

INVENT|ER

Annual Innovation Report

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EMBRY-RIDDLE
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FROM THE PRESIDENT

Research, innovation, entrepreneurship, collaboration, productivity and prosperity are about policy, strategy, people and resources. Research is linked with innovation to drive economic growth. Productivity depends upon innovation, and prosperity results from productivity. Embry-Riddle capitalizes on this constellation of efforts.

Innovation also fuels the continuing transformation of Embry-Riddle into a research university. We embrace innovation in everything we do from providing an innovative academic experience to the experiential opportunities that engage 90 percent of our students, to developing the people, facilities and infrastructure, and offering the resources to support faculty research and student-designed and -led research projects. Our goal is to develop a complete innovative ecosystem - an environment of places and spaces - with well-designed research facilities, talent and mentorship, expertise, investment and tools that supports our students, faculty, staff and alumni inventors, like-minded organizations, creators and entrepreneurs and provides assistance with technology transfer, commercialization, start-up company formation, and offers certifications (e.g., FAA).

The new John Mica Engineering and Aerospace Innovation Center (MicaPlex) will open next spring to add new physical space and a technology incubator with professional services for start-up and nascent companies to begin operations and become successful. This is an extraordinary facility - an innovation destination - with a taxiway into the park from the Daytona Beach Airport, underscoring the uniqueness that capitalizes on what Embry-Riddle is and offers a major resource to attract companies to the MicaPlex.

Incubators catalyze regional economic development through collaborative, technological innovation partnerships among the university, local and national government and private sector partners. We are grateful to our numerous partners who have helped us develop this facility as well as provide legal, financial, IT and accounting assistance to the companies which will colonize the first building.

Embry-Riddle colleges and then MicaPlex provide places to “explore bold ideas” and this publication documents our ever-growing success in protecting and transferring the technology developed by our faculty and students for the benefit of the region, state, nation and the world.

Karen A. Holbrook, Ph.D.
Interim President

COOL TECHNOLOGY ON HOT WHEELS



The hybrid-electric vehicle (HEV) realm is evolving in the Mechanical Engineering Department at Embry-Riddle. Recently, a group of student researchers, led by Dr. Sandra Boetcher and Dr. Marc Compere, developed a novel cooling technology to dissipate the tremendous heat produced by the batteries in today's HEVs. Auto manufacturers use a variety of technologies but none is both efficient and effective.

The ERAU design employs an aluminum casing to transfer heat from the batteries into a phase change material (PCM), a wax-like substance designed to absorb thermal energy. The battery cold plate also utilizes variable liquid cooling technology to prevent heat spikes which can be detrimental to the performance and longevity of the batteries.

With this invention, Embry-Riddle received 3rd place in the National Science Foundation Innovation Awards, as part of the EcoCar3 competition. The cold plate technology was built, tested and installed into a 2016 Camaro, the University's entry into the EcoCar3 competition which is co-sponsored by General Motors and the U.S. Department of Energy. Embry-Riddle has filed a U.S. patent application making the technology available for licensing and commercial production.



U.S. Patent Application 2016 / 0006088

RETROFITTING THE JETWAY



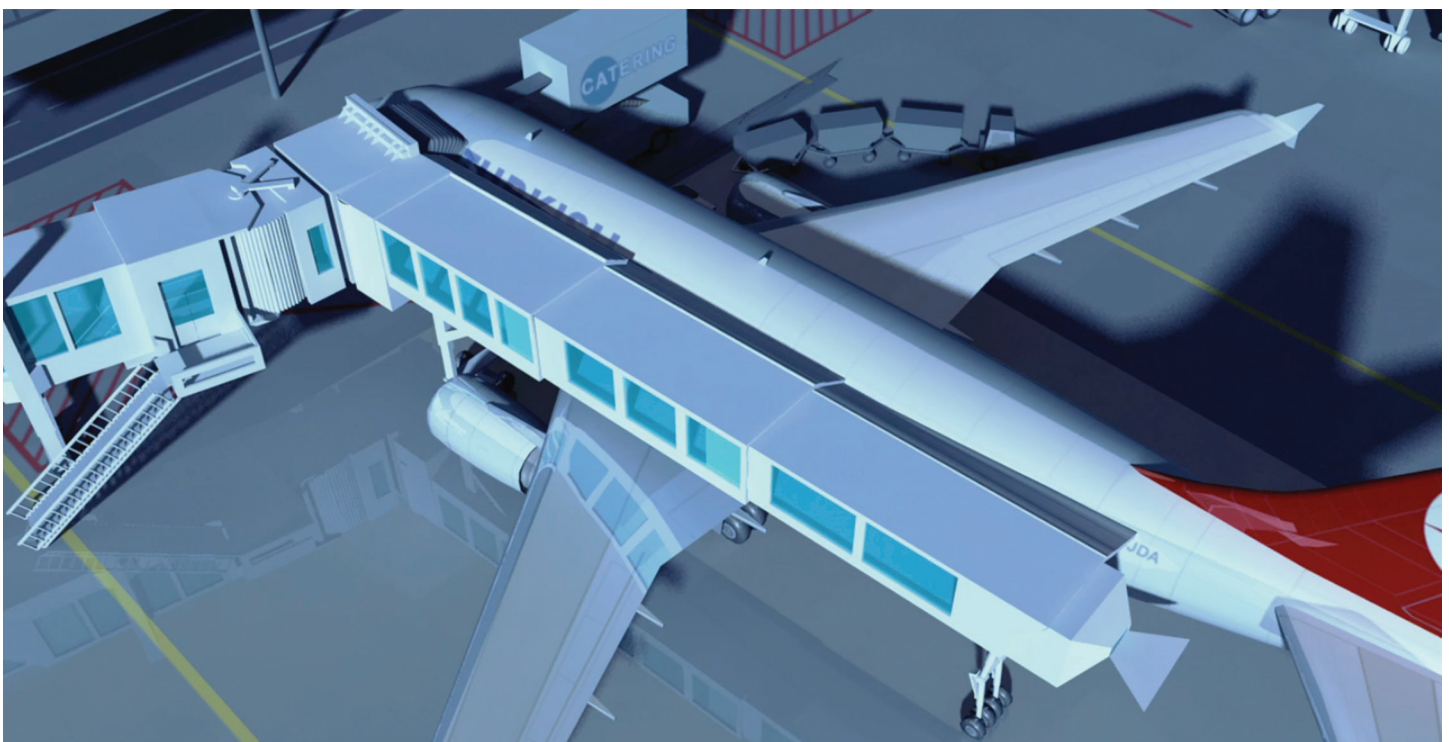
Passengers can spend more time waiting in lines to board and deplane than on their flight; the airlines only generate revenue when airplanes are flying. Consequentially, passengers and the airlines certainly agree that faster-moving lines amounting to less time on the ground is a common goal. A solution to this problem is the invention of Embry-Riddle aerospace engineering student, Dynamite Obinna.

The Dynaerobridge is an innovative add-on system that can be attached to existing equipment and can significantly reduce boarding and deplaning times. Complementing jetways in use, the telescoping bridge can make use of multiple access doors down the side of an aircraft. Using simulation testing, Obinna was able to demonstrate a reduction in the average boarding

time for a Boeing 737 from 35 minutes to 8 minutes with deplaning times cut to just 6 minutes.

Throughout the world, Dynaerobridge will offer airlines and airports a cost-effective solution to increase efficiency, customer satisfaction, and profitability. In March 2016, after multiple consultations with the Embry-Riddle technology transfer office, Obinna filed a U.S. patent application on his innovation. The Dynaerobridge won first-place at the ERAU Discovery Day and the People's Choice award at the Launch Your Venture Entrepreneurship Expo, both held in April 2016. Most recently, Obinna ran an Indiegogo campaign to raise money to further test the design and engineering features of his Dynaerobridge using scaled model prototypes.

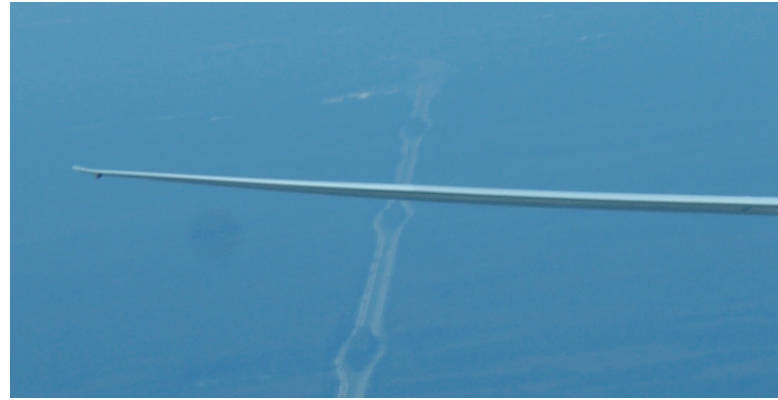
U.S. Patent Application Filed



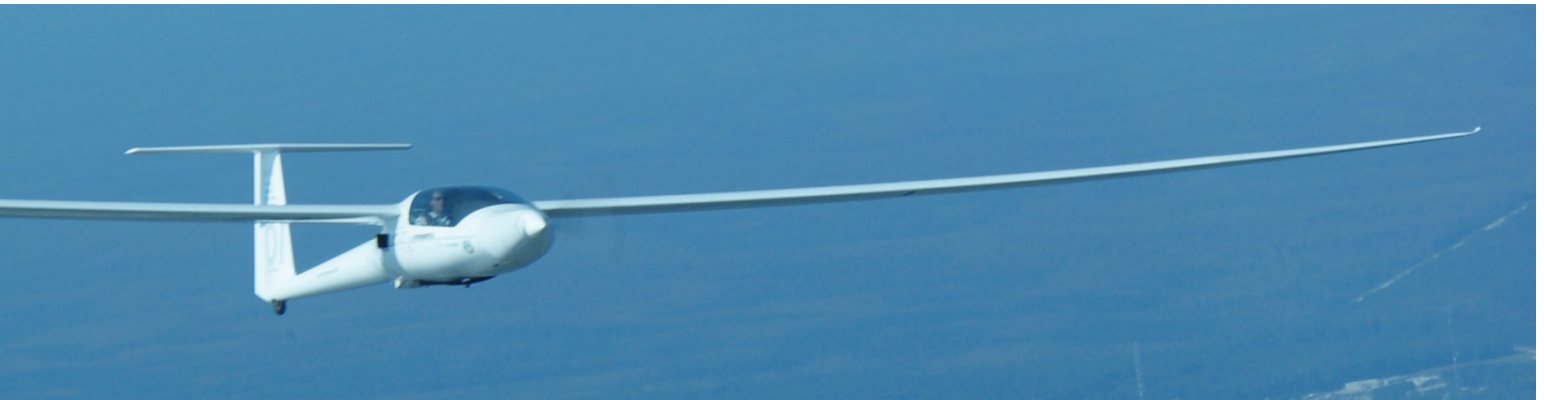
ACCELERATING HYBRID-ELECTRIC PROPULSION

In 2009, a team led by Dr. Pat Anderson began developing a gas-electric hybrid aircraft in the Eagle Flight Research Center. Two years later, the EcoEagle competed in NASA's Greenflight Challenge and featured a unique parallel hybrid propulsion system. It allows the propeller to be powered by the internal combustion engine during takeoff when the most power is required and then switch to electric power at cruising altitude when power demand is lower. The innovative EcoEagle's design prompted Embry-Riddle to file patent applications on both the hybrid aircraft parallel propulsion system and the novel clutching mechanism that was designed to shift between the two power sources. U.S. patents were issued to both in FY16 and have attracted the attention of aircraft manufacturers. To further strengthen the value of its hybrid aircraft intellectual property portfolio, in September 2015, the university filed its first foreign patent applications in the European Union, Canada, and Brazil.

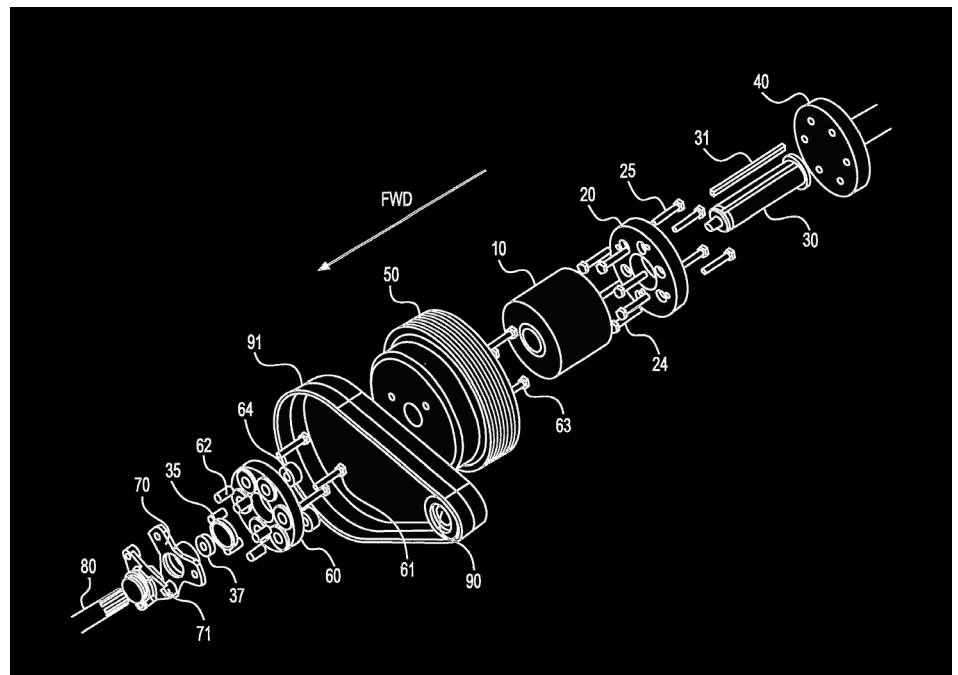
Since the 2009 Greenflight Challenge, Dr. Anderson's team has launched new research to redesign and improve the EcoEagle. For example, they are currently testing with the same batteries used by Tesla and are working to replace the standard air- and liquid-cooling systems with one that employs a cold plate with phase change material. (See Cool Technology for Hot Wheels on the previous page.)



The greatest limitation to using battery-powered aircraft is weight. Dr. Anderson explained, "If the lithium-ion batteries that are used in cars today were converted for aircraft, the weight comparison for a Boeing 787 Dreamliner would be 223,000 pounds of jet fuel vs. 4.5



U.S. Patent 9,254,922
U.S. Patent 9,102,326



million pounds of battery. "Unless there is a cosmic change in the battery, it's just not going to work for bigger, faster airplanes," he said. "It's going to be a really long time before batteries weigh less than liquid fuel."

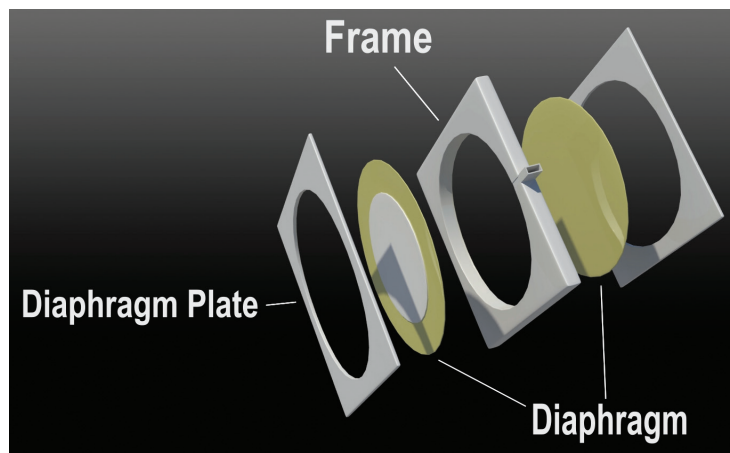
In collaboration with Argonne National Laboratory, a consortium of aircraft manufacturing industry leaders is being assembled to provide expertise and research funding for Embry-Riddle whose goal is to design and test a hybrid turboprop aircraft. Anderson predicts that this project could be completed by 2019.

ADDING STABILITY TO UAVs

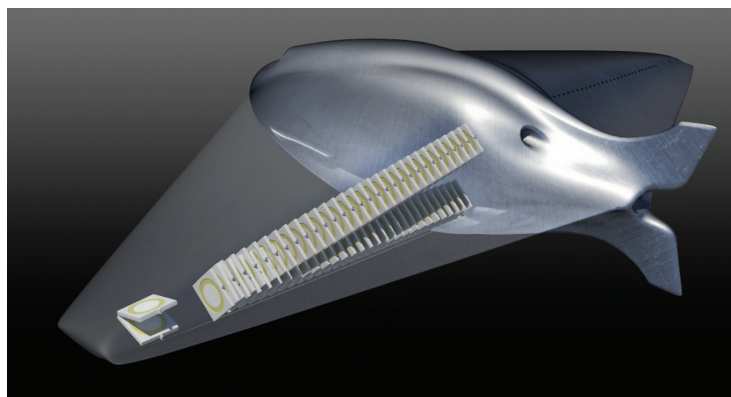


Maneuverability and flight stability, especially in gusty conditions, remain among the greatest challenges for unmanned aerial vehicles (UAV) and mini-UAVs (known by MAV for micro air vehicle). Synthetic jet actuators (SJA) offer a promising solution owed to their small size, ease of operation, and low cost. SJAs use small vibrating diaphragms to create airflow and when installed in an aircraft wing, they can modify the current over its surface. An array of SJAs improves an aircraft's aerodynamic performance and maneuverability by providing instant adjustments, unlike conventional mechanical control surfaces (ailerons, rudders, elevators). The idea of SJA-based MAV flight control was first proposed in 2009 and a National Science Foundation (NSF) EAGER (EARly-concept Grants for Exploratory Research) was awarded. A number of papers were published paving the way for a 2013 NSF Small Business Technology Transfer (STTR) proposal with a grant awarded in 2014 to High Technology Materials, an LLC established by Dr. Vladimir Golubev of the Aerospace Engineering department.

The \$205,000 STTR grant is designated for the testing of the SJA software control system developed by Dr. William MacKunis of Engineering Physics in the Physical Sciences department. This system that can adapt to external disturbances and published results of his computational modeling demonstrate the software's performance. His approach is very different from previous works as it employs



radical minimalism in the software design, rendering it suitable for small air vehicles with limited on-board computational capability. High-fidelity simulations of mini-UAVs equipped with SJAs in gusty urban environments have established the commercial feasibility of this technology. A student team from the College of Business has developed a business plan for the company's long-term objectives, to develop and commercialize this new technology which makes small air vehicles operating in tight, unsteady urban environments capable of achieving unprecedented maneuverability and stability. ERAU has filed a U.S. patent application, which published online this year. The technology will be licensed to High Technology Materials, LLC.



**U.S. Patent Application
2016/0209850**

FY16 BY THE NUMBERS



Securing intellectual property protection for ERAU-owned inventions, including responsibilities for counseling and educating inventors, falls upon the university's Legal Department. Specifically, help is provided by the Director of Technology Transfer and Research Park Initiatives, Stephanie A. Miller, Ph.D. Her primary role is to evaluate inventions produced in the course of university research and invest resources in patent applications for those technologies that are promising candidates for licensing to industry or start-up formation.

Dr. Miller anticipates an escalating rise in the number of patent applications filed as the university's focus on research increases. "There are very ambitious projects underway that show tremendous promise for future commercialization," she reports. "I expect to receive many inquiries for transitioning university inventions into new

start-up companies housed in the MicaPlex. Entrepreneurial faculty and staff have the ideas, inventions, and tremendous passion. The MicaPlex will include a technology incubator, providing business services, education and training to turn those inventions into successful companies. I am very pleased to be able to provide that guidance."

Disclosure activity for FY16

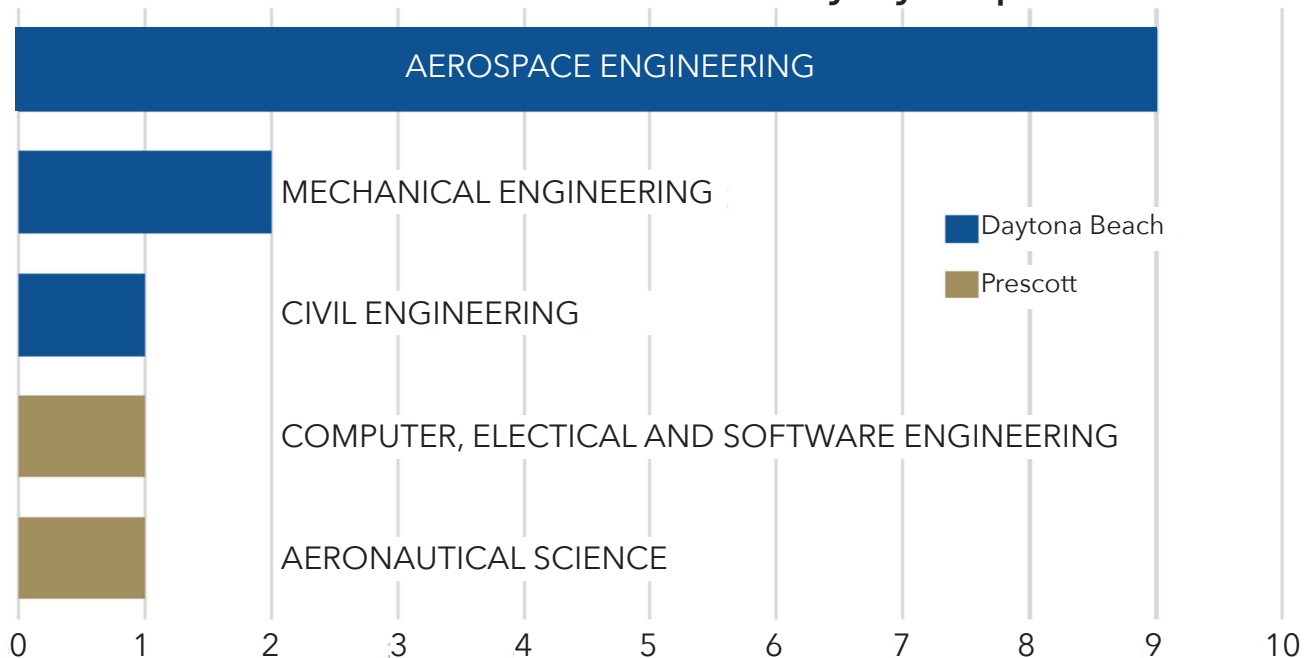
INVENTIONS

- 13 Invention Disclosures Received
- 9 Disclosures under Evaluation
- 5 Departments Disclosing Inventions
- 17 Inventors Submitting Invention Disclosures

PATENTS

- 1 Provisional Patent Application Filed
- 10 Non-Provisional Patent Applications Filed
- 4 U.S. Patents Issued

FY16 Invention Disclosure Activity by Department



HISTORY BY THE NUMBERS



Historical Perspective from FY06 through FY16.

INVENTIONS

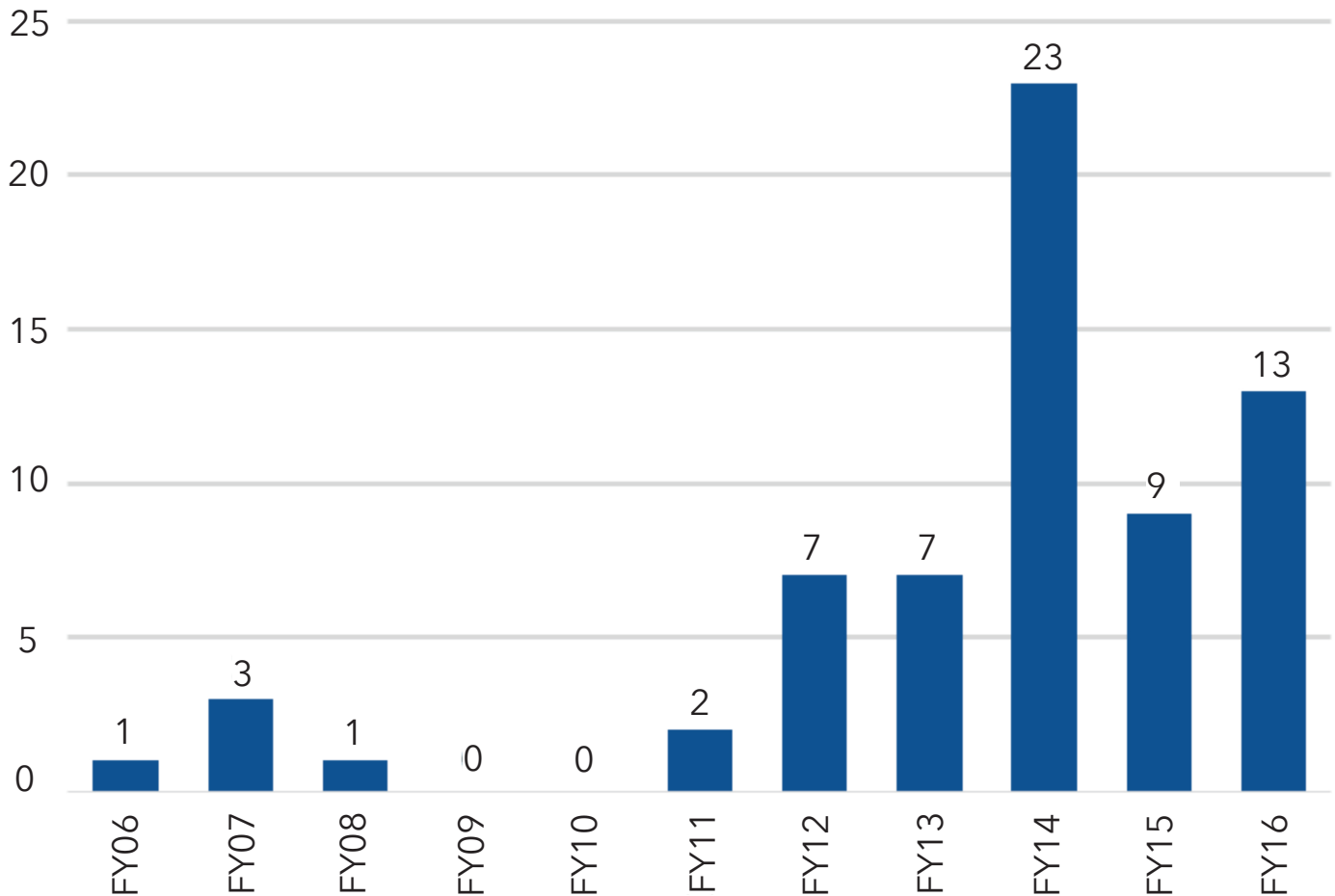
- 66 Invention Disclosures Received
- 13 Departments Disclosing Inventions
- 81 Inventors Submitting Invention Disclosures

PATENTS

- 30 Provisional Patent Applications Filed
- 31 Non-Provisional Patent Applications Filed
- 15 Patent Applications in Prosecution
- 7 U.S. Patents Issued

In addition to the Embry-Riddle activity shown here, our faculty have a history of patenting inventions. A recent survey across all campuses revealed over 40 faculty with issued U.S. patents, and more than half of the 40 hold multiple patents. In total, ERAU faculty are named inventors on over 150 U.S. patents.

Invention Disclosure History



PATENT PORTFOLIO



ISSUED PATENTS

- U.S. 9,369,160 "Communication system using signal modulation" William C. Barott.
- U.S. 9,353,754 "Multi-stage axial compressor with counter-rotation using an accessory drive" Vinod Gehlot, Magdy S. Attia.
- U.S. 9,254,922 "Hybrid assembly for an aircraft" Richard Anderson, Lori Costello, Charles Eastlake, Glenn P. Greiner.
- U.S. 9,102,326 "Hybrid clutch assembly for an aircraft" Richard Anderson, Charles N. Eastlake, Matt Gonitzke, Glen P. Greiner.
- U.S. 8,998,126 "Lift generating device" Juan A. Alvarado Valverde.
- U.S. 8,095,314 "Generation of four dimensional grid of probabilistic hazards for use by decision support tools" Ian A. Wilson
- U.S. 7,184,883 "GPS-based steering needle instrument" Carl Edward Wischmeyer.

PUBLISHED PATENT APPLICATIONS*

- U.S. 2016/0209850 "Robust Nonlinear regulation control of unmanned aerial vehicles using synthetic jet actuators" Vladimir V. Golubev, William MacKunis.
- U.S. 2016/0203901 "Hybrid magneto-active propellant management device for active slosh damping in spacecraft" Balaji Sivasubramanian, Leader Paul, Sathya Gangadharan.
- U.S. 2016/0216292 "Hot wire anemometer" Michael S. Potash, Alfred D. Helfrick.
- U.S. 2016/0160867 "Electrically coupled counter-rotation for gas turbine compressors" Vinod Gehlot.
- U.S. 2016/0137234 "Optimizing jets for wake control of ground vehicles" Domenic Barsotti, Sandra Boetcher.
- U.S. 2016/0047880 "System and method for location of aircraft" Albert D. Helfrick.
- U.S. 2016/0006088 "Battery thermal management for hybrid electric vehicles using a phase-change material cold plate" Sandra Boetcher, Marc D. Compere, Domenic Barsotti, William Townsend Hyatt, Brian Neal Harries.
- WO 2015/106233 "Portable water purification system" Marc D. Compere, Yan Tang, Shavin Pinto, Yung Wong.
- WO 2015/105961 "Floating active baffles, system and method of slosh damping" Daewon Kim, Rudy L. Baum, Vijay Santhanam, Balaji Sivasubramanian, Sathya Gangadharan.
- U.S. 2013/0223984 "Multi-Stage axial compressor with counter-rotation" Vinod Gehlot, Magdy S. Attia, Divyam Garg.
- U.S. 2013/0000247 "Highly vented truss wall honeycomb structures and methods of fabrication" David J. Sypeck.

**Patent applications that have not yet published for public inspection are not listed here.*

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