12-2022

The AFIT ENgineer, Volume 4, Issue 4

Graduate School of Engineering and Management, Air Force Institute of Technology

Data Analytics and Data Science Programs Support DAF and DoD

**By Dr. Brent Langhals and
Dr. Mark Gallagher
Air Force Institute of Technology**

Our modern world generates incredible volumes of data from an ever-increasing number and variety of sources. Seemingly every human interaction, whether physical or virtual, initiates new entries into the overall data repository. In truth, however, human activity represents only a small fraction of the world-wide data creation. Nearly every new system from multi-billion-dollar jet fighters to common household toasters are now designed to autonomously output data, often at a rate of thousands of times per second. Perhaps then, the biggest challenge of our time is how to effectively manage and use the mountains of available data, especially given most of the data is irrelevant to our purposes or even worse, potentially unreliable. Nowhere is answering this challenge more important than for today's military.

For the Department of the Air Force, the reality is the more data we have access to; the more reliant we are on highly skilled Airmen to sift through the noise to find the relevant and important nuggets. In the field, commanders rely on high quality data analytics initiatives to deliver the key insights required to navigate complex military environments.

Recognizing this imperative, in September 2020, the Deputy Secretary of Defense David Norquist published the "DoD Data Strategy". One of the four essential capabilities identified in the DoD Strategy is talent; defined as service members and civilians empowered to use data empowering operations. Shortly after, the Air Force created the Chief Data Officer and the Space Force announced they would become a "digital service" to accelerate innovation. Unfortunately, the ability to recruit high-end data analyst talent has proven challenging given competing opportunities across private and public sectors.

In response, the Air Force Institute of Technology offered an "in-house" means to educate air and space professionals of all ranks and backgrounds on how to make the best use possible of the vast quantities of data generated daily. Starting in 2019, AFIT began offering a Data Analytics Certificate program designed to provide day-to-day data analytic skills. Soon after, in 2021 AFIT created a Master of Science in Data Science to provide a deeper theoretical understanding with advanced skillsets to tackle the toughest data analysis challenges facing the Air and Space Forces today. Pages 14-17 highlight these programs, including early student successes positively impacting military operations today.

> **"There were 5 exabytes of information created between the dawn of civilization through 2003, but that much information is now created every two days."**
>
> —*Eric Schmidt, Executive Chairman at Google*

Pages 14-17

Data Analytics and Data Science at AFIT

U.S. Air Force courtesy photo

AFIT faculty and students met with members of the DAF-MIT AI Accelerator to better understand the data collection process for quantifying pilot attention using physiological signals.

INSIDE THIS ISSUE

Find past issues online at:
www.AFIT.edu/EN/afitengineer

Continued Commitment to Advancing Innovation in 2023

Whether in sports or academia, a national ranking is of premium importance to every organization. It is in this context that I excitedly share the U.S. News and World Report ranking of AFIT's Aerospace/Aeronautical/Astronautical Engineering Programs as #32 in the nation (see inset). This is a well-deserved and widely-broadcasted accolade for our program that has been at the cutting edge of the field consistently for many decades. In addition to educating technical thought leaders for the U.S. Air Force, the program has also generated landmark and seminal research products for U.S. national defense. This has created foundational excellence upon which the entire Graduate School of Engineering and Management has thrived and expanded for many decades. Please join me in celebrating this accomplishment.

As we conclude the fourth year (Volume 4, Issue 4) of the AFIT Engineer Newsletter, I enthusiastically salute our readers, supporters, observers, and cheerleaders. Our commitment to the advancement of innovation is not only in the classroom and research labs, but also in our publications. In this issue, you will see several articles and topics related to the theme of data analytics and data science. These are academic programs that we have expanded in response to the needs of the U.S. Air Force, the U.S. Space Force, and sister services. It is upon the strength of data that AFIT has served as the lynchpin for the development of several critical technologies for national defense, dedicatedly, since 1919.

On this note, I am delighted to announce the just-published *Handbook of Scholarly Publications from the Air Force Institute of Technology (AFIT), Volume 1, 2000-2020*, which is a part of the Systems Innovation Book Series by Taylor and Francis/CRC Press. Future issues of this newsletter will provide more information about the focused and selective contents of the handbook. Meanwhile, please enjoy this newsletter issue and look forward to future issues of the AFIT Engineer.
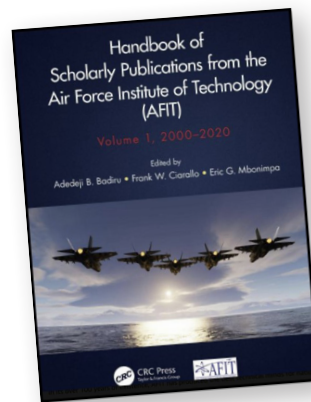
Adedeji B. Badiru, Ph.D., PE
Adedeji B. Badiru, Ph.D., PE
Dean, Graduate School of Engineering and Management

U.S. News & World Report Best Graduate Schools Ranking
AEROSPACE / AERONAUTICAL ASTRONAUTICAL ENGINEERING
#32

Best Aerospace/Aeronautical/Astronautical Engineering Program Air Force Institute of Technology #32 – Ranked in 2022
View online at www.usnews.com/best-graduate-schools

TEACHING WHAT WE RESEARCH. RESEARCHING WHAT WE TEACH.

Systems Engineering Graduation Rates Hit Record High During 2021-2022 Academic Year

The Department of Systems Engineering and Management within AFIT's Graduate School reported significant growth in its Systems Engineering (SE) program's graduation rate during the 2021-2022 academic year. As the Graduate School's home for Digital Engineering, and specifically Model-Based Systems Engineering, the department's portfolio of SE programs graduated 108 students this academic year, which is a record for the program.

This academic year saw an additional important milestone for the department. At the conclusion of the academic year, the department had graduated 1,009 students since the program was restructured in 2003. "For these milestones, I cannot emphasize enough the team effort from across the faculty and staff to make this work. At the core of the department are the continuous efforts of Ms. Lynn Curtis, Dr. Dave Jacques, Dr. John Colombi and Mr. John Reisner. This team has poured so much into our students' success and our program's excellence. They have taken us from 1 to 100 graduates per year over the last two decades; the 1000+ alumni in that time have all benefited from the efforts of these four," said Lt. Col. Amy Cox, Program Chair and Assistant Professor of Systems Engineering.

In 2002 Systems Engineering had only one student and the program was one of the lesser known options in AFIT's Department of Aeronautics and Astronautics. In response to an initiative from the Secretary of the Air Force, the program was restructured in 2003 and became one of the lead programs in the Department of Systems Engineering and Management. "We adapt as we go, incorporating the needs of sponsors and responding to opportunities in the field. Our early efforts in distance learning were fueled by the Air Force Research Laboratory's Space Vehicles Directorate, Space and Missiles Systems Center and Sandia National Laboratory workforce development needs," said Cox.

The department continues to receive support from leaders across the Department of Defense, with persistent sponsorship and funding from Air Force Materiel Command and the Office of the Assistant Secretary of the Air Force for Acquisition, Technology and Logistics. The department's leadership and faculty constantly strives to align itself with the needs of the service and the workforce.

Since 2003, the department has continuously improved its in-residence offerings while steadily increasing its outreach. The first distance learning (DL) options were offered in 2003 and the department has offered a DL masters since 2006. "We have gone from a single degree offering to ever expanding options for students. In addition to our original offering, we now have a family of programs that includes a graduate Systems Engineering Certificate, a capstone-based Masters of Engineering in Applied Systems Engineering, and a Doctorate of Philosophy," said Cox. All but the doctoral program are available both online and in-residence.

The department's portfolio of programs not only draws students from across the Air and Space Forces and from around the globe, but it also attracts students from across the DoD and federal government. "Our robust course offerings, flexible degree plans, and off-duty hour class times have a proven track record, which can be seen in our recent online graduation numbers. Our courses are in alignment with current military objectives and drastically improve the qualifications and capabilities of the workforce," explained Cox.

The department counts at least eight General Officers among its alumni, as well as civilian leaders throughout acquisitions and engineering. "It has been fulfilling to enable the life-long learning of our students and to guide them in defense-focused research. We will build on this legacy to aid our students' pursuit of life-long learning, to accomplish relevant defense-focused research and to support the workforce development needs of the DoD. Here's to the next two decades and beyond," said Cox.

BY THE NUMBERS
SE PROGRAM GRADS
AY 2021-2022
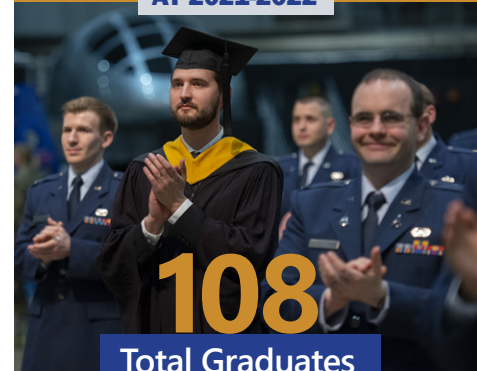
108
Total Graduates

3
PhDs (2 local part-time)

19
Graduate Systems Engineering resident master's degrees

8
Graduate Systems Engineering online master's degrees

51
Systems Engineering Certificates (sponsored by Air Force Materiel Command)

27
Applied Systems Engineering master's degrees (non-thesis/capstone): 7 online and 20 APT (USAFA grads awaiting pilot training)

> "Our robust course offerings, flexible degree plans, and off-duty hour class times have a proven track record, which can be seen in our recent online graduation numbers."
>
> —Lt. Col. Amy Cox, Program Chair and Assistant Professor of Systems Engineering

Dr. Bradley Liebst Retires after 33 Years at AFIT

Upon his retirement from AFIT in September 2022, Dr. Bradley Liebst had dedicated 33 years of his career to AFIT's Graduate School of Engineering and Management – both as a faculty member and as part of the Graduate School leadership. Liebst retired as Head of the Aeronautics and Astronautics Department – a position which he held for 24 years. In addition, he enjoyed time in the classroom as a Professor of Aerospace Engineering.

"I am proud of the high quality of graduates, staff and faculty that have floated through the Aero. Dept over the years. I like to think I did have some positive influence in that," said Liebst.

Liebst received his Ph.D. in Aeronautical Engineering from the prestigious Massachusetts Institute of Technology. "When I arrived at AFIT, professors had 12 month contracts. The Dean at the time pushed to move us to the standard civilian model of 9 or 10 month contracts, which meant faculty had to bring in their remaining salary through sponsored research. This resulted in AFIT having

a major increase in sponsored research and publication production and quality," said Liebst.

During his career at AFIT, Liebst was principal investigator in funded research projects totaling more than $2M and he published over 50 articles and reports. In addition, he received the 2002 Best Paper of the Year Award from the Journal of Aerospace Engineering and became an Associate Fellow of American Institute of Aeronautics and Astronautics.

When asked to share his favorite memory of AFIT, Liebst replied, "I have so many fond memories. AFIT is a special place with a well-defined mission that is vitally important to the future of the Department of the Air Force. I enjoyed working with bright and hard-working students, staff and faculty."

U.S. Air Force courtesy photo

Col. James Fee, Graduate School Associate Dean, congratulates Dr. Bradley Liebst on his retirement from AFIT after 33 years as a member of the faculty and department leadership.

LEARN MORE ONLINE

Read the complete story online at:
https://e.afit.edu/GGwwJJ77

FACULTY PATENT AWARDS

Turbine Cooling System with Energy Separation

PATENT # 11,454,171

DATE: September 27, 2022

INVENTORS: Lt. Col. James Rutledge, Matthew Fuqua and Carol Bryant

ABSTRACT: As the operating temperatures of gas turbine engines continue to increase due to increased power requirements, the cooling requirements also continue to increase. Cooling flow in a gas turbine engine is typically bled from the compressor and diverted to impinge on a hot component downstream of the compressor. Using compressed air to cool portions of the turbine engine in lieu of supplying all of the compressed air for combustion reduces the thermal efficiency of the engine. Many cooling schemes have been used in an attempt to reduce the amount of cooling air bled from the compressor, however, prior art cooling systems have various shortcomings, drawbacks, and disadvantages relative to certain applications. Accordingly, there remains a need for further contributions in this area of technology.

LINK: https://patents.justia.com/patent/11454171

Seal for a Wave Rotor Disk Engine

PATENT # 11,459,902

DATE: October 04, 2022

INVENTORS: Marc Polanka, Christopher Tait, Pejman Akbari, Brian Sell

ABSTRACT: Wave rotor disk engines include a radial rotor and a turbine positioned radially outward of the rotor with each rotatable about a common axis of rotation. An air/fuel mixture enters the wave disk engine proximate the center of rotation and is ignited via a spark plug or other ignition source and is combusted between the radial blades of the rotor. The combustion front moves radially outward toward the turbine. A circumferential rotor case is positioned between the rotor and the turbine. At least one opening in the rotor case permits the combustion working fluid to pass from the rotor into the turbine wherein energy is extracted from the high pressure and high temperature working fluid and converted into mechanical and/or electrical energy as is conventional. In prior art engines, pressure losses and thus efficiency losses occur when the flow of combustion working fluid leaks past a tip clearance region between the rotor tips and the rotor casing. Sealing the tip clearance region would advantageously improve the efficiency of the wave disk engine. Accordingly, there remains a need for further contributions in this area of technology.

LINK: https://patents.justia.com/patent/11459902

AFIT Welcomes Center for Space Research and Assurance Director

The Air Force Institute of Technology welcomes **Colonel Nathan Terry** as the Center for Space Research and Assurance (CSRA) Director and Senior Military Professor.

Terry has a deep experience leading transition in a host of DoD programs including basic research into fiber and semiconductor lasers, active and passive electro-optic sensing, plasma physics, additive manufacturing, radio frequency sensing, computational electromagnetics, high energy lasers, and emerging precision navigation and timing technologies. His assignments include chief of wing analysis, graduate student, research physicist, deputy branch chief, branch chief, assistant professor, assistant to the chief scientist, high energy laser program manager, and military assistant to the Director of Defense Research and Engineering for Research and Technology in OSD. Terry has conducted and published research on a variety of topics including lasers, non-linear optics, educational psychology, and nuclear deterrence.

Col. Nathan Terry

Reeder Named Department of Aeronautics and Astronautics Head

The Graduate School of Engineering and Management recently announced the appointment of **Dr. Mark Reeder** as Head of the Department of Aeronautics and Astronautics. Reeder also serves as a Professor of Aerospace Engineering within the Graduate School.

Dr. Mark Reeder

Reeder has been an AFIT faculty member since 2002 when he joined the Department of Aeronautics and Astronautics as an assistant professor. His research interests include all aspects of experimental fluid mechanics with an emphasis on applications involving wind tunnel testing, mixing enhancement for combustion, and micro air vehicles. Additionally, his expertise in the area of hypersonics has been highly regarded by both AFIT and its students.

He is a graduate of The Ohio State University, where he earned a Ph.D. in Mechanical Engineering in 1994 and a M.S. in Mechanical Engineering in 1991. Reeder also has a B.S. in Mechanical Engineering from West Virginia University in 1989.

Prior to taking a position with AFIT, Reeder served as an NRC Research Associate at NASA Glenn and subsequently as the manager of R&D for a manufacturer of industrial mixing equipment.

He has co-authored articles published in a variety of journals including the *Journal of Fluid Mechanics, Experiments in Fluids, The AIAA Journal of Aircraft, The AIAA Journal of Propulsion and Power, The AIAA Journal of Spacecraft and Rockets, Physics of Fluids, NASA Tech Briefs, and Chemical Engineering Progress*.

He has four patents to his credit, is a licensed Professional Engineer in the State of Ohio, and is a member of AIAA and ASME.

Graduate School Faculty Members Celebrate Retirements

Dr. Anthony Palazotto, Distinguished Professor of Aerospace Engineering within the Air Force Institute of Technology's Graduate School of Engineering and Management, retired in December 2022 after 47 years.

Dr. Anthony Palazotto

Palazotto received the title of Distinguished Professor Aerospace Engineering in 2011 in recognition of his exceptional leadership and research. He is the author of over 700 presentations and publications, 272 are archival. He has received over $5 million dollars in Air Force research funding while at AFIT. To date, Palazotto has advised over 190 theses in Air Force technology with an additional 39 Ph.D. dissertations. Every topic he has worked on has been sponsored by Air Force directorates in some form or other.

LEARN MORE ONLINE

Read the complete story online at:
https://e.afit.edu/GGwwJJ77

Dr. Paul Wolf recently retired from AFIT in September after 28 years in the Graduate School of Engineering Management. Wolf served as the Associate Dean for Academic Affairs and Professor of Physics. Wolf earned graduate degrees from AFIT— an M.S., Engineering Physics in 1979 and Ph.D., Physics in 1985.

Dr. Paul Wolf

Dr. Andrew Terzuoli Jr., Associate Professor of Electrical Engineering, retired in September from full-time teaching in the Graduate School of Engineering Management where he had been a tenured civilian faculty member since 1982. Terzuoli has been named a Professor Emeritus at AFIT.

Dr. Andrew Terzuoli Jr.

Successful Online Outcomes

Distance Learning GNC-focused Master's Degree in Electrical Engineering
Offered through Academic Department and Research Center Partnership

PROGRAM BENEFITS
- Defense-focused, researched-based graduate education
- Ability to conduct classified research
- Unique combination of military and civilian faculty
- Diverse student population including other services, civilians, and international allies
- Strategic partnership with the Air Force Research Laboratory
- Regionally accredited by The Higher Learning Commission, and core engineering programs accredited by Accreditation Board for Engineering and Technology

APPLICATION REQUIREMENTS
Degree Required: BS degree from an accredited institution
Mathematics Required: Ordinary Differential Equations
Test Required: GRE- 153V/148Q (within the last 5 years)
GPA Required: Overall- 3.0; Mathematics- 3.0; Major- 3.0

The distance learning Guidance, Navigation, and Control (GNC)-focused master's degree in Electrical Engineering consists of nine online courses plus a master's thesis. This ABET-accredited degree program is tailored for working professionals and is intended for government and contractor organizations in need of a GNC workforce development pipeline, with a special emphasis on positioning, navigation, and timing (PNT) for military applications. Asynchronous online learning modules with intentional alignment between thesis research and day-to-day job responsibilities maximize the on-the-job relevancy, educational efficiency, and overall value of this program to the entire defense-focused PNT workforce.

Notionally, students will take one course per quarter, finishing all nine courses within two and a half years regardless of when students first enroll. Thesis research begins partway through the program and is expected to finish approximately three years from the date of initial enrollment.

Students enrolled in the program are required to have an academic advisor. The advisor will be an AFIT Autonomy and Navigation Technology (ANT) Research Center faculty member with a Ph.D., and will also serve as a chair on the student's thesis committee. To support successful distance learning outcomes, the ANT Center also requires that each student have an onsite mentor defined as someone at the student's place of work who is 1) knowledgeable in the technical details of the thesis project, 2) who preferably has at least a master's degree, and 3) who is willing to guide the student through technical challenges. Students will not be accepted into the program without an onsite mentor who has confirmed the prospective student's understanding of the arrangement to align thesis research with job duties.

The ANT Center is a forward-looking research center seeking to identify and solve tomorrow's most challenging navigation and autonomous and cooperative control problems. The ANT Center's goal is to develop navigation technology that ensures we can navigate anywhere, anytime, using anything and focuses on three research thrusts: autonomous and cooperative systems, non-GPS precision navigation, and robust GPS navigation/Naval Information Warfare Systems Command (NAVWAR).

ANT CENTER
AUTONOMY & NAVIGATION TECHNOLOGY

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🌐 **Visit www.AFIT.edu/ANT**

Center for Space Research and Assurance Celebrates 10 Years of Academic Research Success

By Mary Anne Sibley
Center for Space Research and Assurance
Air Force Institute of Technology

The Air Force Institute of Technology's Center for Space Research and Assurance (CSRA) celebrated its 10th anniversary this past November. Since its founding, CSRA has transcended its expectations by enhancing AFIT's research-based, space-focused graduate education programs for the Department of Defense and intelligence communities.

In this decade, CSRA has had an evolution of leadership. The Center's first director was Dr. Jonathan Black, followed by Col. Matthew Sambora, Col. Dane Fuller, and Col. Timothy Albrecht. The current director is Col. Nathan Terry, with Lt. Col. Robert Bettinger as the deputy director.

CSRA Major Accomplishments
With great leaders, faculty, and staff, the Center has had many accomplishments to celebrate. CSRA's researchers have brought in over $15M in external funding, maintained more than $12M in essential equipment, graduated 184 master's and 21 doctoral degree space students.

Since its inception, CSRA has advanced space education at AFIT for students in the astronautical engineering and space systems graduate degree programs. CSRA faculty have also created successful certification programs where students can earn graduate certificates in space systems and space vehicle design. The Center has created such a competitive advantage for AFIT in the space domain that the Center was presented the prestigious Muir S. Fairchild Educational Achievement Award in 2019.

CSRA in the Next 10 Years
Lt. Col. Robert Bettinger, CSRA's deputy director said, "I think that we should expand our modeling and simulation capabilities to influence the research push into areas that may be deemed as 'science fiction' at the present. We should be poised to answer the questions that may not be openly asked, such as what future space operations may look like in not only cislunar space, but beyond. We should pivot our curriculum and research to anticipate questions such as this example so that we are proactive to customer needs and impactful on a shorter timeline."

"I think we should strive to be the US Space Force's primary resource for innovations in space mission analysis and design. That should include being national thought leaders in near-Earth to cislunar operations and by that point, looking forward to potential missions in deep space, outside the Earth's sphere of influence, perhaps to interplanetary applications, but definitely in the sense of managing near-Earth asteroids and other significant threats to Earth, and US/USSF space assets," said Dr. Carl Hartsfield, program chair, graduate space systems.

CSRA's director, Col. Nathan Terry, stated, "I see CSRA as the premier technology mentor for Space Force Guardians, offering a range of degree and micro certificate credentialing options to imbue the right Guardians with the right skills at the right time. CSRA will become the center of visionary thought leadership for space research supporting all phases of space operations and growing space power."

As space operations intensify, there will be a need for more advance research and the education of professionals on how to increase the capabilities of the Department of Defense and intelligence communities.

Over the next 10 years, CSRA will continue to evolve its research and graduate education mission by expanding its work with digital engineering, high performance computing, and cutting-edge trajectory/mission development in orbital regimes ranging from low Earth orbit to the cislunar domain.

DAF MISSION IMPACT

Developed five spaceflight experiments:
- AFIT LEO iMESA CNT Experiment (ALICE)
- Space Object Self-Tracker (SOS) Payload
- Skypad Payload
- Grissom-1 CubeSat
- Grissom-P CubeSat

Launched three spaceflight experiments:
- ALICE - 2013
- SOS - 2019
- Skypad - 2020

LEARN MORE ONLINE

For more information about graduate and post-doctoral degrees in astronautical engineering or space systems, please visit the CSRA web page at **www.AFIT.edu/CSRA** and click the "degree programs" tab.

BY THE NUMBERS
GRADUATE SCHOOL OF ENGINEERING & MANAGEMENT

1,063 Students enrolled Fall 2022

198 Faculty members Fall 2022

677 Degrees awarded AY 2021-2022

8 Faculty patents FY2022

Hypersonic Flight Graduate Certificate Now Offered

AFIT Joins Short List of Academic Institutions Offering Graduate Studies in Hypersonics

The Air Force Institute of Technology's Department of Aeronautics and Astronautics is proud to offer a Graduate Certificate Program in Hypersonic Flight. The field of hypersonics has emerged as a technical discipline that is critical to ensure the United States will be able to fight and win future conflicts. The Graduate Certificate in Hypersonic Flight is specifically designed to produce technical professionals who can understand, evaluate, and communicate the unique complexities of the hypersonic flight environment.

The program consists of a rigorous collection of graduate level courses. The courses are offered in-residence at the AFIT main campus located on Wright-Patterson Air Force Base, Ohio. Students must complete three core classes and then select one elective course, for a total of 16 quarter hours of graduate level studies. The three core courses cover the areas of inviscid hypersonic flows, high temperature gas dynamics, and hypersonic propulsion. The one elective course may further the student's understanding in either computational fluid dynamics, nonequilibrium phenomena, reentry dynamics, or chemical propulsion.

HYPERSONIC FLIGHT PROGRAM COURSE LIST

Hypersonic Flight Core Courses [required]
- AERO 622 – Introductory Hypersonics
- AERO 729 – Theory of Gases for Aerodynamics and Propulsion
- MENG 634 – Hypersonic Propulsion

Hypersonic Flight Elective Courses [choose one of the following]
- AERO 640 – Hypersonic Computational Fluid Dynamics
- AERO 740 – Nonequilibrium Hypersonic Flows
- MECH 637 – Astrodynamic Reentry
- MENG 530 – Chemical Rocket Propulsion

Upon completion of the program, graduates will have a general understanding of the differences between hypersonic flight regimes and the subsonic and super-sonic flight regimes which make the hypersonic environment unique. They will also have a thorough understanding of the aerothermodynamic properties of hypersonic flows and how to approach and appropriate engineering analysis given hypersonic flight conditions. Finally, graduates will be equipped with the skills needed to critically analyze hypersonic vehicle systems and subsystems at the appropriate fidelity.

REGISTRATION & APPLICATION INFORMATION

PROGRAM REGISTRATION
Registration is currently open for students who wish to apply.

APPLICATION REQUIREMENTS
Degree Required: ABET-accredited degree in aeronautical, aerospace, astronautical, or mechanical engineering

GPA Required: Cumulative GPA- 3.0 on a 4.0 point basis in that degree

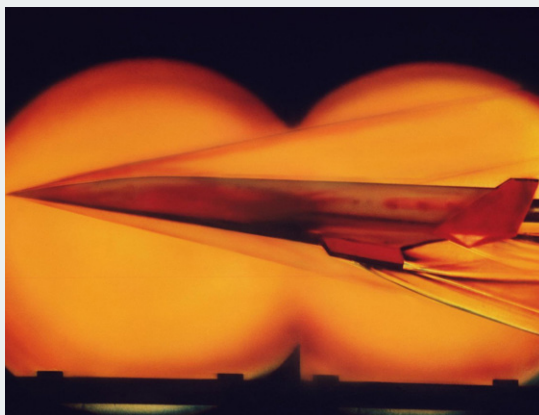*Waivers to the degree or GPA requirement may be considered on an individual basis.*

Photo courtesy of defense.gov

CONTACT FOR MORE INFORMATION

Email questions to the Hypersonic Flight Program Chair:
Robert.Macdermott@AFIT.edu

Visit us online for more program details:
https://e.afit.edu/4qq52CC

NEW CYBER-PHYSICAL SENSING PROGRAM
3 Specialized In-Residence Certificates Offered

- ✓ **Cyber-Physical Sensing: Artificial Intelligence**
- ✓ **Cyber-Physical Sensing: Cyber Attacks**
- ✓ **Cyber-Physical Sensor Analysis**

The AFIT Cyber-Physical Sensing Graduate Certificate Program was developed in partnership with the Air Force Research Laboratory's Sensors Directorate.

- Certificates can be completed in 12 months
- Each program contains 3-4 in-residence courses
- Students will complete a capstone research paper on a topic relevant to AFRL and the CPS community

Visit https://e.afit.edu/Bm2GVTT for more information

Celebrating Fall Graduates

First Group of USAF Officers Awaiting Pilot Training Completes 12-month MS Program

The Air Force Institute of Technology's Graduate School of Engineering and Management held a commencement ceremony Sept. 15 to celebrate 103 new graduates. The graduates join a group of more than 22,000 AFIT alumni.

Of the 103 degrees awarded, the Graduate School conferred 79 master's degrees and 24 doctorate degrees in science, technology, engineering and math fields. Additionally, five master's students and three doctoral alumni who graduated earlier in the academic year returned to participate in the ceremony.

The graduating class included 84 Air Force officers, two Space Force officers, two Army officers, one Marine Corps officer, one Air National Guard officer, and nine civilians. Four international students from Saudi Arabia and Singapore also received degrees.

Participating in the ceremony was the first class of students to complete an in-residence, non-thesis master's degree program option for officers in the USAF pilot training pipeline. The 12-month program allowed the 60 officers to earn an advanced degree instead of remaining in casual status until their undergraduate pilot training start date.

"You have wisely used this waiting period to expand your knowledge and I know you will be better pilots and better officers because of your studies here at AFIT," said Dr. Walter Jones, AFIT director and chancellor.

The graduation speaker for the ceremony was Dr. Vincent Russo, retired member of the Senior Executive Service whose 41 year Air Force career culminated as the executive director of the Aeronautical Systems Center, the predecessor of the AF Lifecycle Management Center. He also served as the director of the Air Force Research Laboratory's Materials and Manufacturing Directorate and led the formation of AFRL from four separate laboratories into one. Russo earned a master's degree in materials engineering from AFIT in 1964 and received the AFIT Distinguished Alumni Award in 2006.

"Of all my education experiences, I believe AFIT most instilled in me the tools to be successful," said Russo. "The academic knowledge you have gained while here at AFIT is invaluable, but so are the other skills associated with receiving an advanced degree. Skills such as discipline, inquisitiveness, and collaboration. These and other soft skills will be vital to your progress throughout your career."

Russo discussed four life lessons with the graduating class: things will happen to you that you can't control, but make the best of what you were given; a strong education base will help you in ways you can't predict; leadership is an art that can be learned, it just takes study, hard work, and a commitment to learning; and pay it forward by using your technical interest and expertise to help develop our Nation's next generation of STEM workforce.

READ MORE ONLINE

Link to graduation news: **https://e.afit.edu/j9n7GG**

U.S. Air Force photo by Katie Scott

The first group of officers awaiting pilot training (APT students) graduate from AFIT's 12-month MS program.

Scenes from the Graduate School of Engineering and Management September 2022 commencement ceremony held at AFIT's Kenney Hall.

U.S. Air Force photos by Jaima Fogg and Katie Scott

Faculty Member Receives 2022 J. Steinhardt Prize

By Dr. Darryl Ahner
Dean for Research
Air Force Institute of Technology

Dr. Raymond Hill, Jr., an adjunct professor of operations research in the Air Force Institute of Technology's Graduate School of Engineering and Management, is the 2022 awardee for the J. Steinhardt Prize for outstanding contributions to military operations research.

Dr. Raymond Hill, Jr.

The award is named in honor of Jacinto Steinhardt, a founding member of the Operations Research Society of America. The winner is selected based on life work rather than for any particular contribution and is accompanied by a plaque and a $2,000 honorarium.

The impacts made by Hill on military operations research are significant, distinguished, and enduring. After earning his master's degree in operations research in 1987 from AFIT, he served as an Air Force operations research analyst until

2002. During that time, he served as a logistics analyst, a weapons and tactics analyst, and a faculty member at AFIT. Following retirement from active duty, he further embraced his ability to teach, research, and mentor analysts, first at Wright State University from 2003-2008, and subsequently at AFIT from 2008-2022.

Hill's contributions over the duration of his professional career have been outsized, expanding far beyond the organizations or educational institutions in which he served. He has authored or co-authored 107 peer-reviewed journals and 93 refereed conference proceedings, and advised 15 doctoral students and 104 master's students. He established the Test and Evaluation Graduate Certificate Program at AFIT which supports the broader Air Force and DoD test communities graduating over 2,200 T&E planning and analysis experts.

Additionally, Hill has served the professional community in multiple roles including as the general chair of the annual Institute for Operations Research and the Management Sciences (INFORMS) Winter Simulation Conference. He is the editor for the journal *Military Operations Research* and the associate editor for *Naval Research Logistics, Journal of Defense Modeling and Simulation, Journal of*

Simulation, and the *International Journal of Mathematics in Operational Research.*

Hill is also a member of several professional societies including the Military Operations Research Society, INFORMS, INFORMS College on Simulation, INFORMS Military Applications Society, the World Scientific and Engineering Academy and Society, the American Statistical Association, and the International Test and Evaluation Association.

Hill retired from a full-time faculty position at AFIT in June 2022 after serving for 20 years as an active duty Air Force officer and a civilian. He holds a Bachelor of Science degree in mathematics from Eastern Connecticut State University, a master's degree in operations research from AFIT, and a doctorate in industrial and systems engineering from The Ohio State University.

Among his awards during his career are the 2016 Air Force Outstanding Science and Engineering Educator Award, the 2016 Affiliate Societies Council of Dayton Outstanding Engineer and Scientist's Award, and the 2006-2007 Excellence in Research Award while a professor in the College of Engineering and Computer Science at Wright State University.

Faculty Research Article Named in Top 30 Breakthrough Stories by Optics & Photonics News Magazine

AFIT Assistant Professor of Electrical Engineering **Dr. Hengky Chandrahalim's** research article titled *Two-Photon Machining of Sensors on Fiber Tips* was selected as one of the top 30 breakthrough stories appearing in the special issue "Optics in 2022" by *Optics & Photonics News* magazine. The article appeared as #23 on the magazine's list which can be found in the December 2022 issue linked below.

Co-authors of the article include **Capt. Jeremiah C. Williams** (M.S. Electrical Engineering, 2020), Joseph S. Suelzer and Nicholas G. Usechak of the Air Force Research Laboratory's Sensors Directorate.

»» LEARN MORE ONLINE

Link to Optics in 2022: https://e.afit.edu/JfSkzz

»» FIBER SENSOR RESEARCH PUBLISHED

Dr. Hengky Chandrahalim's work on fiber sensors with complex moving parts was reported in the Nanoscribe News in November. Nanoscribe GmbH & Co. KG is the world's leading manufacturer of 3D lithography equipment. Read the article at https://e.afit.edu/VVxyyykYY

Provost Inducted into Ohio State Alumni Hall of Fame

By The Ohio State University

The Ohio State University at Marion inducted six members into its Alumni Hall of Fame during an inaugural ceremony held Thursday, November 3. Among those inductees was Dr. Heidi Ries, AFIT's Provost and Chief Academic Officer. The awards program honors outstanding alumni who have contributed significantly to their professions and/or communities. Ries shared that she had no doubt in her mind that attending Ohio State Marion her freshman year was critical preparation, academically and personally, to her long-term success. She also noted that Ohio State Marion Professor of Physics, Dr. Gordon Albrecht, was very influential in building her technical understanding and confidence in her abilities.

"When she entered the workforce, she was often the only woman at the table and overcame stereotypes and biases through her hard work, determination, professionalism, and excellent work ethic to achieve great heights in her impressive career," added Ohio State Marion Director of Development and Community Relations, Cathy Gerber.

Dr. Ries got her college start at The Ohio State University at Marion, earning her Bachelor of Science in Physics from The Ohio State University in 1982 and a Master's in Physics from Ohio State in 1984. In 1987, she earned her Ph.D. in Applied Physics from Old Dominion University.

Dr. Heidi R. Ries joined the Air Force Institute of Technology (AFIT) in 1999 and currently serves as the Provost and Chief Academic Officer; she is also a Professor of Physics within the Graduate School of Engineering and Management. During her previous service as AFIT's chief research officer, Dr. Ries implemented the establishment of research centers yielding over 800% increase in external funding and enhancing AFIT's reputation in the

areas of cyber, directed energy, navigation, nuclear detection and analysis, operational analysis, space, and technical intelligence.

AFIT Provost and Chief Academic Officer Dr. Heidi Ries, far right, is inducted into The Ohio State University at Marion Hall of Fame.

Dr. Ries previously served as Professor of Physics and Director of the Center for Materials Research at Norfolk State University in Norfolk, VA, where she enabled the school's first master's degree program in the sciences, attracted $3M/year in external funding, served as an Associate Director of the Applied Research Center at Jefferson Lab, and directed the National Science Foundation Center for Research Excellence in Science and Technology project "Center for Photonic Materials Research."

Dr. Ries volunteers as a member of the Martin University Board of Trustees, where she serves as the Chair, Academic and Student Affairs Committee. She serves as the Past Chair of the Engineering and Science Foundation of Dayton Board of Trustees and is a member of the Team Chair Corps of the Higher Learning Commission. She serves as a reviewer for the National Science Foundation, and advisor for various university's initiatives. She previously served as Secretary-Treasurer of the American Society for Engineering Education, Engineering Research Council Board of Directors, AFIT Liaison to the Ohio Aerospace Institute Board of Trustees, and a parent-coach for the Centerville City Schools Science Olympiad Team.

GSEM Recipents of the 2022 AFIT Chancellor's Excellence Awards

AFIT INNOVATION AWARD
Dr. Sanjeev Gunawardena
Research Associate Professor of Electrical Engineering

Dr. Gunawardena is an ingenious innovator that is responsible for the development of next-generation GPS research. He has raised $1.3 million dollars and published seven technical papers that have enabled AFIT to redefine position, navigation, and timing applications as we know it. Furthermore, Gunawardena is an outstanding and well sought-after educator who has guided seven master's degree students and one Ph.D. student, and has been rated among the top 1% of all AFIT professors. Due to his academic prowess, he also has been invited to lecture at the Global Navigation Satellite System International Conference for 13 straight years.

Dr. Gunawardena

MENTORSHIP EXCELLENCE AWARD
Maj. Daniel Emmons, USAF, Ph.D.
Assistant Professor of Physics

Maj. Emmons is an outstanding educator that has revolutionized the field of space weather. In addition to winning the Dean's Distinguished Teaching Professor Award, he also won the 2021 Strategic Ohio Council for Higher Education (SOCHE) Excellence Award for his exceptional teaching and research proficiency. Emmons has advised three master's degree students and two Ph.D. students over the past year, and mentored 117 students in AFIT's second lieutenant immersion program. Furthermore, Emmons guided 58 Airmen as Division Chief to an impressive 100% graduation rate enabling AFIT's $8 million education investment.
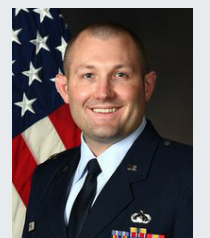
Maj. Emmons, Ph.D.

Congratulations

2022
GSEM Annual 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.

FACULTY SERVICE AWARD

LT. COL. DAVID KING
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

Lt. Col. David King's central contributions revolve around mentoring junior officers, junior faculty members, and students in the Department of Electrical and Computer Engineering. King served as the CSCE Section Lead for 26 M.S. and Ph.D. students over three years and led the Cyber-ANiMaL group for over a year. This 41-member group of faculty, M.S. and Ph.D. students met weekly to hone public speaking and critical research skills by creating a "dry run" environment for conference presentations and thesis/dissertation defenses. King also served as a military mentorship group facilitator for 15 junior faculty members over three years, focusing on getting members a strong start in key teaching, research, and service responsibilities. King joined the AFIT Faculty Handbook Committee to help ensure members have accurate information about programs, policies, resources, and opportunities. He is a Tau Beta Pi lifetime member who has facilitated AFIT recruitment, initiation, and networking opportunities.

King has been an innovator working to solve AFIT problems. Elected to two terms of the Faculty Council Parliamentarian, he adapted Robert's Rules of Order for use in an online environment. Assisting in AFIT's transition to the Air Force network (AFNET), King helped create a roadmap for department faculty software requirements and the transfer of vital department records. He served as a cornerstone information source for faculty and staff when it came to AFNET migration information.

AWARD CRITERIA: Recognizes exceptional achievements in service to the Graduate School, AFIT, the profession, discipline, and/or to the public.

RESEARCH AWARD

DR. DOUGLAS HODSON
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Dr. Douglas Hodson is a highly accomplished author who has published over 90 research articles, including five books/chapters, 42 journal papers, and 46+ research papers in conference proceedings. Publishers of his work are reputable and respected by the computer science and engineering community and all have stringent evaluation procedures. Hodson has won multiple research awards in recognition of his outstanding research contributions to his fields of specialization. His *Journal of Defense Modeling and Simulation* (JDMS) research article entitled "The Art and Science of Live, Virtual, and Constructive Simulation for Test and Analysis" has been cited 65 times, with 20 of these citations by investigators who are affiliated with the top 20 ranked institutions. His *IEEE Access* paper entitled "Using Modeling and Simulation to Study Photon Number Splitting Attacks" has had more than 900 full text views.

Hodson has served as a guest editor for two published JDMS special issues, with a third in progress (Modeling and Simulation in Graduate Military Education). He is an Institute of Electrical and Electronics Engineers (IEEE) Senior Member. Hodson served on the program committee of the military track at the 2016 Winter Simulation conference and was a keynote speaker for the 2017 Winter Simulation conference. He received an Outstanding Achievement Award at the 2018 World Congress in Computer Science, Computer Engineering, and Applied Computing and was the keynote speaker for the 2019 and 2022 conferences.

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.

EARLY CAREER ACHIEVEMENT AWARD

DR. CHRISTOPHER CHINI
DEPARTMENT OF SYSTEMS ENGINEERING & MANAGEMENT

Dr. Christopher Chini's achievements include frequently publishing in high profile journals and conference proceedings, including 19 peer-reviewed articles since 2020. Additionally, he has been involved in over $2.3 million in grants. Chini has taken over the reins as the Engineering Management (GEM) program chair, leading the program through its ABET reaccreditation process and standardizing academic evaluation and reporting processes.

Chini regularly teaches four courses spanning data analytics, infrastructure systems and management, geospatial information systems, and risk assessment. Chini challenges his students through an applied curriculum focusing on data management, uncertainty, and decision-making for infrastructure systems. In building these courses, he is also actively writing a textbook to support these courses and their student learning objectives. Chini's excellence in teaching has been recognized by the student-nominated Instructor of the Year from the Sigma Beta Chapter of Sigma Iota Epsilon at AFIT for 2021 and his GSEM Teaching Award for 2021. His teaching is also recognized by publications where student projects from his courses have been published in a relevant career field journal, *The Military Engineer*.

Chini serves as the curriculum chair for the GEM program that attracts 20-25 students per class. In the past year, he has been instrumental in expanding and standardizing the curriculum to a broader DoD audience, while also managing key stakeholder expectations. The incoming class that will graduate in 2024 has six USMC students, two enlisted bio-environmental engineers, and one enlisted civil engineer, in addition to the 17 civil engineer quota students.

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.

OUTSTANDING STAFF AWARD

MS. LISA SMITTLE
GRADUATE SCHOOL OF ENGINEERING & MANAGEMENT

Ms. Lisa Smittle exemplifies outstanding service to faculty and staff in the Graduate School of Engineering and Management and is a trusted advisor on all civilian and military personnel actions. Smittle surveyed multiple Department of Air Force and Air University policy guidance documents to advise the Dean on how faculty can be hired or appointed for various positions. Her guidance enabled the Dean to utilize the "administrative assignment" process to appoint an academic department head. This process allows the flexibility of selecting an existing faculty member for a career broadening professional development assignment, shortening the timeline to hire a department head from 6-8 months to 1-2 months.

Furthermore, Smittle used a vacated position to quickly seize the opportunity to develop and execute a manpower strategy to reshape the position to provide dedicated military personnel support for military faculty students. This action was completed in a record 30 days from initial idea to completed hiring action.

In addition to Smittle's civilian and military personnel expertise, she builds high morale across the Graduate School as a mentor and confidant to faculty and staff alike. Smittle serves as a subject matter expert for military faculty pipeline actions and has provided selfless support outside of the Graduate School to ensure all AFIT school's faculty resources are requisitioned for and filled through the Air Force's AAD/SPEED process.

AWARD CRITERIA: Recognizes exceptional service by administrative, support and technical staff employees in the Graduate School of Engineering and Management.

AFIT Student Poster Presentation Open House

The Department of Systems Engineering and Management celebrated student research in December by hosting a Graduate of Engineering Management (GEM) Research Showcase at AFIT. The event provided students with the opportunity to internally showcase and discuss their research and to answer questions in a conference type environment.

Additionally, students will present their research to key senior leaders and stakeholders within the Civil Engineer (CE) community in concert with the CE Summit held at AFIT on 27 Feb - 10 March. "We are proud of the work these students have put in and the potential impact their research has across varying aspects of the Air Force, Space Force, larger defense, and civil engineer communities," said Lt. Col. Ben Knost, program chair.
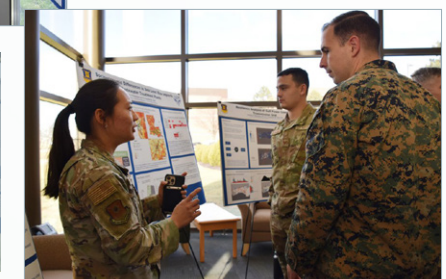
Data Analytics

Data Analytics Certificate Program Pushes Data Analysis Skills to Air and Space Force Communities

Data analytics refers to an emerging field focused on extracting key insights from data using a disciplined, process-based approach which includes analysis, collection, organization, and storage of data, as well as the implementation of computer-based tools and technologies. The primary goal is to apply statistical analysis along with machine learning techniques on datasets to uncover trends and answer specific questions of interest. To accomplish this task, data analysts draw from a range of disciplines including computer science, programing, and statistics to develop the key skills essential to conduct quality data analysis.

The Air Force, in striving to be a data-driven organization – one that purposely collects, creates, shares and acts upon quality, authoritative data in and across mission areas – requires analytic talent at the unit level, where most data is generated. Unfortunately, the human capital needed to effectively analyze data for operational decision making is lacking and has the longest lead time to develop or acquire. Consequently, it is critical to empower both civilian and military Airmen with data analytics education.

In 2019, at the behest of the Air Force Chief Information Officer, AFIT enrolled the first cohort of 40 students into a newly created Data Analytics distance learning certificate program. The program specifically targeted personnel of all ranks and career fields, requiring only a bachelor's degree and basic math background. The program consists of a 5-course sequence covering key data analytics skills such as data management/wrangling, statistics, applied machine learning all supported by a fundamental understanding and use of software coding.

One key objective of the Data Analytics certificate is to push data analysis skills to the broader Air and Space Force communities. Since inception, 399 students have enrolled in the program with 147 students having successfully completed all program requirements and represent nearly every MAJCOM, Headquarters Staff, and a variety of agencies (see chart below). The success of the data analytics program has even extended beyond the Air and Space Forces, drawing the attention of organizations such as Lawrence Livermore National Labs and the National Geospatial Agency, both of which have formalized arrangements with AFIT to send students to participate in the certificate program.

BY THE NUMBERS

399 Students Enrolled Since 2019 | **147** Students Completed Program

Agencies represented by Data Analytics certificate program students
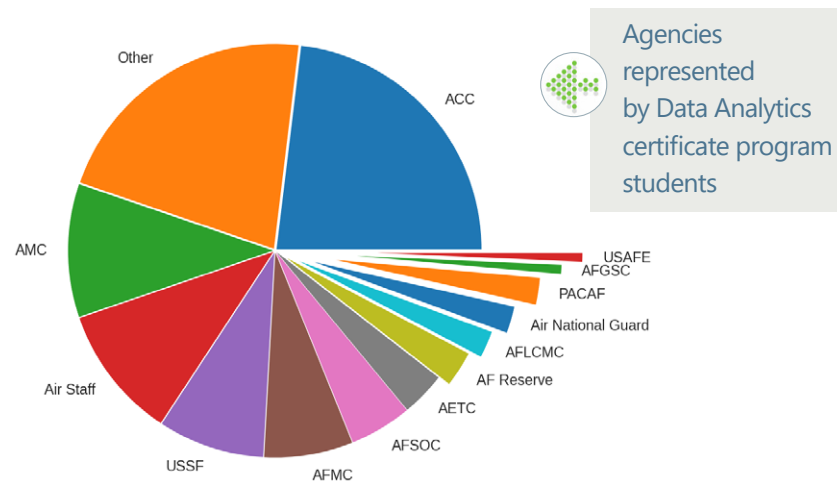
Meet the Faculty

Dr. Brent Langhals earned his Ph.D. in Management Information Systems from the University of Arizona. He is currently the Director of the Data Analytics program and teaches courses in Database, Data Analytics and Machine Learning.

Dr. Paul Auclair earned his Ph.D. in Industrial and Systems Engineering from the Georgia Institute of Technology. His United States Air Force experiences included ICBM operations, headquarters staff analyst, and graduate educator roles. He currently teaches Introduction to Data Analytics.

Dr. Torrey Wagner earned his Ph.D. in Electrical Engineering from AFIT and has 22 years of DoD-focused technical experience in several disciplines. He developed the certificate capstone Machine Learning course, and currently teaches the Object-Oriented Python and Machine Learning courses.

Lt. Col. Chris Weimer is the deputy head of the Department of Mathematics and Statistics and an Assistant Professor of Statistics. He is an Operations Research Analyst who has also served at AFRL, 711th HPW, AFOTEC HQ, AFIMSC HQ, and the 609th AOC.

Dr. Nicole Thorsen is the Data Analytics Program coordinator.

Data Analytics Student Outcomes

## Successful Outcomes Identified Through Student Capstone Projects

Students enrolled in the Data Analytics program complete a capstone project demonstrating knowledge and skills gained through the program. Below are examples of recent capstone projects.

Classifying Chinese News Headlines Using Natural Language Processing - Categorizing news articles by the text of their headlines can be an efficient way to sort the volume of articles into categories for review. In this project, a dataset of 380,000 Chinese language articles in 14 topic areas was modeled using multiple python-based natural language processing (NLP) approaches. The distribution of categories is shown in the figure to the right. Character-based and word-based approaches to selecting the most important model inputs were used, and the best approach was a word-based Naïve Bayes model. The python jieba library was created to segment Chinese text into "words" for this NLP tasks due to the language's lack of spaces separating words. The best model was 91% accurate at classifying the news articles into the 14 categories, as measured on a dataset that was not used for training the model. The performance of the military news topic was comparable to all other categories. The results showed that these machine learning NLP models could effectively sort Chinese articles by the words in their titles and enable more efficient processing of articles and avoiding the extra step of translating the headlines by hand.
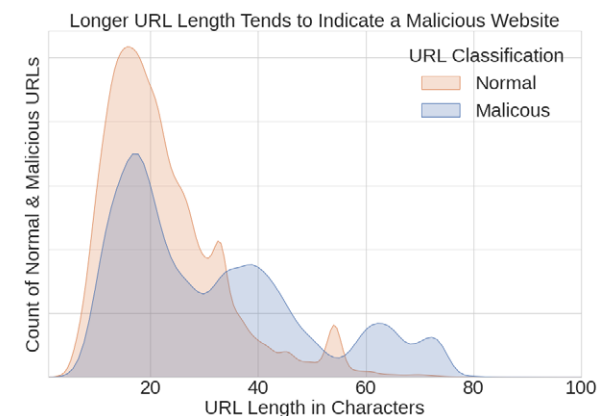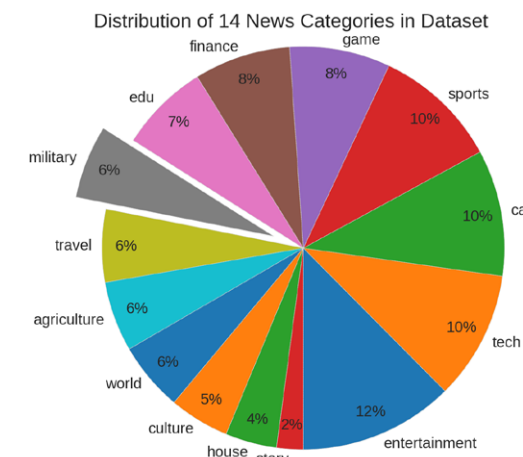
URL-based Malicious Website Prediction - One cybersecurity method to prevent connections to malicious domains is to restrict users from accessing malicious websites. However, new malicious websites are constantly being added, and a blacklist would be outdated as soon as it was created. The approach used in this work is to evaluate characteristics of the website uniform resource locator (URL), such as amazon.com or 06absence01.yolasite.com, to determine if it is malicious. This type of model would be able to identify new malicious websites as they appear. This model was trained on a dataset of 179,000 URLs where 53% were normal and 47% were malicious. Using only the URL, 15 features were extracted that related to URL subcomponents, character statistics, and randomness metrics. The best model was a neural network model with four hidden layers that accurately identified malicious websites 91% of the time, as measured on a 25% split of the dataset that was not used for training. This model drastically improved on a random model that possessed an accuracy of 47%. With this model, cybersecurity teams could potentially identify and respond to malicious domains quickly and without needing third-party enrichment techniques.

Predicting the Expected Lifetime of Satellites - An accurate prediction of a satellite's life expectancy can potentially save millions of dollars and prevent gaps in capability. In this study, the manufacturer's expected lifespan of 3,095 satellites was predicted using nine satellite features including type of orbit, mass, customer, and 6 attributes of the orbit. The lifespans ranged from ¼ year to 30 years and had an average lifespan of 6.3 years. The best neural network model predicted the satellite lifespan with a mean absolute error of 0.47 years, as measured on a holdout dataset. In order to obtain the best model, the neural network models explored hyperparameter sweeps on the number of neurons, the number of layers, the learning rate and the number of epochs. In future studies, the model could potentially be improved using space weather data, as space weather events may affect overall satellite lifetime.
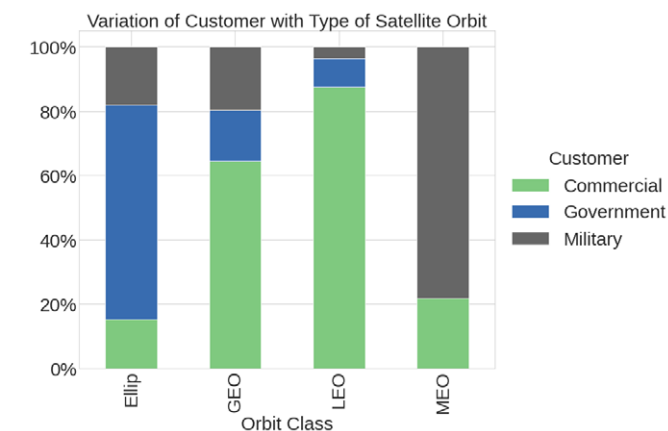
Data Science

First Cohort of MS Data Science Program Students to Graduate in March 2023

The Air Force Institute of Technology also accepted the challenge to educate data scientists within the Air Force and Space Forces, along with the rest of the DoD. The Department of Operational Sciences initiated an 18-month in-residence Master of Science in Data Science program with core courses providing mathematical and statistical foundations, along with education in data engineering, as well as knowledge in developing artificial intelligence and machine learning (AI/ML) algorithms. Program electives allow graduate students to explore diverse topics, such as computer vision, data wrangling, text mining, and reinforcement learning while the research thesis hones their skills to address real DoD challenges using and exploiting data for better performance. The first cohort in the data science degree started in September of 2021 and will graduate in March of 2023.

In today's fast-paced, information-dense warfare, all occupational fields are inundated with data; thus, technical experts from diverse backgrounds benefit from this data-centric education. Beginning with the thesis research from its first cohort, AFIT is developing numerous lines of relevant research. Current research spans data on medical, contracts, and target images. As a partial list of examples of cutting edge research AFIT Data Science students are: developing insight to tailor virtual reality pilot training to ensure trainees maintain optimal stress levels via psychometric data; creating new computer vision models which output accurate classifications with well calibrated certainty measurements; enhancing algorithms to engage in autonomous air-to-air dogfighting; and many additional topics spanning the gamut from basic research to operational issues.

The Department of Operational Sciences continues to grow this vital data capability, and recently hired a new faculty with data engineering expertise. For technically educated experts from diverse fields who want to learn how to exploit their data, the Operational Sciences Department conducts the M.S. in Data Science and plans to start a Ph.D. in Data Science beginning the fall of 2023. Potential Wright-Patterson AFB students (military, civilian, or contractor) should contact the department. Units desiring officers with data science degrees should code their billets with the academic code OCCE. Organizations with significant data challenges should discuss potential research with the faculty. Dr. Bruce Cox (bruce.cox.8@us.af.mil) is the department's program director for data science.

Want More Information?

Program Descriptions: www.AFIT.edu/EN/allprograms

Data Analytics: AFITensDataAnalytics@afit.edu

Data Science: Bruce.Cox.8@us.af.mil

Faculty Bios: www.AFIT.edu/bios

Meet the Faculty

Dr. Bruce Cox, Assistant Professor of Data Science, Program Director for MS in Data Science, Director of Cost Capability Analysis Certificate Program.

Teaching and Research in:
Computer vision, machine learning uncertainty calibration, synthetic data generation, and heuristic search methods.
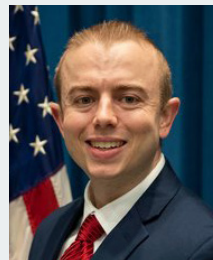
Dr. Nathan Gaw, Assistant Professor of Data Science.

Teaching and Research in:
Multi-modality data fusion, semi-supervised learning, federated learning, interpretability, tensor decomposition, design of experiments (test & evaluation) and industrial statistics.

Dr. Matthew Robbins, Associate Professor of Operations Research.

Teaching and Research in:
Design, development, and testing of approximate dynamic programming and reinforcement learning algorithms to solve large-scale sequential decision-making problems under uncertainty.

LTC Phillip LaCasse, Assistant Professor of Operations Research.

Teaching and Research in:
Empirical modeling; natural language processing and artificial intelligence approaches to analyze and classify social media networks and messages.

Lt. Col. Daniel Pamplona, Brazilian Air Force, Assistant Professor of Operational Research.

Teaching and Research in:
Decision analysis, multi-criteria analysis, applied statistics, and analytical research.

Data Science Student Outcomes

Successful Outcomes Identified Through Student Theses

2d Lt. Gregory Barry
"A Conformal Prediction Approach to Quantify Student Pilot Error via Multimodal Physiological Signals"
Sponsors: AFOSR and MIT Lincoln Labs

Using physiological and positional data recorded from simulated flights, we find that within this multimodal recording, there are key features which allow for accurate, autonomous scoring of pilot error. Through correctly predicting error in training flights within an allowable range, we can eliminate mundane duties of instructor pilots and focus them instead on personalized training for each student pilot. As the figure below illustrates, the methodological process we implement throughout our research to transform vast physiological recordings of pilot data to implementable models which quantitatively define a student pilot's performance. Lt. Barry has presented this research to individuals from MIT Lincoln Laboratory and MIT in Boston, MA, on August 23, 2022. He also presented his research to the DAF-MIT AI Accelerator on November 4, 2022.
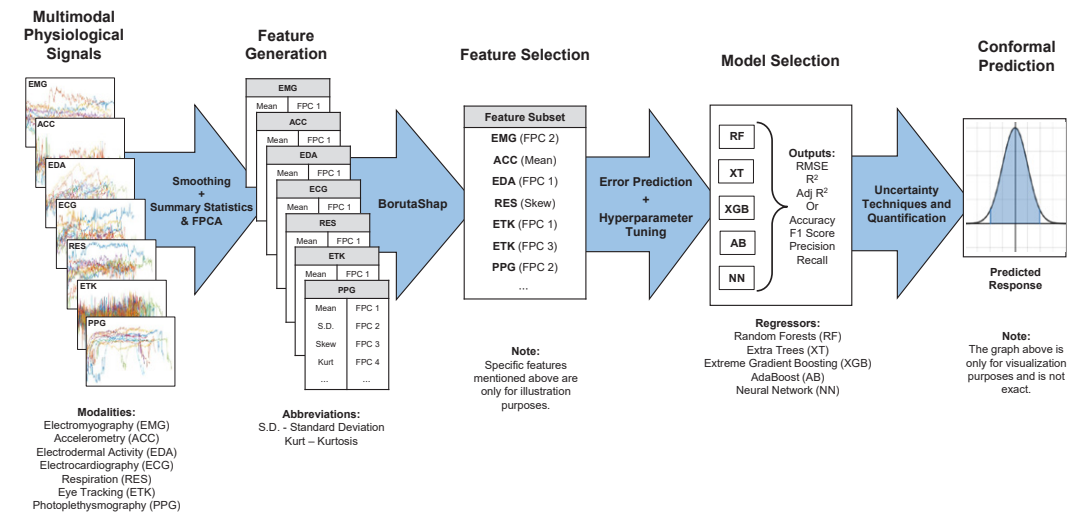

2d Lt. Caleb Taylor
"Generation of Beyond Visual Range Air Combat Tactics via Reinforcement Learning"
Sponsor: Strategic Development Planning & Experimentation

A one-versus-one air combat problem is considered wherein a friendly autonomous aircraft must engage and defeat an adversary autonomous aircraft in a beyond visual range environment. Both autonomous aircraft employ medium-range air-to-air missiles and guns. The Advanced Framework for Simulation, Integration, and Modeling (AFSIM) is leveraged to model the complex and interdependent operations of aircraft, sensors, and weapons. A reinforcement learning solution procedure that leverages a multi-layer neural network is developed and tested to determine effective maneuvering and weapons tactics. This research supports ongoing development of improved modeling, simulation, and analysis techniques for enhanced analysis of USAF capability development activities.

2d Lt. Grace Metzgar
"Supervised Multimodal Spatio-Temporal Smooth Sparse Decomposition for Lightning Prediction"
Sponsor: SpOC/S9A

The uncertainty of lightning greatly impacts a variety of weather-sensitive operations inciting the development of techniques used to predict its behavior. However, the complexity of weather data increases the difficulty of creating models that can accurately recognize and forecast lightning patterns. To address these shortcomings, we develop supervised spatio-temporal smooth sparse decomposition (ST-SSD) to detect anomalies within high-dimensional streaming data to predict the time and location of future anomalies. We employ the Storm EVent ImagRy (SEVIR) dataset which was created to aid in the inefficiencies of developing these complex models by combining spatial and temporal weather data from multiple sensing modalities. We hypothesize that by applying supervised ST-SSD to such data will allow for greater accuracy in predicting the time and location of lightning strikes. Lt. Metzgar presented her research at INFORMS 2022.
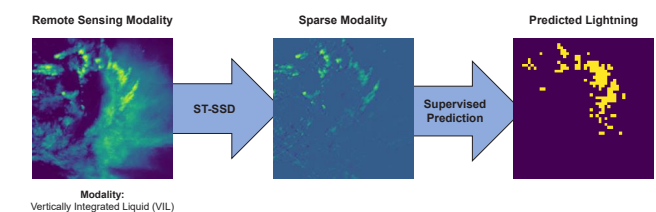
AFIT Selects Alumni Award Winners

Col. (Ret.) Susanne Waylett spoke to AFIT Civil Engineering students before receiving the Distinguished Alumni Award at AFIT.

The Air Force Institute of Technology and the AFIT Foundation selected five graduates to receive alumni awards which were presented at a ceremony in AFIT's Kenney Auditorium on 20 October 2022. The alumni awards recognize and honor graduates who have distinguished themselves and made outstanding contributions in their career. Award winners are typically selected every other year.

AFIT Distinguished Alumni Award

Col. (Ret.) Susanne Waylett (M.S. Engineering Management, 1984) received the AFIT Distinguished Alumni Award. This award is the highest honor bestowed on an alumnus in recognition for high

Susanne Waylett

levels of career achievement. Waylett has been a pioneer throughout her career in the Air Force. She was the first female, officer or enlisted, to enter the civil engineering career field in 1971. She later became the first female CE squadron commander in 1987 and the first CE female to reach the rank of colonel in 1993, paving the way for other women in a traditionally male-dominated career field.

Continuing her career of "firsts," Waylett becomes the first woman to receive the award. The AFIT Distinguished Alumni Award was established in 1979, and to date, 39 alumni have been honored. Waylett joins the ranks of previous award winners including Gen. George Kenney, Gen. Bernard Schriever, Lt. Gen. Jimmy Doolittle, and Col. Edwin "Buzz" Aldrin, Jr.

AFIT International Alumni Award

Two alumni from Pakistan received the AFIT International Alumni Award. Established in 2019, this award honors international graduates who have distinguished themselves through exceptional career achievement.

Dr. Zaffir Chaudhry (M.S. Aeronautical Engineering, 1985) is a technical fellow at Raytheon Technologies Research Center, the most senior rank in the technical ladder at Raytheon. He has over 60 publications, one book chapter, and holds 60 U.S. patents. His engineering achievements include the development of a two-stage fire suppression valve, an active rotor for noise and vibration reduction, and a first of a kind demonstration using refrigerant lubricated bearings in a compressor of a large chiller.

Zaffir Chaudhry

Dr. Mohammad Javed Khan (M.S. Aeronautical Engineering, 1978) is head of the Aerospace Science Engineering Department at Tuskegee University. During his 28 years of active duty service he held several key appointments including commanding officer of the engineering wing for the largest operational base of the Pakistan Air Force and technical advisor to the Royal Saudi Air Force. Khan also serves as the chair of the Board of Directors of a U.S. non-profit, the Central Asia Institute. This organization supports children's education, and especially girls' education, in remote areas of Afghanistan, Pakistan, and Tajikistan. Annual funding for its projects in these countries is approximately $2 million.

Mohammad Javed Khan

AFIT Young Alumni Award

Two alumni were selected to receive the AFIT Young Alumni Award. This award was established in 2019 to call attention to the achievements of alumni who have made outstanding contributions in their career within ten years of graduating from AFIT.

Lt. Col. Juan Jurado (PhD, Electrical Engineering, 2019 and M.S. Electrical Engineering, 2012, DG) is the commander of a flight test squadron for the Air Force Test Center where leads a team of more than 100 engineers, operators, and analysts through multiple elevated-risk, high-impact survivability flight test programs directly supporting national security objectives across 10 aircraft types. As a master's student, he developed a novel camera calibration technique for image-aided navigation in GPS-denied environments, which led to a 35% improvement in navigation accuracy when compared to state-of-the-art methods.

Juan Jurado

Dr. Mark Spencer (Ph.D. Optical Sciences and Engineering, 2014 and M.S. Optical Sciences and Engineering, 2011) is a senior research physicist in the Air Force Research Laboratory's Directed Energy Directorate. Spencer is a significant contributor to the state of the art in optics and photonics having authored more than 100 technical publications, one textbook, one book chapter, 35 journal articles, 64 conference papers, and holds three U.S. patents. He has led 40 projects with funding in excess of $40 million that continue to develop and transition directed-energy technology with an emphasis on beam control for laser systems. As an AFIT student, Spencer founded AFIT's SPIE Student Chapter, which won numerous awards during his tenure. He continues to support the chapter as a professional advisor and sponsor.

Mark Spencer

ABOUT THE AFIT FOUNDATION

The AFIT Foundation is a private organization founded in 1986 for the purpose of furthering the goals of the Air Force Institute of Technology. The Foundation is committed to informing alumni, former faculty, and friends everywhere of the mission, status, goals, and achievements of AFIT and its role in the community, the Department of the Air Force, and in defense-related education. For more information, visit: **www.afitfoundation.org**

LEARN MORE ONLINE

View the recorded Alumni Award Ceremony at: **https://e.afit.edu/TTh1qqs**

Complete list of award winners at: **https://e.afit.edu/xy4HTNQPP**

AFIT ALUMNI NEWS BRIEFS

New Dean is AFIT Alum

Colonel Craig Punches joined the Air Force Institute of Technology's leadership team in the summer of 2022 as the dean of the School of Systems and Logistics. Punches leads a team of more than 100 faculty and staff whose mission is to provide continuing education and consultation in the areas of data analytics, acquisition management, contracting, financial management, logistics management, and systems and software engineering. Punches is the 28th dean of the school since it was established as the School of Logistics in 1958.

Punches was familiar with AFIT having earned his master's degree in logistics management from the Graduate School of Engineering and Management in 2002. "As a logistician, the course work I took was very operational research focused. We did a lot of mathematical modeling and simulation and a lot of work finding mathematical solutions," said Punches.

AFIT Alum Promoted to Brigadier General

The Ohio National Guard hosted a promotion ceremony for **Colonel Matthew Woodruff,** Ohio assistant adjutant general for Army, to the rank of brigadier general on 6 January 2023.

Woodruff has served as the assistant adjutant general for Army since October 2022. He is responsible for establishing policies, priorities, and oversight for the readiness of Ohio National Guard Soldiers in six brigade-level major subordinate commands.

Woodruff began his military career in May 1990 when he enlisted as a medical specialist in the U.S. Army Reserve. He received an active-duty commission as an infantry officer from Bowling Green State University in 1996. He is a graduate of the Infantry Officer Basic Course and the Combined Logistics Officer Advanced Course, Command and General Staff College, Advanced Operations Course, and the U.S. Army War College. Woodruff holds a B.S. in elementary education from Bowling Green State University, a M.S. in logistics management from the Air Force Institute of Technology, and a master's degree in strategic studies from the U.S. Army War College.

CALENDAR EVENTS

JANUARY 2023

AFIT Graduate School Winter Quarter Classes Start
03 Jan 2023 | AFIT Campus, WPAFB, OH

FEBRUARY 2023

AFIT Graduate School Spring Quarter Registration Opens
06 Feb 2023 | AFIT Campus, WPAFB, OH

AFIT Graduate School Graduation Applications Due
17 Feb 2023 | AFIT Registrar's Office

AFIT Engineer's Week
20-24 Feb 2023 | AFIT Campus, WPAFB, OH

MARCH 2023

AFIT Graduate School Winter Quarter Classes End
10 Mar 2023 | AFIT Campus, WPAFB, OH

AFIT Graduate School Commencement Ceremony
23 Mar 2023 | National Museum of the USAF

AFIT FACULTY SEARCH

To search for AFIT Graduate School faculty members and view their research areas of interest, please visit
www.afit.edu/BIOS

Annual Graduate School Faculty Excellence Showcase Now Available Online

Learn about AFIT Graduate School faculty publications and research expertise in the AY 2022-2023 Faculty Excellence Showcase:

www.AFIT.edu/EN/facultyexcellence

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To produce outstanding technical leaders in the Department of Defense by providing superior graduate education built on defense-focused research.

VISION
To be internationally recognized as the school of choice in engineering and applied science for defense-focused and research-based graduate education.

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