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AIR FORCE INSTITUTE OF TECHNOLOGY GRADUATE SCHOOL OF ENGINEERING & MANAGEMENT

AFIT ENGINEER

The Graduate School of the U.S. Air Force

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ADVANCING HYPERSONICS

AFIT's Contributions through Academics, Research and Partnerships

By Heidi R. Ries, Ph.D.
Provost and Chief Academic Officer

Hypersonics capabilities are widely recognized as a critical aspect of Department of Defense modernization efforts. Achieving success in our nation's hypersonics initiatives requires a well-prepared workforce, advancements in technical understanding and supporting technologies, testing and manufacturing capacity, and innovative operational strategies. This issue of the AFIT Engineer highlights some of AFIT's contributions to advancing hypersonics capabilities, with a focus on workforce development and research results.

ACADEMIC SUCCESS

Consistent with AFIT's mission to "educate our Total Force military and civilian defense professionals to innovatively accomplish the deterrence and warfighting missions of the U.S. Air and Space Forces ... today and tomorrow," we produce master's and doctoral graduates who are experts in hypersonics systems, components, and counter-measures. Our students develop technical knowledge and critical thinking skills during their coursework and research projects – and leverage their enhanced capabilities throughout the remainder of their careers. While the majority of our students are in uniform, AFIT also educates federal civilian employees as well as employees of corporations supporting the Department of Defense or the nation's critical infrastructure.

RESEARCH EXPERTISE

AFIT's research contributions to hypersonics rely upon our faculty's expertise as well as our students' efforts. Our military faculty, as officer technologists, provide both academic leadership and operational insights to guide student projects. Through teaching and advising, our military faculty further hone their technical skills and are particularly well prepared for post-AFIT assignments to teams entrusted with the development of future hypersonics systems and employment strategies. Ongoing communications between former and current AFIT faculty members provides an additional "reach back" support capability and maintains broad awareness of current operational priorities.

PARTNERSHIPS

AFIT partners with the Air Force Research Laboratory, the University Consortium for Applied Hypersonics, the DoD High-Performance Computing Modernization Program, and others to execute hypersonics research projects addressing vehicle design, engine development, control approaches, and high temperature materials development. These multi-disciplinary, multi-institutional teams leverage available expertise to solve today's challenging problems, while providing a robust environment for developing the military and civilian workforce of the future.

AFIT will continue evolving our hypersonics-related education and research programs in the coming years to support the workforce development and research innovation requirements of the Air and Space Forces.

INSIDE THIS ISSUE

Read all issues online at:
www.afit.edu/EN/afitengineer

Annual Awards Recognize Faculty and Staff Accomplishments in 2021


Dr. Adedeji Badiru

Welcome to another exciting and informative issue of the AFIT ENgineer newsletter. This December 2021 issue is coming a little late due to pandemic-disrupted operations, similar to what we are all experiencing in many aspects of our day-to-day missions. Demonstrating the notion of "better late than never," this issue is not any less informative and stimulating.

To start off, I am delighted to report that we had a successful ABET visit in October 2021. We expect to receive our final ABET reaccreditation report in the Summer timeframe this year. It is a big pride for us to mention that our eligible academic programs have been continuously accredited since 1964, Astronautical Engineering being the first one. We expect nothing less than the legacy of excellence that we have demonstrated over the past decades.

In this issue, readers will find the various technical involvements of AFIT in the priority topic of hypersonics. This is headlined by the front-page article by Dr. Heidi Ries, Provost and Chief Academic Officer, outlining AFIT's contributions to hypersonics capabilities. If you happened to have missed that article by flipping through the pages too fast, please go back and take a look at that exciting introduction.

This issue also celebrates the diverse awards and recognitions of our faculty for their accomplishments in teaching, research, and defense-focused consultations. Please join me in congratulating everyone, as well as the supporting and enabling teams of students, staff, and administrators. Until we get a chance to have a sports team and charter a slogan, the best we can say is "Go AFIT!"

Adedeji B. Badiru, Ph.D., PE
Dean, Graduate School of Engineering and Management

TEACHING WHAT WE RESEARCH. RESEARCHING WHAT WE TEACH.

AFIT ENGINEER
AFIT Graduate School of Engineering and Management

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Dr. Glen Perram, Professor of Physics, attended the fall commencement ceremony on Sept. 16 held in AFIT's Kenney Hall Auditorium.

AFIT Celebrates Doctoral Graduates

Fall Commencement Ceremony Marks New AFIT Tradition

AFIT's Graduate School of Engineering and Management held its first fall commencement ceremony in several years on September 16 to celebrate 17 students earning doctoral degrees. The newly minted PhD's join a group of more than 960 other AFIT doctoral alumni. The fall commencement will become an annual tradition at AFIT to honor MS and PhD graduates who complete their program in either the spring and summer quarter.

The Graduate School has four quarters in which students might complete their degree and one primary commencement held each March. Although the majority of students complete their program in March, there are many programs that are scheduled outside of this cycle, such as the PhD and the Awaiting Pilot Training programs. Due to military moves, these graduates may not be able to participate in a March commencement and be formally recognized for their accomplishment. Therefore, the Graduate School will hold an annual fall commencement to honor graduates who cannot participate in the March ceremony.

At the 2021 ceremony, Dr. Walter Jones, AFIT Director and Chancellor, acknowledged the difficult circumstances students endured to complete their studies, including limited campus access due to COVID-19 restrictions. "AFIT has offered you a doctoral program filled with technical knowledge on par with any civilian institution you could find. We count on you going forward to take the technical skills you acquired here at AFIT and to use them to push for innovative solutions to the most difficult national security problems facing the military today and in the future. It won't be easy, but I know that you, our graduates, can be the agents of change in our Department of Defense that we so desperately need," said Dr. Jones.

LEARN MORE ONLINE

A complete list of doctoral graduates who participated in the ceremony can be found online at: https://e.afit.edu/8Thh5HH


U.S. Air Force photos by R.J. Oriez

Top: AFIT leadership stands with PhD graduates following the fall commencement ceremony.

Left: Dr. Anthony Palazotto, Distinguished Professor of Aerospace Engineering, served as the Grand Marshall at the fall commencement ceremony.

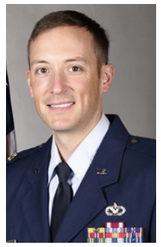
Above: PhD candidates await the conferral of their degrees.

2021 GSEM Award Winners

The value of an academic institution is a function of the accomplishments of its people (faculty, staff, students, and administrators) in both internal and external engagements pertaining to teaching, research, and professional service. The people of AFIT's Graduate School of Engineering and Management (GSEM) continue to excel along all the dimensions of scholarship and preeminence. Congratulations to the 2021 GSEM award winners.

LT. COL. JUSTIN DELORIT
DEPARTMENT OF SYSTEMS ENGINEERING & MANAGEMENT

ADVISING AND MENTORING AWARD



AWARD CRITERIA: Recognizes faculty's efforts as an academic/research advisor and mentor to AFIT graduate students; recognizes creativity for advising that promotes student learning, performance, achievement, progress/success, engagement, growth and connectedness.

With only 2 ½ years of advising experience, Lt. Col. Delorit advised 15 MS students and will advise two students in absentia. A natural leader, Lt. Col. Delorit sets high standards and expectations that results in strong student growth and development as he challenges students to achieve beyond what they thought was possible. Lt. Col. Delorit was recognized for his excellent advising and mentoring through several student-nominated awards, including the AFIT SIE Management Professor of the Year (2020) and he was a Graduate School finalist for the Leslie B. Norton Award (2021).

LT. COL. SAMUEL BUTLER
DEPARTMENT OF ENGINEERING PHYSICS

EARLY CAREER ACHIEVEMENT AWARD

AWARD CRITERIA: Recognizes exemplary contributions to teaching, scholarship, and service following the formative years (the first three years) of a junior faculty member's initial appointment. While nominees may excel in one or two areas, they must be successful in all three.

Lt. Col. Butler has taught 20 regular courses and nine short-term refresher courses since 2015, in addition to co-teaching the laser weapons short course. This includes eight unique graduate-level courses and exceeds the department academic promotion hallmark of excellence. Additionally, Lt. Col. Butler advised six Master's and one PhD student. Each student advised to date has published in conference papers or journal articles. Lt. Col. Butler's research output currently includes seven fully peer-reviewed publications, plus a publication in review, and a conference paper accepted based on a full paper review. Additionally, he has 14 conference papers accepted on the basis of an abstract, and three conference presentations, including an invited presentation. Lt. Col. Butler has served in a total of 11 different academic service positions, including five current positions.

DR. WILLIE HARPER
DEPARTMENT OF SYSTEMS ENGINEERING & MANAGEMENT

RESEARCH AWARD

AWARD CRITERIA: Recognizes outstanding scholars/researchers known externally in the academic community as leaders in their discipline. Recipient is singled out for distinction of his/her track record of scholarly research, and primarily for efforts while at AFIT.

Dr. Harper is an internationally recognized leader and he has used originality and creativity to blaze new scholarly trails in a number of areas. A true innovator, Dr. Harper invented a new theoretical approach for successfully modeling biodegradation, developed new biosensors for real-time monitoring of water quality and collaborated with researchers in Japan to discover an abiotic chemical reaction that emits a powerful greenhouse gas from wastewater treatment basins. Dr. Harper has worked on water and sanitation issues in developing countries and has contributed new knowledge to the body of literature while he impacted full scale water quality operations. Dr. Harper is a well-respected member of the environmental engineering and science community. He served as the primary research advisor to three PhD graduates, 29 MS graduates, 19 undergraduate research assistants and six postdoctoral research assistants. Additionally, Dr. Harper executed more than $2.5M of federally-sponsored research and produced 79 publications, including 52 peer-reviewed journal articles. Over the years, Dr. Harper has been honored with several distinctive awards, including the NSF Faculty Early CAREER Award (2006-2011), the Pennsylvania Water Environment Association Professional Research Award (2011), the Fulbright Scholar Award (2013-2014), the John L. McLucas Basic Research Award (2016) and was named an Embassy Science Fellow (2017-2018).

MR. JOHN REISNER
OFFICE OF E-LEARNING SUPPORT

OUTSTANDING STAFF AWARD

Courtesy photo

AWARD CRITERIA: Award recognizes exceptional service by administrative, support and technical staff employees in the GSEM.

Mr. Reisner's leadership and accomplishments have advanced and accelerated the Graduate School's capability to deliver courses by distance means and enabled blended techniques for resident offerings. Mr. Reisner has designed and constructed turnkey studios and a distance learning classroom for faculty and students to create digital content, including self-made training videos. Mr. Reisner and his team have been recipients of numerous faculty and student accolades over the years for their level of customer service, responsiveness to student and faculty needs, and expertise in supporting faculty and students. Collectively, these are testaments to his leadership, enthusiasm for his work, expertise in his field, and dedication to AFIT's mission. Mr. Reisner lives by his motto, "maximize quality for the student; minimize the onus on the instructor," and he has made both sides a reality. Mr. Reisner provided "emergency" support to the Graduate School at the beginning of the pandemic when many instructors had to pivot quickly to teach virtually for the first time and created an innovative "how to" Canvas course for faculty. Mr. Reisner served on Steven's Institute of Technology's Web Campus Advisory Board (2012-2017), led the migration from Blackboard to Canvas and served on several AFIT committees.

DR. CHRISTOPHER CHINI
DEPARTMENT OF SYSTEMS ENGINEERING & MANAGEMENT

TEACHING AWARD

AWARD CRITERIA: Recognizes faculty who have contributed significantly to the intellectual life of GSEM through demonstrated excellence in classroom teaching; represents innovative curricular leadership over sustained period of time (tenure-track and tenured faculty).

Dr. Chini demonstrated excellence across all three facets of faculty performance: teaching, research and service. His performance earned him the designation as a top performer in his department.

Dr. Chini's passion for teaching is evident and he consistently receives high teaching reviews (from both students and peers). His record of outstanding teaching was recognized via his student-nominated Instructor of the Year award from the Sigma Beta Chapter of Sigma Iota Epsilon at AFIT for 2021. Since 2019, Dr. Chini taught six unique courses for a total of 12 different sessions, not including four different independent studies. Additionally, he helmed the GEM fall refresher/short quarter for two years. Dr. Chini models high-quality teaching techniques and continues to be engaging and informative, as he adapted to the COVID-forced Teams-based teaching style with ease. Dr. Chini demonstrated a willingness to reformat and alter courses as needed based on feedback from students and his own self-reflection. He recently had two articles from his EMGT 723: Advanced Topics in Asset Management course projects published in a relevant career field journal, *The Military Engineer*. Dr. Chini's work is a fantastic example of how AFIT faculty mentor our students to solve real-world problems.

Dean's Distinguished Teaching Professors

AFIT Graduate School of Engineering and Management

The Graduate School of Engineering and Management is proud to announce the Academic Year 2021-2022 Dean's Distinguished Teaching Professors. Two professors were designated from each of the Graduate School's six academic departments as listed below.

Aeronautics & Astronautics

Dr. Fred Schauer
Associate Professor
of Aerospace Engineering

Maj Costantinos Zagaris, PhD
Assistant Professor of
Aerospace Engineering

Electrical & Computer Engineering

Dr. Robert Mills
Professor of Electrical Engineering

Dr. Barry Mullins
Professor of Computer Engineering

Engineering Physics

Dr. Abigail Bickley
Assistant Professor
of Nuclear Engineering

Maj Daniel Emmons, PhD
Assistant Professor
of Applied Physics

Mathematics & Statistics

Dr. Edward (Tony) White
Professor of Statistics

Dr. Aihua Wood
Professor of Mathematics

Operational Sciences

Maj Michael Garee, PhD
Assistant Professor
of Operations Research

Lt Col Aaron Glassburner, PhD
Assistant Professor of Logistics
& Supply Chain Management

Systems Engineering & Management

Dr. Christopher Chini
Assistant Professor
of Engineering Management

Lt Col Scott Drylie, PhD
Cost Analysis Program Chair

February 2022

AWARDS & RECOGNITION

SOCHE Announces 2021-2022 Excellence Awards Honorees

Academic officers at each Strategic Ohio Council for Higher Education (SOCHE) member institution submitted faculty members who demonstrated excellence in teaching, service, and scholarship throughout the 2021 calendar year. Similarly, human resources officers at each SOCHE member institution named staff members who demonstrated excellence in student success, service, and assessment throughout the past year.

All honorees are acknowledged on the SOCHE Excellence Awards webpage at www.soche.org/excellence-awards/ and will be featured throughout 2022 via SOCHE social media channels.

AFIT Graduate School of Engineering and Management SOCHE Excellence Awards Honorees are as follows: **Maj. Daniel Emmons, PhD**, Assistant Professor of Physics, **Ms. Alicia Sprinkle**, Graduate Advisor, Department of Electrical and Computer Engineering, **Ms. Lisa Smittle**, Management Analyst, Graduate School of Engineering and Management, **Dr. Aihua W. Wood**, Professor of Mathematics, and **Mr. Benjamin Doane**, Physical Science Technician, Department of Engineering Physics and Management.

SOCHE is the regional leader for higher collaboration, engaging with colleges, universities, and industry to transform the economy through the education and employment of nearly 200,000 students in Southwest Ohio.

U.S. Air Force official photo

AFIT Director and Chancellor Dr. Walter Jones presented Ms. Ranell Easterday with the 2021 Resource Advisor of the Year Award.

GSEM Budget Analyst Named 2021 Resource Advisor of the Year

Ms. Ranell Easterday, a Budget Analyst within the Graduate School of Engineering and Management, was named 2021 Resource Advisor of the Year. This Secretary of the Air Force's Financial Management (SAF/FM) and Comptroller annual award recognizes individuals who have made significant contributions to Air Force Financial Management efforts through outstanding performance, actions, innovations and results.

Easterday, along with the AFIT/Graduate School of Engineering budget team, won $6.9M in unfunded requirement (UFR) money from Air University, which equals 80% of AFIT's total UFR allocations and 100% of the Graduate School's submissions. Easterday and the budget team secured money for lab equipment and maintenance supporting cutting-edge research across all six academic departments in the areas of Hypersonics, Artificial Intelligence, Additive Manufacturing, Nuclear Engineering, Quantum Physics and Microelectronics.

Rao Wins Best Student Poster Award from SciX

First Lieutenant Ashwin Rao received the Best Student Poster Award from the Society for Applied Spectroscopy at the 2021 Scientific Exchange conference in Providence, RI. SciX is an international conference for analytical chemistry and spectroscopy researchers organized by the Federation of Analytical Chemistry and Spectroscopy Societies.

Rao is a nuclear engineering doctoral student within the Air Force Institute of Technology's Graduate School of Engineering and Management. The award-winning poster titled "Development of tree-based machine learning methods for quantification of gallium in a Pu surrogate matrix via LIBS" is based on Rao's dissertation research. Rao, who earned his master's degree in nuclear engineering from AFIT in 2020, is focusing his PhD research on applications of laser-induced breakdown spectroscopy (LIBS) for analysis of lanthanide and actinide metals as well as applications of machine learning algorithms for chemometric analysis of LIBS spectra.

Graduate Student Recognized with National SHPE STAR Government Award

Captain Cristian Hernandez Rivera, AFIT acquisition and program management graduate student, was selected to receive the SHPE STAR – Hispanic in Technology – Government Award from the Society of Hispanic Professional Engineers (SHPE) in Nov. 2021.

The award is given to a Hispanic engineer or scientist, who has made outstanding contributions in the fields of engineering and/or science. SHPE awards honor outstanding professionals for their dedication, commitment, and selfless efforts to advance Hispanics in STEM careers.

U.S. Air Force official photo

Capt. Cristian Hernandez Rivera was recognized by AFIT Director and Chancellor Dr. Walter Jones for receiving the National SHPE STAR Government Award.

Ground-breaking Research Published by Faculty

Real-time Automated Aerial Refueling with Stereo Vision

Dr. Scott Nykl, Associate Professor of Computer Science, and **Dr. Clark Taylor**, Assistant Professor of Computer Engineering, co-authored the article "Real-time Automated Aerial Refueling with Stereo Vision," which appeared on the cover of the July-August edition of *Inside GNSS*. Additional authors who contributed to the article are James Anderson, Xiaoyang Wu, Capt. Joel Miller and Lt. Col. Warren Watkinson.

The article describes current research at the Air Force Institute of Technology that focuses on aerial refueling while overcoming GNSS-denied environments in or near combat areas. The digital version of the GNSS publication containing the article can be found at this link: https://e.afit.edu/9JJbcVm

Operational Cybersecurity in the Age of Megaconstellations

The Fall 2021 issue of the *Air & Space Power Journal* featured the article "Shifting Satellite Control Paradigms: Operational Cybersecurity in the Age of Megaconstellations," which was co-authored by AFIT faculty members **Maj. Robert Bettinger, PhD, USAF**, **Lt. Col. Mark Reith, PhD, USAF, Ret** and **Capt. Carl Poole, USSF**, a recent graduate of AFIT's MS Space Systems program. Maj. Bettinger is an Assistant Professor of Astronautical Engineering and curriculum chair for the astronautical engineering degree program at AFIT. Dr. Mark Reith is an Assistant Professor of Computer Science within AFIT's Graduate School Department of Electrical and Computer Engineering.

"The introduction of automated satellite control systems into a space-mission environment historically dominated by human-in-the-loop operations will require a more focused understanding of cybersecurity measures to ensure space system safety and security. It is no longer a matter of whether automation will be introduced to satellite operations, but how quickly satellite operators can adapt to the onset of control automation and promote cybersecurity in an increasingly competitive, contested, and congested space domain."

Read the complete article at this link: https://e.afit.edu/8nbcdKK

Research Focuses on Improving Survivability in Air and Space

AFIT's spacecraft survivability research by **Maj. Robert Bettinger** and his students was showcased in the *American Institute of Aeronautics and Astronautics (AIAA) Year-in-Review* magazine. The article highlighted cislunar debris propagation research by Maj. Bettinger who is an Assistant Professor of Astronautical Engineering and curriculum chair for the astronautical engineering degree program at AFIT. Read the article at this link: https://e.afit.edu/kkccBBxymm

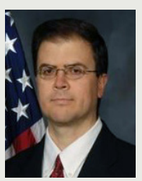
Read about the research at Joint Aircraft Survivability Program online:
Part 1: https://e.afit.edu/vmMR8rr
Part 2: https://e.afit.edu/BY5RRB

Understanding Flow Characteristics in Metal Additive Manufacturing

Members of AFIT's Department of Aeronautics and Astronautics co-authored a paper that was featured in the Nov. 2021 issue of the *Journal of Aerospace Engineering* found in the American Society of Civil Engineers (ASCE) online library at https://ascelibrary.org/journal/jaeeez.

The paper titled "Understanding Flow Characteristics in Metal Additive Manufacturing" was co-authored by **Dr. Carl Hartsfield**, Associate Professor of Aerospace Engineering, **Maj. Ryan Kemnitz**, Assistant Professor of Aerospace Engineering, **Mr. Greg Cobb** and **Mr. Travis Shelton**, research assistants, and **Mr. Joseph Weber**, former Department of Aeronautics and Astronautics intern within the Graduate School of Engineering and Management.

AFIT Electrical Engineering Professor Named Fellow of AMTA


Dr. Michael Havrilla

Dr. Michael Havrilla, Professor of Electrical Engineering within the Graduate School of Engineering and Management, has been named a Fellow of the Antenna Measurement Techniques Association (AMTA). Havrilla was honored as a recipient of the Edmond S. Gillespie Fellowship award in Oct. 2021 by AMTA.

In 2007, AMTA created the Edmond S. Gillespie Fellowship to recognize those members for their outstanding and pioneering contributions to the theory, practice, and art of antenna and RF measurements. Membership in the Fellowship is to honor the memory of Dr. Edmond. S. "Stan" Gillespie who made many contributions to the antenna community as a professor at California State University, Northridge and his activities in both the AMTA and the IEEE Antennas and Propagation Society. The criteria for being named a Fellow are through contributions to AMTA in two of the following three areas: significant technical contributions through publications, excellence in education in the field of antenna measurements, and dedication through active AMTA service.

AWARDS & RECOGNITION

Associate Professor Named 2021 AETC Educator of the Year

By Katie Scott
Air Force Institute of Technology

Air Force Institute of Technology faculty member Dr. Brett Borghetti received the 2021 Air Education and Training Command Civilian Educator of the Year award. Borghetti is an Associate Professor of Computer Engineering within AFIT's Graduate School of Engineering and Management.

The award recognizes officer, enlisted and civilian faculty members who excel in teaching excellence, scholarship of discovery/creating knowledge, scholarship of integration/connecting knowledge, and scholarship of application/using knowledge.

In an email announcing the award winners, Lt. Gen. James Hecker, Commander and President of Air University, said "These are some of the most prestigious award opportunities for our Airmen and the competition in each category was very tough."

During the award nomination period of July 2020 to June 2021, Borghetti educated 47 students in preparation for assignments requiring critical skillsets in machine and deep learning. His method of integrating research in the classroom allowed for every student to complete a vital research project – some of which contributed towards solutions of existing Air Force challenges such as remote device identification, hyperspectral imagery object detection, and light detection and ranging target classification.

"His accomplishments as an educator, researcher, and faculty council leader led to this award, and have contributed immensely to the success of our students and AFIT as a whole," said Dr. Heidi Ries, AFIT Provost and Chief Academic Officer.

"Beyond the immediate mission, being an educator is an investment toward the future of society.
Thus, to be selected as an 'educator of the year' is something very special that transcends the boundary of the individual's academic institution. On this note, the entire AFIT campus celebrates the selection of Dr. Brett Borghetti as AETC educator of the year," said Dr. Adedeji Badiru, Dean of AFIT's Graduate School of Engineering and Management.

Borghetti joined the AFIT faculty in 2008 as an active duty Air Force officer and in 2013 he transitioned to a civilian position. He earned his PhD in computer science from the University of Minnesota, a master's degree from AFIT in computer systems, and a bachelor's degree in electrical engineering from Worcester Polytechnic Institute.


U.S. Air Force official photo

Dr. Brett Borghetti, Air Force Institute of Technology Associate Professor of Computer Engineering, received the 2021 Air Education and Training Command Civilian Educator of the Year award presented by AFIT Director and Chancellor Dr. Walter Jones.

Borghetti's expertise is in artificial intelligence, machine learning and multi-agent systems with a current research focus on machine learning for physical science sensors (hyperspectral, seismic) and improving performance of teams of humans and machines. He teaches graduate-level courses in machine learning, discrete mathematics, data security, artificial intelligence, and algorithm design. He has authored 2 book chapters, 21 journal articles, and 23 refereed conference publications.

"Winning this award, in the face of a very stiff competition, reflects on the commitment of AFIT to teaching excellence. I congratulate Dr. Borghetti and wish him well in mentoring other faculty members to follow his benchmark for a superior integration of teaching, research, and defense-focused consultation," said Badiru.

Faculty Members Receive Professor Emeritus Status

As a result of their distinguished academic records and strong potential to continue to provide significant contributions to AFIT's mission with respect to research, teaching, and service, **Dr. Richard Cobb** and **Dr. William Wiesel** were promoted to Professor Emeritus status upon their faculty retirement dates in the fall of 2021.

Cobb was promoted to Professor Emeritus of Astronautical Engineering upon his retirement in Sept. 2021 after 40 years of government service. Wiesel was promoted to Professor Emeritus of Astronautical Engineering upon his retirement in Oct. 2021 after 47 years of government service.


Dr. Richard Cobb


Dr. William Wiesel

Career Achievement in Government Award Presented to AFIT Graduate School Dean

By Katie Scott
Air Force Institute of Technology

Dr. Adedeji Badiru, Dean of the Air Force Institute of Technology's Graduate School of Engineering and Management, has received the Career Achievement in Government Award from Career Communications Group, publisher of *U.S. Black Engineer and Information Technology* magazine. The peer-reviewed award was presented at the 36th Black Engineer of the Year (BEYA) Awards STEM Conference in Washington, D.C. The goal of the BEYA conference is to create connections between minority students, educators, and STEM professionals while facilitating partnerships with individuals and their local STEM resources.

"Dean Badiru's unique approach to unity at AFIT, as well as the many communities he serves, has enhanced the community by shifting the mindset toward embracing diversity. His contributions span decades of important and impactful writings, theory and model formation, philanthropic endeavors, and so much more," said Dr. Walter Jones, Director and Chancellor of the Air Force Institute of Technology.

"I am delighted and honored to be selected for this prestigious award," said Badiru. "The platform of reaching this pinnacle of an external recognition is not based on what I have done alone or by myself. Rather, it is the result of many years of consistent teamwork support from all my coworkers across the board. All the people that I have worked with over the years have been a source of inspiration and motivation for me. An equal measure of credit goes to my AFIT colleagues for creating an environment where great things can be accomplished."

Courtesy photo

AFIT Director and Chancellor Dr. Walter Jones (center) joins Graduate School Dean Adedeji Badiru (left) and his wife Mrs. Iswat Badiru (right) at the 2022 BEYA Awards Ceremony in Washington, DC.

Badiru's career as an industrial engineer extends over 35 years. A prolific author, Badiru has written or co-authored over 35 books, more than 30 book chapters, over 130 journal and magazine articles, and more than 200 conference presentations. His areas of interest include mathematical modeling, project modeling and analysis, economic analysis, systems engineering, and efficiency/productivity analysis and improvement.

Badiru earned a bachelor's degree in industrial engineering, master's degrees in mathematics and industrial engineering from Tennessee Technological University, and a doctoral degree in industrial engineering from the University of Central Florida. He is a registered professional engineer and a certified Project Management Professional. He is a Fellow of the Institute of Industrial & Systems Engineering and a Fellow of the Nigerian Academy of Engineering. He is a member of several professional associations and scholastic honor societies including the Institute for Operations Research and the Management Sciences and the American Society for Engineering Education.

In 2006, he and his wife endowed two perpetual undergraduate scholarships at their alma mater, Tennessee Technological University, with the intent to reduce the equity gap for historically marginalized students at an institutional level.

In 2021, he extended his philanthropy to establish the Professor Adedeji Bodunde Badiru Prize for Best Graduating Student in Systems Engineering at the University of Lagos, Nigeria.

Varshney Recognized with SASE Promising Professional Award

Dr. Gaiven Varshney, Research Assistant Professor of Nuclear Engineering in the Graduate School Department of Engineering Physics, was recently recognized with the Promising Professional Award by The Society of Asian Scientists and Engineers (SASE). The SASE Professional Conference was held virtually from Nov 3-5.

Dr. Gaiven Varshney

The internationally-competitive award recognizes the great achievements of Asian Pacific Islander American (APIA) students and professionals in the early part of their careers who demonstrate tremendous potential for future contributions.

Varshney entered AFIT in July 2016 as a post doctoral researcher under ORISE and supported by the Department of Homeland Security/ Domestic Nuclear Detection Office. She was promoted to Research Assistant Professor in 2019. Her primary area of expertise is in nuclear forensics.

"Dr. Varshney is one of the most versatile new research faculty we have worked with in some time. She is sought after for her expertise in debris analysis and radiography and consistently seeks to build her knowledge and share it with faculty and students with whom she interacts," said Dr. James Petrosky, Professor of Nuclear Engineering and Director of the AFIT Nuclear Expertise for Advancing Technologies (NEAT) Center for research. Petrosky nominated Varshney for the SASE award for her outstanding performance at AFIT.

AFIT Scholar Readership and Collections Grow

By Richard H. Mansfield, Jr., MLS
Electronic Resources Librarian and AFIT Scholar Lead Coordinator
The D'Azzo Research Library
Air Force Institute of Technology

AFIT Scholar (https://scholar.afit.edu) is the digital repository for AFIT, showcasing research works from graduate students and faculty members, as well as a selection of reports issued by the Institute.

ABOUT THE REPOSITORY

AFIT Scholar got its start online in October 2017 with a successful modest launch of several hundred theses and dissertations. The repository is built on the Digital Commons™ framework, a platform developed by Berkeley Electronic Press (BePress™). All content in AFIT Scholar is curated by the AFIT library. The content submissions must be fully cleared (Distribution A- Public) and free of copyright restriction to be posted on the repository. To optimize the discovery of AFIT research materials on the site, the metadata elements (title, author, subject headings) are harvested by Google Scholar and a few other U.S.-based web searches.

ENHANCED DISCOVERABILITY AND IMPACT

AFIT has a responsibility to ensure that the scholarship produced is both discoverable and accessible to the greatest number of people possible. Research deposited in AFIT Scholar is widely disseminated and receives increased visibility and prestige for both the author and the Institute. This enables AFIT to attract high-quality faculty, staff and students and also produce higher rates of citation, usage and impact.

Map data © 2022 Google

A global map identifies AFIT Scholar download locations from December 2021.

GOING FORWARD

As with any repository project, success hinges on local buy-in. Recently, a page was created within the repository that highlights AFIT's Autonomy and Navigation Technology (ANT) Center work (https://scholar.afit.edu/ant). The page creates a "rallying point" for ANT Center sponsors, collaborators and ANT-affiliated graduate works. Other AFIT research centers are welcome to work with AFIT Scholar administrators to build their own page that showcases research. The works on AFIT Scholar would not grow, and the material would not get used, without local contribution and advocacy. The future of AFIT Scholar is bright. Current faculty members, students and staff members of AFIT are invited to contribute to AFIT Scholar.

AFIT Scholar Downloads
Academic Year 2021

Collection data from Dec. 2021

187,000
TOTAL DOWNLOADS FROM
194 COUNTRIES & 6,840 INSTITUTIONS

AFIT Scholar Collection Highlights

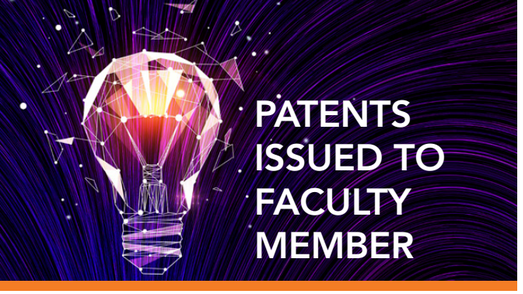
- Nearly 5,000 theses and dissertations from AFIT graduates, from 2000-2021.
- Over 800 faculty publications.
- An archive of case study reports from the AFIT Center for Systems Engineering.
- The Graduate School's research reports, including several scanned from the 'pre-digital' era.
- All past issues of the AFIT Engineer newsletter.

AFIT Scholar Readership and Collections: Increasing Impact AY18 to AY21

Collection Readership	AY18 Oct. 2017 to Sep. 2018	AY19 Oct. 2018 to Sep. 2019	AY20 Oct. 2019 to Sep. 2020	AY21 Oct. 2020 to Sep. 2021
AFIT Documents	781	3112	9106	13766
Faculty Publications	2	19	4788	6597
Theses and Dissertations	8652	21811	110417	166906
Downloads for All Holdings	9,435	24,942	124,311	187,269

Collection Size (posted items)	end of AY18 (9/30/2018)	end of AY19 (9/30/2019)	end of AY20 (9/30/2020)	end of AY21 (9/30/2021)
AFIT Documents	24	39	76	81
Faculty Publications	1	2	615	834
Theses and Dissertations	1580	2218	3743	4868
Entire Repository Size	1,605	2,259	4,434	5,783

The repository went online Oct. 17, 2017



Temperature-Immune Self-Referencing Fabry-Pérot Cavity Sensors

PATENT: #10,942,313
DATE: Mar. 9, 2021

PATENT: #11,204,468
DATE: Dec. 21, 2021

INVENTORS: Dr. Hengky Chandrahalim, Assistant Professor of Electrical Engineering, and **Capt. Jonathan Smith**.

ABSTRACT: A passive microscopic Fabry-Pérot Interferometer (FPI) sensor includes an optical fiber a three-dimensional microscopic optical structure formed on a cleaved tip of an optical fiber that reflects a light signal back through the optical fiber. The reflected light is altered by refractive index changes in the three-dimensional structure that is subject to at least one of: (i) thermal radiation; and (ii) volatile organic compounds.

ONLINE LINK: #10,942,313 https://e.afit.edu/df2Sbc2

ONLINE LINK: #11,204,468 https://e.afit.edu/7qz90

Method of Making Temperature-Immune Self-Referencing Fabry-Pérot Cavity Sensors

PATENT # 11,156,782 **DATE:** Oct. 26, 2021

INVENTORS: Dr. Hengky Chandrahalim, Assistant Professor of Electrical Engineering, and **Capt. Jonathan Smith**.

ABSTRACT: A method of making passive microscopic Fabry-Pérot Interferometer (FPI) sensor includes forming a three-dimensional microscopic optical structure on a cleaved tip of an optical fiber that reflects a light signal back through the optical fiber. The reflected light is altered by refractive index changes in the three-dimensional structure that is subject to at least one of: (i) thermal radiation; and (ii) volatile organic compounds.

ONLINE LINK: #11,156,782 https://e.afit.edu/301HHWW

AFIT and Israeli Air Force Leaders Explore Expanded Partnership

By Katie Scott
Air Force Institute of Technology

Col. Ariel Dvorjetski, PhD, head of the Aircraft Programs and Engineering Center for the Israeli Air Force's Materiel Directorate, visited the Air Force Institute of Technology on Oct. 26 to discuss expanding research collaborations and student education opportunities.

Joining Dvorjetski on the visit from the IAF Materiel Directorate were Lt. Col. Alon Dotan, head of the C4I Architecture Group, Lt. Col. Idan Amsalem, head of the aeronautical engineering branch, Lt. Col. Orr Levy, PhD, head of the data engineering, architecture and cyber branch, and Lt. Col. Shay Yagoda, PhD, chief engineer of the Avionics Branch.

During the visit, Dvorjetski and his team toured the Autonomy and Navigation Technology Center and met with academic leaders within AFIT's Graduate School of Engineering and Management to discuss master's program details. Of particular interest for the two organizations is partnering in aeronautical and aerospace engineering, computer science, and cyber protection education and research. "Our relationship with the Israeli Air Force is a win-win relationship," said Lt. Col. Jason Anderson, Dean of Students in AFIT's Graduate School of Engineering and Management. "We get to further our education and research mission through the collaboration, knowledge sharing, and synergy of this excellent joint international partnership."

Currently, one Israeli AF officer is attending AFIT's Graduate School of Engineering and Management aerospace engineering master's program and four students are attending distance learning courses through AFIT's School of Systems and Logistics.

Additionally, AFIT is hosting an IAF officer as part of the Engineer and Scientist Exchange Program. The ESEP program promotes international cooperation in military research, development, test, and evaluation through the exchange of government military and civilian engineers and scientists. Capt. Daniel Kariv, assigned to the Grad School's aeronautics and astronautics department, is working with USAF counterparts to research aero elasticity issues between both forces' aircraft.

U.S. Air Force photo by K. Scott

Officers from the Israeli Air Force's Materiel Directorate visited the Air Force Institute of Technology on October 26 to discuss expanding research collaborations and student education opportunities.

AIR FORCE IMPACTS

AFIT Faculty Patent Licensed for Wireless Security Technology

Parcell, a last-mile package security and asset control startup, has executed a patent license agreement with the U.S. Air Force. The agreement allows the company to integrate a military-grade intrusion detection technology for wireless personal area networks into Parcell's suite of products, including smart lockers for secure delivery services that communicate with users via mobile app.

"We're offering state-of-the-art solutions for individuals that protect against porch pirates and anyone else who needs to know exactly when their packages arrive," said co-founder Erica Waite. "Enhancing our network security with the Air Force tech prevents any spoofing or man-in-the-middle attacks, allowing our products to be used by commercial and government users that require extra precautions."

The licensed technology, which includes device fingerprinting, was invented by AFIT alumni Benjamin Ramsey (PhD Computer Science, 2014 and M.S. Electrical Engineering, 2009) and Dr. Barry Mullins, Professor of Computer Engineering at the Air Force Institute of Technology.

Parcell's partially exclusive license for U.S. Patent 10,111,094, a 20-year utility patent, was finalized on August 13, 2021.

The deal was facilitated by TechLink, the Department of Defense's national partnership intermediary for technology transfer. Paired with the app, Parcell's smart containers include safety features like an interior manual latch in case a child accidentally locks themselves inside while playing.

Looking ahead, Parcell has begun developing multiple products for military users, with prototype testing to begin in 2022. These products will have applications in non-military markets as well. "Our objective in developing new products for the military and commercial markets is to improve efficiency while maintaining the highest level of security," said Waite.

Article reprinted from https://techlinkcenter.org/

LEARN MORE ONLINE

Wireless Intrusion Detection and Device Fingerprinting Through Preamble Manipulation U.S. Patent No. 10,111,094

Read more about the patent online at: https://e.afit.edu/zbS9np1

AFIT to Co-host Local Hypersonic Innovation Conference

With support from Dr. Mark Lewis (NDIA Emerging Technologies Institute and former Air Force Chief Scientist) and leadership at the Naval Surface Warfare Center, Crane Division (Indiana), the Air Force Institute of Technology is hosting a Hypersonic Innovation Conference from April 26-28 2022.

Over 500 attendees are expected, with plenary addresses from top-level government and industry speakers and numerous interactive technology exhibits.

AFIT is jointly hosting this conference with our colleagues at Wright State University – the first two days of the conference will take place at the Wright State University's Nutter Center. AFIT's faculty, including Dr. Ramana Grandhi and Lt. Col. Darrell Crowe from the Department of Aeronautics and Astronautics, are very active in hypersonics research and will be participants in the conference.

Through its participation in the University Consortium for Applied Hypersonics, led by Texas A&M University, AFIT faculty and students are active in basic and applied research in all aspects of hypersonics and will continue to lead the development of this critical technology for future Air Force and Space Force applications. Researchers and leadership from the Air Force Research Laboratory will also be very involved in this conference.

FALL 2021 GRADUATE SCHOOL BY THE NUMBERS

591 total degrees awarded 2020-2021

1,185 enrolled students

196 faculty members

9 patents awarded 2021

U.S. Air Force graphic

HYPERSONIC SYSTEMS RESEARCH

The Air Force Institute of Technology's Multidisciplinary Approach

By Darryl Ahner, PhD
Dean for Research
Air Force Institute of Technology

Hypersonic systems are those systems that fly faster than five times the speed of sound. Two types of hypersonic weapons that are identified are hypersonic glide vehicles and cruise missile varieties. Both types have been prevalent in the news with public statements by both the Secretary of the Air Force Frank Kendall and the Secretary of Defense Lloyd Austin III on the development of U.S. capabilities and defense against such systems.

It may be surprising that while the discussion of hypersonic systems is relatively new in the press it is not new to AFIT, especially AFIT's research program. The Department of Aeronautics and Astronautics has been offering the Introductory Hypersonics courses since 1988. AFIT often takes on educational initiatives important to the Air Force and Space Forces before they are stressed in contemporary media. What drives these educational initiatives often is AFIT faculty's continual efforts to achieve relevant advancements in scientific fields. Here at AFIT we teach what we research and research what we teach. As with many advanced technical engineering concepts, hypersonic weapon systems advances build upon first principles of science that are taught across the multiple departments within AFIT's Graduate School of Engineering and Management. This leading edge research finds its way back into the classroom through relevant classroom examples and expanded elective coursework.

Hypersonic systems involve many subjects taught in AFIT's graduate school. Among these topics are vehicle design optimization, propulsion design, aero-thermodynamic modeling and analysis, structural design and analysis, computational fluid dynamics, materials development and analysis, sensing, flight dynamics, control theory, artificial intelligence applied to control, systems engineering, model development for digital engineering, operational analysis, and test and evaluation among others.

Since 2002 AFIT faculty members have advised students on 151 theses and dissertations with clear hypersonic weapon system applicability. These theses and dissertations span many engineering and mathematical disciplines. Forty-three PhD dissertations are related to hypersonic systems, hypersonic phenomenology, or defense against hypersonic weapons. Among these are 19 related to propulsion, 19 related to fluid dynamics, nine related to structures and materials, and five related to sensors. In addition to the 43 PhD dissertations, 108 AFIT Masters theses are related to hypersonic systems, hypersonic phenomenology, or defense against hypersonic weapons. Among these are 89 related to structures and materials, 55 related to propulsion, 46 related to fluid dynamics, and 42 related to sensors.

AFIT faculty have not performed their research in isolation. AFIT faculty have collaborated on research proposals and activities with over seven universities which include Purdue University, Ohio State University, Virginia Tech, University of Michigan, and University of Minnesota. There are 18 university-led research teams from the University Consortium for Applied Hypersonics (UCAH), totaling $25.5 million in funding, and AFIT's Professor Ramana Grandhi is lead on one of the multi-university efforts while Professor Mark Reeder is a selected principal investigator on another. AFIT also consults and performs activities with many government entities within the Air Force and NASA as well as supports post-doc appointments and summer intern opportunities.

AFIT's graduated students and rotating military faculty members emerge from this research and educational environment to become part of hypersonic system expert leadership within the Department of the Air Force on programs such as the Hypersonic Air-breathing Weapon Concept (HAWC) program as well as in Air Force Futures and Space Futures staff positions. AFIT's innovative multidisciplinary research programs provide our students forward looking education opportunities and impact the technological advancement needs of our Air and Space Forces.

151
Student theses & dissertations with hypersonic weapon system applicability since 2002

7+
Universities AFIT has collaborated with on research activities and proposals

$25.5M
University Consortium for Applied Hypersonics (UCAH) funding

8
Graduate school faculty with hypersonics-related expertise

Developing Future Officer Technologists

AFIT's Unique Learning Environment Supports Air Force and DoD Missions

By Katie Scott
Air Force Institute of Technology

Lt. Col. Jeffrey Komives is a hypersonics technical expert and airpower strategist working on Air Staff in Air Force Futures (HAF A5/7) with the responsibility to help develop and test new operating concepts for the future Air Force. "My portfolio is long range fires—how we strike and also the kill-chain that's associated with that—how we find, fix, track, and target airpower," said Komives.

Komives also serves as the warfighting integration lead for the principal director for hypersonics in the Office of the Undersecretary of Defense (Research and Engineering). In this role he ensures that hypersonic technologies are accurately and credibly integrated into wargames, exercises, and analysis across the Department of Defense.

"Between those two jobs, my responsibilities are to ensure that the strategy that the Air Force and the Department of Defense comes up with is fully informed by the state of the possible in this technology; and that we then communicate the capabilities that are required of that technology to the S&T community," explained Komives.

In his two roles Komives has to balance technology and strategy, working with operators and strategic thinkers who may understand the basic premise of a technology like hypersonics, but are not experts in the subject. "As a technologist, what I try and do is ensure that the concepts that we are developing are bound in physics, bound in science, and appropriately aggressive given the realm of the possible," said Komives.

FUTURE OFFICER TECHNOLOGISTS

To be successful in carrying out future plans, Komives believes we need Airmen and Guardians who can bridge the technical and strategic communities. As the Air Force modernizes and moves towards more innovative technologies like hypersonics, officers who are technical experts and who are also well versed in operational planning and understand how airpower has been used historically will be critical to intelligently shape capability development and force application. "That takes the right Airman who has the mastery of technology, but then also an appreciation for and study of the operational art. That combination is where the uniformed technologist plays a unique role," said Komives.

HOW AFIT DEVELOPS EXPERTS

Komives sees AFIT as a unique breeding ground for officer technologists based on its foundation of defense-focused education and research. Having earned his master's degree in aeronautical engineering from AFIT in 2009 and serving as an assistant professor of aerospace engineering within AFIT's Graduate School of Engineering and Management from 2016 to 2020, Komives is very familiar with the AFIT mission. "My time as a student helped give me some of that beginning technical development, but my time on faculty really did hone that. If you really want to understand a topic, teach it," said Komives.

As technologies evolve and mature, it will be important to understand how the systems function and operate within the current force. While the personnel system does a good job of identifying technical needs within the fielded units, Komives thinks the next opportunity is to focus on developing and utilizing officers who are technical subject matter experts, like AFIT military faculty members.

The seven year commitment the Air Force invests in an officer to earn a PhD and then follow on with a teaching assignment at AFIT is a significant developmental opportunity for Airmen and Guardians. "They will get to a level of mastery and level of understanding that puts them in a spot where they are primed to help the rest of us understand that technology and how to integrate it into strategy and capability development in a way that is just truly incredible," said Komives.

Komives regards his time on AFIT's faculty as an opportunity not only to deepen his technology expertise through teaching and research, but a mentorship opportunity to help shape the development of future technical leaders in the Air Force. "I'm still in touch with all of my cohorts and I'm still involved in a mentoring capacity with them to help them as they then look at subsequent assignments. It's an opportunity to shape the leaders in your technology for the next three to four years, which is simply wonderful," said Komives.

"Having an operationally informed set of priorities is very meaningful and that's a thing that distinguishes AFIT from the other graduate institutes – the impetus of this institution to prioritize the needs of the Department of Defense. The junior force coming out of institutions like AFIT will be the people really running and leading operations in the future force."


Lt. Col. Komives

Fluid Mechanics Experiments and Wind Tunnel Tests

By Mark Reeder, PhD
Professor of Aerospace Engineering
Air Force Institute of Technology

Traditional design methods for developing any new vehicle configurations inherently employ several simplifications and assumptions in representing multi-physics behavior and model fidelity. Hypersonic vehicle design must account for problems which cross many engineering disciplines, including aerodynamics, propulsion, structures, materials, and heat transfer. Thus, it is a challenge to optimize over those multiple parameters.

One trait of hypersonic flow which affects all of these is the uncertainty surrounding the effect of wall temperature on the transition to turbulence. At first, this might seem a matter of only aerodynamics and heat transfer. However, the design optimization might include ablative materials and, in turn, affect the structural design characteristics. Even the engine performance might even be affected, for example, due to flow through the inlet.

One might suppose that the effect of wall temperature on turbulence development in a flowfield would be straightforward exercise for experimentation. However, as with many elements of hypersonic vehicle design, it is much more challenging than meets the eye. In a hypersonic flow environment, the stagnation temperature is exceptionally high while the surface of a vehicle re-entering the atmosphere is very low. In order to model such an environment in a wind tunnel, the air temperature must either be elevated to a very high level, which can be very difficult and costly to do, or else the model must be actively cooled. At first blush, one might consider cooling to be rather straightforward as well, but as with many engineering problems, the devil is in the details.

For example, much of the prior work on cooled models have to account for frost formation in humid air. Also, many cooled models utilize removable tips which were utilized in order to model effects due to nose shape. A secondary reason is that it can be difficult to fabricate a large part with a sharp tip for a cone, which is often used in fundamental research.

In 2020, AFIT and AFRL engineers teamed to perform a successful set of measurements which addressed all of these challenges. The first results were published in the July 2021 issue of *Experiments in Fluids* as part of a special series on hypersonic flow experimentation. The abstract is presented below.

LEARN MORE ONLINE

The abstract and paper can be found online at https://link.springer.com/article/10.1007/s00348-021-03237-0

Effect of Surface Cooling on Second-mode Dominated Hypersonic Boundary Layer Transition

GRAPHICAL ABSTRACT

Experiments were performed in the low-enthalpy AFRL Mach 6 Ludwieg Tube to investigate the effects of surface temperature on hypersonic boundary layer transition. The test article for all experiments was a 7-degree half-angle cone with a sharp nose tip. The model was designed with a large internal cavity, capable of containing pressurized cryogenic fluids. A cooling system utilizing liquid nitrogen was designed and integrated with the test section of the Ludwieg Tube, allowing for significant surface cooling of the test article while maintaining all other conditions, such as tunnel noise spectra. The reduction of the surface temperature to values below 110 K led to a wall-to-boundary layer edge temperature ratio of 1.4, while this ratio was 4.3 for the uncooled case. Boundary layer transition behavior was observed between freestream unit Reynolds numbers ranging from 2.2 million per meter to 25.9 million per meter. Instability waves within the boundary layer were captured via time-resolved Schlieren visualization using a continuous light source. The images confirmed Mack's second mode was present for both uncooled and cooled model experiments. Turbulence intermittency statistics and frequency content of the instabilities were computed via several image processing techniques. Reducing the surface temperature of the test article decreased the boundary layer thickness, and subsequently increased the frequency of the most unstable waves. Overall, the cooling delayed the boundary layer transition to turbulence for all cases observed.

Figure 1

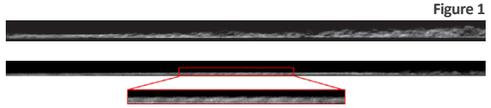


Figure 1: Observed instability waves, varying Re_∞ with respect to $T_w/T_e = 4.35 \pm 0.15$ (top) and $T_w/T_e = 1.39 \pm 0.05$ (bottom) for $Re_\infty = 17.9 \times 10^6$/m.

Figure 2

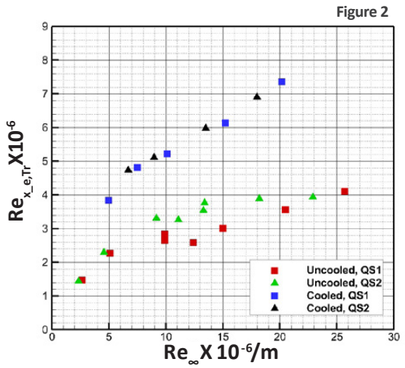


Figure 2: Transition Reynolds number with varying freestream unit Reynolds number, both cooled and uncooled experiments.

AFIT ADVANTAGE OF CLASSIFIED RESEARCH CAPABILITIES

By Lt. Col. Robert MacDermott, PhD
Assistant Professor of Aerospace Engineering
Air Force Institute of Technology

In recent years, interest in hypersonics has increased within the defense community. AFIT, as a premier institution for defense-focused education, research, and consulting, is ideally suited to meet the defense community's needs. Accordingly, AFIT has risen to meet those needs by educating Airmen on hypersonic topics, either through the hypersonics sequence of the graduate program or the hypersonics short course, both of which are offered by the Department of Aeronautics and Astronautics and by engaging in cutting edge defense-focused research.

Hypersonic velocities, those above Mach 5, pose significant technical challenges in terms of vehicle design and employment. The high energy flowfield associated with such speeds induces a highly complicated and fully coupled aerothermodynamic environment. The high temperatures can cause chemical reactions, fundamentally changing the physical properties of the 'air' in which the vehicle is flying. Furthermore, the flowfield can reach a state of thermodynamic non-equilibrium in which the energy state of the fluid must be defined using multiple temperatures. In turn, the effect on aerothermodynamics complicates the vehicle's thermal management processes, navigation, guidance, and controllability.

Due to the high cost of flight and ground testing, simulations are a very cost-effective method of investigating hypersonic phenomena. The computational fluid dynamists at AFIT have access to state-of-the-art computer resources. Both Government and industry flowfield and radiation solvers are available to characterize the complex hypersonic flows in the simulated environments. Researchers and students utilize both the local AFIT network and the Department of Defense (DoD) High-Performance Computing Modernization Program (HPCMP) centers, enabling effective scaling of simulations. Smaller projects are run on the local network while larger problems are solved using one of the DoD HPCMP systems.

An example of the ongoing defense-focused research at AFIT is displayed to the right.

Hypersonic Computational Simulations to Further Defense Community Interests

The ability to detect, identify, and track hypersonic vehicles is of particular interest to the defense community. One observation method is to use the optical emissions, or radiance, produced by the vehicle and both the surrounding and trailing flowfield. However, the source, strength, and distribution of the radiance produced by a hypersonic vehicle is not well understood. To investigate this phenomenon, simulations were run to depict a simple cone in hypersonic flight. The simulation included the cone and extended behind the vehicle into the near and far wake regions. In addition, the flowfield simulation allowed for variations to the vehicle's surface conditions to include modeling of thermal protection system ablation products, which were allowed to enter the flowfield. The radiance of the flowfield was then calculated using a radiation solver. A sample of the simulated radiance is shown in Figure 1 below.

The subsequent analysis and reporting of the simulation resulted in data that required protection at either the Controlled Unclassified Information (CUI) or higher classified levels, highlighting yet another advantage of AFIT. As a Government university, AFIT can perform, protect, and disseminate limited distribution research at the appropriate levels without the need for an exterior sponsor. The ability to conduct research with enhanced protections is critical to meeting current and future defense community needs.

AFIT will continue to be at the forefront of defense-focused hypersonic simulations to support the defense community's needs. As a result, students departing AFIT have the toolset needed to hit the ground running with respect to hypersonic simulation environments. Concurrently, AFIT's resident faculty and staff will continue to provide quality research and consultation products to their defense community partners.

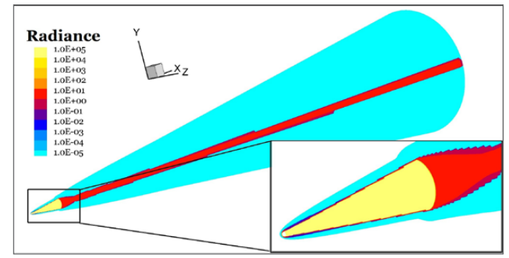


Figure 1: Simulation of optical emissions, or radiance (in arbitrary units), of a hypersonic object in flight representative conditions.

Hypersonic Configuration Creation and Design Optimization

By Ramana Grandhi, PhD
Professor of Aerospace Engineering
and Christopher Corey Fischer, PhD
Research Engineer
Air Force Institute of Technology

The hypersonic research being conducted at AFIT expands the faculty-mentored hypersonic research and workforce development in a multitude of dimensions in collaboration with AFRL scientists, aerospace industry, and academia. The AFIT team consists of experts in the fields of fluid mechanics, propulsion systems, computational fluid dynamics, additive manufacturing, configuration design, optimization, multi-fidelity, and experimental wind tunnel testing to name a few depicted by the multidisciplinary coupling illustrated in Figure 1.

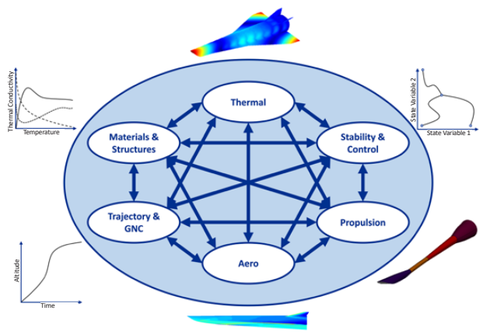


Figure 1: Multidisciplinary coupling considerations necessary in hypersonic vehicle analysis.

With experts amassing decades of experience including early hypersonic research predating the National Aerospace Plane (NASP) in the 80's and 90's, the AFIT team is also well versed in the challenges associated with hypersonic flight. This expertise and knowledge base fosters an environment of growth, education, and direction for the next generation of researchers and Airmen.

GENERIC HYPERSONIC VEHICLE (GHV)

Recent efforts at AFIT in the realm of hypersonic research have focused on the development of a parameterized and versatile test vehicle. This vehicle, dubbed the Generic Hypersonic Vehicle (GHV), was previously described by AFRL scientists in 2012; however, the AFIT team has developed the vehicle with broad research and utilization within an extensive Multi-Disciplinary Analysis and Optimization (MDAO) environment in mind. The current GHV has been parameterized using traditional aircraft design parameters allowing for geometric modification and exploration as well as shape and sizing design optimization. This test vehicle was computationally modeled using a software, developed via a joint effort between Massachusetts Institute of Technology and Syracuse University for AFRL needs, called Engineering Sketch Pad (ESP) and is shown in Figure 2. ESP has been developed alongside Computational Aircraft Prototype Syntheses (CAPS) which is a synthesis tool aimed at providing the ability to link a single geometry to a multitude of commercial and Air Force analysis packages such as the conceptual level flow prediction tool used to generate the temperature profile of the GHV at nominal flight conditions illustrated in Figure 3.

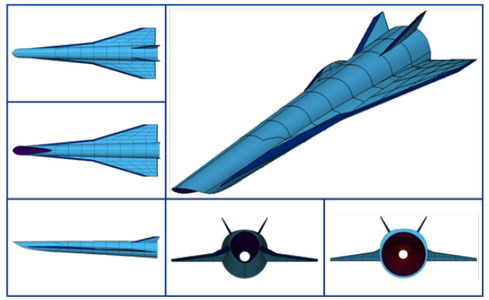


Figure 2: Multiple views of the parameterized Generic Hypersonic Vehicle (GHV) developed at AFIT.

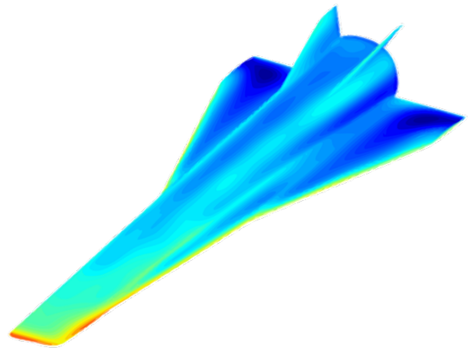


Figure 3: Temperature distribution prediction on GHV test model obtained using a conceptual design level Air Force analysis tool.

Therefore, this GHV model was developed with the intent for unification and integration of multiple disciplines and fidelity levels using a single set of design parameters. Thus, this research vehicle will provide the ability of combining proven computational geometry, meshing, and analyses model generation techniques into a complete environment that is accessible to the entire design team while also allowing for development of specific design tools needed to address the challenges associated with hypersonic flight.

MULTI-FIDELITY DESIGN + OPTIMIZATION

Additionally, current AFIT research is also focusing on the development and maturation of multi-fidelity design, analysis, and optimization techniques. A successful multi-fidelity tool will enable the ability to achieve the required high-fidelity accuracy without the associated computational cost, as well as, assess the individual disciplines and perform coupled analysis when necessary. Such methodologies would utilize a range of fidelity levels, and thus a range of simulation costs and accuracy through leveraging lower fidelity levels to drive the majority of analysis/optimization as outlined in Figure 4. This multi-fidelity optimization flow chart represents the current approach being developed at AFIT under collaboration with AFRL. The partitioned nature of this formulation enables the inclusion and removal of different physics and fidelities while maintaining ability to vary the included fidelity levels. Intelligent decision-making metrics are used to define when high-fidelity analyses are needed as well as the proper disciplines needed to accurately simulate hypersonic flight physics.

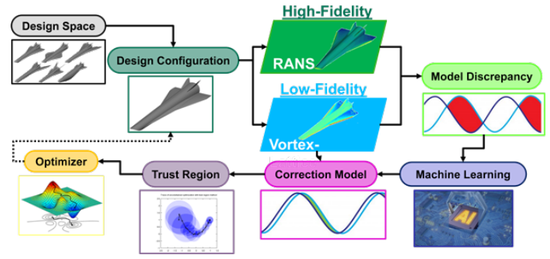


Figure 4: Multi-fidelity optimization flow chart utilizing a low-fidelity correction approach.

SCRAMJET ENGINE ANALYSIS

Another tool developed at AFIT is a conceptual level scramjet engine analysis needed for fully integrated and computationally efficient propulsion performance evaluation demonstrated in Figure 5. An air-breathing engine's performance is strongly coupled with the airframe configuration due to the engine's typical integration into the fuselage. Therefore, proper propulsion modeling is required to efficiently determine if the engine and vehicle configuration meet desired mission goals. The stream thrust analysis uses quasi-one-dimensional approaches to approximate inlet, isolator, combustor, and nozzle performance with sensitivities to area change, skin friction, wall heat transfer, and fuel addition/combustion. This analysis tool has been developed to operate on geometric parameters contained within the GHV model.

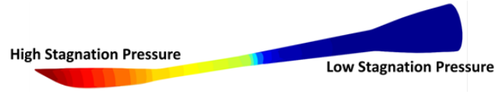


Figure 5: Hypersonic scramjet engine flow state pressure distribution predicted via in-house developed fully integrated stream thrust analysis.

RESEARCH CONTRACT AWARD

AFIT to Collaborate on Contract to Develop MDO Hypersonic Vehicle Design

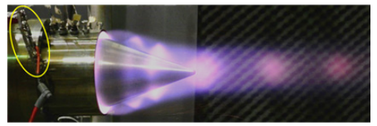
Recently, AFIT (in collaboration with the University of Michigan, The Ohio State University and Virginia Tech) has received a three-year contract for developing Multidisciplinary Design Optimization (MDO) based hypersonic vehicle design techniques addressing propulsion, heat transfer, aerodynamics, controls, structures, and materials disciplines for creating feasible vehicle configurations. This contract was awarded through a national competition spanning a diverse realm of 17 topics under the University Consortium for Applied Hypersonics (UCAH). The UCAH mission is to serve the U.S. Department of Defense (DOD) requirements in science and technology, workforce development, and technology transition. It does this by mobilizing and leveraging the academic community and its partners to deliver time-sensitive applied solutions to the DOD-defined research and prototype projects in the areas of core technology, next-generation projects (enabling technologies), and challenge projects (multidisciplinary efforts).

AFIT will serve as the contract lead in fulfillment of this UCAH award with support from the aforementioned three universities embarking in research oriented towards utilization of appropriate fidelity models that will enable new tactical capabilities for the warfighter. This will be achieved through goal-driven design and optimization methodologies that exploit advancements in modeling, physics-based analysis, and machine learning techniques. Research conducted in fulfillment of this award will expand our understanding of tradeoffs between subsystems in complex offensive and defensive hypersonic systems and to produce conceptual design studies and algorithms (software code, algorithm design documents) to optimize total system performance. Therefore, the methods identified and developed throughout this research will aim to optimize performance for flight, sensor, internal thermal loading, control surfaces/guidance/maneuverability, launch loads, and offensive and defensive lethality and be demonstrated on the GHV.

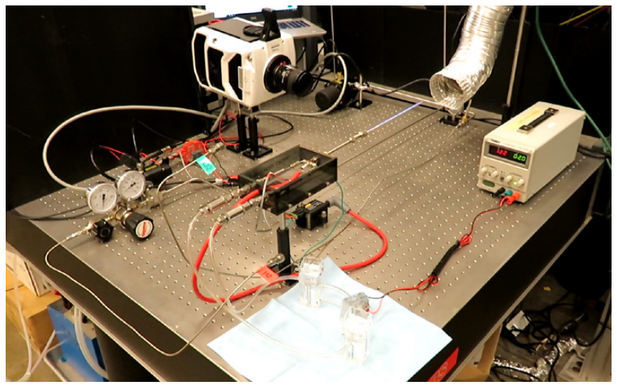
The AFIT team consists of experts in the fields of fluid mechanics, propulsion systems, computational fluid dynamics, additive manufacturing, configuration design, optimization, multi-fidelity, experimental wind tunnel testing and more.

Pulsed Torch Ignitor Successfully Operates on Water in AFIT COAL Lab

By Fred Schauer, PhD
Associate Professor of Aerospace Engineering
Air Force Institute of Technology

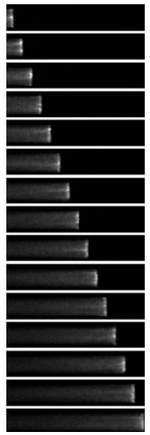


Rotating Detonation Engine with pulsed torch ignitor (highlighted in yellow).

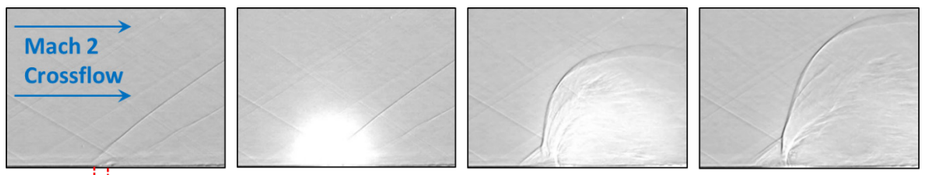


Water powered pulsed torch ignitor in the AFIT Combustion Optimization and Analysis Laser Laboratory. The voltage supply driving the electrolysis system is set at 2 volts and providing less than 2.5 watts to fuel the system. The light blue streak is the nearly instantaneous flash of the pulsed torch ignitor firing.

Engine startup can be challenging, especially for high speed systems that may have to start at high altitude where cold and low pressure combined with high flight speeds can produce exceedingly difficult conditions. Such cold start challenges are akin to lighting a match on Mount Everest where there is less than a third of normal oxygen concentrations, but with the temperature 50 °F below zero or colder and the wind blowing hundreds of miles per hour. The Mach 3+ capable SR-71 required special pyrophoric ignition systems to light off the special thermally-stable fuel even in the afterburner. While effective, the SR-71 system was extremely hazardous and imposed significant limitations on usage. One approach to overcoming the engine startup challenges is the use of torch ignitors, which can serve as a pilot light for high speed propulsion systems. Attempting to keep a pilot light burning in the challenging conditions described above is very challenging for a conventional, steady torch igniter. An alternative approach is to use a pulsed torch ignitor which can have significantly higher stability while propagating significantly further than a conventional steady ignitor.



High speed imaging of pulsed torch ignitor confirming Mach 8 speed.



Mach 2 supersonic flow interacting with pulsed torch ignitor (not visible, location shown in red on left), and subsequent high speed imaging of flow interaction to right. Notable are the lack of upstream interaction and successful propagation across the supersonic flow.

Pulsed Torch Ignitors (PTI's) are highly effective for lighting off advanced combustors, but usually research is limited to engine stands due to fuel hazard and safety risks. A small scale PTI has been successfully developed and operated on very small quantities of gasses available in the AFIT Department of Aeronautics and Astronautics Combustion Optimization and Analysis Laser (COAL) Lab. The PTI has also successfully operated on electrolyzed water, requiring only low voltage electricity instead of pressurized gas cylinders. The small size proved to be compatible with acoustic hazards – reducing noise levels and durations to acceptable levels. The low-noise PTI combined with water electrolysis enables operation in laser labs/research facilities that aren't approved to store flammable gases or originally designed for combustion experiments. The current PTI can operate with electrolyzed water with as little as 2 watts and operate for up to 30 minutes on a standard 9v battery. Advanced imaging capabilities in the COAL Lab have confirmed successful PTI operation with speeds up to Mach 8 from the table top sized system and are being used to resolve the initiation and propagation mechanisms.

With contributions from Mr. David Cyrol, Lt. Col. Levi Thomas, 2Lt Nathanael Kreiser and Dr. Marc Polanka from AFIT; Dr. Brian Sell, Dr. Andrew Knisely, and Dr. Tim Ombrello from AFRL.

U.S. Air Force photo by Katie Scott

Colonel Laurie Richter returned to the Air Force Institute of Technology in June 2021 to serve as the first female Dean of the Civil Engineer School.

Richter Returns to AFIT as First Female Dean of CE School

By Katie Scott
Air Force Institute of Technology

Colonel Laurie Richter returned to the Air Force Institute of Technology in June to serve as the Dean of the Civil Engineer School. It is a homecoming for her as she earned her master's degree in engineering and environmental management from AFIT in 2001 and then served as a course director in the CE school for three years.

"It's just an amazing opportunity to have the ability to come back and contribute in a different role and to know that the fundamentals of what we do, teach, and believe in at the school are still the same," Richter said.

In her new role, Richter leads a team of approximately 50 faculty and staff who provide technical, environmental and engineering management focused professional continuing education to over 9,000 military and civilian members annually as well as providing the initial skills training for all newly commissioned civil engineer officers.

As an invited member of the civil engineer board, Richter stays connected to senior leadership, strategy, and future plans. "I want to continue the tradition of staying vital, relevant and connected," said Richter. She believes that the school is even more relevant today because of the dedicated efforts of her faculty to stay connected to their career field through deployments, consulting, and reach-back support. Sometimes the ideas for change come from listening to what the students are doing at the installation level allowing the faculty to shape their curriculum to ensure it remains relevant.

In a career field where only 16% of civil engineer officers are female, Richter often felt compelled to be more proactive than came naturally to her. "I needed to be a physical presence and a visual representation making sure that my perspective was heard and that I was contributing as much as everyone else," said Richter. "My perspective might be different, and it might be good to hear that there's a different perspective in the room so we don't continue to look at the problem the exact same way. As a whole, we're better as a team when we do that."

Standing in front of a photo gallery of former CE School deans hanging on the wall of the school, Richter recognizes the impact she can have as the first female dean. "That's a wall full of people who don't look like me and it's an opportunity to show a different picture to someone else who might be wondering if there is a place for them to lead in our civil engineer community and across the Air Force," said Richter.

LEARN MORE ONLINE

Read more about Colonel Richter's career and new position at AFIT online: https://e.afit.edu/ZZ71mnp

AFIT Alum Receives Patent Award

INVENTOR: AFIT alum **Lt. Michael D. Sherburne** graduated from AFIT with a MS Electrical Engineering degree in 2020 and was also honored as a Department of Electrical and Computer Engineering Dean's Award winner.

PATENT # 11,168,248 **DATE:** November 9, 2021

TITLE: Nanocrystals impregnated porous article and method of making and using same

ABSTRACT: The present invention relates to devices for detecting radiation by the excitation of colloidal nanocrystals within a porous article and methods of using same. The aforementioned device is inexpensive and can be fabricated quickly in order to detect radiation. Due to the use of colloidal nanocrystals which have been known to have a decay constant of under 100 ps when energetic electrons produced by an incident x-ray excite the nanocrystals, this device can be used in fast radiation detection of x-rays.

AFRL Early Career Award Winner

AFIT alum **Dr. Michael Steinbock**, (PhD Electrical Engineering, 2015 and MS Electrical Engineering, 2012) has been named an Air Force Research Laboratory (AFRL) Early Career Award winner. Dr. Steinbock is currently a principal investigator in AFRL/RD (Directed Energy Directorate).

The AFRL Science and Engineering ECA recognizes junior scientists and engineers for significant research or engineering achievements during the onset of their career. These individuals, who also receive a $300,000 grant, have demonstrated exceptional in-house research contributions. The award is specifically for military/government scientists and engineers who are in the first seven years of their careers with no more than 15 years since the award of their bachelor's degree. Since its inception in 2012, 51 individuals have received this honor.

Alum Assumes Role as AFMC Command Chief

The position of AFMC Command Chief is one that comes with tremendous responsibility, especially when the incumbent is charged with leading at the Air Force major command level.

By Marisa Alia-Novobilski
Air Force Materiel Command

Chief Master Sergeant David A. Flosi assumed the role of AFMC Command Chief in early October 2021, and "hitting the ground running" is exactly what characterized what he did during his first few weeks in office, with multiple meetings, trips, conferences and more keeping him in a state of continuous flow.

As the AFMC Command Chief, Flosi will advise the commander on all matters regarding the readiness, training, professional development and the effective utilization of more than 89,000 total force Airmen. These military and civilian Airmen work across six centers and more than a dozen installations, performing critical missions in support of all aspects of air and space.

"It's rare for an enlisted person to get to serve in a leadership position at the organizational level. That comes with a huge responsibility. I really want to understand our Airmen, their needs and engage with them at their level so I can find out what their barriers are to success and remove them," said Flosi. "My role is to listen, understand and take action."

In addition to executing the commander's intent and ensuring Airmen across the command clearly understand the importance of their mission roles, Flosi plans to maintain a strong focus on building greater resiliency across the force. Today's warfighting environment and the future threat requires ready, agile Airmen, and to be that, it is important to have a resilient baseline, he says.

"We need ready, capable Airmen, and that includes preventative mental, financial and physical care. If our Airmen are worrying about the bill collector, they're not going to be mentally ready to deploy a multimillion dollar weapon system. We need to continue to help take care of our Airmen and each other," said Flosi.

U.S. Air Force official photo

Chief Master Sergeant David A. Flosi (M.S. Logistics & Supply Chain Management, 2010) assumed his role as Command Chief Master Sergeant, Headquarters Air Force Materiel Command at Wright-Patterson AFB, OH in October 2021.

"I learn from Airmen each day. I truly believe that if you are willing to open your mind and learn something new each day you come to work, you can be successful," said Flosi.

Article reprinted and edited for length.

AFIT Alums Receive 2021 Presidential Rank Awards

Meritorious Award

Mr. Edwin Oshiba

AFIT alum **Mr. Edwin H. Oshiba**, SES (M.S. Engineering & Environmental Management, 1997) is a recipient of the 2021 Presidential Rank Award – Meritorious category. Winners of this award are recognized for sustained accomplishment, and receive a cash award of 20 percent of their base salary. No more than five percent of career SES or SL/ST members may receive this award.

Oshiba is the Director of Resource Integration, Deputy Chief of Staff for Logistics, Engineering and Force Protection, Headquarters U.S. Air Force, Arlington, Virginia. He is responsible for the planning, programming and budgeting of weapons systems sustainment, equipment, and logistics and installations resource requirements.

Distinguished Senior Professional Award

Dr. Steven Rogers

AFIT alum and adjunct faculty member **Dr. Steven Rogers** (M.S. Electrical Engineering, 1981) is a recipient of the 2021 Presidential Rank Award – Distinguished Senior Professional category by the Office of Personnel Management.

Distinguished rank recipients are recognized for sustained extraordinary accomplishment, and receive a cash award of 35 percent of their base salary. Only one percent of the career SES or SL/ST may receive this rank.

Rogers is the Senior Scientist for Automatic Target Recognition and Sensor Fusion at the Air Force Research Laboratory, Wright-Patterson AFB, Ohio. He serves as the principal scientific authority and independent researcher in the field of multi-sensor automatic target recognition and sensor fusion. He also serves as an Adjunct Assistant Professor of Information Technology within AFIT's Department of Electrical and Computer Engineering.

Passion of Flight

U.S. Navy photo by Adam Skoczylas

Capt. Elizabeth Somerville, USN (MS Aeronautical Engineering, 2006), commanding officer of Air Test & Evaluation Squadron (VX) 23, says there is nothing quite like the excitement of a deployment, the camaraderie of a ready room or the flight test environment.

AFIT alum Capt. Elizabeth Somerville, USN (MS Aeronautical Engineering, 2006) talks about her passion for flying that led her to become the first female aviator in Electronic Attack Squadron 141 while it was on the maiden deployment of both the Navy's EA-18G Growler and USS George H.W. Bush (CVN 77); first female commanding officer of a naval developmental test squadron at VX-31; and now as the first female commanding officer of VX-23.

AFIT ALUM CAPTAIN SOMERVILLE NAMED COMMANDER OF NAVAL AIR TEST AND EVALUATION SQUADRON

By Kaitlin Wicker and Rob Perry
Naval Aviation News

In a world where engineering, aviation and military defense collide, Capt. Elizabeth Somerville brings a great deal of experience to the table. With bachelor's and master's degrees in aeronautical engineering, two decades of experience between fleet aviation and developmental test, and a love of aviation, she relishes her time in naval aviation.

Somerville was most recently the chief test pilot for Air Test and Evaluation Squadron (VX) 23 and took the helm as the squadron's commanding officer in July at Naval Air Station Patuxent River.

"My primary job as the [chief test pilot] is to work with our chief test engineer to make certain that all of our flight tests are executed safely and effectively," Somerville said. "I am fortunate to be taking command of such a fantastic squadron."

Suiting up to take to the skies is not new for Somerville. Before she received her wings of gold as a naval flight officer, cloud surfing was her favorite escape. Before graduating from high school, she earned her private pilot's license and with a Navy scholarship in-hand, Somerville graduated from the Massachusetts Institute of Technology with a bachelor of science degree in aeronautical and astronautical engineering and went to Pensacola, Florida, for flight training, where she initially thought she might hit a roadblock to her dream of flying.

"In those days there was no Lasik surgery, or corrective action for poor vision," she said. "I had, and to this day, have terrible vision. I didn't even have the choice to be a pilot." Concerned her vision may even preclude her from being a naval flight officer, Somerville said she was ecstatic when she passed the physical. She thinks she's been a good flight officer and made some positive contributions to the community.

Through deployments in support of Operation Iraqi Freedom and Operation Enduring Freedom, Somerville knew she was in this for the long-haul. As she finished her first fleet tour, she wanted her next assignment to pair her engineering background with her experience and skills in the plane, turning her attention to the pursuit of becoming a test pilot.

Somerville was accepted to the U.S. Naval Test Pilot School Class 130. As part of a cooperative program, she attended the Air Force Institute of Technology and when she graduated with USNTPS, she also graduated with a master of science degree in aeronautical engineering.

In her 22 years of service, Somerville has seen her share of firsts, including becoming the first female aviator in Electronic Attack Squadron 141 while it was on the maiden deployment of both the Navy's EA-18G Growler and USS George H.W. Bush (CVN 77); first female commanding officer of a naval developmental test squadron at VX-31, which is where she went upon graduating USNTPS; and now as the first female commanding officer of VX-23.

"After deploying with the Bush in support of several operations, mostly Operation Enduring Freedom in Afghanistan, I knew I wanted to come back. I had a young daughter, and I wanted to explore career opportunities that would allow me to contribute to and focus in areas where I was the best at, where I could leverage my strengths to further naval aviation that didn't take me away from home 75% of the time," Somerville said, which lead her back to VX-23 at Pax River.

Article reprinted from The Southern Maryland News online: www.somdnews.com

CALENDAR EVENTS

MARCH 2022

AFIT Graduate School Graduation Awards & Commencement
WPAFB, OH I 24 Mar 2022

AFIT Graduate School Spring Quarter Classes Begin
AFIT Campus, WPAFB, OH I 28 Mar 2022

APRIL 2022

Hypersonic Innovation Conference
Dayton, OH I 26-28 Apr 2022

MAY 2022

AFIT Graduate School Summer Quarter Registration Begins
AFIT Campus, WPAFB, OH I 02 May 2022

JUNE 2022

AFIT Graduate School Spring Quarter Classes End
AFIT Campus, WPAFB, OH I 03 Jun 2022

AFIT Graduate School Spring Graduation (No Ceremony)
AFIT Campus, WPAFB, OH I 16 Jun 2022

AFIT Graduate School Summer Quarter Classes Begin
AFIT Campus, WPAFB, OH I 27 Jun 2022

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