



2016-2017 Research Directory
Breaking Barriers

2016–2017 Research Directory

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Research at USAFA: Breaking Barriers

The United States Air Force Academy prides itself on being one of our nation's leading academic and research institutions. Earning an offer of appointment and choosing to attend the Academy is

a testament not only to the academic prowess and leadership potential of our future officers, but also their dedication to become character-driven leaders, prepared to guide the United States Air Force into the future. For our faculty, serving here means devoting themselves to training, mentoring and educating agile minds to become modern warriors.

Hands-on participation in cutting edge research at the Academy is essential to providing our cadets with the knowledge, skills and abilities necessary to succeed as leaders in an increasingly complex, interconnected and volatile geopolitical landscape. Finding new and innovative ways to educate and inspire our cadets and faculty while also solving problems of national interest are at the heart of the Air Force Academy and the core of our research program. We are continuing to reach new heights in innovation and discovery, and through our robust research in air, space, cyberspace and beyond, provide a meaningful impact to the Air Force.

Our cadets are immersed in a multitude of inter-disciplinary research topics, taking them all over the world. These topics are broad, ranging from the development of a biofuel that uses extremophile organisms and natural sunlight to generate power for mission essential equipment, to a partnership with the NCAA and the Department of Defense that improves the way concussions are prevented, diagnosed and treated.

The Academy's ongoing pursuit of modernization and innovation is committed to the growth and development of highly trained and educated officers, prepared to provide solutions to the most complex warfighting issues our nation faces. As mentors, educators, research partners and researchers ourselves, we must remember and reinforce that barriers were meant to be broken.

MICHELLE D. JOHNSON, Lt Gen, USAF
Superintendent, United States Air Force Academy

Breaking Barriers: Lead with character and res



Progressive Thinking



Producing Warfighters



spect. Defend our nation in air, space and cyber.



Character Development



Delivering Solutions



Strategy

Black Dart 2016: AFA Cadets Make Their Mark



GULF OF MEXICO An unmanned aerial system, operated by U.S. Air Force Academy cadets and Johns Hopkins University engineers, flies near the guided-missile destroyer USS Jason Dunham (DDG 109) during exercise Black Dart, Sept. 19, 2016. Black Dart is the largest Department of Defense live-fly, live-fire, counter Unmanned Aerial Systems technology demonstration. (U.S. Navy photo by Mass Communication Specialist 1st Class Maddelin Angebrand/Released)

They say big things come in small packages.

Although, determining exactly who ‘they’ are has proved to be an insurmountable task; they were undoubtedly correct, at least when it came to small unmanned aircraft systems.

As the global leader in air, space and cyberspace; it is no surprise that the United States Air Force would send a team of its future officers to participate in the US military’s largest live-fly, live-fire counter unmanned aircraft systems (UAS) joint exercise, Black Dart 2016.

Lt. Col. Kip Kiefer, Director of the Command and Control Laboratory and Lt. Col. Paul Blue, Director of the Small Unmanned Aircraft Systems Innovation Center, both in the Institute of Information Technology Applications took 10 cadets from the Air Force Academy’s Remotely Piloted Aircraft (RPA) Airmanship Program to Black Dart to discover the best mode of protection against small UAS and gain added operational UAS experience. The RPA Airmanship Program trains cadets to become Air Force certified small UAS operators.

The annual event is run by the Joint Integrated Air and Missile Defense Organization. Designed to test the best technologies and systems available from the military, government agencies and private companies protect against attacks using drones NBC News cited it to be “a demonstration of the best countermeasures and capabilities available to counter drone attacks.”

The United States has been using drones in combat for decades, as early as World War II. With a camera mounted on the nose of a drone, a pilot following several miles behind in a control plane could watch a target on a small, grainy, black and white television screen, turn a dial and release the drone’s bomb. Made out of wood, the drones were expendable and would often crash dive on or near their target after accomplishing their mission. But as technology advanced, so did the need for a more sophisticated drone system.

The Air Force knows barriers were made to be broken and breaking barriers is exactly what has been done to deliver the more sophisticated drone system our warfighter demands.

No stranger to combat, the RQ-11B Raven was one of two small UASs the Air Force Academy brought to the event. The Raven is hand-launched, weighs less than five pounds and has an endurance of up to 80 minutes. Despite its small size, the Raven has proven itself in combat, supporting operations for all of the military services in Iraq, Afghanistan and other areas of conflict.

Kiefer said the Air Force Academy cadets participating in the exercise were all very well trained cadets from the Academy RPA Airmanship Program. Their participation included flying nine sorties with RQ-11B Raven fixed-wing small UASs and 13 sorties with DJI Inspire quadcopter small UASs on land and at sea. They were able to engage in missions as a red force team, the enemy team, and as a blue force team, the friendly team.

As the red force team, cadets supported the navy destroyer, the USS Jason Dunham, testing its radar and tracking systems to determine the ranges and altitudes at which it detects and tracks small UASs.

As the blue force team, cadets assisted in demonstrating government contractor capabilities to negate red force UASs operating in the same airspace.

The ability to see and participate in missions as both attackers and defenders gave cadets a more holistic view of cyberwarfare that they may have not been able to gain from the classroom, a skill that will prove invaluable to them as future officers.

“Cadets are flying UASs as active participants in Black Dart and they aren’t even commissioned yet.

I’ve been in the Air Force for 20 years and can’t say that I was able to participate in an exercise of this magnitude, the way these cadets have and they have excelled” said Kiefer.

Cadet contributions were significant enough to earn the Academy an invitation to return for Black Dart 2017, an opportunity that will not only allow them to receive real-world airmanship experience

but will also serve as a valuable capstone event for cadets involved in the RPA Airmanship Program.

As the Air Force continues to lead the fight in air, space and cyberspace, the Air Force Academy will continue its mission to develop future officers of character, ready to face the complex and uncertain global environment that lies before them in defense of our nation.



GULF OF MEXICO Cadet 1st Class Hanson Oxford, a student at the U.S. Air Force Academy, makes adjustments to an unmanned aerial system aboard a rigid hull inflatable boat during exercise Black Dart, Sept. 19, 2016. Black Dart is the largest Department of Defense live-fly, live-fire, counter Unmanned Aerial Systems technology demonstration. (U.S. Navy photo by Mass Communication Specialist 1st Class Maddelin Angebrand/Released)

Bioenergy Research Harnesses the Power of Solar Energy

The U.S. Air Force Academy Life Sciences Research Center (LSRC) harnesses the free and abundant power of solar energy into bioenergy using extremophile organisms that exist in extremely hot environments, building on the power of photosynthesis of some of these organisms.

Dr. Don Veverka, 21 year Air Force veteran and Director of the LSRC, says cadets will encounter

similar technology as Air Force officers and can continue bioenergy research efforts to support the warfighter in their future careers.

Veverka says “We know from the literature and our own research that select microorganisms can be used to generate power but on a very small level. We suspect we can combine traits from different microorganisms to create additional power via enhanced electron transport.”

In recent studies, the LSRC has successfully developed photosynthetic microbial fuel cells (a type of battery) that harness electrons from cyanobacteria to generate power. Electrons exist in nature and are one way in which biological systems move and store energy. Researchers explore methods of finding alternative energy sources by studying photosynthetic microorganisms, such as cyanobacteria, that can generate power self-sufficiently. Cyanobacteria are highly adaptable microorganisms which can be selected for the ability to grow in various environments and can produce their own food using photosynthetic processes. Through their studies, researchers have found that cyanobacteria can use light to both sustain themselves and to generate power in fuel cells in order to potentially fuel threat detection and remote sensing devices.

The center is now working on a blend of traits from different organisms that takes cyanobacteria and manipulates them in hopes of producing more electron flow to the fuel cell to generate more power. In order to determine the amount of energy produced by the cyanobacteria, Cadet Vicki Bittleston set up photosynthetic microbial fuel cells.

Bittleston says “With the assistance of my mentor, LSRC genetic engineer Melanie



Cadet Victoria Bittleston, a biology major at the U.S. Air Force Academy, observes multiple strains of bacteria being cultivated for use in a genetic engineering research capstone project in a growth chamber at the Air Force Academy. Bittleston's research is exploring the use of cyanobacteria to generate power as a source of renewable energy. (U.S. Air National Guard photo/Staff Sgt. Michelle Y. Alvarez-Rea)

Grogger, I insert bacterial electron transfer genes into the cyanobacteria. Theoretically, the combination should increase the rate at which the electrons pass over an extracellular electron transfer chain, resulting in an increase in power.”

As part of the experimental process, Bittleston combined wild-type *Synechococcus elongatus* with *Shewanella oneidensis* extracellular electron transfer genes to increase the ability of the cyanobacteria to move electrons, creating power. *Shewanella oneidensis* is very good at moving electrons from inside the microbial cell to the electrode of a fuel cell, but it is not photosynthetic and thus needs to be fed regularly. The combination of these genes and a photosynthetic microorganism could result in a photosynthetic microbial fuel cell that uses solar energy to maintain itself and efficiently transfer electrons to an equipment system for a prolonged period of time.

Veverka says “The fuel cells are meant to be sustainable.”

The idea is to get to a point where remote power sources can operate for months or years with the cyanobacteria turning sunlight into a food source for itself through photosynthesis and moving electrons to an electronic device, creating sustainable power. This sustainable power will allow the military, particularly Special Forces teams, to fuel remote communication and sensing devices when electricity is not available.

Bittleston says “The longest lasting fuel cell so far, maintained power for five weeks.” This time frame is consistent with the LSRC mission to conduct basic science research, including proof of concept studies. Optimization of functional prototypes would be the mission of applied science researchers at other facilities.

“To be able to do two and a half years of genetic engineering research as an undergraduate student is absolutely amazing! It is my favorite experience at the Academy. Research has helped me with so many other classes by teaching me different ways to think. I know my time in the LSRC will help with problem solving in my Air Force career. Sometimes there is no text book in which to find the answer and that is what research taught me” said Bittleston.

As cadets mature into Air Force officers and go on to become senior leaders, they will see their research efforts in the world around them have a huge impact on Air Force policy decisions. Advancement in basic sciences for energy efficiency will provide benefits to the warfighter that allow them to be more effective in the field and in defense of our nation.

Bittleston hopes to one day continue her fuel cell research for the Air Force, but while at the Academy she knows her contribution to the technology is important to future warfighter experiences as well as her own development into an Air Force officer.



Cadet Victoria Bittleston uses multimeters that measure energy output to analyze data collected from microbial fuel cells at the Air Force Academy. Bittleston is experimenting with the cross cultivation of bacteria strains to create sustainable power. (U.S. Air National Guard photo/Staff Sgt. Michelle Y. Alvarez-Rea)



Microbial fuel cells contain different strains of bacteria and are monitored by multimeters at the Air Force Academy to determine the best environment for maximum energy output. Current research data shows the bacteria produces almost double the amount of energy during simulated hours of daylight vs non-daylight hours, making it a viable option for renewable energy through the process of photosynthesis. (U.S. Air National Guard photo/Staff Sgt. Michelle Y. Alvarez-Rea)

Automatic Ground Collision Avoidance System expands realm of possibility

The Academy continues to develop and lead the research efforts on a technology that has proven its ability to significantly reduce the number of aircraft mishaps. This technology, known as Automatic Ground Collision Avoidance System (Auto GCAS), was fielded into the Air Force F-16 Block 40/50 fleet in 2014 and has already demonstrated its value to the warfighter during four real-world life-saving automatic recovery executions on F-16 fighters.

Auto GCAS provides an autonomous response that predicts imminent collisions, determines alternate flight paths and ultimately, reduces the number of mishaps resulting from controlled flight into terrain (CFIT). According to the Federal Aviation Administration, CFIT is a leading cause of aviation fatalities and includes pilot mishaps such as spatial disorientation, target fixation and G-force induced loss of consciousness (G-LOC).

Spatial disorientation occurs when a person

is unable to determine their true body position, motion, and altitude relative to the earth or their surroundings whereas target fixation is when an individual becomes so focused on an observed object or target that they inadvertently increase their risk of colliding with that object. G-LOC describes excessive and sustained G-forces draining blood away from the brain, resulting in a loss of consciousness. Any of these phenomena can be fatal to a pilot, thus the need for an autonomous system that can execute a ground avoiding maneuver if the system detects an impending collision.

Seen as a technology that can extend well beyond the F-16, the United States Air Force and the NASA Armstrong Flight Research Center have been working together to develop automatic collision technologies for nearly three decades. Currently, the Academy research is focusing on the expansion of the technology beyond the F-16 and the possibility of transferring the algorithm to heavy aircraft (known as Heavy Auto GCAS), such as the C-130 transport aircraft.

The Air Force Research Laboratory, NASA Armstrong, the Air Force Institute of Technology, and the USAF Test Pilot School (TPS) have been working to transition this technology to other aircraft, resulting in a successful flight test of Auto GCAS on a Small UAV in 2013 at NASA Armstrong and a successful flight test of Heavy Auto GCAS on a Learjet in 2015 at USAF TPS.

To prepare for the next flight test of Heavy Auto GCAS at TPS in 2018, Air Force Academy cadets have been leading the Heavy Auto GCAS research and development since January 2016 as part of a senior independent research project that pushes



A C-130 Hercules from the 144th Airlift Squadron, Alaska Air National Guard, flies over Denali National Park, Alaska, March 4, 2017. After 41 years of flying the C-130 aircraft, the 144th Airlift Squadron's eight C-130s were divested, with the planes either being transferred to outside units or retired from service. The unit's last two aircraft departed Joint Base Elmendorf-Richardson, Alaska, the following day. (U.S. Air National Guard photo by Staff Sgt. Edward Eagerton/released)

them to provide answers to the most complex problems our warfighters face.

While the development, integration, and testing of the Heavy Auto GCAS technology are expensive, Director of the Academy Unmanned Aerial Systems Center at the Air Force Academy, Col. Angie Suplisson says “If Heavy Auto GCAS prevents one mishap, then the technology pays for itself.”

Aeronautics major, Cadet Mary Kim Weidman says, “We are using pilot input to test Heavy Auto GCAS in more real-life situations. Pilots want something that reacts the way a real pilot would in a potential ground collision situation and to make sure nuisance is reduced as much as possible”

Cadet David Wagner, a mathematics major, says, “I look at the technology from a different perspective than an aeronautics student would. I am working the numbers in the algorithms to transition the system model from the relatively simple 3-degree of freedom (DOF) model to a more complex and accurate 6-DOF model.”

In order to determine the changes and costs necessary to utilize the technology on heavier aircraft, cadets review historical mishaps, analyze current collision avoidance systems, and talk to operational pilots. After calculations have been refined, cadets are able to create a business case analysis that determines cost-effectiveness.

According to Cadet Andrew LeValley, a systems engineering major, “In the Air Force, system development involves many moving parts, involving lots of different people and mission elements. I have enjoyed working in an interdisciplinary project like Auto GCAS to gain that experience.”

The current business case analysis shows the average cost of a C-130 to be approximately \$68 million. If one aircraft is saved by the execution of Heavy Auto GCAS, the technology would pay for itself.

Director of Curriculum for the Department of Management at the Air Force Academy, Maj. Josh Wolfram says “Management capstone cadets will revisit the idea of making changes to the Heavy Auto GCAS software or hardware for the C-130 or other mobility aircraft and

determine if it makes financial sense to do so.”

Auto GCAS has proven its technology can and should extend beyond its demonstrated capabilities and into the realm of heavy aircraft, automobiles, marine systems and even spacecraft. This life-saving research and technology allows cadets to cultivate the necessary decision-making skills required of future officers and the partnership between NASA and the Air Force will continue to lead to application beyond aviation.



AFA Cadets present a video that demonstrates the automatic ground collision avoidance system to Air Mobility Commander Gen. Carlton D. Everhart II at Innovation Showcase, Sept. 26, 2016. Innovation Showcase is an annual event that provides cadets and faculty an opportunity to highlight Academy research to senior Air Force leadership. (U. S. Air Force photo/Jason Gutierrez)

Air Force Academy Participates in National NCAA Concussion Study



Cadets at the U.S. Air Force Academy perform various baseline and post-injury tests as part of a research initiative to improve diagnosis and treatment of concussion injuries. Baseline tests are used to determine athletic ability before a concussion occurs which aids in the determination of cognitive and performance impact during the recovery process. (U.S. Air Force Photos/Darcie Ibiidapo)



The Air Force Academy is taking an active part in a larger research initiative between the Department of Defense (DOD) and the NCAA to more accurately diagnose, treat and prevent concussions among cadets, NCAA student-athletes, service men and women and the broader public. The Concussion Assessment, Research and Evaluation (CARE) Consortium serves as the scientific and operational framework for the collaboration, which includes 30 total NCAA member institutions. According to the CARE Consortium website, the study marks what is considered to be the most comprehensive investigation of sport-related concussions conducted to date.

The Academy's, Athletic Department, 10th Medical Group and the Department of Behavioral Sciences and Leadership have partnered to collect concussion data and develop programs for the Academy as part of the study. The goal is to create better brain care for cadets by understanding the natural history of concussion recovery.

The NCAA and the DOD have led the way in advancing the science of sport-related concussions over the past 20 years, supporting discoveries that have had a major influence on domestic and international guidelines for best practices in the evaluation and management of concussion.

Cadets suffer concussions from a variety of activities other than intercollegiate athletics, such as physical education classes, military training, slips and falls, skiing or other recreation. The Air Force Academy uses this data to improve the daily treatment of concussion in the Cadet Clinic. Confusion about concussions has often lead cadets to indecision about whether they are suffering from a concussion. To alleviate this, the USAFA team is developing programs to better education cadets on the signs and symptoms of a concussion.

According to Behavioral Sciences Assistant Professor Dr. Chris D'Lauro, "We are learning it is athletes and cadets alike that believe concussion myths. It's even more prevalent in cadets who want to be pilots."

The concussion testing team at the Academy works to educate cadets about the need for early, self-reporting of concussion injuries. Early reporting creates a best case scenario for care from athletic trainers and medical staff. Self-reporting develops integrity among cadets as well as health and safety awareness.

Behavioral Sciences Assistant Professor Lt. Cmdr. Brian Johnson says, “We believe that the Academy is the first institution to conduct exhaustive concussion baseline assessments on its entire student body. We feel our cadets are getting the latest in brain care, largely due to our participation in this study.”

Every cadet will participate in a series of baseline concussion assessments upon arriving at the Academy. Baseline testing includes, but is not limited to, disclosure of brain injury/concussion history, symptom evaluations, cognitive assessments and balance evaluations.

“The great thing about baseline testing is medical and training staff already know a cadet’s average performance. When a concussion does happen, a cadet may try to rush their recovery. However, the medical team gives them a post-injury test that shows the cadet where they are in the recovery process versus where they should be,” says Cadet Kristen Chapman, biology major and researcher in the concussion study.

According to the Center for Disease Control and

Prevention, comparing post-injury test results can assist health care professionals in identifying the effects of an injury and aid in making more informed decisions on when a student can and should return to school and/or play. This data is often times the only tangible evidence that coaches and medical professionals can use to demonstrate to a cadet the impact a concussion actually has on their cognitive performance and abilities.

Academy Chief of Sports Medicine and Director of the Concussion Clinic, Col. Darren Campbell says, “The importance of the Academy is we have the right staff to research concussion data. We can take that information to the rest of the Air Force or the rest of the DOD. The information we gather to use in the civilian community pushes research to catch up to public opinion.”

Under the CARE Consortium, researchers from the DOD and the NCAA have collected more than 25 million data points from more than 16,000 student-athletes across the 30 participating institutions. This study has not only allowed the Air Force Academy to improve the way in which concussion injuries are reported and treated but has also played a key role in the way cadets view the importance of early reporting. A complete shift in culture takes time and effort, but in the end, the Air Force Academy is developing healthy, well-informed, future officers, equipped to lead our nation.



A U.S. Air Force Academy cadet performs the baseline balance test at the Falcon Athletic Center for a concussion study, Dec. 9, 2016. The test informs athletic and medical staff where the cadet’s average ability is if the cadet suffers concussion. (U.S. Air Force photo/Jason Gutierrez)

American Democracy and Racial Progress



U.S. Air Force Academy cadets join students from Colorado College to discuss current political events on Feb. 11, 2016. Dr. Greg Laski encourages cadets to participate in public discourse such as healthy dialogue about race and democracy throughout their time at the Academy. (U.S. Air Force photo/Jennifer Green-Lanchoney)

Among other things, cadets at the Air Force Academy develop maturity and learn communication skills relevant to their future careers. The Air Force relies on inventive faculty to educate, train and inspire cadets to become leaders of character by using innovative teaching methods and incorporating new research techniques in the classroom.

Dr. Greg Laski, assistant professor in the U.S. Air Force Academy's Department of English and Fine Arts and author of *Untimely Democracy: The Politics of Progress after Slavery* compels cadets to understand how research enhances their education and highlights the problems of humankind to continue public dialogue towards solutions of societal equity.

Laski's theory of untimely democracy incorporates history, literature and philosophy to define and enhance the way future Air Force leaders of character view democracy and encourages them to use innovative approaches to studying future dilemmas.

Laski poses the question "How, as a democratic nation, do we presently achieve racial progress?" Counterintuitively, Laski studies the

time 10-20 years after the Civil War, which is often known as the lowest point of race relations. During this time, the excitement of freedom from slavery gives way to an increase in lynching attacks and policies enforcing separate but equal facilities.

In his book Laski studies diverse publications from the late nineteenth century and how their insight into post-Civil War equality can help advance modern race relations, cultivate American democracy and influence Academy cadets to use historical literature to inform their understanding of current political events.

The promise of equality for all men and women that the Civil War represented did not materialize; however, the writers of Laski's research have vibrant theories of fairness that inform modern understanding of democracy for Americans. Through fiction and non-fiction works, writers such as Frederick Douglass, Stephen Crane, W.E.B. Du Bois, and Callie House push for racial equality by remembering the foundation of democracy, that all men and women are created equal. Laski shows how race relations at the time after the

Civil War provided an abundance of profound thought and activism to progress the promise of equality.

Laski says, “This group of writers offers what I call a theory of untimely democracy which is a version of democracy that can really achieve the kind of progress we want, but it has to do so by never forgetting the uglier parts of our past.”

One of Laski’s courses, *Representing Race: African American History on the Page and Screen* examines the representation of race in American culture. Cadets watch films such as *12 Years a Slave*, *Django Unchained* and *Lincoln*, as a historical commentary on race relations. Laski leads discussions comparing 21st century and historical race representations to help cadets develop complex thinking about diverse relationships in their futures as Air Force leaders.

For Laski, discussing race representations in culture is not a one way conversation. Laski’s courses intentionally exchange ideas between professor and cadets. To incorporate multiple points of view in the classes he teaches, Laski brings his research into the courses he teaches. Cadets show an impressive maturity level, according to Laski, to intelligently discuss race in culture and how it relates to democracy influencing Laski’s thinking about his own writing.

As cadets prepare to graduate from the Academy and transition into the Air force, Laski mentors those that wish to pursue graduate degrees. Using his own experience in publishing original

research, he guides cadets to achieve their own goals of contributing to academia and becoming future decision-makers.

Through his research, publishing and teaching, Laski inspires cadets to explore public and political topics to increase awareness about current events and how historical literature can inform democratic progression.

How then, do we achieve racial progress in our democratic nation?

Laski says “The writers I study are skeptical about arguments that appeal to a better future, when those appeals force us to forget the problematic past of racial slavery. For them, the question is not about comparing past vs. present to show what a difference there is, but rather to inquire about the similarities between past and present – to attend to historical legacies, repeated patterns of exclusion and ghosts of the past. Progress is the goal, but the term necessarily has a perpetual question mark accompanying it.”

Allowing cadets to engage in mature conversations about historical race relations and the influence that race relations have on modern politics gives cadets a lens to view the complexities they encounter as officers. Air Force officers serve in diverse locations, leading diverse populations of Airmen on a variety of missions. Using innovative methods to study literature and its influence on democracy clearly helps develop leaders of character for our nation.



U.S. Air Force Academy cadets and Colorado College students discuss current democratic topics and possible solutions at Colorado College, Feb. 11, 2016. Dr. Greg Laski, assistant professor in the Department of English and Fine Arts, encourages cadets to increase their awareness about current events that inform democratic progression which cadets demonstrate at events. (U.S. Air Force photo/Jennifer Green-Lanchoney)



Dr. Greg Laski accepts the Robert F. McDermott Award for Research Excellence in the Humanities Division at the 21st Annual Research Awards Ceremony on Jan. 26, 2017. The research Dr. Laski conducted for his book, *Untimely Democracy*, was recognized by Air Force leadership and Colorado Springs Mayor John Suthers. (U.S. Air Force photo/Jason Gutierrez)

Department of Aeronautics

Director: Dr. Tom McLaughlin

Email: tom.mclaughlin@usafa.edu

Telephone: 719-333-2613



Overview: The Aeronautics Research Center in the Department of Aeronautics seeks to provide every Aeronautical Engineering cadet with a meaningful research experience, employing projects supporting customers in the Air Force, DOD, other government agencies and commercial partners. The center makes use of the USAFA Aeronautics Laboratory, the best-equipped such facility in all of academia. It is complemented by a broad range of faculty and researcher expertise in aerodynamics, flight control, propulsion and flight test. These capabilities combine to produce highly motivational cadet learning experiences, quality research products for the customers, and faculty/researcher technical currency.

Core Competencies:

- ✓ Aerodynamic flow control
- ✓ Subsonic wind tunnel testing in five different facilities
- ✓ Supersonic/hypersonic experiment and computation
- ✓ Gas turbine and internal combustion research
- ✓ Small air vehicle design/build/fly
- ✓ Parachute canopy development/computation



Major Projects:

- A-10 Rocket Pod Aerodynamic Characteristics
- AF Observatory Wind Loading
- Parachute Design and Optimization
- Flight demonstration of innovative flight control effectors
- Multiple UAV design/build/fly programs



Major Projects:

- USAF Aircraft Structural Integrity Program support; component and full-scale testing, teardown analysis, flight data acquisition, root-cause analysis, modeling, etc.
- Structural re-design, material substitution, prototyping, and validation testing
- Basic research in material degradation prevention and control. OSD sponsored Technical Corrosion Collaboration between university, DOD, and commercial research groups

Department of Engineering Mechanics Center for Aircraft Structural Life Extension

Director: Dr. Gregory Shoales

Email: gregory.shoales@usafa.edu

Telephone: 719-333-6213



Overview: The Center for Aircraft Structural Life Extension (CAStLE) has a two-fold research mission in support of the safe sustainment of aging structures. First, to perform a wide range of research and technology development projects focused on delivering critical science and technology (S&T) data, tools and other products required to understand the impact of material degradation in structural systems to various government, academic, and commercial sponsors. Second, but no less important, to educate, train, inspire, and otherwise prepare future generations that might become the core of the S&T community within the government and the general professional population. CAStLE's core competencies, developed over more than two decades of successful research product delivery to our sponsors, fully address all aspects of the mission.

Core Competencies:

- ✓ Structural testing and analysis (full-scale, component level, and coupon)
- ✓ Material degradation (corrosion, cracking, etc.)
- ✓ Material processing, testing, and development
- ✓ Structural teardown analysis and root-cause analysis
- ✓ Educational outreach and curricula development
- ✓ Measurement and impact analysis of operational loads, stress, and environment



Major Projects:

- FalconSAT-6
- FalconSAT-8
- EyasSAT Technology Demonstrator
- Cadet Space Operations Squadron

Space Systems Research Center

Director: Lt Col Todd Nathaniel

Email: todd.nathaniel@usafa.edu

Telephone: 719-333-3315



Overview: The Space Systems Research Center (SSRC) designs, builds, tests, and flies five cadet-built, DOD-backed satellites. It focuses on cadet education while achieving real DOD objectives and supports national Science, Technology, Engineering, and Mathematics (STEM) educational objectives.

Core Competencies:

- ✓ Designing, building, testing, and flying small spacecraft
- ✓ Systems engineering
- ✓ Avionics testing/simulation



Astronomical Research Group and Observatory

Director: Dr. Devin Della-Rose

Email: devin.della-rose@usafa.edu

Telephone: 719-333-3266

Overview: The Astronomical Research Group and Observatory (ARGO), based at the USAFA Observatory, houses 61- and 41-cm telescopes, and supports the worldwide Falcon Telescope Network (FTN). Our 61-cm telescope is the oldest active telescope in the Air Force inventory, and we are pursuing funding for a new 1-meter telescope to replace it. ARGO conducts near-Earth research including resolved and non-resolved space object tracking, and deep-space research including asteroid tracking, astronomical spectroscopy and photometry, and exoplanet studies. ARGO also supports the other DFP research centers and grant work. Finally, ARGO hosts STEM outreach activities at the observatory for Scout groups, school groups, and teachers.

Core Competencies:

- ✓ Deep space photometry and spectroscopy
- ✓ Space object identification and tracking
- ✓ Space object photometry and spectroscopy
- ✓ STEM education and outreach in astronomy and space science



Major Projects:

- Search for exoplanets using the FTN
- Spectroscopy of exoplanetary host stars
- Light curve photometry of binary stars and supernovae
- Hazardous near-Earth asteroid tracking
- One-meter telescope acquisition

Center for Space Situational Awareness

Director: Dr. Francis Chun

Email: francis.chun@usafa.edu

Telephone: 719-333-2601



Overview: The Center for Space Situational Awareness Research (CSSAR) provides cadets and faculty at the United States Air Force Academy an education and research program in space situational awareness (SSA) using world-class facilities and capabilities.

Core Competencies:

- ✓ Small aperture optical telescopes for satellite characterization
- ✓ Non-imaging photometric, spectral and polarimetric techniques for characterization of unresolved space objects.
- ✓ Data fusion and modeling



Major Projects:

- Development of the Academy's global Falcon Telescope Network
- Spectral measurements of solar panel glints from geosynchronous satellites
- Two-channel polarimetry to determine horizontal/vertical polarization states from un-resolved satellite optical signatures
- Long-term photometric observations of inactive geosynchronous satellites for debris monitoring



Major Projects:

- Diode pumped alkali lasers
- Fiber lasers
- Atomic and nuclear physics
- Novel materials
- Photon sieves and wavefront sensors

Laser Optics Research Center

Director: Dr. Randy Knize

Email: randy.knize@usafa.edu

Telephone: 719-333-4165



Overview: The Laser and Optics Research Center (LORC) performs research in laser development, laser applications and large optics for space with cadets, faculty and contractors using a well-equipped laboratory. Lasers and large optics are increasingly used by the military for directed energy weapons, precision munitions, communications, and surveillance.

Core Competencies:

- ✓ Pulsed tunable lasers
- ✓ Laser and optical test equipment
- ✓ Laser and optical modelling
- ✓ Design and fabrication of unique laboratory apparatus
- ✓ High power continuous wave lasers



Space Physics and Atmospheric Research Center

Director: Dr. Matthew McHarg

Email: matthew.mcharg@usafa.edu

Telephone: 719-333-2460



Major Projects:

- Delivery of two of five total Integrated Miniaturized Electrostatic Analyzer instruments for the DOD Space Test Program
- Designing the Falcon Solid State Energetic Electron Detector in collaboration with the Air Force Research Laboratory
- Designing the Falcon Orbital Debris Experiment in collaboration with NASA for the Air Force Operational Test and Evaluation Center (AFOTEC)

Overview: The Space Physics and Atmospheric Research Center (SPARC) faculty and cadets perform basic research in the solar terrestrial environment and investigate how perturbations in that environment can negatively impact the performance and longevity of U.S. Air Force space assets. SPARC specializes in development of aggressively miniaturized payloads that fly on experimental spacecraft to make observations of the ionosphere. SPARC then works with cadets to incorporate these measurements into the broader framework of the ionospheric system, with the long-term goal of developing physics-based predictive models eventually leading to the ability to forecast the geospace environment.

Core Competencies:

- ✓ Miniaturized payloads
- ✓ Space physics
- ✓ Applied physics



Academy Center for Cyberspace Research Department of Computer Science

Director: Dr. Barry Fagin

Email: barry.fagin@usafa.edu

Telephone: 719-333-7623

Overview: The Academy Center for Cyberspace Research (ACCR) conducts research in a wide range of research areas within the field of Computer Science in support of the Air Force, DOD and other government and commercial sponsors. ACCR seeks to develop cadets as cyber innovators by participation in and exposure to research projects in the domain of cyberspace. Current research focus areas for ACCR include cyberspace education and training, cyber-warfare topics and information assurance.

Core Competencies:

- ✓ Cybersecurity education
- ✓ Malware analysis
- ✓ Provably secure internet software



Major Projects:

- Malware Similarity Detection
- Cyberdeception
- Intrusion Detection for SCADA Systems
- IRONSIDES – A provably secure DNS server

Air Force CyberWorx

Director: Col Jeff Collins

Email: jeffrey.collins@usafa.edu

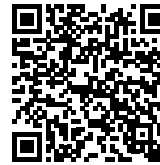
Telephone: 719-333-4170

Center of Innovation

Director: Dr. Terry Pierce

Email: terry.pierce@usafa.edu

Telephone: 719-333-3974



Overview: AF CyberWorx is a partnership of Airmen, industry, and academia reimagining how technology enriches and protects our nation, businesses, and lives. CyberWorx is primarily a human-centric design center that seeks out unique ways to apply current and future technologies to create desirable experiences for Airmen prosecuting the fight in Air, Space and Cyberspace. Within CyberWorx, the Center of Innovation (COI) conducts research and proofs of concepts with large market shaping companies on disruptive technologies. Together the design and research efforts of CyberWorx accelerate the agility of the AF, DOD and DHS by driving creative solutions and preparing the government to leverage technology before it hits the open market.

AF CyberWorx and the COI provide unique immersive opportunities for cadets to interact with industry and government experts through design projects, internships and travel opportunities. The center expends almost \$250K annually creating high-impact experiential learning environments for cadets that have produced scientific papers, CORONA discussion topics, research awards and motivational experiences that have transformed cadet performances.

Core Competencies:

- ✓ Design Thinking
- ✓ Cadet Education
- ✓ Public/Private Partnerships
- ✓ Basic and Applied Research with Market Shaping Companies



Major Projects:

- Designing a 21st Century Cyber Training Model to improve the sustainment of the AF Cyber workforce
- Designing a Cyber Risk Ecosystem to quickly and effectively convey mission risks from cyberspace to non-cyber commanders
- Design a "Smart Base" using modern technology to simplify the lives of Airmen
- Anti-malware research focused on code reuse versus variant detection
- Research on open source and government legacy software to fully leverage a new capability called Software Guard Extensions, new microcode embedded in Intel Corporation's 7th generation microprocessor



Major Projects:

- Computational aerodynamic modeling of full-aircraft for Air Force and DOD
- Reduced-order modeling for stability and control characteristics for NATO air vehicles
- Computational modeling of the USAFA Mach 6 Ludwig Tube and hypersonic vehicles
- Efficient use of next-generation, highly parallel computers

High Performance Computing Research Center

Director: Capt Matthew Satchel

Email: matthew.satchell@usafa.edu

Telephone: 719-333-9526

Overview: The High Performance Computing Research Center (HPCRC) provides access to high performance computing resources (local and remote), high speed network access to those resources, and the expertise to use them efficiently. These resources are available to all faculty, staff and cadets, regardless of academic department or discipline. As part of the Department of Aeronautics, HPCRC researchers assist aeronautical engineering majors to conduct research in computational modeling of aerodynamics and high-speed gas dynamics.

Core Competencies:

- ✓ Access to DOD supercomputing resources
- ✓ High-speed network access and local storage systems
- ✓ Partnerships with local universities for HPC research
- ✓ Expertise in Computational Fluid Dynamics





Center for Physics Education Research

Director: Lt Col Randy Carlson

Email: randall.carlson@usafa.edu

Telephone: 719-333-9733



Overview: The Center for Physics Education Research (CPER) engages in pedagogical innovation and the thoughtful application of technology to the learning experience by developing and evaluating effective teaching strategies using research-based approaches.

Core Competencies:

- ✓ Developing research-based educational resources
- ✓ Assessing effectiveness of educational approaches
- ✓ Providing resources and support for the Just-in-Time Teaching pedagogy

Major Projects:

- Innovative classroom pedagogies
- Just-in-time teaching
- Flipped learning
- Worked-Examples



Overview: The Department of Management (DFM) develops and inspires Air Force leaders to manage complex systems of people, resources and technology. DFM strives to be the renowned center of management education and expertise for the Air Force.

Core Competencies:

- ✓ Organizational strategy, research and behavior
- ✓ Diversity and inclusion
- ✓ Project management

Department of Management

Director: Dr. William Jennings

Email: william.jennings@usafa.edu

Telephone: 719-333-2336



Major Projects:

- Review and evaluate institutional marketing strategies to bolster the USAFA brand
- Use Appreciative Inquiry to build upon organizational strengths in multiple key areas
- Collaboration with local government organizations and nonprofits to improve processes and provide decision support
- Curricular support to the Quad program, a cooperative innovation initiative consisting of USAFA, UCCS, Colorado College and Pikes Peak Community College

Eisenhower Center

Director: Mr. Deron Jackson

Email: deron.jackson@usafa.edu

Telephone: 719-333-8253



Overview: Named after President Dwight Eisenhower, the first American president to establish a national policy shaping U.S. engagement in space for both military and peaceful purposes, the Eisenhower Center is the research center of the Department of Political Science. It provides cadets and faculty with unique opportunities to participate in research and policy discussions on the future of American security through first-hand contact with senior leaders and experts in the military, civilian government, and private sector from the United States and major space-faring nations. In addition to its founding interest in space policy, the Eisenhower Center examines challenges to America's national security across other frontiers of technology development, to include cyber security and developments in hypersonic delivery vehicles. Through its journal, Space and Defense, the Eisenhower Center promotes an ongoing discussion of space and security policy issues from a broad range of professional and intellectual perspectives among academic experts and defense policy makers.

Core Competencies:

- ✓ National security policy, with an emphasis on deterrence theory, particularly in the space and cyber domains
- ✓ Supports research and scholarship related to challenges to U.S. security



Major Projects:

- First-ever cyber forum in April 2016
- Celebrated the tenth anniversary of its Space Forum in December 2016
- Collaborating with the 58th Air Force Academy Assembly which will be focused on cyber security
- Will host the next Space Forum in September 2017 with a focus on the Air Force role in space security and the future of conflict
- Working to produce the ninth edition of the Department's classic textbook American Defense Policy



Scholarship of Teaching and Learning

Director: Dr. Lauren Scharff

Email: lauren.scharff@usafa.edu

Telephone: 719-333-3277



Overview: The Scholarship of Teaching and Learning (SoTL) Program represents a growing national and international professional movement that recognizes, publicizes, funds, and advocates the scholarly approach to understanding factors that impact student learning. These factors include specific teaching techniques, incorporation of technology, organization of materials and use of group work.

Core Competencies:

- ✓ Resources for evidence-based teaching approaches
- ✓ Opportunities to discuss and share evidence-based practices
- ✓ Guidance on research method design and ethics approval for educational research and support for educational research project presentation at conferences

Major Projects:

- Investigation of the principles of negotiation course shifted to a two-hour, 20 lesson format
- Investigation of four team formation methods on performance and attitudes in engineering
- Grit and diligence as predictors of success in USAFA math courses and retention at USAFA
- Investigation of how to most effectively share evidence-based learning strategies across the faculty body and the Cadet Wing



Major Projects:

- 1.5 mile Altitude Dose research study to determine if a significant difference in aerobic performance exists between 5 different altitudes
- A three year study to investigate the benefits offered by PX3's Bite Regulator technologies in reducing concussions among USAFA athletes
- Falcon Fuel
- An internship program for senior level undergraduate or graduate students, in the field of exercise physiology, from around the country

Human Performance Lab

Director: Ms. Dyana Bullinger

Email: dyana.bullinger@usafa.edu

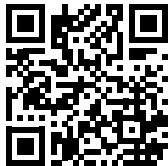
Telephone: 719-333-4188



Overview: The Human Performance Laboratory (HPL) applies sports science principles to improve Academy athletic teams and individual cadet performance. Coaches, cadet athletes and cadets receive specific physiological information by way of testing, research, training and education. The HPL also provides subject matter expertise on the Air Force fitness program and human performance, offering scientific data through research and exercise physiology principles. Through the use of various physiological tests, to include Dual Energy X-ray Absorptiometry (DXA) scans for body composition, Resting Metabolic Rate, VO2max, Anaerobic Endurance, Anaerobic Power and Anaerobic Threshold, the HPL can aid athletes and cadets to improve their performance, nutritional habits, and overall fitness levels. The HPL tests and trains more than 2,000 cadets and approximately 200 faculty, staff, and active duty members annually while also hosting and conducting informational and educational tours for more than 150 high schools, college universities, elite athletes, professional sport teams and military personnel from all over the world.

Core Competencies:

- ✓ Training and enhancing vision for sports performance
- ✓ Interval and maximal effort training to further adapt the skeletal muscle and improve athletic performance



Air Force Humanities Institute Department of English and Fine Arts

Director: Dr. Thomas McGuire

Email: thomas.mcguire@usafa.edu

Telephone: 719-333-8524

Overview: The Air Force Humanities Institute (AFHI) offers a wide array of programs, lectures, interviews, art exhibits, seminars, and discussions aimed at fostering interdisciplinary conversation and exchange. AFHI allows USAFA faculty and cadets a forum for exploring a broad range of intellectual traditions and paradigms that enrich our understanding the human condition.

Core Competencies:

- ✓ Examining the intersections of art, literature, technology, science, and ethics
- ✓ Promoting interdisciplinary dialogue about perennial questions in the humanities
- ✓ Fostering creativity and ethical reflection through fine art, imaginative literature, history, philosophy, & foreign language
- ✓ Providing professional development and research opportunities for faculty and cadets



Major Projects:

- Lectures
- Speakers
- Interdisciplinary Conversations
- Performing Arts Presentations
- Faculty Development Seminars

Department of Foreign Languages

Director: Dr. Ismenia de Souza

Email: ismenia.desouza@usafa.edu

Telephone: 719-333-1787



Overview: Research and faculty development in the Department of Foreign Languages (DFF) is about encouraging innovative, interdisciplinary research and teaching at once, while paying due attention to the details of a particular topic without losing sight of the larger questions raised by history, literature, philosophy and the study of language and cultures.

Core Competencies:

- ✓ Educational and developmental resources for teachers and cadets
- ✓ Research publications and scholarly presentations for teachers and cadets



Major Projects:

- Using Technology and Innovating Methods in the Teaching of Foreign Languages and Cultural Acquisition
- A Comparative Study between the Audio – Lingual Method and the Communicative Approach in Teaching Portuguese as L2
- Computer Assisted Language Learning (CALL) for L2 Japanese Vocab Acquisition
- Directing and advising four undergraduate research papers



Major Projects:

- Developing Modeling and Simulation software which allow replicable strategy analysis and quantitative data gathering on key airpower variables
- Developing strategies to defeat 5th generation aircraft with 3rd generation fighters
- Investigating Command and Control concepts to support the Combat Cloud / Fusion Warfare concepts

Air Power Studies Department of Military and Strategic Studies

Director: Lt Col Michael Martindale

Email: michael.martindale@usafa.edu

Telephone: 719-333-9435



Overview: The Department of Military and Strategic Studies (DFMI) Center for Airpower Studies produces cognitively agile, action-oriented thinkers to meet the challenges in translating strategic guidance into operational and tactical successes to meet national security policy goals with the military instrument of national power. The center develops strategic and critical thinking through education in the rational, responsible, and restrained use of military power in a variety of violent and nonviolent contexts and conducts innovative research into the effective use of air, space, and cyberspace powers in the joint warfighting environment.

Core Competencies:

- ✓ Cadet Battle Laboratory to provide environment for presenting and solving strategic and operational challenges
- ✓ Air Warfare Laboratory to provide environment for translating strategic guidance into kinetic and non-kinetic tactical action
- ✓ Warfare simulation processes and software for qualitative and quantitative comparative strategy research and analysis
- ✓ Interactive educational environment for collaborative learning



Major Projects:

- Publishing textbook in engineering ethics
- Study of the philosophy of religion while growing and sustaining the first religious studies minor at a U.S. service academy
- Publishing and providing editorial assistance in major disciplinary organs such as the international Journal of Military Ethics

Department of Philosophy

Director: Dr. Brent Kyle

Telephone: brent.kyle@usafa.edu

Telephone: 719-333-1590



Overview: The Department of Philosophy (DFPY) takes great pride in being the only stand-alone philosophy department among U.S. service academies. Like nearly all philosophy departments, DFPY emphasizes critical thinking in several domains, including aesthetics, ethics, applied ethics (e.g. military and STEM ethics), philosophy of language and mind, logic, metaphysics, and philosophy of religion.

Core Competencies:

- ✓ Critical thinking in military ethics, especially the just-war tradition; all department members teach and publish in this area



Institute for National Security Studies

Director: Dr. Jim Smith

Email: james.smith@usafa.edu

Telephone: 719-333-7144

Overview: The USAF Institute for National Security Studies (INSS) is located within the Air Force Academy faculty. INSS has focused continuously on arms control, strategic stability, and strategic security, advising the USAF and Defense communities on current and emerging issues of interest to them. USAF sponsorship to INSS today comes from HAF/A10S, the Strategic Stability and Countering WMD Division of the HAF/A10, Deputy Chief of Staff for Strategic Deterrence and Nuclear Integration. Other core sponsors include the Defense Threat Reduction Agency (DTRA) and broader Defense strategic research community. INSS manages the DTRA Project on Advanced Systems and Concepts for Countering WMD and its research portfolio that advises the DTRA strategic planning process. These projects include both cutting-edge strategic security and countering WMD strategy and policy studies, but also a series of Track II (non-official) strategic dialogues with allies, adversaries, and states of WMD concern.

Core Competencies:

- ✓ Strategic policy and strategy research and analysis
- ✓ Arms control and strategic stability, strategic deterrence and assurance, proliferation and countering weapons of mass destruction, and emerging strategic security challenges



Current Projects:

- Re-conceptualizing Strategic Stability
- Future of Arms Control
- China's Nuclear Future
- Countering WMD Challenges and the Emerging Strategic Environment
- Regional Strategic Challenge: The Day After the Next Nuclear Employment

Institute for Information Technology Application

Director: Gen Jim McCarthy, USAF, Ret

Email: jim.mccarthy@usafa.edu

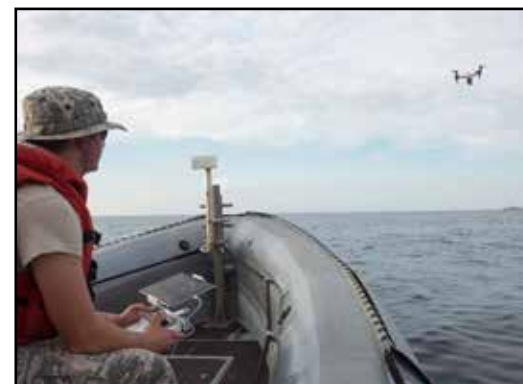
Telephone: 719-333-8255



Overview: The Institute for Information Technology Applications (IITA) engages in multidisciplinary research at the US Air Force Academy to research and develop products with information technology that would benefit education and operations at the Academy, the Air Force, and the DOD.

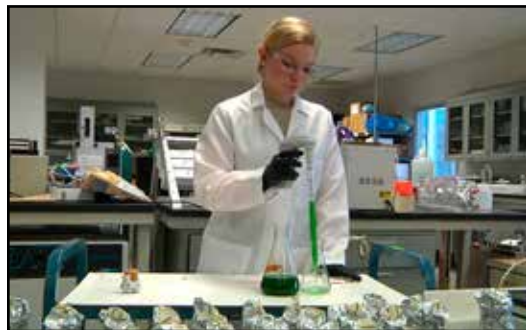
Core Competencies:

- ✓ RQ-11 Raven UAS Fleet with designated air space
- ✓ Trained cadet and officer UAV Operators
- ✓ UAS Battle Lab to exercise command and control
- ✓ Software innovation lab providing rapid development of visualization tools for planning, collaboration, and mission management of aircraft and sensors for warfighting units and commands



Major Projects:

- USAFA participation in DOD's counter UAS exercise, Black Dart
- Simulation of UAV command and control dilemmas in the UAV Battle Lab
- Integrating sensor data feeds across tactical networks for distribution and collaborative management



Major Projects:

- **Biosystems** - isolate extremophiles with interesting and robust extracellular electron transfer capabilities to potentially power remote sensing devices
- **Human Performance** - Interrogate known mitochondrial metabolic phenomenon that are still not well understood in terms of electron transfer mechanisms which control organism survival and viability
- **Biomedical** - identifying secreted proteases from *Aeromonas sobria* that affect avian influenza virus infectivity

Life Sciences Research Center

Director: Dr. Don Veverka

Email: don.veverka@usafa.edu

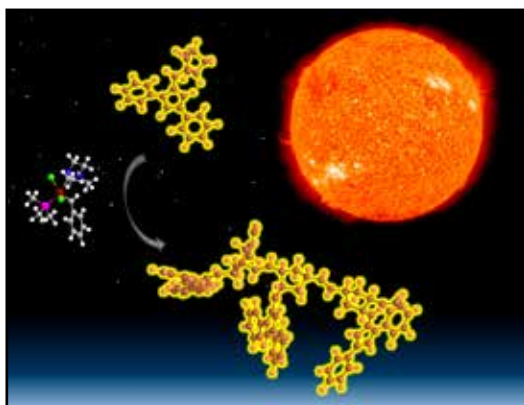
Telephone: 719-333-9670



Overview: The Life Sciences Research Center's (LSRC) primary mission is to support the Air Force Office of Scientific Research (AFOSR) and Air Force Surgeon General (AF/SG) through faculty and cadet research efforts. The main objective of the LSRC is to develop basic research within a broad range of biological sciences topics. Multidisciplinary, there are three main research thrusts which include biomedical, biosystems, and human health/performance areas.

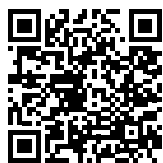
Core Competencies:

- ✓ Screening methods for detecting bacterial agents that can activate/deactivate avian flu viruses and interrogating select cell lines for microbiome research
- ✓ Cultivating/isolating select extremophile organisms as a source of alternative energy production for biosensing capabilities
- ✓ Cellular lipid and protein analysis for investigating molecular redox mechanisms



Major Projects:

- Light harvesting material for new solar/green technologies towards federal zero net energy goals
- Stimuli-responsive coatings for the development of chemical warfare nerve agent detection
- High temperature resins and high strength fibers for next-gen solid rocket motor case composites
- Metallized composites from additive manufacturing towards structural energetics for propellants with tunable energy output



Chemistry Research Center

Director: Dr. Scott Iacono

Email: scott.iacono@usafa.edu

Telephone: 719-333-6005



Overview: The research team in the Chemistry Research Center (CRC) at the US Air Force Academy focuses on preparing functionalized polymer and hybrid polymer composites directed toward developing next-generation, high-performance materials to meet operational Air Force and DOD mission partner needs. In order to accomplish a portion of this, the CRC has had proven success by external partnering with academia, industry and national laboratories in order to leverage an expanding technology base.

Core Competencies:

- ✓ Advanced materials and composites processing and fabrication
- ✓ Robust small molecule, biomolecular, and macromolecular synthesis and characterization
- ✓ Molecular computational modeling and simulation for predictive chemical properties
- ✓ Senior and post-doctoral associates and faculty with a broad spectrum of specialties to adapt to the ever-changing world of chemistry challenges

Department of Civil and Environmental Engineering

Director: Dr. Thomas Phelan

Email: thomas.phelan@usafa.edu

Telephone: 719-333-2516



Overview: The Department of Civil and Environmental Engineering (DFCE) produces problem solvers, meeting the challenges of environmental degradation, building and improving infrastructure, energy needs, natural disaster responses, sustainable development and community planning by improving the full spectrum of the built environment.

Core Competencies:

- ✓ Testing capability to construct experimental earth structures through a large field site
- ✓ Fully functional soils laboratory
- ✓ Static structural testing capability via a 25-foot-long reaction floor and multiple hydraulic actuators
- ✓ A high-bay laboratory space with a 5-ton crane and multiple universal testing machines
- ✓ Extensive experience with multiphase flow simulation techniques
- ✓ Sampling and DNA extraction/sequencing of human and built environment microbiome

Major Projects:

- Forest Service Bridge Design and Construction
- Cadet Longitudinal Study of Microbiome Homogenization
- Screening-level Modeling of Bioenhanced Dissolution in Field-Scale Bioremediation Remedies
- Computational modeling of granular material fracture and wheel loading on soil
- Use of energy foundations to provide geothermal heating and cooling to buildings

Academy Center for Unmanned Aircraft Systems Research Department of Electrical and Computer Engineering

Director: Dr. George York

Email: george.york@usafa.edu

Telephone: 719-333-4210

Overview: The Academy Center for Unmanned Aircraft Systems (UAS) Research, hosted by the Department of Electrical and Computer Engineering, focuses on adding autonomy to UAS, to allow one operator to control multiple UAS that can autonomously search, find, identify and track various targets. UAS serve as an excellent platform for our cadets across various disciplines to conduct meaningful research supporting the warfighter.

Core Capabilities:

- ✓ Simulating and test flying autonomous algorithms for multiple UASs
- ✓ Sensor Fusion (EO, IR, RF)
- ✓ GPS-Denied Navigation
- ✓ Sense and Avoid Path Planning
- ✓ Counter-UAS Methods



Major Projects:

- Hosted a 5 University Counter-UAS demonstration at USAFA
- Developed Range-Sensor and Image-based Navigation for GPS denied environments
- DARPA Unmanned Capture-the-Flag Competition, a drone war fielding 25 autonomous USAFA UASs vs 25 USMA/USNA UASs



Department of Engineering Mechanics

Director: Dr. Ioan Feier

Email: ioan.feier@usafa.edu

Telephone: 719-333-7315



Major Projects:

- Effects of friction stir welding and temperature on microstructure, corrosion resistance and mechanical properties of metals
- Fatigue and corrosion characterization and protection, including crack growth and residual stress effects
- Additive manufacturing techniques including ordnance disposal, titanium alloys, and supersonic particle deposition for aircraft structural repair
- Thermodynamic analysis of multiple real-world applications, including aircraft icing, athletic stadium field heating for de-icing, and airbase petroleum oil and lubricant (POL) storage/distribution systems

Overview: The Department of Engineering Mechanics (DFEM) develops Air Force problem-solvers to meet the needs of the warfighters through innovative design techniques, infrastructure monitoring and improvements, aging aircraft analysis and solutions, and aircraft structural integrity improvement. DFEM runs the Center for Structural Life Extension (CASTLE), the largest research center at USAFA. In addition to consistent faculty research, multiple cadet research opportunities are provided via cadet summer research opportunities, senior capstone projects, and independent cadet research endeavors.

Core Competencies:

- ✓ Materials characterization including microstructure, properties, and corrosion effects
- ✓ Mechanical testing including fatigue, corrosion, and welding effects
- ✓ Composite structures and additive manufacturing laboratories
- ✓ Automotive laboratory including chassis and engine dynamometers
- ✓ Dynamic testing including vibrational and structural response under transient loading
- ✓ Parallel high performance simulations including Finite Element Analysis (FEA) and thermal/fluid Computational Fluid Dynamics (CFD)



Warfighter Effectiveness Research Center

Director: Maj Chad Tossell

Email: chad.tossell@usafa.edu

Telephone: 719-333-3132



Overview: The Warfighter Effectiveness Research Center (WERC) is the research arm of the Department of Behavioral Sciences and Leadership, and is dedicated to facilitating faculty and cadet research in the behavioral sciences that enhance warfighter effectiveness. Current collaborators include government laboratories, academia, industry, and military operators—all dedicated to the same warfighter-focused approach to science and technology.

Core Competencies:

- ✓ Enable the warfighter
- ✓ Facilitate faculty and cadet research
- ✓ Establish and maintain a world-class Behavioral Science research facility
- ✓ Be the Air Force's model for efficient, effective, affordable warfighter research

Major Projects:

- Human-Machine Teaming
- RPAs
- Concussion Research
- Respect for Human Dignity
- Evidence-based Leadership



Center for Character & Leadership Development

Director: Dr. John Abbatiello

Email: john.abbatiello@usafa.edu

Telephone: 719-333-0933

Overview: The Center for Character and Leadership Development (CCLD) is the Academy's most visible focal point for understanding, enhancing, and integrating Academy cadet and staff efforts to achieve the essential mission of developing officers of character. CCLD conducts research and brings scholars and practitioners together to understand the evolving Profession of Arm and the changing demands of military leadership and character development. We support the developmental processes which prepare cadets to serve effectively as leaders.

Core Competencies:

- ✓ Generates and shares research, assessment and understanding of military character and leadership questions of importance
- ✓ Designs and coordinates selected professional development activities for Academy-assigned personnel, to provide for their own personal growth and to enhance cadet development
- ✓ Leverages the newly-completed Polaris Hall to support both cadet development and USAFA institutional outreach to external (USAF, DOD, national and international) discussants in character and leadership issues
- ✓ Publishes print and electronic scholarship in the field of character and leadership integration



Major Projects:

- Achieving full operational capability of Polaris Hall
- Collection and publication of character- and leadership-related oral history and the Journal of Character and Leadership Integration
- Liaison with Air Force and national character- and leadership-developing organizations
- Executed the annual National Character & Leadership Symposium and Scholars Forum

The USAFA Office of Research

Supporting Your Research

The USAFA Office of Research exists to support the researcher as they develop career officer and operations-ready warfighters through access to federally developed technology, STEM education, national security and job growth.

Visiting Researcher Programs

Engineer and Scientist Exchange Program (ESEP) and Administrative Professional Exchange Program (APEP) - A DOD effort to promote international cooperation in military research, development, and acquisition through the exchange of defense scientists and engineers. It provides on-site working assignments for U.S. military and civilian engineers, scientists and administrative professionals for a 12 month period.

Air Force Science & Technology Fellowship Program - Provides USAFA labs an opportunity to bring on postdoctoral and senior scientists and engineers for 12–24 month periods to assist with research and contribute to overall efforts of the laboratories.

Summer Faculty Fellowship Program (SFFP) - USAFA researchers can bring on SFFP fellows for collaborative research over a summer period of 8–12 weeks.

Technology Transfer

Commercial Test Agreements - Agreements to extend services from a USAFA laboratory to a third party for the testing of materials, equipment, models, computer software and other items for an appropriate fee.

Cooperative Research and Development Agreement (CRADA) Services - Legal agreements between a USAFA laboratory and a nonfederal party to offer both parties the opportunity to leverage each other's resources when conducting research and development; resulting royalty income is shared between the inventors and the laboratory.

Educational Partnership Agreement (EPA) - A formal agreement to transfer equipment from a USAFA laboratory to a K–12 facility or any non-profit institution that is dedicated to improving science, mathematics and engineering education. EPAs increase awareness and visibility of military developed technologies and increase potential for commercialization of military technology.

STEM Outreach

The mission of the United States Air Force Academy STEM Outreach Program is to offer a variety of programs and services that effectively engage, inspire and attract the next generation of STEM talent.

Col Mark Reimann
Associate Dean of Research
719-333-4195

Dr. Jim Solti
Chief Scientist
719-333-4195

Mr. Tom Fulton
Deputy Head of Research
719-333-2847

Ms. Michelle Alvarez-Rea
Research Program Manager
719-333-3273

Ms. Dayo Aladeniyi
Technology Transfer
719-333-3311

Ms. Jenn Kuster
Programs and Publications
719-333-0725

Ms. Sandy Lamb
STEM Outreach
719-333-8990

Staff Sgt Prince Bandong
Budget Analyst, NCOIC
719-333-8318

Mr. Chad Leasure
Budget Analyst
719-333-2868

Mr. Joe Augusto
Budget Analyst
719-333-1589

UNITED STATES AIR FORCE ACADEMY RESEARCH

Enhancing cadet education

Developing future problem solvers

Partnering for innovative solutions



