedy Space Center Family Weekend over the past year. In addition to these events, the Embry-Riddle AIAA volunteered at the AIAA H-ARC competition. This competition pits local high schools against each other to build a semiautonomous quadcopter using a designated kit.

To prepare members for the industry, the organization attends company tours and AIAA conferences. This year, members toured Gulfstream in Savannah during the fall and spring semesters, and 12 students attended the 2017 AIAA SciTech Forum in Grapevine, Texas.

Finally, the club hosted speakers to excite and inform members. This year the AIAA brought two speakers: Nicole Stott, Embry-Riddle alumni and retired astronaut, and Michelle Evans, author of The X-15 Rocket Plane. The student branch also hosted an information session with the Lockheed Martin Skunk Works.

KSC Family Weekend Volunteering

H-ARC Competition



Nicole Stott, Embry-Riddle Board of Trustees member, with the 2016/17 Embry-Riddle AIAA Board

DBF News

For the second year in a row, the Daytona Beach Campus set an Embry-Riddle record for placement in the AIAA Design/Build/Fly (DBF) competition. After finishing No. 11 in the 2015/2016 competition, the team finished in the top 10, earning No. 8 in the 2016/2017 competition out of 138 entries.

DBF is an international collegiate UAV competition sponsored by the AIAA Foundation, Raytheon Missile Systems and Textron Aviation. The 2016/2017 competition was hosted by Raytheon in Tucson, Ariz.

The goal of the 2016/2017 competition was to build an aircraft that could be stowed and survive drops in a launch tube while also being able to accomplish three flight missions: unloaded, a speed flight loaded with three hockey pucks, and a range flight loaded with hockey pucks.

The Embry-Riddle Daytona Beach team was comprised of 22 undergraduate students ranging from freshmen to seniors and advised by Professor Leishman. The 2017/2018 Embry-Riddle DBF team has many students returning and hopes to build off of the success and experience of the past two years to win the competition.

1st Place in AIAA Individual Design Competition

Annually, AIAA hosts a series of design competitions for students in several aerospace fields including aircraft design. Both graduate and undergraduate students can participate in the competition either in a team or individual categories. Competitors are provided with a Request for Proposal (RFP) which describes a mission and a set of requirements for the future aircraft. The RFP is usually provided in September, and the final report submission deadline is in early May. The participants design a "blank sheet of paper" aircraft, whose characteristics are presented in a design report. The quality of the work is then assessed by an AIAA committee composed of professionals from industry and academia. The judges evaluate the report based on technical content, originality, organization, presentation, and practical application and feasibility. After the review, the judges submit their recommendations and comments, followed by the AIAA announcing winners of the competition. As in other kinds of competition, the team or individual who scores the highest wins the competition and receives a prize.

Stanislav Karpuk (Aerospace Engineering graduate student)

For the 2016-2017 AIAA Graduate Individual Design Competition, students were to design a Multi-Mission Amphibious aircraft (MMA), intended to transport passengers and cargo for island nations or in regions with access to bodies of water. Stanislav Karpuk, an Aerospace Engineering graduate student participated in this competition, representing Embry-Riddle. He was advised by Dr. Snorri Gudmundsson of the Aerospace Engineering Department. The final reports were evaluated by university faculty as well as representatives from industry, including Boeing. The judges awarded Stanislav's design first place in the category. In addition to taking the top sear, he was given an opportunity to present his work at the Aircraft Design Technical Committee Meeting at the 2018 AIAA SciTech Forum.

Useful links: Design requirements: aiaa.org/GradIndividAircraftDesignComp2017

Aerospace Engineering Alumni Direct Spaceport America Rocket Competition

Two Embry-Riddle graduates, Matthew Ellengold and Dustin Koehler (both BSAE DB 2011) have been named President and Vice President, respectively, of the Experimental Sounding Rocket Association (ESRA). They organized and directed the first Spaceport America Cup (SA Cup), held this past June at Spaceport America, N.M. Ninety six university teams participated in the competition.

Ellengold explains, “The SA Cup was previously the Intercollegiate Rocket Engineering Competition (IREC). For the past ten years, ESRA has offered IREC in Green River, Utah, to give engineering students a unique opportunity to design, build and fly actual launch vehicles and payloads in an environment similar to the professional world they are soon to enter. IREC entries have doubled in each of the past two years, necessitating partnership with the New Mexico Spaceport Authority, and formation of the SA Cup. This is a one-of a kind, international forum for these students to showcase their work before dozens of industry sponsors. Furthermore, the airspace above Spaceport America is restricted to aircraft by the Army’s White Sands Missile Range from surface to unlimited, so launches at the SA Cup can reach as high as students’ skill and imagination can carry them!”

SA Cup has categories based on propulsion type, with target altitudes of ten thousand and twenty five thousand feet. Student teams are evaluated by forty judges from the space and rocket industry, and government research agencies. Evaluation criteria are design reporting and presentation, target altitude accuracy, safety, engineering and airworthiness, and technical merit of a scientific payload. The event also included demonstration launches by Oregon State University and United Launch Alliance.

Ellengold and Koehler’s involvement in ESRA began in 2009, when they led successive teams that won Embry-Riddle’s first two entries in IREC. Ellengold is now a Project Engineer for The Aerospace Corporation in Dayton, Ohio. Koehler is a structural engineer for Northrop Grumman in Melbourne, Fla.

Koehler adds, “My time with Embry-Riddle’s rocket club was the best and most memorable part of college. The leadership and technical skills I gained designing rockets and working hands on with composites put me a step ahead in my career. Helping Ellengold lead ESRA into its next chapter with Spaceport America wouldn’t have been possible without this experience.”

Matthew Ellengold and Dustin Koehler (from left) with Embry-Riddle’s 2017 team.

Embry-Riddle’s team this year placed sixth overall with their Pathfinder VI rocket. They were the second team to launch, early on the first day. The Embry-Riddle Pathfinder team was among only 22 teams to successfully launch and recover their rocket, all of the others ending in failure. The entire team is expected to return next year.

96 university teams attended the inaugural Spaceport America Cup.

New Programs

The Distance Master of Science in Aerospace Engineering (MSAE) Program

The Master of Science in Aerospace Engineering (MSAE) program at Embry-Riddle is designed for students who might already have a degree in aerospace engineering, or a related engineering field who wish to further their education. In conjunction with the Worldwide campus, industry personnel are now able to pursue the MSAE degree online from the convenience of their home. No need to commute to the campus or a residential center. There is no traditional classroom requirement to further your education. The courses are offered by Wolrdwide and are exactly the same as the courses of Daytona Beach Campus (catalog.erau.edu/daytona-beach/engineering/masters/aerospace-engineering) and are taught by Embry-Riddle Professors at the Department of Aerospace Engineering on the Daytona Beach Campus.

A minimum of 30 credit hours of graduate-level work (i.e. 10 courses, or 7 courses plus a thesis) are required for this degree. Courses in the Structures and Materials area started in January of 2017, while courses in the Aerodynamics and Propulsion and Dynamics and Control areas will be offered starting in the Fall of 2019.

More details can be found at: daytonabeach.erau.edu/degrees/master/aerospace-engineering

The Airworthiness Program Starts; Gets Engineering Council Award

The Certificate of Study in Airworthiness Engineering (CSAE) program successfully started on January 13, 2017. The first cohort consisted of 10 Northrop-Grumman (NG) participants, one of whom was an alumnus of Embry-Riddle's BSAE program from the Prescott Campus. In February, the Engineers' Council awarded NG and Embry-Riddle their Distinguished Engineering Project Achievement Award. In March, the CSAE program was approved by the Southern Associations of Colleges and Schools (SACS).

The program consists of 4 courses (or 12 graduate level credits) that span over a 15 month time-frame. The courses include:

- AWE 510 (Aircraft Airworthiness Engineering Principles)
- SYS 505 (System Safety and Certification)
- UAS 501 (Introduction to Unmanned Aircraft Design)
- AWE 520 (Aircraft Airworthiness Capstone Project)

The first cohort of students are currently taking their third course within the program. The program consists of courses that cover topics in the Joint Service Specification Guide (JSSG), MIL-HDBK-516, multiple ARPs, RTCA DOs and other documents related to the certification of aircrafts. The Capstone course (AWE520) is project based. Students will prepare to present their accumulated knowledge to NG leadership in April of 2018. The CSAE program is synchronously broadcasted from the Daytona Beach Campus to multiple Worldwide Campuses and individuals.

This first Airworthiness Engineering program in the U.S. is currently preparing for the second cohort which will start January 2018. This program is now available to all industry partners. If you would like further information regarding the program, please contact the College of Engineering, Office of Industry Relations and Outreach at the Daytona Beach campus dbiore@erau.edu.

"We are proud to be the first university in the U.S. to offer a graduate program in Airworthiness Engineering."

Dr. Maj Mirmirani, Dean of the College of Engineering at Embry-Riddle in Daytona Beach

Alumni Update
Where Are They Now?

F-16 pilots ***Mike Driscoll*** ('97, BSAS) and ***Luke Weyhmuller*** ('08, BSAE) were at Embry-Riddle's Daytona Beach Campus on a recruitment mission during Homecoming Weekend. In addition to their recruitment activities, the pilot-alumni offered up-close views of their high performance aircraft and visited with fellow graduates and students at the university's fly-in event on Saturday, October 14.

Jeffrey S. Osterlund ('89, BSAE) was inducted into the AIAA Associate Fellow Class of 2017 on January 9, 2017 during the SciTech Forum at the Gaylord Texan. Joining AIAA in 1987 while at Embry-Riddle, Osterlund is currently the space and launch vehicle engineering capability integration manager for The Boeing Company.

Elizabeth Geren ('16, BSAE) was hired as a systems engineer associate at Lockheed Martin in Colorado Springs, Colo. in February 2017.

Shawn R. Brueshaber ('94, BSAE), a doctoral candidate at Western Michigan University, has earned a NASA Earth and Space Science Fellowship. Brueshaber is one of only 28 applicants to be awarded a $30,000 award for 2016-17 from the fellowship's planetary science research division. He is investigating polar vortices, which are large patches of air circulating near the Earth's poles.

Robert Glasscock ('88, BSAE) was named a program administrator within the Gulfstream Aerospace Corporation's Organizational Designation Authorization (ODA) office. Glasscock manages ODA type certification activities associated with research and development. Previously, he was the Gulfstream G650 Certification Product Development team lead. He joined Gulfstream in 2006, and has worked for the FAA, Piper Aircraft, Bombardier Learjet, Lockheed Martin and Hawker Beechcraft.

Benjamin Breitberg ('12, BSAE) completed a master's degree in systems engineering from the Naval Postgraduate School and was accepted into Class 152 at the U.S Naval Test Pilot School. He is currently an AIM-120 AMRAAM flight test engineer for the Naval Air Warfare Center, Weapons Division, at China Lake, Calif. He will be enrolled in the Airborne Systems course at the U.S. Naval Test Pilot School and commenced the year-long course in January 2017.

Justin Martin ('14, BSAE) is an aerospace engineer and safety inspector for the Office of Commercial Space Transportation's Safety Inspection (CSTSI) division of the FAA. The FAA licenses and regulates all commercial launch operations within the U.S. Its CSTSI division is responsible for ensuring that operators remain compliant with these regulations. Martin is based out of the office in Cape Canaveral, Fla. He previously worked as a general engineer for the FAA's NextGen National Air Space Lifecycle Integration office.

Keep your fellow Eagles soaring high!

As we transition to a Ph.D.-granting department, we'll need your support to improve the facilities and sponsor worthy students to hold on to our rank as the No. 1 Aerospace Engineering Department in the nation.

To make a difference, please donate at: givingto.erau.edu, click on 'Make a Gift' and select Aerospace Engineering.

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Faculty Roster

Marwan Al-Haik
Professor (Ph.D., Florida State University)

Richard Anderson
Professor & Director of Eagle Flight Research Center (Ph.D., University of Central Florida)

Magdy Attia
Professor & Associate Chair (Ph.D., Texas A&M University)

Mark Balas
Distinguished Professor (Ph.D., University of Denver)

Yechiel Crispin
Professor (Ph.D., Israel Institute of Technology)

John Ekaterinaris
Distinguished Professor (Ph.D., Georgia Institute of Technology)

Bill Engblom
Professor Joint Appointment with Mechanical Engineering Department (Ph.D., University of Texas)

Habib Eslami
Professor (Ph.D., Old Dominion University)

Ebenezer Gnanamanickam
Assistant Professor (Ph.D., Purdue University)

Vladimir Golubev
Professor (Ph.D., University of Notre Dame)

Glenn Greiner
Associate Professor & BSAE, CSAE & MMSE Program Coordinator (M.S., Embry-Riddle Aeronautical University)

Snorri Gudmundsson
Assistant Professor (Ph.D., Embry-Riddle Aeronautical University)

Troy Henderson
Assistant Professor & Honors Program Coordinator (Ph.D., Texas A&M University)

Dae Won Kim
Associate Professor (Ph.D., Virginia Polytechnic Institute & State University)

Mandar Kulkarni
Assistant Professor (Ph.D., Virginia Polytechnic Institute & State University)

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J. Gordon Leishman
Distinguished Professor (D.Sc., Glasgow University)

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Assistant Professor (Ph.D., University of Minnesota)

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