Digital Transformation

Universities Often First Adopters of Latest Technological Advancements

By Dr. Adedeji Badiru
Air Force Institute of Technology

Welcome to the digitally-themed June 2022 issue of the AFIT Engineer. From stone tablets to digital devices, universities around the world are transforming themselves daily, at the speed of bits and bytes. In the Summer of 2018, I was invited to lecture at Complutense University in Madrid, Spain—one of the oldest universities in the world. What I witnessed at that university made me to reflect on how universities have transformed over the centuries into what we see and enjoy today. I reflected on how my own university, AFIT, although only 100 years old, has transformed over the years in a manner akin to what has happened at universities that are over 800 years old.

The common thread in university transformations has been the exponential rise of digital platforms. Even in the early days of computerization, universities were often the first adopters of the latest technological advancements for educational purposes. I recall how AFIT’s Graduate School of Engineering and Management, under my command in 2014, radically shifted from the traditional paper-based system to electronic theses and dissertations, in spite of doubts and vacillation at that time. We overcame all the Doubting-Thomas scriptures and we have never looked back. Today, AFIT students and faculty are accustomed to electronic theses and dissertations.

The most important aspect of digital transformation is that we have to jump into it and swim against the tide, if need be, onward toward a platform of better efficiency, effectiveness, and consistency. Digital transformation requires boldness to take risks, but with the comfort that digitalization under the banner of Internet of Things (IoT) is the new way of the world. To not be left behind is to keep up with the transformation going on around us. We must be in the game to win the game.

That’s how the world’s oldest universities have survived over the centuries. Universities of the future will increasingly operate on digital platforms and remote operations.

Continue reading on page 2

Digital Engineering
AFIT Supports DAF Digital Missions
Pages 12-17
Digital Transformation of the World’s Oldest Universities
(continued from cover)

Although the digital transformation and remote operation trend has been going on for many years, the emergence of COVID-19 pandemic expedited the movement. In just two years, universities have discovered the pedagogical power of remote delivery of education.

AFIT’s commitment to digital engineering is a part of that new normal. Fully remote and hybrid deliveries will be embraced and will be less reliance on the traditional brick-and-mortar infrastructure of universities. This will, no doubt, expand the worldwide footprint of education. Are we ready for that digital modernization? Yes, we are. Articles in this issue of the AFIT Engineer show us how, within the context of national defense needs.

Please read on!

Adedjé B. Badru, Ph.D., PE, PMP
Dean, Graduate School of Engineering and Management

AFIT ENGINEER
AFIT Graduate School of Engineering and Management

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FROM THE DEAN’S DESK

GRADUATE SCHOOL NEWS

AFMC Leverages AFIT Toolset in Training Digital Experts

By Estella Holmes
Air Force Material Command

The Air Force Materiel Command continues to employ all available means to transform today’s warriors into tomorrow’s digital experts. Training equips Department of U.S. Air Force teams to engage as peers with industry partners.

“Command experts must be prepared to utilize and interface with the digital tools and system models which are being used more frequently by the acquisition community,” said Steve Tormey, Systems Engineering Technical Expert, Air Force Life Cycle Management Center.

Training command engineers in the use of Model Based Systems Engineering (MBSE) and SysML, a systems modeling language, helpswarrior support teams more efficiently digitally design, sustain and modernize platforms. “Model Based Systems Engineering supports the Digital Campaign, and training arms members to achieve that vision,” said Tormey.

MBSE is the formalized application of models at different levels of product development. An existing contract leveraged through the Air Force Institute of Technology is focused on training approximately 3,400 members of the AFMC workforce. The Model Based Systems Engineering: Theory-to-Practice Model Creator course instructs attendees on use of the Cameo software tool for MBSE and how to create models within that software suite.

AFIT Grad Wins Prestigious USAF Cost Analyst of the Year

Captain Daleth Hogan, a 2020 graduate of AFIT’s Cost Analysis program and current analyst at the Air Force Cost Analysis Agency (AFCAA), has been recognized as the Air Force’s top Cost Analyst. The Air Force Financial Management and Comptroller Annual Acquisition Cost Analyst of the Year recognizes the acquisition cost analyst who set their self apart by demonstrating exemplary performance and service excellence. The Honorable Kristyn E. Jones, Assistant Secretary of the Air Force for Financial Management, and Comptroller and Brig. Gen. Michael A. Greiner, Deputy Assistant Secretary for Budget, presented the award.

Among Capt. Hogan’s major accomplishments was uncovering a significant programming disconnect in funding/quantity for the F-35. His analysis averted a $3.7 billion budget shortfall across the FYDP that garnered SECAF interest. Capt. Hogan credits AFIT for providing the foundation and critical skills needed. “The AFIT Graduate Cost Analysis Program and Data Analytics Graduate Certificate Program afforded me the domain knowledge, technical skills, and critical thinking abilities necessary to hit the ground running in my current role of providing cost estimating and analysis for major defense acquisition programs at AFCAA,” said Hogan.

Hang with Hangar 18

Aug 3, Sep 7, Oct 5, Nov 2, Dec 7

Join us to learn about Hangar 18 and to ask any questions you might have at our virtual seminar held the first Wednesday of each month, 1400-1500 Eastern. For U.S. Military, DoD Civilians and DoD Contractors.

Hangar 18 was born from a need to create an Agile approach to help the Air and Space Force communities in efficiency and deliverables in a cost-effective way. We pride ourselves on understanding our clients’ needs and delivering a prototype in rapid succession. Data already exists. We take that data and get your project moving at warp-speed. The new Hangar 18 is a modern symbol for inspiring technology that is “out of this world!”

Questions? Send Email to: hangar18@afresearchlab.com

Seminar Link: https://www.zoomgov.com/j/1605033208?pwd=dEZEQ1h undercut.k1BZUkdRU HZVjdzZj09

Contact: Please contact Matt Jacobson for more information: matthew.jacobsen.1@afrl.af.mil
Reinforcing National Security Through International Collaboration

As we are witnessing now in the current developments around the world, partnerships and collaboration are essential for resolving and/or preempting conflicts. No single government has the wherewithal to advance and protect its interests around the globe. Consequently, it becomes very important for allied nations to establish and sustain international cooperation. The benefits of collaboration are multifaceted and include topics such as national defense, economic advancement, intellectual exchange, and advancement of democracy. When we host exchange visitors, we are able to better understand what each partner brings to the table in areas of common interest. When a threat to national defense develops, we can count on our partnering nations for a collaborative response that is prompt and appropriate for the specific threat. I am happy to welcome Mr. Andreas Mertens to AFIT’s Graduate School of Engineering and Management and look forward to a year of collaborative research endeavors between our partner nations.

APIT Hosts German Civil Servant as Participant of APEP Program

By Stacy Burns & Andreas Mertens

AFIT Graduate School of Engineering & Management

As an example that illustrates my recent contribution is a research paper at the 47th Dayton-Cincinnati Aerospace Sciences Symposium. I am focused on incorporating views and approaches from my academic discipline into engineering problem solving methodology, and thereby contributing to improved organizational efficiency, performance, and effectiveness.

“...I am focused on incorporating views and approaches from my academic discipline into engineering problem solving methodology, and thereby contributing to improved organizational efficiency, performance, and effectiveness.” — Mr. Andreas Mertens, APEP participant

By the end of my assignment at AFIT, the purpose and the length of the exchange program, accompanied by the German Liaison Office for Defense Material USA/Canada, provides career-broadening work assignments for foreign government defense personnel in U.S. defense establishments. Thus, it serves to strengthen national military and administrative capabilities, to develop and consolidate common standards, and to produce interoperable, competitive solutions for the mission-oriented equipment of the armed forces.

AFIT designed to last one year, and during this time, I will be cooperatively involved in AFIT’s processes and primarily support research initiatives of the Graduate School of Engineering and Management (GSEM). My spouse and my children are accompanying me for the whole period. Hence, not only gaining considerable work experience, but also the intercultural experience of integrating into the United States of America, is a substantial part of the assignment.

QUESTION: Describe your title/role at AFIT, the purpose and the length of your exchange program.

ANSWER: My assignment as a civil servant of the German Federal Ministry of Defense (MoD) at AFIT is based on the “Administrative and Professional Personnel Exchange Program” (APEP). This professional development exchange program, accompanied by the German Liaison Office for Defense Material USA/Canada, provides career-broadening work assignments for foreign government defense personnel in U.S. defense establishments. Thus, it serves to strengthen national military and administrative capabilities, to develop and consolidate common standards, and to produce interoperable, competitive solutions for the mission-oriented equipment of the armed forces.

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QUESTION: How did you learn of the opportunity to work at AFIT and what motivated you to take on this role?

ANSWER: A German MoD colleague of mine, a former APEP participant, strongly recommended an assignment at AFIT with its collaborative and extraordinary working environment as well as its eminent academic mission. From my point of view, the features of a successful exchange program are dedication and contribution of the participant on the one hand, and being well integrated and involved by the host institution on the other hand. In this context, AFIT is an excellent place to gather work experiences, while it also provides an exceptionally integrating atmosphere.

In my application for the assignment, I specified AFIT as a preferred institution; therefore, I was delighted that it specified AFIT as a preferred institution.

QUESTION: Describe your background and the type of work you were doing in Germany before coming to AFIT. What do you hope to learn and to contribute while in the United States?

ANSWER: I have extensive experience as a government professional, having served the German Federal Armed Forces both on active military duty and as a civil servant in different administrative positions at German MoD and subordinate agencies. My business administration background and experience in project officer positions, particularly in connection with economic efficiency and optimization studies, have made my assignment at AFIT a natural fit.

In my previous position, I served as an assistant project manager of a MoD task force on the follow-up solution of the German Federal Armed Forces’ organization for clothing and personal equipment management. Duties of previous stations in my civilian career with the Federal Armed Forces Administration included strategic purchasing measurement and procurement process optimization, conducting of organizational studies as well as economic feasibility study consulting.

Participating in the exchange program has allowed me to expand my horizon of experience with the aspect of international cooperation. It has enabled me to learn firsthand from our U.S. ally and partner, and to experience efficient strategies and initiatives. As a representative not only of the German Federal Armed Forces staff, but also of my country, I am confident of my ability to contribute to mutual trust and partnership between our allied countries. Being embedded in the U.S. defense education, science and technology community, it is my honor to support AFIT’s mission and to make a contribution to the U.S. military requirements and the evolution of military capabilities.

QUESTION: What projects will you be collaborating on during your time at AFIT?

ANSWER: I am currently working with Dr. Badiru on scholarly research of international collaboration using a systems thinking approach. The overall goal is to develop and deliver work products in response to the Graduate School’s mission needs. I am specifically focused on incorporating views and approaches from my academic discipline into engineering problem solving methodology, and thereby contributing to improved organizational efficiency, performance, and effectiveness.

An example that illustrates my recent contribution is a research paper collaboration on the Mathematical and Graphical Representation of Systems Integration in the trademarked DEI Systems Model, which was developed by Dr. Badiru. I brought expertise of cost benefit analysis to this project. Not only was I involved in the creation of the joint research paper, but also in its co-presentation at the 47th Dayton-Cincinnati Aerospace Sciences Symposium. The applicability of the integrative approach of the DEI Systems Model on multi-faceted platforms and domains allows techniques from different perspectives to be incorporated into the structured framework.

Furthermore, I am collaborating on additional journal and research papers as well as providing administrative process support for a handbook of AFIT GSEM technical journal publications.

QUESTION: Describe some of the differences in government work culture you found between Germany and the United States?

ANSWER: Our countries are strongly connected partners which share common values. I believe our similarities by far outweigh our differences; most notably due to the joint membership in NATO and the perpetual exchange of expertise. As a result, our modes of operation and workplace cultures have a mutual foundation. Furthermore, I am glad to have experienced for both work environments to have teams consisting of military and civilian personnel.

Nevertheless, I have experienced some dissimilarities in the field of centralization vs decentralization—specifically in administrative and support processes such as infrastructure, IT-support, recruiting and human resources management, and finance. For example, the different level of centralization influences government work culture in the way of organizational responsibilities and structure. Also, the career pathways both of military and civilian staff seem to differ.

QUESTION: What have you experienced so far that will be of benefit when you return to Germany?

ANSWER: I have found the Graduate School’s implementation of MS Teams to be an effective way of optimizing day-to-day operations. The benefit of this collaborative IT-tool is the uncomplicated way it improves cooperation among team members in the area of communication and I expect to continue using similar integrated task progress tracking and communication systems after returning to Germany. Additionally, the professional and fascinating onboarding process I experienced at AFIT exemplified the prototype of a welcoming and effective integration for newcomers. From my perspective, a positive onboarding experience contributes to a collaborative and inclusive work atmosphere that serves a common mission by incorporating diverse views as an integral part of the culture. Experiencing the collaborative work culture of AFIT will serve me well in future assignments.

Finally, I have much respect for the exceptional mission-related focus of educational, technological and research work, programs and initiatives at AFIT, which are aligned to anticipate the requirements and to meet the challenges of the Armed Forces’ missions and to advance its military capabilities.
Graduate Thesis Research on DoD Software Factories

The field of software development within the DoD has received renewed attention over the past five years as Congress and other decision-makers have made it a priority to improve how the services develop software systems. There have been a number of legislative and organizational changes that have caused a new type of acquisitions organization, the “Software Factory,” to become a popular new model with which to develop and deliver software. This new type of organization utilizes non-traditional acquisition methods and has proven itself difficult to define and at times fit within standard acquisition pathways.

AFTT MS Acquisition and Program Management graduate student, 1Lt. Zachary Ryan’s thesis research looks to help define these organizations through the use of network mapping techniques in order to identify common characteristics and provide a method of guiding future organizational development.

Thesis Work & Publication
1Lt. Ryan teamed up with AFTT Faculty Dr. Mark Reith, Assistant Professor of Computer Science, and Lt. Col. Paul Beach, Assistant Professor of Systems Engineering, to perform an exploratory network analysis on a single organization to test the approach’s validity and provide input and guidance from the software community. The team analyzed a single organization and wrote an article about their proposed approach which will appear in the May 2022 issue of CrossTalk, The Journal of Defense Software Engineering.

“I’m excited about this research because it allows me to combine my acquisitions background and my interest in software development and use that perspective to provide value to the greater DoD community,” 1Lt. Ryan said.

DoD & Air Force Briefings
In addition to submitting the article for publication, 1Lt. Ryan briefed two joint audiences on the approach and its initial results. In March, he briefed the DoD Software Factory Working Group on his project and it was positively received. As a result of that briefing, 1Lt. Ryan was asked to brief the Air Force Chief Software Officer’s office on his work. In June, he again pitched his work at the DoD level, at the DevSecOps Community of Practice as a part of the Hangar 18 presentation. This group also expressed positive reception.

Research Impacts
1Lt. Ryan and his team hopes that this effort will provide the DoD with a method to guide future Software Factory development and provide a new tool to help guide strategic messaging for Software Factory organizations. This effort is the first to propose a value network mapping technique as a method to quantify and define the DoD’s Software Factory organizations. Previous efforts have primarily focused on traditional cost-schedule-performance metrics so this is a novel new approach.

Future Goals
1Lt. Ryan and team intends to apply this tested technique to multiple software factory organizations in an attempt to identify commonalities, value streams, and organizational relationships that would be missed with more traditional approaches. It is the team’s intent to take the value maps and develop a formalized framework by which to define future and current Software Factory organizations.

“I am incredibly lucky to have advisors like Dr. Reith, Lt. Col. Beach, and Lt. Col. Koschnick who have encouraged me to pursue my interdepartmental interests,” 1Lt. Ryan said. “The faculty have been incredibly supportive of my goals and I’m grateful to be an active part of the AFTT community.”


Faculty, Students, and Alumni Earn AF STEM Awards

Eight Air Force Institute of Technology faculty, students and alumni earned 2021 Science, Technology, Engineering, and Mathematics (STEM) Awards.

“Congratulations to our award winners, who, once again demonstrate the technical landscape of AFTT in meeting the national-defense needs of our nation,” said Dr. Adedeji Badiru, dean, Graduate School of Engineering and Management. “The foundation for excellence in AFTT’s Graduate School is our dedication to defense-focused graduate research. What emanates from that provides the basis for these competitive awards. I am delighted that our students, faculty, and alumni are flying the AFTT flag high everywhere.”

AF Outstanding Science and Engineering Educator Award

Maj. Costantino Zagaria won the Air Force Outstanding Science and Engineering Educator Award. This award recognizes the efforts and achievements of the top Air Force instructor in the sciences and engineering fields, who consistently demonstrates and performance best characterizes the principles of excellence in science and engineering education. Zagaria is an assistant professor of aerospace engineering within AFTT’s Graduate School of Engineering and Management. He made significant improvements to three graduate level courses, updating materials and including new methods to challenge students, earning numerous accolades from students. Additionally, he taught four highly technical graduate level courses to 55 students and directly contributed to the development of future Air and Space Force leaders.

AF Science and Engineering Award, Exploratory or Advanced Technology Development – Individual Category

Lt. Col. Robert Bettiger earned the AF Science and Engineering Award, Exploratory or Advanced Technology Development – Individual category. This award is given for noteworthy achievements in areas of applied research or advanced technology development (budget activity 62, 63, or 64 equivalent) with emphasis on improving the technology readiness level, transitioning into acquisition programs, or direct fielding to operational forces. As an assistant professor of astronautical engineering within AFTT’S Graduate School of Engineering and Management, Bettiger secured SSDK in DOD research grants to support space-based missile defense, satellite navigation and systems engineering in 2021. A subject matter expert, Bettiger advised a graduate student in exploring the use of nighttime city lights for satellite navigation in a contested environment and received a provisional patent for the technique.

AFTT Systems Engineering Award

The Cubesat Modeling Team received the AFTT Systems Engineering Award. This award recognizes AFTT students or teams for outstanding achievements in furthering systems engineering understanding in the Department of the Air Force. The student group of Maj. Sean Kelly, USFF, Capt. Keith Dreyer, USFF, and 1st Lt. Kyla Brown-Miller, USFF, completed groundbreaking research as part of their systems engineering master’s theses, demonstrating the use of model based systems engineering reference architectures in support of rapid prototyping of Cubesats. Their research documents an agile approach using MBSE, shortening the learning curve for new developers and facilitating rapid prototyping and system verification.

AF Alumni Receiving Awards

Additionally, three alumni from AFTT’s Graduate School of Engineering and Management earned awards. Lt. Col. Joseph Lay (M.S. Systems Engineering, 2014) received the Air Force Outstanding Science/Engineer Award–Mid Career Military; Maj. William Adorno (M.S. Operations Research, 2015) received the John J. McLaughlin Basic Research Award; and Maj. Eli Garduno (M.S. Applied Physics, 2014) received the Engineering Achievement Award.

Gunawardena Recognized by NAVIGATION Journal for Top Ten Downloaded Paper of 2021

Dr. Sanjeev Gunawardena, AFTT Research Associate Professor of Electrical Engineering, was recently recognized by NAVIGATION: Journal of the Institute of Navigation for authoring one of the publication’s top ten downloaded papers of 2021. Technical paper downloads are one of the leading indicators for measuring a paper’s ultimate success in the academic world.

“Gunawardena’s research in Software Defined Radios for use in Satellite Navigation continues to have tremendous impact on the Air Force, Space Force, and broader DOD,” said Dr. Kenneth Hopkinson, AFTT Electrical and Computer Engineering Department Head.

Read Gunawardena’s research article “ION GNSS software-defined radio metadata standard” online at https://navi.ion.org/content/68/1/11

AWARDS & RECOGNITION
Dr. Walter Jones, Air Force Institute of Technology director and chancellor, presented the 2021 Air and Space Forces Association Wright Memorial Chapter awards to five AFIT faculty members on May 19. The awards, sponsored by the Wright Memorial Chapter 212, recognize faculty who advance aerospace power and technology through innovative efforts in education and research. The AFA has sponsored the awards since 1982.

**GENERAL BERNARD A. SCHRIEVER AWARD**

Dr. Steven Fiorino

This award is given in recognition of a person who advances aerospace power, technology, doctrine, or the Air Force as a profession. The award is named in honor of Gen. Schriever, an AFIT alumn from 1941, who organized and formed the Air Force’s ballistic missile and military space program. Fiorino is a professor of atmospheric physics and director of the Center for Directed Energy within AFIT’s Graduate School of Engineering and Management. He expertly led a team of over 10 scientists, engineers, and research interns, whose effort contributed to the overall goal of advancing directed energy science and technologies. Fiorino was heavily involved in the Directed Energy Professional Society over the last 10 years, while he chaired numerous technical sessions for the society’s annual and systems symposia and served as the technical editor of the Journal for Directed Energy.

Fiorino is widely recognized throughout the DoD, academia, industry and internationally, and was recently designated as a subject matter expert for NATO STO-264 and STO-316 Atmospheric Effects on Laser Propagation, the Effects of High Energy Lasers Project Agreement Atmosphere Effects on Laser Propagation, and AFRL’s Directed Energy Directorate Scientific Advisory Board.

**COLONEL CHARLES A. STONE AWARD**

Capt. Sven Ellefson

This award is given in recognition of an individual who has made outstanding contributions to furthering the AFIT mission through new and innovative efforts involving demonstrating personal leadership. The award is named in honor of Col. Stone, the dean of AFIT’s School of Systems and Logistics from 1962-1966, who was instrumental in the school receiving accreditation to award master of science degrees.

Ellefson is an instructor in AFIT’s Civil Engineer School teaching courses on project management, readiness, and emergency management. In his first year at AFIT, Ellefson superbly directed four courses, taught 85 lessons, and achieved over 1,500 student contact hours resulting in educating 900 total force engineers across 118 installations. He blazed a new path for the Civil Engineer School by developing new educational content for the enlisted force, an expanding demographic in the school’s mission.

Ellefson leveraged his deployed and overseas construction management experiences to redesign the 10-hour introduction to project management course. These updates enabled the course to meet the newly mandated upgrade training requirements for over 25,000 enlisted engineers and provided all civil engineer professionals working on construction projects a foundational understanding of project management. His efforts contributed to a 25% increase in enlisted force students at the Civil Engineer School.

**PROFESSOR EVA KOTCHER AWARD**

Capt. Danielle Tabb

This award is given in recognition of an individual who made significant contributions to curriculum or instructional development within AFIT. The award is named in honor of Col. Kotcher, the first director of AFIT and an aeronautical engineer who worked on inflight fueling and directed the development of the X-1 and X-2 jet planes.

Tabb is a project management instructor in AFIT’s Civil Engineer School. She displayed unprecedented creativity to achieve student learning objectives to overcome distance learning challenges and increase student participation during pandemic operations. Using gamification tools, she authored an instructor guide for the hands-on and immersive Project Safety “Escape Room” lesson in the Air Force Civil Engineer Initial Skills course, effectively increasing student exam and homework scores from 43% to 85%.

Because of her innovative mindset, Tabb was selected to present “Synchronous and Asynchronous Project Management Gamification” at the 2022 Air Force Learning Professionals’ Consortium. In addition, Tabb developed a “choose your own path” scenario for the Introduction to Project Management course that enhanced comprehension and application levels of learning for 697 students. She increased student accessibility by 80% through embedding this scenario in the learning management system.

**GAGE H. CROCKER OUTSTANDING PROFESSOR AWARD**

Dr. Christine Schubert Kaban

This award is presented to the individual who made the most significant contribution to the AFIT mission through excellence in teaching, research, and service in order to maintain the excellence of AFIT’s degree-granting academic programs. The award is named in honor of Col. Crocker who served as the dean of AFIT’s School of Systems and Logistics from 1971-1972 and was a coauthor of papers on turbulence associated with blunt body flow.

Schubert Kaban is a professor of statistics in AFIT’s Graduate School of Engineering and Management where she teaches courses on applied statistical data analysis, applied general linear models, theory of probability, and nonparametric statistics. She exhibited outstanding leadership in classroom teaching and course development, earning her an amazing 4.78 out of five possible on the online student evaluation system.

**AWARDS & RECOGNITION**

GSEM Faculty Research Receives Publication

AFIT Graduate School of Engineering & Management faculty member Dr.ergy Changdahaihahn, Assistant Professor of Electrical Engineering, and Dr. Jeremiah C. Williams (MS Electrical Engineering, 2020) recently received publication of their work titled “Multiphoton Nanoscopy of Optical Resonant and Nonresonant Microsensors on Fiber Tips” in the ACS Applied Materials & Interfaces journal. ACS Applied Materials & Interfaces is considered a reputable journal in its field as indicated by its journal Impact factor of 9.2. This work was also featured as the supplementary cover art of the ACS Applied Materials & Interfaces journal (Vol. 14, Issue 17) as shown in the photo. Co-authors of the article include Joseph S. Suelzer and Nicholas G. Usechak of the Sensors Directorate, AFRL.

READ THE JOURNAL ARTICLE ONLINE

https://pubs.acs.org/doi/10.1021/acsami.2c011033

A prolific author, she published critical articles that addressed important applications that advance the Air Force, such as of protection strategies aimed at extending the lifespan of critical infrastructure elements. Schubert Kaban chaired the Graduate Applied Mathematics Curriculum Committee and served as academic advisor to all mathematicians students, providing new students with wise counsel and mentorship, as she aided them in setting up their education plans.

This award is presented to the individual who made the most significant contribution to AFIT as evidenced through excellence in teaching in order to maintain the excellence of AFIT’s professional continuing education academic programs.

Joslin is a mechanical systems instructor in AFIT’s Civil Engineer School. In his first year, he single-handedly executed the two-instructor mechanical engineering course for eight months. As the largest of the technical engineering portfolios, he directed five course offerings and taught an additional seven courses for a total of 112 hours of live instruction to 408 students. Joslin significantly revamped the introduction to Mechanical Systems course curriculum after the original became corrupted and was no longer accessible. He created new lessons and re-formatted an additional 13 lessons. His quick thinking and long hours saved the course for 72 students.

As the director of the officer field education portion of the Civil Engineer Officer Initial Skills course, Joslin led 15 officer cadre and 25 enlisted through a seven-day contingency field training capstone that cyclic 63 new civil engineer officers through 54 hours of full spectrum capabilities.
AFIT Collaborates with Air Force Orgs on STEM Projects to Advance State-of-the-art Research

The Air Force Life Cycle Management Center Engineering and Technical Management Directorate (AFLCMC/EN-EZ) is collaborating with Air Force Research Laboratory Sensors Directorate (AFRL/RY) and the Air Force Institute of Technology Center for Directed Energy (AFIT-CDE) to advance state-of-the-art research with a unique patented laser sensor system that measures turbulence in the atmosphere above the laser, while allowing AFRL/CED to acquire new hires (PAQs) and part-time interns to demonstrate STEM technology development.

The Turbulence and Aerosol Research Dynamic Interrogation System (TARDIS) is an invention of several researchers at AFRL/RY and AFIT. TARDIS detects turbulence by using a laser beam and timed sensor to measure pulse reflections from different atmospheric layers to create a profile along the beam. Knowledge of turbulence is a key parameter for optimizing laser propagation. The system has been built under a research collaboration between AFRL/RY and AFIT/CDE.

The Air Force’s graduate school of engineering and strives to be the student’s first air and space force’s graduate school of engineering and strives to be the student’s first...

Professor Awarded Patent for Spacecraft Re-entry Time Prediction System

By Jacyln Knapp
Center for Space Research and Assurance
Air Force Institute of Technology

Lt. Col. Robert Betttinger, assistant professor of astronautical engineering, Air Force Institute of Technology, was recently awarded a patent for his invention, “Early Warning Reentry System Comprising High Efficiency Module for Determining Spacecraft Reentry Time.” The system utilizes simplified representations of both the satellite and atmosphere to predict the re-entry time of uncontrolled spacecraft with improved prediction accuracy.

“Using coarse approximation, the linear model enables increased confidence in re-entry time prediction nearly a week prior to the event without the need for exact spacecraft aerodynamics or knowledge of the solar cycle,” said Betttinger, assistant professor and deputy of AFIT’s Center for Space Research and Assurance.

Space professionals estimate there are more than three thousand active spacecraft of various sizes orbiting the Earth. The disposal of spacecraft from low Earth orbit in the atmosphere is important to reduce the growing population and associated risks of space debris. Not all satellite re-entries are controlled; however, the re-entry of uncontrolled spacecraft poses a risk to both people and property.

Recently uncontrolled atmospheric re-entries of low Earth orbiting spacecraft have highlighted the necessity of accurate re-entry time and location predictions. The problem and potential hazard of re-entering “space junk” has become a global news story, such as the re-entry of the Tiangong-1 space station in April 2018 and the Long March 5 Upper Stage in mid-2021.

Unfortunately, re-entry time predictions are highly uncertain due to the very nature of the re-entry environment: the atmosphere. In recent decades, the inclusion of increasingly precise models for spacecraft aerodynamics and atmospheric density into re-entry prediction algorithms has improved overall prediction accuracy, but at a cost of computational complexity.

“AFIT faculty, students, and staff are conducting leading-edge research with a direct application to the immediate and long-term technical challenges facing our Nation and its allies. Patents are one important way to recognize our technical innovations and are a laudable achievement for both the inventor and the Department of the Air Force,” said Dr. Walter Jones, AFIT Director and Chancellor.

In the future, the Center plans to utilize the patent for expanding AFIT’s re-entry analysis program and to spur the development of enhanced models to predict the re-entry time of spacecraft in highly elliptical orbits, such as a launch vehicle in a Geosynchronous Transfer Orbit.

The Air Force Institute of Technology, or AFIT, located at Wright-Patterson AFB, Ohio, is the Air and Space Force’s graduate school of engineering and strives to be the student’s first choice for advanced academic and technical professional continuing education.

To contact the inventor of the patent, email: Robert.Bettinger@afit.edu or robert.bettinger@us.af.mil

READ THE COMPLETE ARTICLE ONLINE

https://www.afit.edu/news.cfm?Article=03604020

“Using coarse approximation, the linear model enables increased confidence in re-entry time prediction nearly a week prior to the event without the need for exact spacecraft aerodynamics or knowledge of the solar cycle.”

—Lt. Col. Robert Betttinger, Assistant Professor of Astronautical Engineering

Hinged Mirror Temperature-Immune Self-Referencing Fabry–Pérot Cavity Sensors

By Air Force Life Cycle Management Center Public Affairs

ABSTRACT: A passive microscopic Fabry–Pérot interferometer (FPI) sensor includes a three-dimensional microscopic optical structure formed on a cleaved tip of the optical fiber utilizing a two-photon polymerization process on a photosensitive polymer by a three-dimensional micromachining device. The three-dimensional microscopic optical structure having a hinged optical layer pivotally connected to a distal portion of a suspended structure. A reflective layer is deposited on a mirror surface of the hinged optical layer while in an open position. The hinged optical layer is subsequently positioned in the closed position to align the mirror surface to at least partially reflect a light signal back through the optical fiber.

PATENT #: 11,320,596. DATE: May 3, 2022

INVENTORS: Dr. Hengky Chandrabahum, Assistant Professor of Electrical Engineering, and Lt. Jeremiah C. Williams, MS Electrical Engineering, 2020.

ABSTRACT: A passive microscopic Fabry–Pérot interferometer (FPI) sensor includes a three-dimensional microscopic optical structure formed on a cleaved tip of the optical fiber utilizing a two-photon polymerization process on a photosensitive polymer by a three-dimensional micromachining device. The three-dimensional microscopic optical structure having a hinged optical layer pivotally connected to a distal portion of a suspended structure. A reflective layer is deposited on a mirror surface of the hinged optical layer while in an open position. The hinged optical layer is subsequently positioned in the closed position to align the mirror surface to at least partially reflect a light signal back through the optical fiber.

ONLINE LINK: https://patentimages.storage.googleapis.com/a0/e2/16/12bdb23153113a/US11320596.pdf

Professor Awarded Patent for Spacecraft Re-entry Time Prediction System

By Jacyln Knapp
Center for Space Research and Assurance
Air Force Institute of Technology

Lt. Col. Robert Betttinger, assistant professor of astronautical engineering, Air Force Institute of Technology, was recently awarded a patent for his invention, “Early Warning Reentry System Comprising High Efficiency Module for Determining Spacecraft Reentry Time.” The system utilizes simplified representations of both the satellite and atmosphere to predict the re-entry time of uncontrolled spacecraft with improved prediction accuracy.

“Using coarse approximation, the linear model enables increased confidence in re-entry time prediction nearly a week prior to the event without the need for exact spacecraft aerodynamics or knowledge of the solar cycle,” said Betttinger, assistant professor and deputy of AFIT’s Center for Space Research and Assurance.

Space professionals estimate there are more than three thousand active spacecraft of various sizes orbiting the Earth. The disposal of spacecraft from low Earth orbit in the atmosphere is important to reduce the growing population and associated risks of space debris. Not all satellite re-entries are controlled; however, the re-entry of uncontrolled spacecraft poses a risk to both people and property.

Recently uncontrolled atmospheric re-entries of low Earth orbiting spacecraft have highlighted the necessity of accurate re-entry time and location predictions. The problem and potential hazard of re-entering “space junk” has become a global news story, such as the re-entry of the Tiangong-1 space station in April 2018 and the Long March 5 Upper Stage in mid-2021.

Unfortunately, re-entry time predictions are highly uncertain due to the very nature of the re-entry environment: the atmosphere. In recent decades, the inclusion of increasingly precise models for spacecraft aerodynamics and atmospheric density into re-entry prediction algorithms has improved overall prediction accuracy, but at a cost of computational complexity.

“AFIT faculty, students, and staff are conducting leading-edge research with a direct application to the immediate and long-term technical challenges facing our Nation and its allies. Patents are one important way to recognize our technical innovations and are a laudable achievement for both the inventor and the Department of the Air Force,” said Dr. Walter Jones, AFIT Director and Chancellor.

In the future, the Center plans to utilize the patent for expanding AFIT’s re-entry analysis program and to spur the development of enhanced models to predict the re-entry time of spacecraft in highly elliptical orbits, such as a launch vehicle in a Geosynchronous Transfer Orbit.

The Air Force Institute of Technology, or AFIT, located at Wright-Patterson AFB, Ohio, is the Air and Space Force’s graduate school of engineering and strives to be the student’s first choice for advanced academic and technical professional continuing education.

To contact the inventor of the patent, email: Robert.Bettinger@afit.edu or robert.bettinger@us.af.mil
AFIT Poised to Lead Digital Efforts

Integration is Key for Success in Digital Implementation

By Dr. Adedeji Badiru
Air Force Institute of Technology

This article is a revisit to my previous article entitled “Digital Engineering is Foundational for the Air Force Mission” published in the March 2021 issue of the AFIT Engineer. (Visit www.afit.edu/en/afitengineer to read the article.) A lot more digital movement has occurred since that article. The Department of the Air Force (DAF) is even more digital-centric in 2022 and the trend is projected to continue. Are we ready to take on and utilize all that digital engineering has to offer? The answer is a resounding “Yes,” judging by the recent digital-centric initiatives at AFIT and elsewhere throughout the DAF.

Unlike buzzwords of the past, digital engineering is not a fad. The proof for this can be easily seen, observed, and felt in our present-day operating environment, and can be seen and read in the coverage of this issue. The ongoing wave of artificial intelligence products, tools, and techniques are facilitated by new digital platforms. The smartphones we carry around with us demonstrate how our communication modes have been transformed on a rapid scale by digital platforms, and the phones are getting smarter with each new release.

Digital engineering will continue to revolutionize operations in all aspects of our lives. Digital engineering will continue to advance how we do everything in business, education, industry, government, and the military. Any entity that is sluggish in embracing digital engineering will be left behind, cannot participate in digital efforts to succeed and be sustainable, we cannot claim to be on the leading edge of technological advancements, and otherwise, the product will be misaligned and not leveraged to its fullest extent.

As we are foraging more and more into Space, we must be cognizant of how things integrate up there in relation to here on Earth. For example, based on the emergence of digital engineering with potential applications of additive manufacturing (3D printing) on the International Space Station, we can influence the world positively from way above the Earth. Coincidentally, advanced research in 3D printing for space applications is one of AFIT’s current initiatives.

In the context of what we do at AFIT, to collaborate on digital engineering, we must all have a common understanding of what it entails. For our common understanding, digital engineering is the combined art and science of creating, capturing, designing, evaluating, justifying, and integrating data using digital (i.e., electronic) tools and processes. This requires the humans in the loop of the process to also have a digital mindset. A digital tool that is devoid of the digital readiness of humans will be for naught. So, workforce development along the digital spectrum is essential for sustainable success.

With its education mission, AFIT is most suited for leading and participating in digital initiatives for the U.S. Air and Space Forces. For digital efforts to succeed and be sustainable, we need new and novel methods, systems-based processes, and appropriately-customized tools. One tool that is being embraced both in academia and business is the trademarked DEJI Systems Model® for design, evaluation, justification, and integration (see Figure 1).

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Integration is key for success in any digital implementation. Any digital product must integrate into how people think and work. Otherwise, the product will be misaligned and not leveraged to its fullest extent.

References:


Figure 1. DEJI Systems Model® to Digital Engineering Integration
Digital Transformation
Improved Integration and Enhanced Insights in the Developmental Lifecycle

By Lt. Col. Amy Cox & Dr. Michael Miller
Department of Systems Engineering & Management
Air Force Institute of Technology

WHY DIGITAL TRANSFORMATION IS IMPORTANT
Digital Transformation and Digital Engineering are key topics in defense acquisitions. Many may ask “what is behind this interest” or “is this another fleeting management trend?” Like the transition from the drafting table to Computer Aided Design (CAD) in the 1980s and 90s which dramatically streamlined the engineering to production process, we are at the cusp of a similar transition. At the core of this transformation is improved integration. The models permit tracing of requirement sets to elements in systems models which interact with life cycle data and engineering models to enhance insights and create more robust tradeoffs throughout the development lifecycle. This integration and traceability, enabled by new tools, offers a means to better manage the complex systems that exist across the DoD.

Largely, the Digital Transformation triggers the following questions:

1. Why, when, and how should we pursue a future state of integrated models and data?
2. What are the costs and benefits of these integrated models?
3. How do these tools transform the way we acquire, sustain, and operate these systems?

These questions are at the heart of curriculum and research in AFIT’s Graduate School of Engineering and Management.

AFIT HISTORY IN DIGITAL TRANSFORMATION
AFIT has a long history of creating and applying digital models across the graduate school to include physics-based models through operations models. These types of models are part of the Digital Transformation, the new challenge is integration of these models and data structures. How does one take data from a physics-based model (ex. kinetic weapons effects) and have them integrate with an operations model (ex. a sortie into denied airspace) and have those models trace to stakeholder requirements (ex. mission effectiveness and lethality) or perhaps to trade studies (ex. life cycle cost versus effectiveness across various architectures)?

ONGOING INNOVATIVE RESEARCH
To fulfill the promise of Digital Engineering, it will be necessary to integrate various models and modeling environments within a robust acquisition process. Recent AFIT systems research has focused on application of systems models using Model-Based Systems Engineering to explore systems to include smart munitions, aircraft, spacecraft, and maintenance systems.

Under the guidance of Dr. David Jacques and Lt. Col. Jeremy Geiger and Warren Connell, a group of four recent AFIT graduates investigated Networked Cooperative Autonomous Systems (NCAS). By implementing digital twins of the munitions in MBSE and AFSIM, the team investigated a range of potential system architectures and behaviors. The integration of MBSE tools with AFSIM permitted the team to explore how the combinations of these tools could be used to facilitate selection of various architectures as well as to perform verification, validation, and accreditation processes. Just one of the tools developed in this research permitted an automated verification of all system interfaces to assure their compliance with published standards (minutes versus weeks). The ability to have such automated verification provides just one answer to ‘what are the benefits?’ The associated research with mission models considered thousands of architectures virtually, allowing more informed selection of a design.

While the NCAS research considered a future system, Lt. Col. Jeremy Geiger and his student Capt. Patrick Assel measured and quantified the hours necessary to transition legacy documentation of an ACAT III program to full structural system models. With just under 100 hours of effort, the program documentation was transferred to permit automated queries to be completed in minutes to determine the effect of eliminating interfaces, changing components, or changing interfaces.

To explore how this digital transformation changes our acquisition processes MBSE tools were applied to support both airworthiness decision factors as well as physical structure design and visualization. Dr. Tom Ford led a project in which MBSE tools were used to computationally evaluate various physical arrangements of aircraft components. These tools were integrated with Engineering Sketchpad to provide additional analyses and visualizations. This arrangement provided the ability to rapidly evaluate various sizes and placements of wings among other physical components for future aircraft designs.

The impact of these tools are not limited to system acquisition, they influence mission engineering and operations. Space related projects led by Lt. Col. Paul Beach included evaluation of notional space domain awareness and satellite communication architectures. These projects included the definition of space assets using MBSE software which was integrated with either Systems Tool Kit or AFSIM to model the dynamic performance of assets and to understand the benefits and deficiencies of various architectural solutions for addressing mission needs.

Besides modeling hardware and software components, work was also conducted to model human performance and support. This included research, led by Dr. Michael Miller and Maj. Joe Kristbaum that explored reference architectures for augmented reality systems to support aircraft maintenance, as well as models to analyze and guide training development. A related project led by Lt. Col. Amy Cox explored organizational structures designed to further user driven innovation through support of user toolkits. This research leveraged MBSE models to understand organizational structures, human roles, and tasks within user toolkit ecosystems described in the literature to synthesize the important roles and tasks which support user innovation using these toolkits.

Overall, AFIT research and graduate curriculum on Digital Engineering and Model-Based Systems Engineering has been designed to support the DoD’s digital transformation. We are developing the workforce that can lead this transformation. We are driving research to advance our understanding of how to transform our current structures and processes. This is a transformation that spans all DoD systems; altering acquisition processes, enhancing our insight into hardware, software, and personnel integration, and driving changes to how we ultimately carry out our missions.
Digital Literacy

AFIT Programs Target Increased Digital Literacy Across the DAF

The Department of the Air Force created a digital literacy core competency for its workforce which involves taking advantage of technologies such as high-speed information technology pipelines, cloud-hosted data repositories, cloud computing, the Internet of Things, artificial intelligence, and digital data management and visualization. Key to this enterprise is a workforce that has the necessary knowledge, skills, and abilities to implement these technologies, and a workplace culture that embraces them. The Air Force Institute of Technology offers education, research, and consulting targeted to making the Department of the Air Force a digital enterprise.

Digital Literacy Education at AFIT is Focused on These Six Topic Areas

“AFIT primarily approaches digital engineering in the context of conducting technical activities for managing weapon systems,” said Richard Sugarman, head of the department of software and systems engineering management within AFIT’s School of Systems and Logistics. “This includes concepts like model-based engineering, model-based systems engineering, multidisciplinary design analysis and optimization, and model-based simulation and analysis.”

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Digital Engineering

Cybersecurity

Data Science

Mission Engineering

Joint All-Domain Operations

Digital Acquisition

Digital Engineering

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Digital acquisition is a larger category of activities associated with managing weapon systems that includes digital engineering technical topics, plus insights from structured and unstructured data. “Primary institute activities are the graduate data science and operations research degrees offered by the Graduate School of Engineering and Management, and the data analysis continuing education courses in the School of Systems and Logistics,” said Sugarman.

AFIT has a long history of cybersecurity education and has been designated as the Air Force’s Cyber Technical Center of Excellence since 2008. “With respect to AFIT’s role in digital literacy education, cybersecurity is largely in the context of securing information technology networks and cyber physical systems, and conducting offensive and defensive cyber warfare,” explained Sugarman.

Mission engineering uses mission-focused threat-informed analyses to evaluate capability solutions, advise on development of requirements, and inform technology investment decisions. Joint All-Domain Operations integrates mission engineering across the joint force in multiple domains including air, land, maritime, cyberspace and space domains, and the electromagnetic spectrum.

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For additional information, including course and degree programs, please visit our website at https://www.afit.edu/digital/
8 Alumni General Officer Promotions

By Jaclyn Knapp
Center for Space Research and Assurance
Air Force Institute of Technology

By Maj. David Swanson, Ph.D. (far right), AFIT materials science doctoral alumnus, and recent transfer to the European Office of Aerospace Research and Development, Air Force Office of Scientific Research, London, United Kingdom. Pictured is a renowned European research collaborator in their laboratory that was selected to receive an AF grant funding from the EORD AFOSR.

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CALENDAR EVENTS

**JULY 2022**

AFIT Graduate School Fall Quarter Registration Begins  
5 July 2022  |  AFIT Campus, WPAFB, OH

Advanced Cyber Education (ACE) Summer Course  
11 July-5 Aug 2022  |  AFIT Campus, WPAFB, OH

**SEPTEMBER 2022**

AFIT Graduate School Summer Quarter Classes End  
02 Sep 2022  |  AFIT Campus, WPAFB, OH

AFIT Graduate School Summer Graduation Ceremony  
15 Sep 2022  |  AFIT Campus, WPAFB, OH

Call for AFIT Alumni Award Nominations

In conjunction with the AFIT Foundation, AFIT is seeking nominations for three alumni awards to recognize and honor alumni who have distinguished themselves and made outstanding contributions in their career. The categories are: AFIT Distinguished Alumni Award, AFIT International Alumni Award and AFIT Young Alumni Award.

Information on eligibility, criteria, nomination procedure, timeline, and selection process for each of the awards can be found at the link below. Nomination deadline is 14 Aug 22.

https://www.afit.edu/ALUMNI/?source=GovD

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