The cover photo is of a water-gel sphere made of sodium polyacrylate being held by Capt. Samantha Adee (DFC).

Photograph was taken by Lt. Col. Royce Beal in the USAFA Department of Chemistry.
Just like the kaleidoscope, the sponsored research program at the United States Air Force Academy (USAF Academy) reveals new experiences and scientific discoveries, with each of its facets revealing the diversity, strengths, innovation, and commitment of the cadets who call USAFA home. This ever-evolving arena offers cadets a chance to develop depth and dimensions as future officers and leaders of character.

Multiple prisms focus the Academy’s mission to educate, train, and inspire men and women to become officers of character, motivated to lead the United States Air Force (USAF) in service to our nation. The Academy’s sponsored research program instills in cadets all of the elements of scientific inquiry, real-world research experience, innovative approaches to teaching and learning, character and leadership development, and military discipline.

With one twist of the kaleidoscope, the Academy’s learning-focused methodology and faculty commitment offer cadets a nationally-recognized undergraduate education. Cadets have access to more than $73 million dollar research program, world-class labs and equipment, and professional Cadet Summer Research Program (CSRP) opportunities with the Department of Defense (DoD), the USAF, and private industry. Graduating cadets also have unprecedented opportunities for placement at top graduate programs around the world including the University of Oxford (U.K.), Massachusetts Institute of Technology, and Stanford University.

In the light of sun and another twist, the colors of the Academy’s kaleidoscope come into full view. Inspiration is revealed in cadets giving of their free time to support local Science, Technology, Engineering, and Mathematics (STEM) outreach efforts. It is also demonstrated in the heroic actions of faculty such as Department of Aeronautics assistant professor Lt Col Ryan Osteroos and his life-saving actions during the tragic aerial accident at the Reno Air Races in 2011. Inspiration is found every day in the halls, classrooms, and labs of the Academy. As a community, as a cadre, and as an institution of higher learning, Academy cadets and faculty embody integrity, service before self, and excellence in every endeavor they undertake.

Combined together, these images, colors, and experiences make USAFA Research, the Academy, and the nation a better place. This is Research at USAFA.

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RESEARCH AT USAFA 2012
With a research enterprise now exceeding $60 million annually, the US Air Force Academy’s sponsored research program is on the front-line of educating the next generation of officers of character equipped with sophisticated critical thinking skills and inspired to execute visionary leadership—characteristics that on today’s complex battlefields will help them to anticipate and respond to evolving missions in air, space, and cyberspace.

Cadets today are immersed in complex summer research projects, national student paper competitions, and priceless one-on-one mentoring from leading experts and faculty in support of the Academy’s mission to educate cadets.

The 20 research centers and institutes at USAFA offer cadets a diverse choice of real-world, Air Force mission-relevant research opportunities, as well as opportunities for cadets to mentor the next generation of potential cadets and Science, Technology, Engineering, and Mathematics (STEM) professionals via the Academy’s regional K-12 STEM Outreach Center. Cadets also benefit from the research efforts and opportunities offered via the USAFA Center for Character and Leadership Development including participation in the National Character and Leadership Symposium. From the game-changing development of disruptive technologies in our Center of Innovation to the successful world’s only undergraduate-only small satellite research FalconSat program, the opportunities are unlimited.

What this means to the Academy and more importantly, to the US Air Force, is the assurance that the continued quality of the long blue line of well-developed and educated officers of character is assured for our nation’s future. I take no greater pride than during graduation when I know that the class members standing before me and their friends and families have contributed to the great academic mission of the Academy and are going forth as our best representatives in the diverse specialty areas for which we have prepared them. I know they will be beacons of leadership and innovation not only in service to the nation but also in service to our local and broader Air Force communities.

As new technologies emerge, cadets are given the opportunity to be on the very cutting edge, quickly becoming familiar with some of industry’s most advanced research tools and labs. For example, cadets are conducting cutting-edge nano-technology and metamaterials research in our Chemistry Research and Laser and Optics Research Centers. Recognizing that budget realities will require the Air Force to operate much of its aging fleet for years to come, cadets are today helping the Air Force manage that challenge by making life-saving research discoveries in the arena of aging aircraft analysis, structural integrity and maintenance programs. Simultaneously, cadets in our Space Systems Research and Space Physics and Atmospheric Research Centers are designing, launching, and operating real-world, real-client Department of Defense small satellites and sensors in orbit and on the International Space Station.

This annual research report is but a glimpse into the many diverse and multi-disciplinary research successes achieved over the past academic year. I invite you to explore these wonderful and growing research centers and endeavors. To our cadets, my congratulations for a job well done.

Lt Gen Mike Gould
Superintendent, USAFA
As a 1983 graduate, I have come full circle from cadet to Dean of the Faculty and Austin Dusty Miller’s quote on the Eagle and Fledglings statue rings as true today as it did when I was a cadet—“Man’s Flight Through Life is Sustained by the Power of his Knowledge.” The cycle of mentoring and leading our cadets, watching them become officers of character, like the Eagle to the Fledglings, is one of the most rewarding jobs in the US Air Force.

Under the guidance of our dedicated faculty, cadets have the chance to partake in the nation’s #1 federally-funded undergraduate-only research program. With a research enterprise now valued at more than $60 million, access to cutting-edge technologies and laboratory equipment, more than 400 professional researchers and faculty as mentors, and real-world cadet summer research and independent research projects; the research program at USAFA continues to evolve and contribute to our mission to educate, train, and inspire men and women to become officers of character motivated to lead the United States Air Force in service to our nation.

The research program at the Academy spans all of the disciplines from Aeronautics to English and offers all cadets the opportunity to apply the knowledge gleaned from coursework to real-world problems. The dedication of our faculty and the depth of our academic and research programs can be seen in the record number of cadets awarded graduate school slots for FY 2011-2012. Totaling 117, these graduate slots included our 37th Rhodes Scholar, two Marshall Scholars, and a record 26 graduates heading directly to Medical Schools including four nurse and one dental, for a total of 31 medical professional scholarships.

Via our Cadet Summer Research Program (CSRP) and our more than 120 Cooperative Research and Development Agreements (CRADAs), cadets have the chance to partake in top US Government agency, Department of Defense, USAF, and industry projects that have the potential to save lives, save dollars, and contribute to private technology transfer. Some of the projects cadets are involved in include on-the-ground training opportunities such as the NASA Orion Crew Exploration Vehicle parachute deployment research, coordinating airborne mission activities for sponsors for programs such as the multi-million dollar cadet-built CSANYT sensor, which is mounted on the International Space Station, as well as cutting-edge renewable energy research programs for solar and bio-fuels, and more.

Our aim is not only enhanced education, but enriched character and leadership opportunities. Our character education and community outreach efforts are strong in helping our cadets both live the values that they can be as officers and individuals. The Center for Character and Leadership Development (CCLD) offers cadets and faculty the chance to learn from some of today’s greatest examples of character leadership via the annual National Character and Leadership Symposium. The Academy’s Center for K-12 Science, Technology, Engineering and Mathematics (STEM) Outreach and Research, funded by the Office of the Secretary of Defense’s National Defense Education Program, has continued to expand its impact on hundreds of regional educators and thousands of K-12 students. A Cadet Wing STEM Outreach Club has been established and cadets have submitted several hundred hours of their time to support regional and USAFA STEM events.

It is all this and more that makes our USAFA Research program the success it is. This annual research report is only a small window into the diverse and meaningful learning-focused world of USAFA Research. I hope you enjoy this report as much as I have enjoyed watching our cadets grow as students and future officers and our faculty blossom with career-enhancing research opportunities.
Computer technology and the Internet have transformed our world. The United States has literally come to depend on cyber capabilities for all facets of government, commerce, and military defense. These capabilities are highly valuable and are under constant attack. Cybercrime, such as identity theft and corporate espionage, is estimated to have an annual global cost of $375 billion. Cyber Vandalism, such as malicious code, has become more sophisticated and economic systems, transportation, communications, and national power grid. A neural network approach is being developed to investigate the possibility of using visualization to detect network anomalies. Initial findings from this project have already led to two publications. A newly funded project by NSA is looking at the application of artificial intelligence techniques to monitor and control the national power grid. A neural network approach is being developed to investigate optimization strategies for dealing with intentional or unintentional faults in this critical infrastructure.

In addition to educating cadets through research, practical experience through hands-on activities provides students the opportunity to learn the principles of cyber warfare in a more realistic environment. The USAFA competitors finished first, besting all undergraduate and graduate programs. Outreach efforts such as regional seminars and competitions allow faculty and students to interact with other educators and practitioners. "Creating greater cyber awareness and fostering collaborations is a win for everyone," said Schweitzer.

ACCR continues to look for ways to extend cyber research and education to more cadets as well as the larger Colorado community. Basic Cyber, a new summer program, teaches cyber operation topics to cadets of all disciplines. Outreach efforts such as regional seminars and competitions allow faculty and students to interact with other educators and practitioners. "Creating greater cyber awareness and fostering collaborations is a win for everyone," said Schweitzer.

The Academy Center for Cyberspace Research (ACCR) develops cyber innovators to defend our nation. Students learn, first-hand, the techniques and tools for conducting offensive and defensive cyber warfare, they study current cyber threats, they conduct research in current cyber topics, and they practice hands-on cyber operations through simulated exercises. According to ACCR Director, Dr. Dino Schweitzer, "Cyber capability spans none of the greatest opportunities as well as none of the largest threats in the history of mankind. Cyber warfare is not an academic exercise. Preparing cyber warriors is crucial to the security of the nation."

ACCR involves faculty, students, and industry in a variety of research projects, funded byDoD and NSA. DARPA funding provided resources to investigate the feasibility and benefits of the approach for commercial use. Based on previous findings, researchers implemented algorithms on software radios demonstrating the effectiveness of using visualization to detect network anomalies. Initial findings from this project have already led to two publications. A newly funded project by NSA is looking at the application of artificial intelligence techniques to monitor and control the national power grid. A neural network approach is being developed to investigate optimization strategies for dealing with intentional or unintentional faults in this critical infrastructure.
The value of these novel public-private partnerships is twofold. First, government can see into the future of market-shaping research technology; private industry gains insight into the technology needs of government; and USAFA Cadets gain unprecedented research opportunities with the private sector.

USAFA Cadet involvement is critical and is a prerequisite for the Center of Innovation (CoI) at the US Air Force Academy (USAFA), established in 2008, to conduct cutting-edge research both at USAFA and within industry.

In October 2011, the CoI conducted the fourth annual Rare Event Scenario. The Rare Event Scenarios have two primary focuses—the field-testing of emerging technologies and the assessment of social collaboration strategies. Participants are tasked with collaborating through various types of multimedia collaborations and public alerts between individuals, communities, and the government. Cadets believe that many communications challenges dealt with during the 9/11 attacks and Hurricane Katrina could be prevented in the future with the use of innovative communication technologies now under development by CoI partners.

By utilizing emerging social networking technologies, Cadet researchers hope to increase collaboration by facilitating greater sharing of information and public alerts between individuals, communities, and the government. Cadets believe that many communications challenges dealt with during the 9/11 attacks and Hurricane Katrina could be prevented in the future with the use of innovative communication technologies now under development by CoI partners.

The evolution of technology is facilitating new patterns of communication. The market demand is being driven by the web 2.0 millennia generation, who view cyberspace as their natural habitat.

Today’s USAFA Cadets view cyberspace as their natural domain. A multitude of USAFA Cadets have been heavily impacted by the CoI’s efforts. “I was inspired to put my ideas to work and not restrict myself” said an anonymous Cadet from Dr. Hepburn’s Technological Innovation Management class. “Cadets have outstanding minds and the Center of Innovation Lab is something that should be taken full advantage of while at the Academy. I wish I had known about this place sooner,” added another anonymous Cadet.

The greatest focus of the October 2011 Rare Event Scenario was the value of 2D vs. 3D environments. The goal is to determine if 3D environments add to social collaboration in a distributed fashion, specifically for First Responders and Edge Warfighters. The Rare Event Scenarios are analyzed by IBM Watson Research Labs for Social Software.

“One of the most exciting things the Center of Innovation has to offer USAFA Cadets is the one-of-a-kind experience in the private sector. For me, it is very rewarding to see these Cadets being mentored by and working along- side leading researchers who are focused on gaming-changing innovations. Our USAFA Cadets, through the CoI, are provided the tools to develop into leaders of character—leaders who will have a great impact on the future of market-shaping research technology; private industry leaders who view cyberspace as their natural habitat,” states Dr. Terry Pierce, Director of the Center of Innovation.

During the 2011-2012 academic year, the CoI sponsored 5 USAFA Cadets to conduct research with Intel Corporation’s leading scientist at Intel Research Labs in Hillsboro, Oregon. USAFA Cadets had the opportunity to work side leading researchers who are focused on gaming-changing innovations. “He’s simply fantastic and his time with me has been nothing short of impressive. “He’s simply fantastic and his time with me has been nothing short of delightful. He is very likely the best mentor I ever worked with. He’s smart, innovative, mutually, ethically driven, and makes an excellent argument. He taught me what it means to critically evaluate and synthesize a poorly written paper’s components for us,” said Intel Labs’ expert. In previous years the CoI has sent USAFA Cadets to study at Intel Corporation, IBM Watson Research Center, and SHaRP. Upon graduation, the hope is USAFA Cadets can leverage that research experience to champion solutions to tomorrow’s threats.

In addition, Dr. Pierce is regularly a guest speaker on disruptive innovations both at the USAFA and throughout the private sector. “Disruptive innovation is an improved performance along a trajectory that traditionally has not been valued. Fostering a disruptive innovation mindset for USAFA Cadets provides the exposure to game-changing technologies and the now skill set for USAFA Cadets to become great leaders of character in today’s ever changing technological domain,” states Dr. Pierce. “The Cadets who understand through its emerging private and public sector innovation model.

At the time of this report, the CoI was working with Intel Corporation Research Labs to build the CoI Anti-Malware Laboratory—the first anti-malware research lab within Intel. This unique research laboratory will train a new breed of the most current hardware and software innovations being researched at Intel Research Labs and give USAFA Cadets and our USG agency partners unprecedented access to antimalware research technology. Through Intel’s antimalware technology research is strictly limited to defensive efforts, the CoI Anti-Malware Laboratory will afford USAFA Cadets and faculty the opportunity to run malware experiments in a controlled setting. The public-private goal for the CoI Anti-Malware Laboratory is to complement and supplement existing academic and military training programs in the area of cyber-attacks and defense for the modern cyber warrior.
Understanding ISR requirements and their impact on today’s operations and tomorrow’s Air Force leaders is becoming crucial to mission success. In the next generation of RPA, formerly known as unmanned aerial systems (UAS), are crucial for today’s intelligence, surveillance, and reconnaissance and RPA operations for intelligence, surveillance, and reconnaissance (ISR) to Department of Defense (DoD) capabilities as one of the five USAF acquisition priorities. The interdisciplinary aspects of RPA design and the increasing opportunities for RPAs in both military and civilian applications offer complex challenges to cadets and require them to solve problems on a myriad of levels. “As the cadets strive to solve these problems, I often hear them saying the problem is too complex and too difficult,” according to Dr. Dan Jensen, the Center’s director. “They become more confident as individuals, believe in the strength of teamwork and are well on their way to becoming excellent officers and leaders.”

The Center’s efforts to meet this critical operational need through ground-breaking research on a variety of new technologies including multiple, autonomous Remotely Piloted Aircraft (RPA) operations for Intelligence, Surveillance, and Reconnaissance (ISR) to Department of Defense for Research and Engineering (DDR&E), Rapid Reaction Technology Office. The goal for both projects is for RPAs, unmanned ground vehicles, and surface as well as surface vehicles to perform protection of a sea and land area. During the 2011/2012 academic year, the Center successfully demonstrated these capabilities through actual RPA flight tests cooperating with unmanned ground and unmanned surface vehicles and through simulations in the case of RPAs cooperating with the Penn State unmanned submarine and surface vehicle. Another cadet project sponsored by the Air Force Research Laboratory (AFRL) has demonstrated this year in a project sponsored by the DDR&E Rapid Reaction Technology Office. Also demonstrated as part of the mission were the capabilities to maintain surveillance of the building and then continuously track both a vehicular and human target using the appropriate sensor for each target. Other cadet projects involve developing innovative airframe designs for future RPAs. Cadets are designing a very durable small RPA to support the future requirements of the USAF for officers who understand the capabilities and employment of unmanned systems. Our efforts in the ACUASR help to prepare our faculty and cadets for this important responsibility before they leave the Academy.”

ACADEMY CENTER FOR UNMANNED AIRCRAFT SYSTEMS RESEARCH

AEROSPACE AT USAFA 2012

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AERONAUTICS RESEARCH CENTER

The Aeronautics Research Center (ARC) of the U.S. Air Force Academy (USAF) conducts fundamental research in the areas of aerodynamics, fluid dynamics, propulsion, hypersonics, and flight control and aircraft design. The ARC is composed of faculty, support staff, and students, and is organized into four research programs: Aerodynamics, Fluid Dynamics, Propulsion, and Flight Control and Aircraft Design. The ARC is one of the leading research centers in the United States in the field of aerospace engineering, and is recognized for its contributions to the advancement of aerospace technology.

The ARC has a long history of conducting research in the areas of aerodynamics, fluid dynamics, and propulsion. The ARC’s research programs are focused on developing new technologies and techniques for improving the performance and efficiency of aerospace vehicles. The ARC’s research is conducted in a variety of facilities, including wind tunnels, computational fluid dynamics (CFD) centers, and laboratories.

The ARC has a strong tradition of involving students in research projects, and many of its research programs are conducted in collaboration with industry and government agencies. The ARC has a strong track record of producing high-quality research, and its research has been used to develop new technologies and techniques for improving the performance and efficiency of aerospace vehicles.

The ARC’s research programs are funded by a variety of sources, including government agencies, industry, and private foundations. The ARC’s research is conducted in a collaborative and interdisciplinary environment, and the ARC’s researchers work closely with other researchers in the aerospace engineering field.

The ARC’s research is focused on a wide range of topics, including aerodynamics, fluid dynamics, propulsion, and flight control and aircraft design. The ARC’s research programs are designed to address the challenges faced by the aerospace industry, and the ARC’s researchers are committed to developing new technologies and techniques that will improve the performance and efficiency of aerospace vehicles.
“Cadet research at the USAFA Observatory develops future technical leaders who know how to apply the scientific method, as well as employ observational tools and techniques required of Air Force space scientists,” says Director of the ARGO, Dr. Devin Della-Rose. Under the guidance of Della-Rose, the ARGO directs an array of four cadet astronomy research projects each academic year, and facilitates all cadet research conducted by the Center for Space Situational Awareness (CSSAR).

One key research area in which 2d Lt Howard and eight other cadets have worked is the study of transiting Earth-type planets. In ongoing research, a known exoplanet passes between its star and Earth (called a transit). Data analysts refine techniques refined by Lt Howard, Lt Peter Tarvin, and C1C Grant Boehme have given ARGO the capability to monitor such transits with the same fidelity as world-class astronomical observatories.

Starting in Fall 2018, cadet researchers showed that four cadet astronomy research teams would detect the minuscule drop in light as a known exoplanet passes between star and Earth (called a transit). Data analysts refine techniques refined by Lt Howard, Lt Peter Tarvin, and C1C Grant Boehme have given ARGO the capability to monitor such transits with the same fidelity as world-class astronomical observatories.

In early 2012, C1C Samantha Lach and Gordan Spahr are researching and analyzing ground-based transit observations of the exoplanet Wasp-12b. “It’s exciting,” said a 2011 graduate who now works for the Air Force Research Lab (AFRL) at Wright-Patterson AFB. “She wrote to tell me that she regularly employs the knowledge she gained from her observatory research experiences.”

“Another example of impromptu cadet-led ARGO research came in early November 2011, when the asteroid 2005 YU55 passed close to Earth again in 2041. As with the Pinwheel Galaxy supernova, Dr. Della-Rose, C1C Spahr, and a group of cadets imaged YU55, knowing that a direct impact with Earth would be catastrophic. As with all other Earth-based remotes we must be informed and able to manage our research.”

As ARGO research continues to grow, future cadet and faculty researchers will be able to leverage the expanded coverage of CSSAR’s Falcon Telescope Network to capture the limits of what we can see in the Colorado Springs night sky. Dr. Della-Rose concluded: “I’m very proud of the legacy of ARGO cadet, faculty, and citizen research that continues to build. It’s all based made possible by the unqualified support given to us and the USAFA Observatory by all levels of USAFA leadership.”

“Astronomical Research Group & Observatory”

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The Cadet Summer Research Program (CSRP) is one of the Academy’s longest-running research success stories. Multi-disciplinary in nature, an average of 200 rising seniors every year participate in hands-on real-world research programs across the nation in federal laboratories such as the Air Force Research Lab (AFRL), the Air Force Global Strike Command, Air Force Space Command and other military branches’ research programs, other universities such as the Massachusetts Institute of Technology, and in private sector companies such as Boston Scientific, Boeing and Intel Corporations.

The CSRP program supports the education and research mission of the Academy and offers cadets the opportunity to apply all they have learned from their time at USAFA to a real-world situation. Through Cooperative Research and Development Agreements (CRADAs), these research partners are able to get the best of both worlds—top-notch research for reasonable investment. The Academy has nearly 80 active CRADAs that include not only CSRP projects but also year-round projects within the labs that leverage the Academy’s equipment, faculty, and cadet resources.

Over the summer of 2012, cadets went to far-flung as well as close-to-home research programs. Management major C1C Chris Kirk completed his five-week CSRP at SAF/AQ at the Pentagon working on budgeting and management challenges at the very upper levels of US Air Force leadership. In addition to getting kudos from USAF budget personnel, Cadet Kirk has also been recognized for his heroism. Kirk witnessed a horrific car accident, pulled over and saved one of the passengers in the vehicle, which had burst into flames.

The praise for the cadets’ 2012 efforts is immeasurable with both new and repeat customers praising cadets’ innovations, deductives, and professionalism. Several cadets had their work recognized as the best. C1C Yasmin Sarmiento’s work on ionic liquids as a forensic tool to identify explosive materials was selected by the U.S. Army Criminal Investigation Laboratory as the DoD Project of the Month. “Though it’s not necessary appropriate to compare, he is very likely the best intern I’ve ever worked with. He’s smart, persevering, motivated, technically curious, organized, enthusiastic, and makes an excellent argument. He sought out what he needed, critically evaluated it and synthesized a lovely vision of the compute continuum for us. But his ‘ace in the hole’ is his listening skills. He ‘actually’ listens carefully, attentively, openly and integrates actively what he’s hearing with what he knows. You can see it in his eyes…” said Dr. Tony Salvador, Senior Principal Engineer and Director of Intel Corporation’s Experience Insights Lab, of C1C Woody Go.

The cadets also come back with renewed energy and excitement. Many will continue the work they have started with CRADA partners as part of their senior capstone or independent study courses during their senior year. Many CSRP participants also seek to continue their education and aggressively pursued and won recognized scholarships from top-tier universities and medical schools.

“CSRP allows our cadets to apply what they’ve learned up through their junior year to real-world situations while contributing to the mission and gaining experience at other agencies. This provides the motivation and stimulation of their interests to continue research and contributes to their devotion to lifelong learning,” said USAFA Chief Scientist Col Bob Kraus.
According to the Air Force Times in 2010, the average age of aircraft in the Air Force is more than 28 years and some of the newer aircraft such as the F-22 Raptor are take in excess of 20 years old. And the fleet is not getting any younger. This fact combined with the ever-dwindling Air Force inventory makes safe operation and maximum readiness of the remaining aircraft critical to the warfighter.

The center is currently involved in projects ranging from new materials research, multiple aging aircraft structural teardown analysis programs, full-scale and component fatigue testing, validation of structural repair methodologies, corrosion characterization and modeling research, and energy harvesting projects. Funding for these efforts comes from a variety of sources including Air Force Air Logistics Centers, Air Force Office of Scientific Research (AFOSR) and other DoD organizations.

"CAStLE supports our cadet's education by giving them hands-on, real-world structural sustainment experience. Many USAF aircraft are nearing their third generation of pilots—some of our cadets will be flying airplanes their grandparents flew. They are seeing first-hand the breadth and depth of the technical problems that must be addressed to keep these 'mature' aircraft flying for decades to come," said Shoales. "Our cadets get to work with government and contractor teams charged with solving today's aircraft structural issues and, upon graduation, will be flying airplanes our cadets have seen fly. Our cadets get to work with government and contractor teams charged with solving today's aircraft structural issues and, upon graduation, will be flying airplanes our cadets have seen fly. Our cadets gain insight as to the condition of the entire fleet for extended safe service beyond original design service goals. Due to its previous record of successful research in this arena, CAStLE authored the USAF manual for Teardown Analysis Programs and is currently considered to be the world's expert on the subject. Cadet contributions, through their research projects, added to this content not possible by any other means. Such insight in turn enables cadets to run on the condition of the entire fleet for extended safe service beyond original design service goals. Due to its previous record of successful research in this arena, CAStLE authored the USAF manual for Teardown Analysis Programs and is currently considered to be the world's expert on the subject. Cadet contributions, through their research projects, added to this content not possible by any other means.

Since the academic program of all department cadets includes key elements of one or more CAStLE projects, CAStLE is an integral part of the cadet curriculum. The center is the envy of the services of aircraft structural degradation issues and their impact on structural integrity. Led by Dr. Gregory Shoales (Director), Dr. James Greer, Jr. (Technical Director), and Dr. Philip Sanzone (Technical Advisor), CAStLE has a laser Computer Numerically Controlled (CNC) multitasking machine for reverse engineering.

"CAStLE is credited for their contribution. Their work on the front lines of a full spectrum of materials degradation issues and their impact on structural integrity. Led by Dr. Gregory Shoales (Director), Dr. James Greer, Jr. (Technical Director), and Dr. Philip Sanzone (Technical Advisor), CAStLE has a laser Computer Numerically Controlled (CNC) multitasking machine for reverse engineering. Our cadets publish their work and present their successful solutions to DoD and contractor teams. This program is expected to yield more than 30,000 inspection results per aircraft to help fleet managers reach the current service requirement beyond 2040. Cadets have been intimately involved in the evaluation of the fatigue residual life in fuselage lip joint panels, the evaluation of the static residual strength of similar fuselage lip joint panels, and real-life root cause analysis of the inspection indications. Multiple cadets have accomplished full analyses of inspection indications which have become part of the formal report and data used by the USAF's fleet managers.

Another major thrust in the center’s mission is its USAF Aircraft Structural Integrity Program Support. Due to the center’s recognized structural integrity expertise, several of our cadet and faculty teams are today in excess of 50 years old. And the fleet is not getting any younger. This fact combined with the ever-dwindling Air Force inventory makes safe operation and maximum readiness of the remaining aircraft critical to the warfighter.

The 2010–2011 Academic Year also saw the completion of a six year project for the U.S. Coast Guard collecting critical flight data and analysis. This project was not only critical to cadet-developed temperature correction equations for a strain measurement device and the validation of CAStLE developed structural models, but also resulted in the safe extension of the life of the U.S. Coast Guard HC-130H fleet by several thousand flight hours.

"One facility’s professional development is enhanced in much the same way, by providing them with state-of-the-art tools to address current maintenance problems for the Air Force. Working with either DoD practitioners in the field, our facility is able to bring the most current and relevant topics into the classroom. This obviously benefits the cadets, but has a ‘re-DOD’ effect on the faculty, fostering their professional development, and increasing their value to the cadets and the Air Force," added Greer.

As an example of ongoing research conducted in the center, cadets work on the CAStLE 1953 Tornadoes project, a partnership with Tinker AFB, involving three composite aircraft undergoing the most comprehensive non-destructive evaluation and zero-rigging teardown analysis of any aircraft ever undertaken worldwide. Project researchers anticipate the inspection of more than 25,000 parts by multiple techniques from each aircraft. This program is expected to yield more than 30,000 inspection results per aircraft to help fleet managers reach the current service requirement beyond 2040. Cadets have been intimately involved in the evaluation of the fatigue residual life in fuselage lip joint panels, the evaluation of the static residual strength of similar fuselage lip joint panels, and real-life root cause analysis of the inspection indications. Multiple cadets have accomplished full analyses of inspection indications which have become part of the formal report and data used by the USAF’s fleet managers.
**CENTER FOR CHARACTER & LEADERSHIP DEVELOPMENT**

The Center for Character & Leadership Development (CCLD) was established at the United States Air Force Academy in 2003. It serves as a bridge between the academy and the broader Air Force. The Center does this by providing world-class education and experiences for USAFA cadets and staff, enlightening and equipping future officers to advance lifelong habits of honorable living. The academic year 2011-2012 was critical in the Center's advancement toward being the Air Force's Center for Character and Leadership Development while preparing this development and promoting its integration across the broader Air Force. The Center describes its mission as advancing the understanding, practice, and integration of character and leadership development while preparing USAFA cadets for service to the nation in the profession of arms. The Center is staffed to comanage and deploy a cadre of permanent faculty and staff whose role is to engage in research that impacts both knowledge and application. Our conceptual framework drives and informs the research questions we ask and how we execute our "theory of program." The Center also oversees the administration of the revised Honor Survey, which annually assesses the impact of multiple Honor Directorate initiatives purposefully focused on "firing honorably," as opposed to a more litigious approach to honor education. The data has provided an important baseline for longitudinal analysis of program impact toward this important goal.

The Center for Character & Leadership Development (CCLD) continued to expand its scholarly impact with a variety of publications. In addition, two new publication platforms were introduced: Scholar Brief and Character Connections. The Scholar Briefs are standalone monographs on topics of relevance to targeted audiences, and are available in hard-copy and electronic formats. The first Scholar Brief, entitled "Return to Duty," was written by Lt Col Patrick Donley, a faculty member in the Academy's Department of Military Strategic Studies. This article challenged the Academy on its approach to developing a sense of duty among cadets. The second Scholar Brief by Department of Mathematics instructor Dr. Bradley Warner, presented a thoughtful perspective on how to teach character in technical classes.

Character Connections is a quarterly online publication that presents a compelling character and leadership-based question, and then invites relevant contributors to respond in two-to-three page influence pieces. The publication includes a comment forum that generates interaction among the participating readers. The first issue's question, "Is Duty Done?" was authored by all authors, such as the Chair of the Joint Chiefs of Staff Gen Martin E. Dempsey and the CCLD Senior Scholar (Dr. Arthur Schwartz). In the second issue, top consultants, educators and practitioners responded to a lead Thought Provocative to be Uncomfortable! All these publications have reached broad audiences in the military, civilian academic and practitioner arenas.

Finally, CCLD conducted a very promising formal research project on character coaching. The "Character Mosaic" pilot study examined the impact of developing a more in-depth and giving cadets an opportunity to improve their virtues. Participant versus those who did not. The results of this quasi-experimental study have significant implications for character and leadership development at the Academy. Cadet feedback on the pilot program has been consistently encouraging. As one cadet participant said, "Overall, this program helped me look at how I live my life more in-depth and gave me guidelines on how to improve my virtues." The CCLD with its many goals for its programs, events, and scholarship expansion is always striving for innovative instruction and research into the disciplines of character and leadership, to continuously build and adjust to the demands of change, and to challenge established worldviews about character and leadership.
P roviding a platform on which faculty and students can become fully engaged in physics, education and Science Technology Engineering and Mathematics (STEM) endeavors, the Academy’s Center for Physics Education Research (CPER) is on the forefront of transforming the Academy’s learning and teaching environment. Housed in the Department of Physics and led by Lt Col Steven Novotny and Dis-tinguished Scholar Dr. Gregor Novak, the center spearheads multiple research efforts with the goal of improving STEM education at USAFA through research and instruction. CPER research is looking beyond classroom instruc- tion and directly into the minds of the students. Cognitive science and education research suggest limiting that incorporates metacognitive knowledge and skills leads to longer lasting outcomes. The research also suggests that metacognitive skills can be acquired with curricula that help students develop an awareness of their inquiry process and the ability to reflect on what they are doing. Such curricula will help them deconstruct and analyze. This “Worked-Examples” approach, implemented as the foundation for all core physics courses, has been tested on over 3,000 students, with encouraging results and wide-radiat-ing impacts.

The CPER is working to impact USAFA and the nation’s STEM education by further developing a library of research-based materials that will aid instructors in providing the proven benefits of an active learning environment. The CPER is beginning the task of developing 200 pre-instruction learning modules, classroom-tested materials, and disseminating the materials nationwide through a digital library funded by the National Science Foundation (NSF). All of these efforts produce future Air Force officers possessing better critical thinking skills in technical and non-technical problem solving. Instead of leav-ing their physics courses with a handful of memorized equations, they will leave better able to attack any intellectual problem. With a concept-oriented ap-proach to a concept-oriented science, the equa-tions become the tools they are supposed to be instead of the solutions in a test. (Anonymous Cadet Third Class)

“Worked-Examples” pedagogy, CPER has focused ef-forts on creating research-based materials to enable any school and any instructor to take advantage of improving STEM education by further developing a library of research-based materials that will aid instructors in providing the proven benefits of an active learning environment. The CPER is working to impact USAFA and the nation’s STEM education by further developing a library of research-based materials that will aid instructors in providing the proven benefits of an active learning environment. The CPER is beginning the task of developing 200 pre-instruction learning modules, classroom-tested materials, and disseminating the materials nationwide through a digital library funded by the National Science Foundation (NSF). All of these efforts produce future Air Force officers possessing better critical thinking skills in technical and non-technical problem solving. Instead of leav-ing their physics courses with a handful of memorized equations, they will leave better able to attack any intellectual problem. With a concept-oriented ap-proach to a concept-oriented science, the equa-tions become the tools they are supposed to be instead of the solutions in a test. (Anonymous Cadet Third Class)

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The space environment around Earth has become increasingly congested, contended, and competitive as more nations develop and launch satellites for civil and military purposes. Consequently, space situational awareness (SSA) is a vital component of U.S. national security and is foundational to our country’s success in operating safely and freely in space.

The Department of Physics Center for Space Situational Awareness Research (CSSAR), led by Dr. Francis Chun, is providing cadets and faculty with cutting-edge SSA research. This past year, CSSAR continued to garner recognition from the space community for providing unique capability and opportunities foundational to our country’s success in operating satellites safely and freely in space.

In Fall 2011, Drs. Chun, Roger Tippets, and Michael Dearborn of CSSAR were awarded a $791,500 grant from the Air Force Office of Scientific Research under the Defense University Research Instrumentation Program to develop a global network of small aperture optical telescopes for non-resolvable space object identification called the Falcon Telescope Network (FTN). Along with an additional $1,080,000 from the Academy, CSSAR is partnering with educational institutions around the world to build an initial FTN of 12 fixed telescope observatories and 2 mobile observatories. The remaining fixed sites will be in the state of Colorado to include Colorado Mesa University in Grand Junction, Colorado, Fort Lewis College in Durango, Northeastern Junior College in La Junta. An additional two Colorado sites are co-located at the Academy and at the Fath Recreation Area just west of the Academy. The remaining U.S. sites for the FTN include Penn State University in State College, and the U.S. Military Academy (West Point). The Avenue sites include Chile and Australia, with a potential location in South Africa. According to Dr. Beason, the FTN offers the space community a low-cost, high-payoff approach for pushing the state-of-the-art in non-resolvable space object identification.

In Spring 2012, Garduño and Silverio undertook the project of comparing the shape determination algorithm previously developed by Lt Dan Fulcoly (CSSAR Class of 2010) with the improved identification algorithm when data from more telescope sites were combined. This result confirmed and demonstrated, for the first time, the validity of the CSSAR’s premise that observation of satellites simultaneously from multiple telescopes is inherently better than from a single telescope. C2C Brandon Madden joined the team to create an FTN computer model that will help determine various observational scenarios and produce simulated data to compare to real-world observations.

CSSAR’s development of the cadet education and research program in SSA is paying dividends to the Air Force. Recently, Lt. Fulcoly noticed some space surveillance radars in the New England area and remarked that the SSA course at USAFA “gave me more than qualified to communicate effectively with the staff at both facilities, something even asking questions that were beyond their knowledge.” In short, CSSAR’s development of the cadet education and research program in SSA is paying dividends to the Air Force. Recently, Lt. Fulcoly noticed some space surveillance radars in the New England area and remarked that the SSA course at USAFA “gave me more than qualified to communicate effectively with the staff at both facilities, something even asking questions that were beyond their knowledge.”

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CHEMISTRY RESEARCH CENTER

The Chemistry Research Center (CRC) at the United States Air Force Academy has continuously evolved since its inception in 1995. For 33 years, the Frank J. Seiler Research Lab has been the inspiration and guiding hand to Dr. John Wilkes, the director of the CRC for nearly 25 years, but has been the inspiration and guiding hand to hundreds of faculty members and thousands of cadets. Known as the father of ionic liquids, Wilkes has established the center as one of the top Chemistry Research Centers in undergraduate institutions nationwide. The CRC currently has several partnerships such as the Air Force Research Laboratory, Los Alamos National Laboratory, the US Army Criminal Investigation Laboratory, and the Air Force Office of Scientific Research. The CRC continuously offers cadets at the Academy excellent opportunities to discover new uses and applications of ionic liquids.

"Ionic liquids can be designed by chemists to dissolve just about anything, sort of like medicinal chemistry can design pharmaceuticals that affect your body and mind in specific ways," said Wilkes. "Worldwide interest ranges from pure basic research on the synthesis and properties of new ionic liquids at universities to applications of now commercially available ionic liquids to industrial chemical processes." Wilkes has seen hundreds of uses for ionic liquids during the course of his career. The research center has offered cadets at the Academy excellent opportunities to discover new uses and applications for ionic liquids.

Some of the more recent efforts and discoveries include the discovery of a new thermal heat transfer ionic fluid, application of ionic fluids in chemical warfare agent neutralization, and illicit drug detection and analysis. Researchers in the CRC have contributed to discoveries on the synthesis and properties of new ionic liquids at universities to applications of now commercially available ionic liquids to industrial chemical processes. Wilkes and his colleagues have been looking for new ways to detect, identify and neutralize CBRNE agents in the lab for both national security purposes, as well as criminal forensics applications where CBRNE or illicit drugs, such as methamphetamine, are suspected. In 2012 Cadet Michelle Kiyota conducted USACIL research on which type of ionic liquid is most suitable and stable for detection of TNT residue. She identified the best type of polymer swab for the transfer of the substance from a surface to the ionic liquid and determined if the method was capable of preserving the evidence of TNT residues.

This ability would be important to law enforcement agents who would need to also preserve the evidence discovered by any future applications of this technology. Kiyota successfully showed through her research that samples could indeed be preserved for 55 days or longer after sample collection. This research project was continued by Cadet Yasmin Sarmiento during the 2012 Cadet Summer Research Program with funding provided by the Defense Threat Reduction Agency. Now this research is seeing a cadet's progression of becoming independent thinkers which is truly what makes them critically thinking leaders.

Instead of just seeing chemistry in the classroom, I saw our research being applied to real-world forensic investigations and applications," said Sarmiento of her research, which she and her fellow research partners are working to publish. "That’s a huge leap from where research is applied in the broader Air Force.” Sarmiento hopes to apply what she has learned in her career as an officer and said that work in forensic chemistry can be applied to many jobs in the Air Force including the Office of Special Investigations, research acquisitions, or in law enforcement.

"The Chemistry Department, under the leadership of Dr. Wilkes, has a long-standing tradition of premier cadet research. I plan to continue this tradition by equipping our chemistry majors with the tools they need in order to meet demands of the operational Air Force as future officers,” said Dr. Scott Kline, who took over leadership of the center upon Wilkes’ retirement. "Cadet research goes beyond the grind of mixing chemicals to come up with the next big thing, rather it is seeing a cadet’s progression of becoming independent thinkers which is truly what makes them critically thinking leaders."
RESEARCH AT USAFA 2012

DFCE research motivation is based on the development of energy-efficient, safer, and less costly infrastructure. DFCE research efforts focus on four subject areas: infrastructure protection, environmental engineering, energy conservation and sustainable systems, and engineering education. Cadets are required to conduct the research, and publish their efforts with faculty mentors.

DFCE faculty Lt Col John Christ led a project developing research efforts also focused on indoor air quality (IAQ) measurement, and is being used to evaluate the importance of service and field learning activities in an engineering curriculum. Some of the elements assessed include the importance of service and experiential learning on cadet cultural awareness, engineering technology, and community partnerships. The faculty team developed a course entitled Cultural Consciousness and Humanitarian Aid, in which cadets designed and constructed a prototype sand filter to supply drinking water for African villages. The project is part of an ongoing partnership with the University of Colorado-Boulder and will also be included in 2012 ASCE's Colorado Springs Area Infrastructure Report Card.

DFCE cadets work with mentors to construct two Navajo Hogan-style homes, which are then donated to the Navajo Nation. The wood frame construction activity offered during FERL continues to be an annual project and is being used to evaluate the importance of service and field learning, influence of learning contracts on student commitment and academic performance. DFCE cadets work with mentors to construct two Navajo Hogan-style homes, which are then donated to the Navajo Nation. The wood frame construction activity offered during FERL continues to be an annual project and is being used to evaluate the importance of service and field learning, influence of learning contracts on student commitment and academic performance. The faculty team developed a course entitled Cultural Consciousness and Humanitarian Aid, in which cadets designed and constructed a prototype sand filter to supply drinking water for African villages. The project is part of an ongoing partnership with the University of Colorado-Boulder and will also be included in 2012 ASCE's Colorado Springs Area Infrastructure Report Card.

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English and Fine Arts division where Dr. Pam Aloisa English to Aeronautics and Computer Engineering, Foreign Languages, History, Military and Strategic Studies, and Philosophy, and each of these departments sends cadets on both foreign and domestic projects. While one cadet participated XI Congreso Internacional de Literatura Hispánica in Peru. The work of these young researchers was well-received and met with critical acclaim.

To broaden cadets’ educational foundation and further encourage integration and collaboration, the divisions sent cadets on both foreign and domestic Cadet Summer Research Projects (CSRP). Through the CSRP program, these cadets presented a research paper at the IX Congreso Internacional de Literatura Hispánica while one cadet participated XI Congreso Internacional de Literatura Hispánica in Peru. The work of these young researchers was well-received and met with critical acclaim.

Adding to the diversity of research projects across the Humanities Division, Cadets Kathy Bogan and Joanna Pattugalan, from the English and Fine Arts Department, studied senior leadership communications and social networking at Los Angeles Air Force Base. Cadets Bogan and Pattugalan jumped in head first to better understand communication avenues and techniques available to them as young officers in a technologically advanced Air Force. As methods and technologies in communication change, it is imperative that cadets understand how to use these tools purposefully and strategically. Taking yet another research avenue, Cadet Ali Khan participated in a business writing project at the Darden School of Business at the University of Virginia. Khan reflected on her experiences there, saying, “My time at the Darden Business School at the University of Virginia taught me how valuable a degree in English is. This was not an internship where I made copies and got coffee. I wrote real case studies and technical data reports that will be used in Darden curriculum. It was a great educational experience.”

Cadet research in the Humanities Division is about first-hand experiences and exploration of the subjects and practices associated with the discipline. Those experiences and explorations are driven by a desire to learn about the endeavors humans and cultures, people, and ideas and how those differences enhance both personal and professional growth as an individual and a leader.
The multi-disciplinary USAFA Cadet Summer Research Program (CSRP) offers cadets unique opportunities to apply their knowledge to real-world situations—in essence a “laboratory application” of classroom learning. The program is designed to provide cadets with the opportunity to engage in research and training under the guidance of experienced mentors. The CSRP includes a wide range of research opportunities, from basic science to applied research, and is open to cadets from all majors. The program is administered by the Office of the Provost and is one of the key components of the USAFA’s commitment to academic excellence and research.
The Eisenhower Center for Space and Defense Studies is the research center for the Department of Political Science, providing a focus for faculty and cadets in the field of defense and security studies, which has been a tradition in the Department for fifty years. The Center works to create opportunities to bring cadets and faculty members together with policy makers and contribute new ideas to improve the understanding and analysis of emerging challenges in the 21st Century. Through first-hand exposure to national and international leaders in workshops and discussions organized by the Eisenhower Center, cadets learn directly from leading experts about the issues and problems that will confront them in their Air Force careers. In particular, the Center engages cadets who are neither from engineering or science degree programs nor destined for assignment in the space and missile career fields. In so doing, the Eisenhower Center increases the number of Academy graduates with a greater depth of understanding of the security and policy issues in the space and cyber domains and how these play in overall U.S. defense and strategic policy, contributing not only to enhancing military capability but also to achieving overall U.S. foreign and strategic policy goals.

Led by Ambassador Roger Harrison, over the past seven years the Eisenhower Center has greatly increased the resources the Academy devotes to space and security studies, including the publication of its Space Defense Policy textbook, expansion of graduate study opportunities in space policy for cadets, funding cadet and faculty research projects and internships, and bringing cadets together with senior officials and other experts in workshops on key space policy issues facing the United States. These workshops have included a series of discussions on topics ranging from improving space situational awareness, the dynamics of U.S.-Chinese strategy and security in space, and trans-Atlantic space cooperation.

In 2012 the Eisenhower Center begins its first year of research under the Minerva Initiative, sponsored through a grant from the Office of the Secretary of Defense. Through the Minerva research grant, the Center will host two civilian guest researchers who will pursue their individual research projects examining internal and external developments shaping the strategic relationship between the United States and China. The Minerva Fellows will also provide a means to nurture research partnerships in the social sciences between the Department of Defense and civilian universities.

The Center is named in honor of Dwight D. Eisenhower. Eisenhower was the first American president to establish a national policy on the use of space for both military and civilian purposes. His legacy—the creation of both the National Reconnaissance Office and NASA—fueled the foundation for the manned space program, the use of space tobolster national security, and the infrastructure which led toorkflows in battle management and global communications. This foundation remains the benchmark against which all successive policies are measured.

“We must think about space, we must think about it technically. We need to think about it politically and strategically. This space domain confronts the war fighter with distinct challenges, both operationally and in terms of policy. The Center’s role is to prepare Air Force Academy cadets for these challenges, giving them the opportunity for cutting edge research and to nurture them as future leaders of the greatest space force in the world,” said Harrison.
The study conducted during AY 2011-2012 was de- signed to continue previous research from AF 2010- 2011 for the purposes of increasing statistical power. This study was led by Lt Col David Wegler, an assist- ant professor in the biology department. This collabo- rative effort provided C1C Elvira Chiccarelli, C1C Zach Schumacher, and C1C Lane Thaut an opportu- nity to obtain research experience and understand the processes and diligence of effort required to achieve understand of the research process such as prepar- ing manuscripts, abstracts, and presentation of results. Chiccarelli provided data analysis, and presentation of results,” said HPL director Dr. Jeff Nelson. “What goes into a final product, such as a manuscript, abstract, or poster presentation, is often the result of long hours of hard work. Additionally, cadets appreciate that at- tention to detail in the research process has a direct correla- tion to the quality of the results.”

The findings of ongoing altitude acclimatization research have a direct application to DoD and AF missions in theatre. It is important to be aware of the time course of altitude acclimatization in that it takes longer than previously thought to fully acclimatize. Individual differences in acclimatization rates, which can be influenced by genetics, can predispose a person to be either a fast or slow responder. This is no less the case when it comes to altitude. Being a slow responder to altitude may necessitate an individual to pre-acclimatize at a moderate altitude location prior to being deployed to theatre at altitude. Additionally, altitude acclimatization research has emphasized the importance of considering physician-supervised iron supplements if one becomes iron deficient upon taking residence at altitude. This has direct application to cadets, including those involved in athletic competition. The indirect evidence of neocytolysis, or the breakdown of young red blood cells when you go from a higher altitude to a lower altitude, has brought to light the de-acclimatization that occurs over such temporary sojourns as winter break. When cadets return to altitude from sea level, their performances on aerobic and anaerobic exercises is negatively impacted. The importance of this is highlighted by the fact that higher intensity and/or duration exercise performed while at sea level can buffer the loss in hemoglobin mass and subsequently reduce the loss in performance.

Nelson said that cadets participating in research can be provided a perspective of opportunities available post-graduation. Cadets can understand that the idea of re- search is to investigate and seek out pieces of the puzzle—to further explain con- cepts and principles that further add to the knowledge base. Research at USAFA is just another element that contributes to developing leaders of character. It further supports the concepts of integrity first, service before self, and excellence in all we do. The human performance lab seeks to continue providing research opportunities to cadets in order to further support the mission of USAFA,” said Nelson.

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The Airdrop Enhanced Logistics Visibility Information Technology (AELVIS) Program, directed by Lt Col Freddie Rodriguez, blends multiple technologies to provide airdrop bundle situational awareness data to warfighters. In light of Air Mobility Command’s (AMC) delivery of more than 80 million pounds of cargo via airdrop in 2011, AELVIS has been heralded as a force-multiplier, particularly for airdrops to highly mobile units on the move. This year, AELVIS was included in the AMC-AFRL (Air Force Research Laboratory) Precision Airdrop Flagship Capability Concept baseline and was singled out by the AMC Commander as a “MacGyver” solution for warfighter operations. The project was fully funded by AFRL last year and after several successful demonstrations this year, AELVIS is positioned to deliver the initial installment of this cutting edge capability in FY13.

The Warfighter’s Edge (WEdge) team is directed by Lt Col Andy Berry, a warfighter and visionary for a service-oriented architecture. WEdgeNET is the backbone for a secure file transfer capability on Air Force classified networks and will provide the foundation for distributed mission planning applications. The Warfighter’s Edge team also took on two other initiatives enabling collaboration. WEdge adopted a mission planning route translator enabling warfighter operators using disparate tools to share route information. Additionally, the WEdge Shuttle was used in distributed UAS-RPA collaboration experiments with the F/A-22 RMAESTRO suite of tools.

The Unmanned Aerial Surveillance—Remotely Piloted Aircraft Program (UAS-RPA), directed by Lt Col John McCurdy, has made great progress over the past year in its mission to develop cadet leadership with a relevant and realistic training environment. The program provides faculty and cadets with UAS-RPA academic knowledge, experimental learning, operational familiarization and a research foundation to support warfighting effectiveness while minimizing requirements for new training and equipment. This year, the program created WEDGE.NET using a service-oriented architecture. WEDGE.NET is the backend for a secure file transfer capability on Air Force classified networks and will provide the foundation for distributed mission planning applications. The Warfighter’s Edge team also took on two other initiatives enabling collaboration. WEdge adopted a mission planning route translator enabling warfighter operators using disparate tools to share route information. Additionally, the WEdge Shuttle was used in distributed UAS-RPA collaboration experiments with the F/A-22 RMAESTRO suite of tools.

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The Air Force Institute for National Security Studies (INSS) has focused research, published reports, and developed leaders with strategic knowledge and perspective for 20 years, and it is well-positioned to continue to support Air Force interests in enduring and emerging strategic security issues. Housed within the faculty at USAFA, INSS reaches out across the USAFA faculty and the broader military academic community to conduct research and to bridge the academic, think tank, and government policy communities on strategic issues. Led by Dr. Jim Smith since 1998, the INSS mission is to guide research on enduring and emerging strategic security issues, and to provide outreach through publications and workshops to convey the lessons of that research. The Institute also seeks to develop policy knowledge and analytical skills to help build military officers, and the faculties that educate them, with enhanced strategic knowledge and skills.

Across academic year 2011-2012, INSS focused on two primary areas: USAF support to regional extended deterrence and assurance, and strategic policy education and development. INSS hosted three interactive workshops in Washington DC on regional extended deterrence and assurance. In June 2011, INSS hosted a workshop, “Extended Deterrence and NATO/Europe.” The workshop combined unclassified and classified discussion on the US commitment, varied allied perceptions of assurance, and the USAF roles in advancing this mission set into the mid-term future. INSS followed-up on this effort with support to a workshop hosted by the US Army and US Navy War Colleges on “Tactical Nuclear Weapons and NATO.” The Army War College published the collected presentations from that workshop in a book of that same name, and two of the INSS staff were represented in that publication.

A second INSS workshop, “Extended Deterrence and Northeast Asia,” was hosted in September 2011. This workshop used the same unclassified/classified format as for NATO/Europe, and it too engendered active and continuing discussion among the various principals and informed the USAF on its continuing challenges in this important theater. The third workshop in the series, “Extended Deterrence and the Middle East,” was hosted in April 2012. It was also timely and useful to the Air Staff planners. A fourth series workshop focused on extended deterrence and arms control will be held in 2013. INSS is combining the four individual workshop reports and publishing a consolidated report on Extended Deterrence and the USAF. According to Mr Richard Benson, Chief of the USAF International Treaties and Agreements Branch, “These workshops provide the perfect forum for consolidating our understanding of what the USAF needs to plan for, what capabilities we need to develop and maintain, and what we need to protect in arms control negotiations to be able to continue to fulfill our mission.”

In the area of strategic policy education and development, INSS developed and presented its first Strategic Policy Overview in August 2011 in Washington DC to incoming Pentagon action officers and newly assigned Unified Command/Treaty Compliance Officers from the USAF arms control community. INSS then repeated the course in September 2011 in Colorado, this time for a select group of graduate students and new PhD recipients from across the country, including faculty from the Air Force Academy, the Military Academy, and the Naval Academy. This event was also our third annual Junior Summer Strategic Seminar. INSS then presented the course in March 2012 at the Defense Nuclear Weapons School for faculty development for their faculty and the training staff of the USAF Nuclear Weapons Center. This will be a continuing program with two offerings planned each year.

The INSS Director believes, “The USAF has a continuing and essential national tasking to retain and advance strategic expertise as long as the nation retains deterrence requirements. INSS will be one of the players in maintaining that strategic expertise and ensuring a continuing ‘bench’ for the USAF.”
The center, supported by 11 full-time researchers, focuses on optics research including fiber lasers, holographic optical devices, and materials. The LORC offers the unique environment where cadets and researchers can together investigate and develop promising ideas for the Air Force, Department of Defense and industry partners.

Led by Dr. Randy Knize, the LORC has become one of the most extensive, well-funded unique environment where cadets and researchers can contribute to innovative projects that can influence the future of Air Force weapons and technology.”

A world leader in holographic optics technologies, Dr. Geoff Andersen directs the LORC’s adaptive optics and large space optics program. Using diffraction instead of refraction to collect and focus light, Andersen-developed large diameter, flexible membrane photo-sieve “lenses” to be deployed in space on the DARPA-funded FalconSAT-7. Andersen’s lightweight adaptive index materials (NIMs), tunable plasmonic metamaterials, and high sensitivity single-atom detectors. Tunable plasmonic metamaterials, for example, offer unique active responses to transverse wavelengths, potentially wide applicable to sensors, antennas, and cloaking in various AF tasks. Drs. Brian Patterson and Jerry Sell are also investigating plasmonic effects in various materials via an investigation of the effect of plasmonic layers in thin film silicon solar cells. The LORC’s materials and nanotechnology research represents an emerging field that cadets have the opportunity to contribute to and that may lead to more efficient energy conversion devices or advanced semiconductors capable of optical sensing, detection, cloaking or shielding applications in the future.
The Life Sciences Research Center (LSRC) is making significant strides towards facilitating the use of microalgae for biofuel production. Refining the scope of the center’s research towards understanding, identifying, and developing microalgae species that produce liquid hydrocarbons, cadet research has been a driving force in the center. This work has given AFRL researchers the ability to potentially use deployed biologically derived energy, which would enable the US Air Force to develop and demonstrate technologies that could drastically reduce time and logistics footprint to harvest algae for propulsion additives. Wojdan’s work was praised by AFRL staff scientists who said his research “enabled his branch to develop and demonstrate expected efficiencies that, linked with significant and anticipated improvements in microalgae productivity, could enable our mission to use algae, rather than fossil fuels, for the USAFA Thomas D. Moore Award for Cadet Research Laureates.

The center makes substantial equipment upgrades including new advanced cultivation and measuring equipment to carefully analyze optimization trials. Additionally, the center attracted new research partners which bring depth and expertise to LSRC and the center experience. One of these new partners which bring depth and expertise to LSRC and the center experience is CSRP Award winner and he was a semi-finalist for the 2012 USAFA Basic Science computing and molecular biology. In 2009, he was a co-lead author on a paper published in the Journal of Applied Biology, which demonstrated the potential of using microalgae to produce biofuels. Wojdan’s research efforts resulted in his selection as the 2012 USAFA Basic Science Computing and Molecular Biology Laureate, and he was awarded the 2012 USAFA Basic Science Computing and Molecular Biology Award. Wojdan’s work has given AFRL researchers the ability to potentially use deployed biologically derived energy, which would enable the US Air Force to develop and demonstrate technologies that could drastically reduce time and logistics footprint to harvest algae for propulsion additives. Wojdan’s work was praised by AFRL staff scientists who said his research “enabled his branch to develop and demonstrate expected efficiencies that, linked with significant and anticipated improvements in microalgae productivity, could enable our mission to use algae, rather than fossil fuels, for propulsion additives.”

Another 2012 CRADA with the Colorado School of Mines, which has considerable understanding in the fermentative aspect (ethanol) and hold great promise for producing large yields of biomass available for creating renewable biofuels. Nowadly’s efforts were recognized in 2011 by the Air Force Surgeon General Lt Gen Bruce Green who in Air Force tradition, coined Nowadly for his outstanding poster presentation given during the annual Air Force Medical Research Symposium in Washington DC. Nowadly was the first ever research cadet to be singled out for this prestigious honor.

Our cadets represent the cornerstone of our center. Their endless inquisitiveness and thirst for greater knowledge has immeasurably added to our research momentum,” said Veverka. "The School of Mines will add our efforts in better profiling the results obtained from some of our higher producing algal strains. These new developments along with our current academic and private industry partners are anticipated to help advance our media optimization research significantly and at the same time offer our cadets a cross-cutting perspective of government, academia and commercial industry working together,” said Veverka.

LSRC also took under its new Science, Technology, Engineering and Mathematics (STEM) partnership with a regional high school. Sara Volz, a high school junior at Cheyenne Mountain High School, joined the LSRC during the 2011/2012 year, assisting the LSRC with some experiments involving environmental manipulation of select algae for biofuel. Already carrying out experiments in her home while in middle school, Volz had an innate interest in cultivation of algae and has brought with her some of her year’s experience that she has just started. Working with the center and Dr. Timm Knoerzer of the Academy’s Department of Chemistry, she has already won some local and regional science fair awards based on her recent work and is slated to go onto to both national and international competitions in the fall part of 2012. The quest for stable Polymerase Chain Reaction (PCR) dye reagents adding to the detection and mitigation of biological threats remains a high priority for molecular-based work whether in the laboratory or the field. These reagents are typicallyAs a result of successful PCR experiments, NC95s and C02C Craig Nowadly has indicated a stable PCR master mix may be possible under the PDR the dye reagent must. Nowadly and Nowadly’s research has found that when exposed to certain temperatures, certain reagents remain stable, even at temperatures exceeding 45 degrees C. Future experiments are needed to model long-term temperature risks.

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As future leaders in the Air Force, it is vital that cadets be exposed to the methods and tools that will be used to advance the state of technology for the foreseeable future," said Lt Col Reed. The MSRC plays an important role in this process through sponsorship of immersive summer research projects, making state of the art computational resources available to any interested researcher and cadet, and supporting the integration of modeling and simulation tools into the curricula. Over the next several years, the emphasis on modeling and simulation will continue to grow and become a natural part of many more research projects and extend into academic courses across USAFA. It is truly an exciting time to be in the Modeling and Simulation Research Center.
As the 33rd best university in the nation, the U.S. Air Force Academy places a heavy emphasis on developing a diverse and dedicated collection of instructors, highly valued in making cadet learning the number one priority. During the past three years, some of them have taken the step of engaging in the Scholarship of Teaching and Learning (SoTL), which promotes a scientific approach to understanding what works best in both education and the classroom. An added bonus is the inclusion of cadets in SoTL research. As co-investigators, cadets have an opportunity to improve their learning, we can avoid educational fads and more widely adopt data-supported best practices,” said Scharff.

By systematically studying what works to enhance learning, we can avoid educational fads and more widely adopt data-supported best practices,” said Scharff.

Building on work from last year, some SoTL projects incorporated a focus on the use of new technologies. For example, during the spring 2012 semester, Dr. Mark Jensen of the Philosophy Department created a completely paperless classroom. While being completely paperless is common for online courses, it is not typical for face-to-face courses. Each student was given a Fujitsu slate to use for the semester, pur chased a new stylus rather than paper notes, was instructed how to use electronic annotation while reading and taking notes, and received and submitted all documents online. Cadets’ focus group comments last year indicated that many students hesitate to annotate their paper texts, but that they were more likely to electronically highlight and annotate when they used electronic texts. Dr. Jensen assessed differences in individual course projects, multi-course projects, cadet-facilitated research, and institutional-level projects.

“As part of the Academy’s Computer Security and Information Warfare course, CCG Ryan Cooney and Jacob Rudolph worked with Dr. Steven Fulton on a project to understand the role of privacy in and the social networking situations and to understand how cadets’ expectations of privacy related to their activities on social networking sites. The cadets collected feedback from cadets enrolled in the Introduction to Computer Science courses and performed an assessment of cadet politically available information on the most common social networking sites. The results of this project will be utilized to create a teaching tool for future instructors of computer science courses.

SoTL projects are also “cutting edge” in ways that don’t involve technology. For the spring 2012 semester, Capt. Timothy Frank and Josh Aldred from Civil Engineering, along with Dr. Aiko Meyers of the Department of Foreign Languages created a new interdisciplinary course in Foreign Area Studies that puts new meaning to the term “interdisciplinary.” As an overview for interdisciplinary courses, this course involved three instructors who attended and actively participated in each lesson. However, in addition, more than half the lessons were led by instructors and staff from across the Academy (e.g. history, literature, political science, economics, behavioral sciences, project management, military strategy, culture, language, and engineering). Cadets were exposed to a wide array of perspectives that pertained to meaningful ways to the course’s objective: the application of these fields to the study of Mozambique and foreign aid, the design of a water purification method that would be appropriate for the Mozambican popula tion, and actual delivery and implementation of their purification method. This course approach optimizes the development and application of critical thinking that we desire for our graduates—processes they will need to bring to bear as they move into an operational environment.

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On a larger scale, there were several multi-course SoTL projects involving mul tiple courses. Prof. John Harrel (Law), Dr. George Mastropini (Behavioral Sci ences), Dr. Andy Katayama (Behavioral Sciences) and Dr. Scharff (SoTL), began an ongoing series of studies that investigates best practices in Scholar courses and how these might be transferred to non-Scholar courses. Additionally, eight course direc tors from the fourth-class year continued working together to enhance foundational critical thinking skills and created a common critical thinking guide and explicit links across courses. Projects such as these support institutional outcomes and harness the potential to positively impact every cadet who attends USAFA.

SoTL researchers share their projects and inspire other Academy instructors at the annual SoTL Forum, held in September of each year. They additionally share their ideas and findings via monthly SoTL Circle discussions and departmental brown bag presentations. During the AY 2011-2012, at least fifteen SoTL projects were pro posed at conferences, several of which had international audiences, and these pro ject papers were accepted for publication. “The ongoing, enthusiastic involvement in SoTL research across all DF divisions illustrates the dedication of our instructors to providing the best possible education for our cadets,” said Scharff.
E
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Center, the Space Physics and Atmospheric
Research Center (SPARC) is to provide cadets real-world research experience, allow-
ing them to “learn space by doing space.”

Led by Dr. Geoff McHarg, SPARC’s goal is to de-
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space and bring to the fight, and our cadets are bringing their
best efforts ever.” The Miniaturized Electrostatic
Analyzer (MESA) and Canary instruments are on the way to
success. The 2012 SPARC cadets started development of a new experiment,
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Analyzer (MESA) and Canary instruments.

A multi-disciplinary project involving several USAFA Research Centers,
Peregrine, to take images of the Sun using a deployable space telescope.

The FS-7 and Peregrine payload is funded by the Defense Advanced Research Pro-
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The Air Force Space Command Chief Scientist, Dr. Doug Beason said “The Fal-
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Space Physics & Atmospheric
Research Center

RESEARCH AT USAFA 2012

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At the recent Symposium on the Advancement of Space Flight, the new Peregrine and
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The Space Systems Research Center (SSRC) continues its role as a national leader and catalyzes the opportunity to design, build, test, launch, and operate Department of Defense (DoD) and other paradigms—the risk undertake-only effort of this kind in the world. Combined with its FalconOPS “Space for All” program and fully-capable ground operating system, a world-class commercial-grade clean room, and USAFA faculty and research experts from the space and launch industry, the “Space for Design” program offers cadets of all the chance to work within FalconSAT’s program provides cadets with the opportunity to participate, making the program truly multi-disciplinary. Colonel Martin France, Astronautics Engineering Department Head says “Harnessing cadets in a multi-disciplinary program where they need to work as a team and real-world needs that can be ambiguous—not just contact with the balky bird, and some of the payloads and subsystems have not performed as expected, but the cadets, faculty, and staff have kept FS-3 flying, all the while solving problems and actually improving its performance.” France pointed out FalconSat-3 was originally designed for a one-year mission and he expressed hope it may make it to its tenth birthday in 2017! In addition to successful operations missions, the SSRC has expanded its overall AF mission and offi- Space Systems Research Center (SSRC) currently operates FalconSAT-3 communications complex capabilities. In March of 2012 FalconSat-3 celebrated its fifth birthday and Col France, expressed his pride in the new academic center—not just is not the only project dedicated for Air Force and DoD space research but also produces cadets that are far ahead of the peers in terms of experiential manage- ment and leading complex technical programs.” One of the most successful SSRC cadet research ef- forts in 2012 was Cadet Jacob Kramer’s development of task executable code for FalconSat-3. His code tackled an operation that had plagued Falcon- SAT-3 since its launch in 2007—a lack of attitude control data, which is essential to operation of two experimental payloads: a plasma sensor and a pulsed Hall Effect Thruster as well as operated the Academy’s own Space Physics Analyzer (iMESA) and Wafer Integrated Spectrometer (WISPERS) sensors. Hall Effect Thruster as well as operated the Academy’s own Space Physics...

The Center continued to enhance its capabilities during 2012-2013. The USAFA Payload Laboratory was built and commissioned under the leadership of Dr. Michael Holmes Holmes, who is serving a two-year sabbatical from AFRL as a distinguished visiting professor to USAFA, brought a vacuum chamber from the AFRL Propulsion Directorate at Edwards AFB for this new facility. This state-of-the-art equipment allows cadets the opportunity to develop and test high-efficiency Electric Thruster to power future spacecraft. This novel concept in space propulsion has the potential to provide efficiencies 95 times greater than thrusters in use today and may be used on future FalconSATs. The SSRC has established itself as a leadership in top graduate schools for many cadets, with over 10 per year since 2006 headed to prestigious graduate schools including the Massachusetts Institute of Technology, Stanford, Rice University, Virginia Tech, and AFIT. The Center is being recognized as a center of space professionals to the Air Force but also to become a greater part of our nation’s next chapter in space operations and exploration. Cadets and SSRC alumni are conducting research critical to enhancing the Air Force space mission, and leading to the development of new technologies to drive our nation’s security in space, air, and cyberspace. At the 2012 USAFA Research Awards ceremony, AFRL Commander Major Gen- eral Nick McCauley named the Center’s sky’s the limit. “This has been a huge step for FalconSAT and I’m very pleased with the progress that has been made so far. The key thing is that we’ve taken the first step towards our goal of building the next generation of spacecraft.” The USAFA Payload Laboratory was built and commissioned under the leadership of Dr. Michael Holmes Holmes, who is serving a two-year sabbatical from AFRL as a distinguished visiting professor to USAFA, brought a vacuum chamber from the AFRL Propulsion Directorate at Edwards AFB for this new facility. This state-of-the-art equipment allows cadets the opportunity to develop and test high-efficiency Electric Thruster to power future spacecraft. This novel concept in space propulsion has the potential to provide efficiencies 95 times greater than thrusters in use today and may be used on future FalconSATs.
"As a leader in undergraduate education for Air Force (USAFA) has been a key contributor to America’s K-12 STEM Outreach & Research Center in 2011 to support a wide variety of STEM outreach to K-12 students and educators. The Center applies the Academy’s Core Values—Integrity First, Service Before Self, and Excellence in All We Do—to thoughtful educational plans and system engineering analyses to create an effective, valuable, local K-12 STEM outreach program.

’As a leader in undergraduate education for Air Force officers in STEM fields, the U.S. Air Force Academy has been a beneficiary of K-12 STEM education at the back end of the STEM talent pipeline. Until recently, the Academy viewed itself as a beneficiary of STEM workforce needs. Until recently, the Academy viewed itself as a beneficiary of the STEM education component of the Academy’s central mission, which is to train, educate, and inspire officers of character. Rather, it leverages and coordinates existing services, partnerships and resource strategies to create an effective, flexible, scalable, local K-12 STEM outreach program.

The Center does not play a role in the undergraduate STEM education system or in K-12 STEM education. The Center supports and coordinates STEM outreach by USAFA’s academic departments, individual faculty, and cadets. For example, the Department of Physics is typical in supporting multiple efforts for the local community, including its popular “Physics is Phun” and Astronomical Observatory Programs. Departments, individual faculty, and cadets support more than 10,000 regional students who visit our various research centers, laboratories, and classrooms annually. The Center supports STEM outreach via judging at local science fairs, giving live STEM demonstrations to local school groups, and supporting STEM visits and events all over the region.

Dr. William Crisler, who also teaches aircraft design at the Academy’s Department of Aeronautics, says Center Director Dr. William Crisler, who also teaches aircraft design in the Academy’s Department of Aeronautics.

The Center does not play a role in the undergraduate STEM education system or in K-12 STEM education. The Center supports and coordinates STEM outreach by USAFA’s academic departments, individual faculty, and cadets. For example, the Department of Physics is typical in supporting multiple efforts for the local community, including its popular “Physics is Phun” and Astronomical Observatory Programs. Departments, individual faculty, and cadets support more than 10,000 regional students who visit our various research centers, laboratories, and classrooms annually. The Center supports STEM outreach via judging at local science fairs, giving live STEM demonstrations to local school groups, and supporting STEM visits and events all over the region.

Dr. Crisler concludes by saying, “The key to solving the national STEM workforce crisis for America is a widespread, loosely-connected network of effective, flexible, local or regional solutions, not mere top-down, directives, one-size-fits-all programs. The Pikes Peak region and southern Colorado make an ideal proving ground for the collaborative model and pilot program we’ve developed for K-12 STEM outreach.”
A
t the sun rose against the Rocky Mountains on September 11, 2001, Lieutenant Colonel Tim Conklin, USAFA Class of 1988, had no idea what would happen that day. O
ginally slated to join his wing commander on a check flight, within a few hours after arriving at Buckley Air Force Base, he found himself strapped into his F-16 on a combat mission, patrolling the skies over Colorado. As he took off, he anchor
d to a larger giving campaign to support that project, and the COH hopes to

**USAFA CENTER FOR ORAL HISTORY.**

As he took off, he acknowledged an airmate message from the controller who usually
dismissal from the Department of History, where the center is currently housed. “By
in the voice of the people who experienced it. Building upon earlier oral history efforts conducted by the Department of History and on behalf of the

But the center is not only interested in preserving these narratives. It is also firmly committed to outraged by their own research and publication. Dr. Wettemann currently

study the history of USAFA, trace the involvement of USAFA graduates in Operation ALLIED FORCE, chart the construction of the USAFA

To ensure this lasting utility, the USAFA Center for Oral History continues to pur

and serves as course director for History 230: Histori

In September 2001, Conklin, a former USAFA Class of 1988 graduate, was

Building upon earlier oral history efforts conducted by the Department of History and on behalf of the Friends of the Library, the center believes its role of

Friends of the Library, the center believes its role of preserving yesterday for tomorrow’s profession of arms is of lasting importance to the larger USAFA

Preserving the history of the U.S. Air Force Academy through the voices of the people who experienced it. While the COH has conducted oral history

with cadets for their own research and publication. Dr. Wettemann currently

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A request by the American Institute of Aeronautics and Astronautics also sparked a new effort to chronicle the history of Aeronautics at USAFA. When

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friends of the USAFA Class History Project. The Class of 1963 has commit

already identified as a leadership lesson, or demonstrates core values of integrity, service, and excellence, it is worthy of being recorded.” To these ends, the USAFA COH has con

In 2001, USAFA cadets had an important experience to share with future generations,” opines Dr. Bob Wett

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Research at the United States Air Force Academy continues to be a highlight of the cadet experience and has promoted an environment enabling cadets' critical and analytical skills as well as shaping their future job prospects. The funding doesn't truly indicate the value for the thousands of cadets exposed to cutting-edge research opportunities in these programs. Officer training happens in the labs as they learn the negotiation and relationship skills required of tenured program managers. The only way for this to take place is in a lab environment with entrepreneurial spirit like the research centers at the Academy. When the funding impacts a cadet’s ability to conduct research then he or she quickly absorbs the business mindset from which future officers benefit. Financial support is still high, despite a decrease from year’s past. Funding arrives from two primary vehicles—the first vehicle being the Memorandum of Understanding (MOU)/Memorandum of Agreement (MOA) with Air Force, Department of Defense, and other federal agencies. The second vehicle is the Cooperative Research and Development Agreement (CRADA); used for research collaborations with non-federal entities. Whether it is for a cadet’s senior capstone course or an intriguing independent study in their field of interest, these funding vehicles allow every cadet the opportunity for exposure to an array of research projects.

The research program has a total value of $58.2 million for the 2011-2012 Fiscal Year (FY). This can be broken into three main categories: External In-Kind, External Funding, and Internal Support (See Figure 2). External In-Kind support includes the value of visiting researchers and in-kind supercomputer time contributed by the Department of Defense High Performance Computing Modernization Office, which totaled $9.25 million. External funding is the direct monetary funding that research centers receive from outside partners, pulled in from the Department of Defense (DoD), other government sources and non-federal entities. The Internal support value is determined by an evaluation of USAFA-provided laboratory facilities, USAFA personnel time, and totaled $11.8 million.

Figure 1 indicates the sources of external funding. Outside partners contribute to the continued overall growth rate since 2001. Agreement between USAFA’s Center for Aircraft Structural Life Extension (CAStLE) and the Life Cycle Management Center continues to support research on the KC-135 project. USAFA’s Center of Innovation (CoI) and Department of Homeland Security continue a multi-year endeavor to enhance the Rare Event Scenario. USAFA continues to receive core funding from the Air Force Office of Scientific Research (AFOSR), the basic research manager of the Air Force Research Laboratory.

Fig. 1 External Sources (FY 12)

Fig. 2 Econometric Value

Fig. 2: Values as of 31 August 2012.