

# FAA Center of Excellence for Technical Training & Human Performance

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## Executive Summary

Year 1 - August 15, 2017

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**Federal Aviation  
Administration**

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## LETTER FROM THE CO-EXECUTIVE DIRECTORS



We are pleased to release the first DOT FAA Centers of Excellence for Technical Training and Human Performance Executive Summary. The Executive Summary is extracted from the research priorities, project recommendations, and individual research and technical expertise of a world-class, public-private partnership of over 65 academic institutions and corporations. This report includes the COE TTHP organizational structure, roles, and responsibilities.

In partner and sponsorship with the FAA Office of Safety and Technical Training and with valuable input from the controllers and technicians, the consortium is tasked with conducting front-line research, designed to develop enhanced training and NextGen technology of today's aviation professionals and tomorrow's aviation practitioners. Leveraging the COE TTHP findings will allow the FAA to build a more highly trained technical workforce in areas, such as part-tasking, modeling, immersive human-in-the-loop simulation, and adaptive learning technologies. The COE TTHP will continue to examine human factors issues, including changes in learner expectations and academic best practices required for training a new generation. The COE TTHP research seeks new generation, fresh, innovative, training methodologies addressing mobile learning and new ways of collecting and managing training data.

As the COE TTHP moves into the second year, a priority is to take advantage of evolutions in teaching that will become the standard in aviation workforce protocols. Thank you for providing the opportunity to present our research and best practices.

Thousands of voluntary manhours have contributed to our success. We especially want to thank Abigail Smith, Karen Callihan, Angelia Kinston-Thomas, Jonathan Gray, Pat Watts, and the support teams at the FAA COE TTHP and the FAA Center of Excellence Program Office.

A very special THANK YOU to the FAA Air Traffic Organization for its visionary leadership, direction, and support over the past year. Together our commitment will result in safer skies and better practices.



Mark Friend, Ed.D.  
*Embry-Riddle  
Aeronautical University*



James Pappas, Ph.D.  
*University of Oklahoma*



John Tomblin, Ph.D.  
*Wichita State University*

## PREFACE



The Federal Aviation Administration (FAA) Office of Safety and Technical Training (STT) is pleased to release this FAA Center of Excellence for Technical Training and Human Performance (COE TTHP) Year 1 Annual Report Executive Summary. This first year saw the selection of the University of Oklahoma and Embry-Riddle Aeronautical University as the technical co-leads and Wichita State University as the administrative co-lead of a 16-core member and 11-affiliate member university partnership. This collection of incredible universities (as will be described in more detail later in this document), supplemented by affiliate and associate members and complemented by numerous private organizations, industries, and research institutions are working on 55 funded tasks through 64 cooperative agreements and grants.

Supporting the brilliant principal investigators, researchers and the students is an important group of financial officers, contractors, business men and women, executives, administrators, controllers, technicians, and government researchers.

These individuals' efforts make the phenomenal research possible, provide matching cash and in-kind contributions, make available the extensive technical and financial data for government-required reports, and provide the overall system functionality. The first year of operation focused on building relationships (e.g., research, administrative, financial, personal, etc.) among the many entities at each of the 64 universities and the many government offices. The complexity of the relationship network makes the smooth operation of any FAA COE challenging. Despite this complexity, the COE TTHP successfully emerged from the initial "honeymoon" period as a fully functional, cohesive unit.

During this phase, emphasis is placed on educating the aviation community of the COE TTHP capabilities and strengths. It is also a time of aligning and understanding industry needs of the evolving NEXGEN marketplace. Dr. Patricia Watts, National Program Director of the FAA COEs, is an individual without whose support the COE TTHP could not function today. She is recognized as a driving force for the past successes of the FAA COE program and will be a source of any future accomplishments as well. The COE TTHP is very grateful for her support.

Each of these individuals, representing the dozens of participating organizations and institutions, cannot be given enough words of thanks or acts of appreciation in recognition for their contributions of time, effort. Thank you ALL. For more information about the content of this report, please visit the COE TTHP web site at [www.coetthp.org](http://www.coetthp.org). Please address any questions or corrections to COE TTHP Program Manager, Ms. Karen Callihan 202-267-8327, [karen.callihan@faa.gov](mailto:karen.callihan@faa.gov). For more information about the tasks presented in this report, please visit the COE TTHP website at [www.coetthp.org](http://www.coetthp.org).

EXECUTIVE SUMMARY



## INTRODUCTION



This document accompanies a detailed Year 1 Annual Report of the FAA Center of Excellence for Technical Training and Human Performance (COE TTHP) that began operation on August 12, 2016. The period of performance of the first year of the COE TTHP is August 12, 2016 – August 11, 2017. The five-year award for the Center of Excellence extends through August 11, 2021.

This executive summary begins with overviews of the FAA Office of Safety and Technical Training (STT), the sponsoring organization; the FAA COE Program, and the COE TTHP.

Additional information in this summary includes:

- Brief introductions of the sixteen core institutions
- Research facilities and equipment
- Research area summaries and tasks
- Research charts outlining tasks initiated, conducted, and concluded during the Year 1
- Research partners, students, publications and awards
  - The Executive Summary is accompanied by three additional volumes
  - Volume 1 provides a full description of the FAA COE TTHP including research, structure, member universities, funding and research tasks
  - Volume 2 is a comprehensive set of presentation charts of each research task as presented at the technical meetings
  - Volume 3 is a comprehensive set of notes and links to recordings from all FAA COE TTHP teleconferences and face-to-face meetings
  - These volumes are available at the COE TTHP website [www.coetthp.org](http://www.coetthp.org).

## OVERVIEWS



### FAA OFFICE OF SAFETY AND TECHNICAL TRAINING

The FAA Office of Safety and Technical Training (AJI) is responsible for the development of ATO's Safety Management System and the integration of safety and training standards into the provision of air traffic services. Technical Training (AJI-2) has a responsibility to its stakeholders to ensure that the training meets the operational need and supports the continuous development of a highly skilled technical workforce. In the office's commitment to ensure controllers and technicians have the skills, abilities, and knowledge they need to successfully and safely operate the airspace system, the focus is on learning innovation, business intelligence, organizational growth, and strategic partnerships to efficiently and effectively develop and deliver Air Traffic and Technical Operations training.

## FAA CENTER OF EXCELLENCE PROGRAM

The FAA COE program was established by the Omnibus Budget Reconciliation Act of 1990, Public Law 101-508, Title IX, Aviation Safety and Capacity Expansion Act.

COEs are established through cooperative agreements with the nation's premier research universities, their members and affiliates. COEs conduct focused research and development activities intended to be multi-year, multi-disciplinary partnerships among partners in academia, industry, and government. They work in combining world-class resources to address current and future challenges for the aviation technologies and commercial space.

Over the life of the program, the COE universities, with their non-federal affiliates, have provided more than \$300 million in matching contributions to augment FAA research efforts. Through these long-term, cost-sharing activities, the government and university-industry teams leverage resources to advance the technological future of the nation's aviation industry while educating and training the next generation of aviation scientists and professionals.

The COEs provide the taxpayer with a hard return on their dollars – matching dollar-for-dollar contributions from non-government sources. This match offsets government funds.

Currently, the FAA oversees the following active COEs:

Center of Excellence	Lead Institutions	Established
Joint Center for Advanced Materials Research	Wichita State University and University of Washington	2004
Commercial Space Transportation	University of Texas Medical Branch	2010
General Aviation Safety	Purdue University	2012
Alternative Jet Fuels and Environment	Massachusetts Institute of Technology and Washington State University	2014
Unmanned Aircraft Systems	Mississippi State University	2015
Technical Training and Human Performance	Embry-Riddle Aeronautical University, University of Oklahoma and Wichita State University	2016

The COE members have assisted in mission-critical research and technology areas focusing on the following topics:

- Technical Training and Human Performance
- Unmanned Aircraft Systems
- Alternative Jet Fuels and Environment
- General Aviation Safety, Accessibility, And Sustainability
- Commercial Space Transportation
- Advanced Materials
- Airliner Cabin Environment and Intermodal Transportation Research
- Aircraft Noise and Aviation Emissions Mitigation
- Airworthiness Assurance
- Operations Research
- Airport Technology
- Computational Modeling of Aircraft Structures

### FAA CENTER OF EXCELLENCE FOR TECHNICAL TRAINING AND HUMAN PERFORMANCE

The FAA Center of Excellence for Technical Training and Human Performance (COE TTHP) unites over 64 organizations from the public sector, private sector, and academic institutions to perform basic and applied research, education, and training tasks through a variety of analyses, development, and prototyping activities. This world-class consortium is focused on research and development of technical training for air traffic controllers, aviation safety inspectors, engineers, technicians, and pilots. Embry-Riddle Aeronautical University, University of Oklahoma and Wichita State University were chosen by the FAA in August of 2016 to lead this dynamic center of excellence, the COE TTHP.

Six goals have been identified by the Air Traffic Organization (ATO) as current priorities. The COE TTHP aligns all research projects to the goals listed below:

- Redesign the Platform for Content Management and Development;
- Update the Development Processes for Course Management and Maintenance;
- Expand and Enhance the Partnerships Among FAA, Academia, and Industry to Define Future Learning;
- Develop Implementation and Integration Strategies to Utilize Available Technology That Will Improve the Learning Environment;
- Establish Communication and Transparency with Stakeholders; and
- Continually Align Business Goals to Organizational Requirements for Growth and Development.

### COE TTHP YEAR 1 HIGHLIGHTS

The following are the major milestones for the COE TTHP during its first year:

- Creation of the Executive Committee, Consolidating the Core Institutional Members into a Single Entity for Governance and Oversight Activities
- First Year of Operation for the Industrial Advisory Board
- Twenty-Two Research Projects
- Three Annual Administrative Meetings at ERAU (1) and OU (2) September and November 2016
- Two Annual Technical Meetings - ERAU (1) and Washington, DC (1) March and June 2017
- Executive Committee Bi-Annual Meeting - Daytona Beach, FL March 2017
- Executive Committee Strategic Planning Retreat - Washington, DC June 2017
- COE TTHP Year 1 Research Expo Event - FAA HQ June 2017
- COE Outreach - Air Traffic Control Association (ATCA) Conferences in Washington, DC October 2016 and Atlantic City, NJ May 2017

• At-A-Glance Metrics	• Year 1 Outcomes
• # Core Institutions	• 16
• # Research Tasks	• 22
• # Principal Investigators	• 50
• # Subject Matter Experts	• 30
• # Student Researchers	• 52
• # Industry Partners	• 40
• # Affiliate Members	• 9

### COE TTHP CORE INSTITUTION MEMBERS



Sixteen COE TTHP core institution members are Auburn University, Drexel University, Embry-Riddle Aeronautical University, InterAmerican University, Oklahoma State University, The Ohio State University, Purdue University, Tennessee State University, Tulsa Community College, The University of Akron, University of Nebraska – Omaha, University of North Dakota, University of Oklahoma, University of Wisconsin – Madison, Western Michigan University, and Wichita State University.

These members provide a comprehensive geographical distribution, representing 14 states across the U.S. All facets of the air traffic system are represented by our core institutions. These include remote areas; heavily trafficked, en route corridors; hubs of regional airline activity; and dense urban airspace areas. Collectively, our members possess a penetrating element of multicultural diversity, cutting across demographics of age, race, culture, and socioeconomic status. Our team has a proud history of reaching learners from diverse socioeconomic and cultural backgrounds.



Unmanned Aircraft Systems and previously served as lead of the FAA Center of Excellence for General Aviation Research.

*University of Oklahoma (OU) – Technical Co-Lead*

Since 1947, the University of Oklahoma has offered top-tier aviation and engineering education. OU's Department of Aviation offers four degree concentrations: Professional Pilot, Aviation Management (Flying and Non-Flying), and Air Traffic Management. These programs are all accredited by Aviation Accreditation Board International (AABI). OU's programs include an FAA-approved, Part 141 and Part 61 Flight School and FAA Air Traffic Collegiate Training Initiative. The Aviation program has strong partnerships with the National Weather Center, Tinker Air Force Base, Federal Aviation Administration, American Airlines, Envoy Air, Jet Blue, and FedEx. The institution also offers engineering undergraduate and graduate degrees in the following areas: aerospace and mechanical, computer science, data science and analytics, electrical and computer, industrial and systems. These programs are all accredited by the national Accreditation Board for Engineering and Technology (ABET). The institution has a 50-year history of successfully managing technical training contracts and related research grants for the federal government. OU owns and operates the Max Westheimer Airport located on OU's north research campus.

*Wichita State University (WSU) – Administrative Lead*

Wichita State University has operated the National Institute for Aviation Research (NIAR) since 1985, the most capable university-based aviation research center in the U.S. WSU provides research, design, testing, certification and training to the aviation manufacturing industry, government agencies, educational entities and other clients. NIAR operates on a non-profit budget that has steadily increased to more than \$46 million. Clients include Boeing, Bombardier Learjet, Cessna, Beechcraft and Spirit Aerosystems. The institution offers engineering undergraduate and graduate degrees in the following areas: aerospace, biomedical, electrical and computer, industrial, systems, and manufacturing and mechanical. These programs are all ABET accredited. NIAR is home to the FAA Center of Excellence for Composites and Advanced Materials (CECAM) and the National Center for Advanced Materials Performance (NCAMP), which is funded through the FAA and Air Force Research Laboratory. WSU is also a core institution partner of the FAA Center of Excellence for UAS Research.

*Auburn University (AU)*

Since 1941, Auburn University has been actively involved in aviation education and is considered a leader in aviation research. The Harbert College of Business offers two aviation-related degree programs; Aviation Management and Professional Flight Management. These programs are all accredited by the national and international Aviation Accreditation Board International. Included in the Auburn Aviation Center is the FAA approved Part 141 and Part 61 Flight School that offers pilot training from Private Pilot through Flight Instructor. The institution also offers engineering undergraduate and graduate degrees in the following areas: aerospace, computer science and software, electrical and computer, industrial and systems,

and mechanical. These programs are all accredited by the national Accreditation Board for Engineering and Technology. Auburn is an affiliate academic partner of the FAA Center of Excellence for UAS Research.

#### *Drexel University (DU)*

Since its founding in 1891, Drexel University has emphasized its strengths in engineering, science and technology undergraduate and graduate degree programs. These programs are all accredited by the national Accreditation Board for Engineering and Technology. Drexel offers extensive published research in human-computer interaction, modeling and simulation, and other safety and human factors topics. Among other initiatives, faculty have worked to characterize ATC judgment and decision making with respect to conflict detection. Through a \$12.5 million grant from the Department of Defense, Drexel also established the Applied Communications and Information Network (ACIN) Center. Drexel was re-designated by the National Security Agency (NSA) as a Center of Academic Excellence in Information Assurance Education. The college's \$35 million Bossone Research Enterprise Center is home to facilities in nanotechnology, information networking and smart infrastructures. Drexel is a core institution partner of the FAA Center of Excellence for UAS Research.

#### *InterAmerican University (IAU)*

The InterAmerican University of Puerto Rico School of Aeronautics offers two-degree programs: Aircraft Systems Management (Professional Pilot) and Aviation Management. A Commercial Pilot minor and an Air Traffic Control minor are available. These programs are accredited by Aviation Accreditation Board International. The programs include an FAA-approved Part 141 Flight School for Private Single Engine Airplane Pilot, Commercial Single Engine Pilot, and Instrument Airplane rating. Additionally, FAA-approved Part 61 certifications include Multi-Engine Airplane, Instructor Airplane, Instrument Instructor Airplane, Multi-Engine Instructor, Flight Review for Single Engine, Flight for Completion of Wings Program, Maintaining Instrument Rating Flight Experience, Recent Flight Experience for Pilot in Command, Instrument Flight Proficiency Check, Airline Transition Training Experience and ATP Certificates Training.

#### *Oklahoma State University (OKSU)*

Oklahoma State University's School of Aeronautics offers five undergraduate degree options: Professional Pilot, Aviation Management, Technical Services Management, Aerospace Security, and Aerospace Logistics. Graduate degree options also include a Master of Science in Aviation and Space and a Doctor of Education in Aviation and Space. These programs are all accredited by Aviation Accreditation Board International. OSU's programs include both FAA-approved Part 141 and Part 61 flight training programs. The institution also offers engineering undergraduate and graduate degrees in the following areas: aerospace, computer, electrical, industrial and mechanical. These programs are all accredited by the Accreditation Board for Engineering and Technology. OSU is also home to the Oklahoma Aerospace Education Research Symposium and NASA Johnson Space Center Strategic Education Alliance Program.

### *The Ohio State University (OSU)*

Since 1917, the Ohio State University has offered leading aviation and engineering degree programs. These programs are all accredited by the Aviation Accreditation Board International and the Accreditation Board for Engineering and Technology. The OSU Center of Aviation Studies incorporates engineering, business, and behavioral philosophies into a multi-disciplinary approach to the many components of the aviation industry. It supports world-class, flight-education programs; academic degree programs; research initiatives; and outreach activities on local, regional, national, and international levels. OSU also owns and operates the Ohio State's Don Scott Field airport and associated FBO which first opened in 1942. OSU's FAR part 141 certified flight education program is supported by more than 20 training aircraft and flight simulators. The institution has partnered with several airline bridge programs to facilitate the matriculation of students into professional pilot positions and NetJets, Flight Safety International, and other industry players to support general aviation research and education. Aviation and aerospace research at OSU accounts for more than \$7.5M in annual research expenditures. OSU is currently a core institution partner of the FAA Center of Excellence for General Aviation and the FAA Center of Excellence for Unmanned Aircraft Systems.

### *Purdue University (Purdue)*

Purdue's School of Aviation and Transportation Technology, one of six departments and schools in the Purdue Polytechnic Institute, is recognized worldwide as a leader in aviation education. Since 1930, Purdue has offered world-class aviation and engineering educational programs: aeronautical engineering technology, aerospace financial analysis, airline management and operations, airport management and operations, aviation management, professional flight, and unmanned aerial systems. These programs are all accredited by the Aviation Accreditation Board International and the Accreditation Board for Engineering and Technology. Purdue also owns its local airport, Fixed Base Operator, and large fleet, including Cirrus, Piper, and Embraer aircraft. The institution also houses an Aviation Materials Lab, Dynamic Flight Lab, Engine Test Cells, and Hanger of the Future Lab. Purdue leads the FAA Center of Excellence for General Aviation and is a core institution partner of the FAA Joint Center of Excellence for Advanced Materials and the FAA Center of Excellence for Alternative Jet Fuels and Environment.

### *Tennessee State University (TSU)*

Tennessee State University has offered engineering undergraduate and graduate degrees since 1967. TSU degree areas include: aeronautical and industrial, computer science, electrical and computer engineering, and mechanical and manufacturing. These programs are all accredited by the Accreditation Board for Engineering and Technology. The institution also operates an NSF-funded Interdisciplinary Graduate Engineering Research (TIGER) Institute, a graduate level research facility within the College of Engineering, Technology and Computer Science. TSU graduates the largest number of African-American engineers in the state of Tennessee. Defense organizations like Lockheed Martin, Boeing, and branches of the military often collaborate with TSU in conducting research and offering internship and employment opportunities to TSU students.

*Tulsa Community College (TCC)*

Since 1992, the Aviation Center at Tulsa Community College has offered degree programs in Air Traffic Control, Professional Pilot, Aviation Management and Aviation Logistics. These programs are all accredited by the Aviation Accreditation Board International. Included in the program is the FAA-approved Part 141 and Part 61 Flight School.

*University of Akron (UA)*

Since 1913, the University of Akron has offered undergraduate and graduate degree programs in engineering. Akron degree areas include aerospace systems, computer, electrical, and mechanical. These programs are all accredited by the Accreditation Board for Engineering and Technology. Akron is home to one of the oldest, traditional co-op programs in the country in which students gain valuable, practical work experience in between periods of rigorous academic coursework. The co-op program successfully maintains and establishes relationships in private industry and with government agencies all over Ohio and around the United States.

*University of Nebraska-Omaha (UNO)*

Since 1990, the University of Nebraska-Omaha's Aviation Institute has offered degree programs in Aviation Studies, Air Transport Administration, and Professional Flight. Graduate degree programs are also offered at the master's and doctoral level in Aviation Administration. These programs are all accredited by the Aviation Accreditation Board International. UNO's programs include both FAA-approved Part 141 and Part 61 flight training programs. The institution also offers engineering undergraduate and graduate degrees in the following areas: computer, software, electrical, and mechanical. These programs are all accredited by the Accreditation Board for Engineering and Technology. The institution also manages the NASA Nebraska Space Grant and NASA Experimental Program to Stimulate Competitive Research (EPSCoR) program.

*University of North Dakota (UND)*

Since 1968, the University of North Dakota has offered atmospheric research and aviation education programs. The John D. Odegard School of Aerospace Sciences is now the second largest of UND's degree-granting colleges and operates one of the largest fleets of civilian flight training in North America. This world-renowned center for aerospace learning is nationally acclaimed for its achievements in collegiate aviation education, atmospheric research, space studies, and earth system science and policy research. Degrees include airport management, aviation management, air traffic control, aviation technology management, commercial aviation (fixed-wing and helicopter), flight education, UAS operations, business aviation, and safety. These programs are all accredited by the Aviation Accreditation Board International. The Aerospace program has strong partnerships with Endeavor Air, Envoy Air, ExpressJet, JetBlue, and SkyWest. The institution also offers engineering undergraduate and graduate degrees in the following areas: computer science, electrical, and mechanical. These programs are all accredited by the Accreditation Board for Engineering and Technology. UND is currently a core institution partner of the FAA Center of Excellence for Unmanned Aircraft Systems.

*University of Wisconsin-Madison (UWM)*

The University of Wisconsin-Madison has offered undergraduate and graduate engineering degrees since the early 1900s. The program has grown to include computer engineering, electrical engineering, engineering mechanics, and industrial engineering. These programs are all accredited by the Accreditation Board for Engineering and Technology. UWM has a fleet of 36 aircraft and is home to the Flight Simulation Research Laboratory, a custom-built advanced aviation training device (AATD) with advanced weather simulation in support of full-mission and part-task, scenario-based training. The FAA's Human Factors Division has also funded projects through UW's Space Science and Engineering Center.

*Western Michigan University (WMU)*

Since 1942, Western Michigan University has offered aviation and engineering education. These programs are all accredited by the Aviation Accreditation Board International and the Accreditation Board for Engineering and Technology. The College of Aviation offers the only comprehensive aviation program at a public university in Michigan, and with nearly 900 undergraduate students, is one of the largest aviation programs in the nation. WMU has extensive research and publication history in the fields of aviation human factors, safety training, flight training, and electronic training and simulation applications. WMU is currently an affiliate academic partner of the FAA Center of Excellence for General Aviation.

**COE TTHP LEADERSHIP TEAM**



**Mark Friend, Ed.D.** (Embry-Riddle Aeronautical University, Technical Lead) serves as Co-Executive Director for the COE TTHP and is responsible for technical oversight and governance. He has over 45 years of higher education experience and serves as Professor in the School of Graduate Studies in the College of Aviation at Embry-Riddle University. Dr. Friend is also the former Dean of the Central Region for the Worldwide Campus and Chair of the Applied Aviation Sciences Department at ERAU. Prior to joining Embry-Riddle, he was Professor of Safety and Director of the Center for Applied Technology at East Carolina University. He has also served as Chair of the Department of Occupational Safety and Health at Murray State University after holding faculty positions at West Virginia University, Fairmont State College, and Waynesburg College. Dr. Friend served on the governing board of the Board of Certified Safety Professionals and is a professional member of the American Society of Safety Engineers. He has also served as a commissioner and team leader of site visits for the Accreditation Board for Engineering and Technology and site visitor for the Aviation Accreditation Board International.



**James Pappas, Ph.D.** (University of Oklahoma, Technical Lead) serves as Co-Executive Director for the COE TTHP and is responsible for technical oversight and governance. He has been in academia for over 40 years and served as the Vice President of University Outreach at the University of Oklahoma, the federal business arm of the university responsible for over a \$100M in technical training contracts for the government and corporate sector, each year in addition to overseeing OU's Department of Aviation. Dr. Pappas has a long-standing history with the FAA including leading OU's collaboration with the FAA to mitigate the impact of the air traffic controller strike in 1981. His numerous contributions resulted in OU being selected as prime contractor of the FAA Air Traffic Instructional Support Services contract for 27 years. His work was crucial in the partnership with the FAA Office of International Aviation to offer a Partnership 21 program for all Senior Director Generals of Civil Aviation in the Western Hemisphere. He was an essential part of the FAA Civil Aerospace Medical Institute in the development of the Air Traffic Selection and Training program for potential air traffic control candidates.



**John Tomblin, Ph.D.** (Wichita State University, Administrative Lead) serves as Co-Executive Director for the COE TTHP and is responsible for administrative and reporting oversight. He is the Vice President for Research and Technology Transfer and the Executive Director of the National Institute for Aviation Research at Wichita State University. Dr. Tomblin has overall administrative responsibility for developing, coordinating and stimulating research and creative activity; for enhancing external funding; and for ensuring compliance with all applicable laws and regulations. He also serves as the director of NIAR's Composites and Advanced Materials Laboratory, Mechanical Test Laboratory, the FAA Center of Excellence for Composites and Advanced Materials, and National Center for Advance Materials Performance. In addition, Dr. Tomblin oversees eighteen laboratories and has directed a number of multidiscipline and multi-investigator projects with external funding exceeding \$125 million. He has provided testimony to the U.S. Senate Department of Commerce Committee on Science, Space, and Technology on the future of the aerospace industry relative to the role of academia in partnership with government and industry.



**Sid McGuirk, J.D.** (Embry-Riddle Aeronautical University, Technical Advisor) serves as a Lead Technical Expert for the COE TTHP and is responsible for assisting and mentoring researchers with project designs, data collection, reporting, and prototyping. He currently serves as Chair of the Department of Applied Aviation Sciences at ERAU in Daytona Beach, Florida. Prior to ERAU, he served 35 years with the FAA in a variety of positions, including Air Traffic Controller, Air Traffic Supervisor, FAA Headquarters Assistant Division Manager for Air Traffic Technical Training, and FAA Headquarters Division Manager for Technical Operations Training. He holds a Master of Arts degree in Government, a Juris Doctor degree, and a Master of Laws degree in Taxation. Mr. McGuirk also serves as the chair of the FAA ARAC Air Traffic Controller Basic Qualification Training Working Group.



**Stephanie Fussell, M.S. Aeronautics** (Embry-Riddle Aeronautical University, Technical Lead) serves as Lead Research Assistant for the COE TTHP and provides day-to-day operational support to include communications, data management, meeting and conference planning, and information dissemination. She currently is a Ph.D. residential student with research interests in aviation education, the effect of learning styles, and the process of learning. Ms. Fussell holds a private pilot instrument rating, B.S. and M.S. degree in Aeronautics from ERAU, and is a member of the Air Traffic Control Association. In 2016, she co-presented at the International Symposium on Aviation Psychology regarding an approach to teaching aviation studies on how to conduct situation awareness research.



**Stephen West, M.A. Leadership** (University of Oklahoma, Technical Lead) serves as a Lead Technical Expert for the COE TTHP and is responsible for assisting and mentoring researchers with project designs, data collection, reporting, and prototyping. He has 28 years of FAA and Air Traffic Controller training experience. Currently, he serves as the Director of the Air Traffic Collegiate Training Initiative program at OU. Previously Mr. West served as the Acting Alternate Project Manager/Instructional Supervisor of the \$138M FAA ATISS, managed more than 300 instructors, and assisted in communications with the COR in day-to-day contract execution. Mr. West also serves as a member of the FAA ARAC Air Traffic Controller Basic Qualification Training Working Group and as an accreditation visiting team member and AT-CTI Committee Chair of the Aviation Accreditation Board International. During his time as an Air Traffic Control Specialist, he worked in El Paso, TX; Monroe, LA; Tulsa, OK; Palo Alto, CA; and Fremont, CA.



**April Millaway, M.Ed. Adult Education** (University of Oklahoma, Technical Lead) serves as Co-Program Manager for the COE TTHP and is responsible for day-to-day center operations as well as a liaison to the COE TTHP Industrial Advisory Board. She has 17 years of experience in business development, adult education and training, and executive coaching with the FAA, DoD, DOE, and DHHS. Currently, Ms. Millaway oversees OU's Office of Business Development for the College of Professional and Continuing Studies and is responsible for securing federal funds for military education, aviation training, and leadership and management development projects. She is certified in assessing and coaching professionals and individuals using the Emotional Intelligence (EQ-i) 2.0 and 360 leadership inventory and Assess report tools.



**Tisha Merchant, B.S. in Business Administration and Management** (University of Oklahoma, Technical Lead) serves as Program Coordinator for the COE TTHP and provides day-to-day operational support for the COE to include communication and data management support, meeting and conference planning, and information dissemination – e-newsletter, tech talks, and research events. In addition, Ms. Merchant supports OU's Office of Business Development for the College of Professional and Continuing Studies and is responsible for financial and operations support for several federally funded projects. Prior to her time at OU, she worked for over 12 years as a legal assistant and medical records clerk for over twenty attorneys. Her academic background is in business administration, management, and accounting.



**Caleb Loss, B.S. in Business Administration** (Wichita State University, Administrative Lead) serves as Co-Program Manager for the COE TTHP. In collaboration with the FAA's Program Management Office, he oversees the grants.gov submission and award process as well as quarterly and annual reporting. Mr. Loss is currently the Contracts Manager for the Office of Research at WSU. In this role, he oversees the negotiation of contracts, awards, and grants for WSU's research centers, institutes, departments and other sponsored programs. During his time at WSU, Mr. Loss has worked closely with the FAA COEs for Joint Advanced Materials and Structures (JAMS) as well as Unmanned Aerial Systems (UAS), proposing and awarding hundreds of projects. Prior to his time at WSU, he worked in Supply Chain Management for a major OEM supplier of aircraft systems and structures and was responsible for negotiating contracts with suppliers all over the world and for bills of material that ranged from composite structures to insulation systems.

## COE TTHP CORE INSTITUTION REPRESENTATIVES



**James Birdsong, Ph.D.** (Auburn University) serves as a Core Institution Representative and an Executive Committee Member for the COE TTHP. Currently, he is an instructor in meteorology, air transport economics, and operations management courses and is faculty lead for the youth aviation summer enrichment program. Prior to his time at Auburn, Dr. Birdsong served as an Air Force officer, a command C-130 pilot, a headquarters staff officer, and a squadron operations officer. He has held various positions in finance, operations, safety, systems acquisition, and strategic planning, and has extensive international experience working in Asia, Europe, Africa, and South America.



**Kurtulus Izzetoglu, Ph.D.** (Drexel University) serves as a Core Institution Representative for the COE TTHP. Currently, he is a member of the functional optical imaging research team at Drexel, where he is a project engineer. Dr. Izzetoglu's current research projects focus on development of optical sensors, novel algorithms and techniques to deploy the optical brain imaging system, human performance assessment (cognitive workload and expertise development), and depth of anesthesia monitoring. Prior to his time at Drexel, he gained professional software development and medical imaging experience as a member of consulting companies in the United States and the Netherlands.



**Caroline Ocasio, MBA** (InterAmerican University) serves as a Core Institution Representative for the COE TTHP. She has over 20 years of experience in multiple roles in the aviation industry with experience in airlines such as Continental Airlines, Aerolíneas Argentinas, Ladeco Chilean Airlines, and aviation consulting. Currently, Ms. Ocasio is an instructor in the School of Aeronautics and oversees the Aviation Management and Air Transportation practicum programs. She is a member of the Editorial Board of INTEResante Magazine, a unique publication in Puerto Rico targeted at highlighting the research and academic efforts of the Bayamon Campus faculty and students. Under her leadership, Girls in Aviation, an educational program to promote aviation education among girls in Puerto Rico, was created with the sponsorship of the JetBlue Foundation.



**Jon Loffi, Ed.D.** (Oklahoma State University) serves as a Core Institution Representative for the COE TTHP. Currently, he is an Assistant Professor in the Aviation and Space program at OSU. His research agenda is centered on homeland defense and security and small unmanned aviation systems (sUAS) where he works with the College of Mechanical and Aeronautical Engineering. Dr. Loffi also serves on a counter sUAS committee with the engineers in concert with the U.S. Department of Defense involving classified research in sUAS and UAS countermeasures. Additionally, he is researching sUAS and manned aircraft in proximity to one another for visibility in determining a pilot's visual efficacy to sense and avoid sUAS in the national airspace.



**Seth Young, Ph.D.** (The Ohio State University) serves as a Core Institution Representative and an Executive Committee Member for the COE TTHP. He has nearly 20 years of experience in academia and industry focusing on issues of site selection, infrastructure planning, capacity and delay estimation, airside and landside operations, security policies, engineering, and financing of civil use airports. Currently, Dr. Young is the Director of OSU's Center for Aviation Studies and is on the faculty of the OSU College of Engineering. He is an active participant in aviation research and professional committees with the American Association of Airport Executives, the Florida Airports Council, and the National Academies Transportation Research Board, where he serves as outgoing Chair of Committee AV020 – Aviation System Planning. Dr. Young is an Accredited Airport Executive with the American Association of Airport Executives and holds an instrument-rated commercial airplane and seaplane pilot's license and certified flight instructor certificate from the U.S. Federal Aviation Administration.



**Steve Landry, Ph.D.** (Purdue University) serves as a Core Institution Representative and an Executive Committee Member for the COE TTHP. Currently, he is an Associate Professor and Associate Head of the School of Industrial Engineering specializing in the areas of Human Factors and Air Transportation Systems Engineering. Previously, Dr. Landry worked as research engineer at NASA's Ames Research Center in Mountain View, California where he worked on the Multi-Center Traffic Management Advisor system, an air traffic management decision support tool which was successfully developed, tested, and evaluated in four FAA En Route control centers. Dr. Landry is a retired Air Force C141B pilot with over 2,500 heavy jet flight hours including extensive international flight experience and participation in Desert Shield/Storm and numerous other operations.



**Keith Hargrove, Ph.D.** (Tennessee State University) serves as a Core Institution Representative for the COE TTHP. Currently, he is the Dean of the College of Engineering and Director of the TIGER Research Institute at TSU. He has received research funding from the National Science Foundation, and conducted research projects with Sikorsky Aircraft, Boeing, NASA, U.S. Navy, and the U.S. Army. Dr. Hargrove's research areas include systems engineering, design, virtual and augmented reality, advanced manufacturing, and minority engineering education. He has received several awards for teaching, research, mentoring, and is an Associate Member of the Society of Manufacturing Engineers, Institute of Industrial Engineers, ASEE, Tennessee Academy of Science, and the Tennessee Society of Professional Engineers.



**Gary Wescott** (Tulsa Community College) serves as a Core Institution Representative for the COE TTHP. Currently, he serves as an Assistant Professor and Coordinator of the TCC's Aviation Program. He worked with the FAA for almost 22 years before retiring in 2011. During his career, Mr. Wescott was certified as an Air Traffic Controller and also served as a Front Line Manager at Riverside ATCT, a level 8 VFR tower, and Tulsa ATCT, a level 9 terminal facility. He also has experience working as a member of the Terminal Planning and Requirements Department in the Central Regional Office in Fort Worth, TX. In addition, Mr. Wescott served as a Cadre Instructor for the Operational Supervisors Workshop and an FAA Quality Assurance Training Specialist.



**Chen Ling, Ph.D.** (University of Akron) serves as a Core Institution Representative for the COE TTHP. Currently, she is an Associate Professor of Systems Engineering in the Mechanical Engineering Department at Akron. Dr. Ling's research interest is in cognitive systems engineering of complex systems to enhance system safety and efficiency. Her research has been funded by the FAA, NSF, DOT, and DOC. Dr. Ling is published in journals such as *Behavior and Information Technology*, *International Journal of Human Computer Studies*, *Ergonomics*, and *Theoretical Issues in Ergonomics*. She is a member of the Human Factors and Ergonomics Society and the Institute of Industrial Engineering.



**Scott Tarry, Ph.D.** (University of Nebraska-Omaha) serves as a Core Institution Representative and an Executive Committee Member for the COE TTHP. Currently, he is the Director of the Aviation Institute at UNO and serves as the Director of the NASA Nebraska Space Grant and NASA EPSCoR program. Dr. Tarry is responsible for establishing the strategic direction of a consortium of 11 universities and colleges across the state of Nebraska. As Chair of the national NASA EPSCoR Caucus, he is a liaison between the NASA EPSCoR Program Manager and the 26 NASA EPSCoR states and jurisdictions. Dr. Tarry is also Treasurer for the Board of Directors for the National Space Grant Alliance and has served as Secretary of the National Council of Space Grant Directors and Co-Chair of the Aeronautics Working Group. He has served as President of the Transportation Research Forum, a national transportation organization; and as Chair of the Section on Transportation Policy and Administration for the American Society for Public Administration. He was a Faculty Research Fellow at NASA Langley Research Center in 2000.



**Elizabeth Bjerke, Ph.D.** (University of North Dakota) serves as Core Institution Representative and an Executive Committee member for the COE TTHP. Currently, Dr. Bjerke is the Associate Dean for the Odegard School of Aerospace Sciences at the University of North Dakota and a Professor in Aviation. She has nearly twenty years of experience in collegiate aviation education starting at certified flight instructor and working her way up through the academic ranks. Her research focuses on pilot supply and sourcing, along with persistence within collegiate aviation programs. Dr. Bjerke is an active participant in the Aviation Accreditation Board International, having served on their Board of Trustees for nine years. She is also a member of the National Pilot Source Forum.



**Douglas Wiegmann, Ph.D.** (University of Wisconsin – Madison) serves as a Core Institution Representative for the COE TTHP. Currently, he is an Associate Professor in the Department of Industrial and Systems Engineering at UWM. Dr. Wiegmann is a nationally respected expert in the areas of aviation safety and accident investigation, receiving two U. S. Navy commendation medals for research on human factors safety issues during extended flight operations and for development of a technique for classifying and studying pilot error in aviation accidents. Prior to UWM, Dr. Wiegmann served as an aviation accident investigator for the National Transportation and Safety Board, where he led the team that was responsible for taking and interpreting testimony from eye-witnesses to the TWA Flight 800 crash. Dr. Wiegmann was also the official human factors consultant to the U.S. DOE during the

investigation of the August 2003 blackout and consultant to the Columbia Accident Investigation Board during their analysis of the crash of the NASA space shuttle.



**Raymond Thompson, Ph.D.** (Western Michigan University) serves as a Core Institution Representative for the COE TTHP. He has 36 years of experience in aviation and aerospace education and currently is the Associate Dean of the College of Aviation at WMU. Dr. Thompson's research areas include aviation maintenance faculty development, using technology and multimedia in the classroom, applied advanced composite technology, and airline maintenance management. He serves as an Educator Board of Trustee member for Aviation Accreditation Board International with a focus on promoting the aviation maintenance profession and increasing AABI accreditation in aviation maintenance technology programs.



**Jibo He, Ph.D.** (Wichita State University) serves as a Core Institution Representative for the COE TTHP. Currently, he is an Associate Professor of Psychology and Director of the Human Automation Interaction Lab at WSU. Dr. He's research interests are in the areas of fatigue, eye movement, and human performance. He has received over \$1M in funding from the NSF and invented eight patents registered in the U.S., China, and 27 European countries. Dr. He is the recipient of the Star of Tomorrow Award from Microsoft and Most Valuable Graduate from the University of Illinois. His work has been reported by Bloomberg News, Forbes, Kansas City Star, New York Public Radio, and APA Monitor.

## COE TTHP RESEARCH AREAS



Human performance is enhanced through the technical training of air traffic controllers and technicians. This important research is investigated in the projects aligned to six focus areas: curriculum architecture, content management and delivery, simulation and part task training, human factors, analytics, and safety.

The FAA tasked the COE TTHP with examining the *curriculum architecture* of the FAA Academy and creating initiatives with industry partners to modernize training. The project teams are working with ATO Technical Training to standardize the field training of technicians and

controllers, as well as training administrators, and improving the training of Certified Professional Controllers (CPCs). Principal investigators are measuring the gaps and redundancies in the current training curriculum and investigating the practices leading to modular curriculum.

As the training needs evolve, the content management and delivery of the courses are examined to support development and implementation of new content. Virtual training delivery methods are being explored for air traffic control students. It is expected that dedicated research for technical operators will follow. Researchers are working with FAA stakeholders to create a course development structure for the FAA electronic learning management system (eLMS), to develop a learning taxonomy aligned to ATO standards and learning outcomes, and to review Instructional Systems Design (ISD) methodologies that could facilitate course design for the Academy.

Implementation strategies of learning *analytics* (e.g., completion records, learner progress) will provide the FAA with recommendations for new training processes and systems. To transform useable information for efficient and effective training, researchers will explore existing FAA data, integrating job task analysis into existing courses that have become outdated or that have no task alignment. This task will build a more effective knowledge search engine for the Agency, thus maximizing customer satisfaction for ATO Technical Training constituents.

The COE TTHP members continue researching the capabilities and expanding the instruction delivery opportunities of the Academy through *Human factors* research and how it is being applied to technical training. Project teams are applying game theory to enhance training and study decision making, benchmarking best practices for multi-modal training, and studying the eye movement of expert air traffic controllers. Scenario-based training is being studied to view pilots and air traffic controllers and how they can better integrate probabilistic hazard information to enhance safety.

To train learners, using new technology including optimizing simulation for the classroom, the simulation and part-task training offers the FAA new opportunities. Researchers are analyzing technical-training courses for enhancement with the new technologies and further exploring the use of gamification for aviation safety training.

A safety research team is assessing international harmonization and integration of educational best-practices for alignment with technical training. Incorporating *safety* into technical training will influence not only ATO Technical Training courses but will be incorporated by other groups within the ATO. The TTHP emphasizes efficiency and efficacy of training, through greater understanding of learning taxonomy and how the international community trains its air traffic controllers.

Safety of our national airspace system is of paramount importance as demonstrated at Ohio State University where an extensive amount of human factors research with respect to pilot

performance, testing, and integration of advanced cockpit technologies (such as angle of attack indicators and in cockpit weather information systems), as well as gaining a greater understanding of system safety through safety management systems research has been done. All of OSU and Drexel University’s expertise in these areas will have benefits and applications to future TTHP related work.

<p><b>Curriculum Architecture</b></p> <ul style="list-style-type: none"> <li>• Field Training Standardization</li> <li>• Standardization of Training for Training Administrators</li> <li>• Curriculum Architecture Gap Analysis</li> <li>• Enhanced AT-CPC Training</li> <li>• Modular Curriculum Design</li> </ul>	<p><b>Content Management and Delivery</b></p> <ul style="list-style-type: none"> <li>• Best Practices and Methods for Virtual Training Delivery</li> <li>• Development of Learning Taxonomy</li> <li>• Research Alternative ISD Model</li> <li>• Course Development</li> </ul>	<p><b>Simulation and Part-Task Training</b></p> <ul style="list-style-type: none"> <li>• Optimize Simulation</li> <li>• Explore Use of Gamification for Training</li> <li>• Analysis of a Technical Training Course for Specific Part-Task Training Implementation</li> </ul>
<p><b>Human Factors</b></p> <ul style="list-style-type: none"> <li>• Universal Design for Learning and Multi-modal Training</li> <li>• Applied Game Theory to Enhance ATC Training</li> <li>• Characterization and Application of Air Traffic Controllers Visual Search Patterns</li> <li>• Scenario-Based Training with Advanced Weather</li> </ul>	<p><b>Analytics</b></p> <ul style="list-style-type: none"> <li>• Learner Data Management</li> <li>• Analysis of Technical Operations Job Tasks</li> <li>• Technical Training Knowledge Architecture</li> <li>• AJI-2 Customer Satisfaction Process</li> </ul>	<p><b>Safety/General</b></p> <ul style="list-style-type: none"> <li>• International Harmonization and Integration</li> <li>• COE Strategic Framework</li> </ul>

## COE TTHP RESEARCH TASKS



### TASK # CFA001-02-03. CREATE COE STRATEGIC FRAMEWORK

#### PROJECT AT-A-GLANCE

- **UNIVERSITIES:** Embry-Riddle Aeronautical University, University of Nebraska-Omaha, University of Oklahoma, Wichita State University
- **PRINCIPAL INVESTIGATORS:** Dr. Martha Banz (OU), Dr. Mark Friend (ERAU), Dr. James Pappas (OU), Dr. Scott Tarry (UNO), Dr. John Tomblin (WSU)
- **INDUSTRY PARTNERS:** Adacel, American Airlines, C<sup>2</sup> Technologies, Ci2 Aviation, CNI Aviation, Computer System Designers, KeyBridge Technologies, Leidos, Robinson Aviation, Veracity Engineering

#### RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

- This research project focuses on developing a roadmap for future research for the Center of Excellence for Technical Training and Human Performance. The roadmap will ensure the achievement of FAA's strategic priorities of making aviation safer and smarter, delivering benefits through technology and infrastructure, enhancing global leadership, and empowering and innovating with the FAA's people.

#### STATEMENT OF WORK

- The research team will be responsible for the following:
  - Hosting initial workshops, webinars, and/or teleconferences with representatives from industry, academia, and government to discuss priority research objectives and the underlying organizational structure.
  - Developing and documenting a mission statement per research areas and programs and goal statements for research sub areas.
  - Reviewing the status (early action plans and outcomes) of corresponding initial FAA research project assignments and alignment with strategic direction of COE research areas.
  - Highlighting future high priority research that contributes to the strategic vision and goals of AJI-2 and other FAA stakeholders responsible for training technical aviation professionals
  - Hosting ongoing research forecast symposiums, in conjunction with a COE meeting, for PIs to discuss initial research ideas with FAA stakeholders to determine linkages to COE strategic roadmap and priority projects.
  - Compiling of all information into an official COE roadmap publication.

#### COE TTHP Leadership at Year 1 Meetings



#### STATUS

- Project is on schedule. Survey will be sent to FAA representatives during fall of 2017.

#### FUTURE WORK

- The upcoming quarter will focus on working with Karen Callihan to align upcoming proposals and potential projects with the AJI strategic framework.
- A survey will be distributed to assess needs of the aviation community from various stakeholder groups.
- Focus groups/interviews will be held to provide discussion opportunities to assist with the strategic framework
- In the short-term: Many current projects have opportunities for continued research, and the team will work with PIs and the FAA to identify these as possible projects for Year 2 funding.
- In the long-term: Forecasting focus groups will also be held to plan for Year 3 and beyond research for the COE to include projects outside of AJI to address the needs of constituents such as pilots, DoD, etc.



### TASK # CA001-02-09. FIELD TRAINING STANDARDIZATION

#### PROJECT AT-A-GLANCE

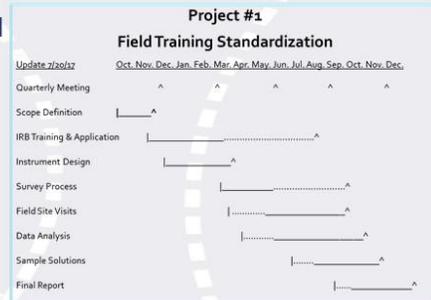
- **UNIVERSITIES:** Inter American University, University of Oklahoma, Tulsa Community College
- **AFFILIATE UNIVERSITY:** Texas State Technical College
- **PRINCIPAL INVESTIGATORS:** Al Culp (TSTC); Dr. Robert Dionne (OU), Caroline Ocasio (IAU), Cary Wescott (TCC)
- **INDUSTRY PARTNERS:** Leidos, Chickasaw Nation Industry, Computer System Design, Robinson Aviation, CI<sup>2</sup> Aviation

#### RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

- The purpose of this research project is to assist the FAA with the analysis of standardization within tech op's and air traffic controller field training. The goals are to 1) identify a fundamental baseline of training that is common across all facilities in the NAS and 2) determine the best delivery method to standardize fundamental knowledge.

#### STATEMENT OF WORK

- A cross-collaboration between academic and industry members with NAS, FAA, and/or Tech Ops or ATC professional and/or instructor experience will result in the following SOW tasks for the project:
  - Team will review current state of delivery for OJT and other types of field training in varied types and levels of FAA facilities.
  - Team will identify baseline commonalities that exist in OJT and other types of field training in varied types and levels of FAA facilities
  - Team will analyze whether current baseline commonalities in field training among varied types and levels of FAA facilities are sufficient from the perspective of training standardization across each organizational unit
  - Team will identify areas where additional standardization of field training in ATC and/or Tech Ops facilities would be beneficial
  - Team will develop suggestions for and/or a sample for increased standardized delivery of curriculum
  - Team will develop a final report of recommendations for the FAA



#### STATUS

- Literature review process continues
- Documentation review underway
- Process mapping underway
- Survey/Interview process on hold until procedural issues resolved with FAA-Labor Relations

#### FUTURE WORK

- Gain formal approval from FAA and NATCA on survey/interview questions and interview site visits.
- Continue team effort to collect and analyze existing literature for report.
- Finalize details of research protocol for IRB covering both electronic survey and interviews.
- Initiate survey and site visits.
- Develop a sample of course or curriculum
- Develop recommendations and conclusion



## TASK # CA003. STANDARDIZATION OF TRAINING FOR TRAINING ADMINISTRATORS

### PROJECT AT-A-GLANCE

- UNIVERSITY: ERAU
- PRINCIPAL INVESTIGATOR: Dr. John Griffin
- STUDENT: Alyssa Pavlik
- INDUSTRY PARTNER: Washington Consulting Group

### RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

- This project would research and compare the training needs of multiple facilities to recommend a standardized training program that would "train the trainers" and enhance their knowledge base along with their performance level.

### STATEMENT OF WORK

- Individuals may be thrust into the position of Training Administrator without prior experience in the effective application of training. Any training provided to them may be facility centric, lacking external situational experiences. The training is usually provided, managed, and assessed by facilities.
- This style of training lacks the type of robust and diverse training that would be provided by an organization-wide, standardization program.
- This training would provide the type of training exposure that would take years, if ever, in the working environment.
- The resulting program would result in Training Administrators that would be more knowledgeable in the aspects and requirements of training their personnel.
- This, in turn, would produce more capable, confident, and well-rounded administrators with a standardized approach to training.

Training ATC Students



### STATUS

- Currently conducting on-site research at various FAA facilities.

### FUTURE WORK

- Compile collected data for analysis.
- Determine best practices for course content and delivery mythologies.
- Recommend changes to FAA.
- Suggest follow-on development of training course.

## TASK # CA006. CURRICULUM ARCHITECTURE GAP ANALYSIS

### PROJECT AT-A-GLANCE

- UNIVERSITY: University of Akron
- PRINCIPAL INVESTIGATORS: Dr. Forrest Bao, Dr. Chen Ling
- STUDENT: Mazyar Askari Karchegani, Yichuan Zhao

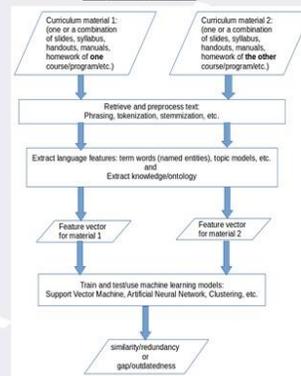
### RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

- The objective of this study is use Artificial Intelligence (AI) methods to identify and measure the gap or redundancy in training curriculum by automatically analyzing information in curriculum materials using a data-driven approach, with minimum of human involvement.

### STATEMENT OF WORK

- Task A. Understanding FAA's needs and obtain test data.
- Task B. Literature review on document similarity comparison.
- Task C. Implementing and testing language feature methods
- Task D. Implementing and testing knowledge base methods
- Task E. System integration and user feedback

Project Overview



### STATUS

- Task A. 100% complete.
- Task B. 90% complete
- Task C. 50% complete
- Task D. 35% complete
- Task E. 10% complete

### FUTURE WORK

- Apply the gap analysis method to more technical training materials to identify redundancy and gap
- Update curriculum materials that address the gap and eliminate redundancy

## TASK # CA007-08. ENHANCED AT-CPC TRAINING

### PROJECT AT-A-GLANCE

- UNIVERSITIES: Embry-Riddle Aeronautical University and University of North Dakota
- PRINCIPAL INVESTIGATORS: Paul Drechsel (UND), Marty Lauth (ERAU)
- STUDENT: Mattie Milner (ERAU)
- INDUSTRY PARTNER: TransLumen, UFA

### RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

- Air Traffic Control is a multifaceted system made up of many elements. While the technologies used in modern air traffic control systems have improved, the accreditation process and training techniques for experienced Certified Professional Controllers have remained mostly unchanged. Even though the use of high fidelity simulation is being used extensively throughout the industry's initial training process there is a need for a variety of low fidelity, lower cost, part task training that can deliver the information to experienced controllers in a Just-in-Time (JIT) format yet still maintain the integrity of a full simulation experience.

### STATEMENT OF WORK

- Identify requirements for enhanced / advanced training and
- Examine current methods of advanced training
- Review existing research on ATCS advanced training
- Evaluate benefit for providing this training at the FAA Academy in Oklahoma City
- Identify several alternatives for implementing the advanced training concept model and identify associated risks and limitations for each alternative.

Advanced Air Traffic Controller Training



### STATUS

- Examined current methods of advanced training

### FUTURE WORK

- Review the FAA's courses for Proficiency Training to determine if delivery of individual courses could be modified to more effective and efficient delivery method.
- Review the research concerning training methods and delivery completed through the FAA COE SOAR. Analyze Project 6 survey results along with this review.
- Research to determine if the use of part task training can be accomplished affordably and in a mobile format.
- Determine whether the mainstream use of cloud based applications and mobile devices can be leveraged and introduced as training devices with integration of voice recognition and response capabilities.



## TASK # CA010-011. MODULAR CURRICULUM DEVELOPMENT

### PROJECT AT-A-GLANCE

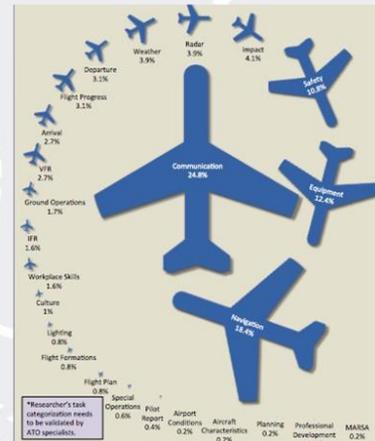
- UNIVERSITIES: Embry-Riddle Aeronautical University/Western Michigan University
- PRINCIPAL INVESTIGATORS: Dr. Raymond Thompson (WMU), Dr. Daryl Watkins (ERAU)
- STUDENT: Sarah Catherine Lewis (WMU)
- INDUSTRY PARTNER: ADDX

### RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

- Create a concept for curriculum architecture design to show feasibility of deploying modular, reusable curriculum in a variety of learning modalities.

### STATEMENT OF WORK

- Task 1: Conduct Literature Review. 1.1.1. Activity: Investigators will collect, review, and synthesize literature from the body of knowledge related to this project.
- Task 2: Collect FAA-ATO Artifacts. 1.2.1. Activity: The investigators will collect key artifacts related to the project. The following represents a subset of necessary documents.
- Task 3: Map Current Process. 1.3.1. Activity: The investigators will map a portion or all of the FAA ATO office system that encompasses the processes starting from job-task analysis and assignment through training and delivery.
- Task 4: Validate Understanding. 1.4.1. Activity: The investigators will meet with FAA staff to validate the process maps from task 3.
- Task 5: Map New Process. 1.5.1. Activity: The investigators will map a future state for the processes that were previously mapped.
- Task 6: Develop concept for enhanced curriculum architecture. 1.6.1. Activity: Investigators will develop a new concept for an enhanced curriculum architecture that would facilitate modular curriculum design
- Task 7: Develop list of recommendations. 1.7.1. Activity: Investigators will develop a list of recommendations for implementation of best practices, changes to existing practices, issues that were noticed throughout the project, and recommendations for future phases or actions to continue the efforts begun in this project.



### STATUS

- Project is running on time.
- Literature review is near completion.
- Analysis of FAA ATO Academy and Shared Academy is completed. Tasks have been categorized by topic and taxonomy.

### FUTURE WORK

- All remaining tasks need to be completed.
- Validation of task categorization by ATO expert is pending.





**TASK # CMD003. RESEARCH AN ALTERNATIVE INSTRUCTIONAL DESIGN MODEL**

**PROJECT AT-A-GLANCE**

- UNIVERSITY: Embry-Riddle Aeronautical University
- PRINCIPAL INVESTIGATORS: Dr. Steven Hampton, Jan Neal
- STUDENT: Lusine Carlsson
- INDUSTRY PARTNERS: JMA, ADDX

**RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE**

- The project team is tasked with the identification of best ISD practices and providing recommendations to the ATO on improving the instructional development (ID) processes for education and training for air traffic controllers and technicians.

**STATEMENT OF WORK**

- The researchers are examining best practice literature from both government and industry, analyzing available FAA course materials and data, and interviewing instructional design leads from AJI-2000 and from the Academy.
- To inform future ISD practices at the AJI-2100 to increase productivity of the development of instruction for both the ATC and Technical Operations workforces.



*Agile learning design (ALD) flowchart. From What is Agile learning design? by J. Huhn, 2013. Copyright 2013 by Bottom-Line Performance*



**STATUS**

- Review of current FAA Practices complete
  - Survey complete
  - Interviews Complete
- Literature review in process
- Initial draft report complete

**FUTURE WORK**

- Finalize literature review of best industry/government practices
- Draft recommendations based on results of discovery and established best practices
- Complete final report

**TASK # CMD004-05. COURSE DEVELOPMENT**

**PROJECT AT-A-GLANCE**

- UNIVERSITY: Oklahoma State University, University of Oklahoma
- PRINCIPAL INVESTIGATORS: Dr. Todd Hubbard (OU), Dr. Matt Vance (OKSU)
- INDUSTRY PARTNER: Computer Systems Designers

**RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE**

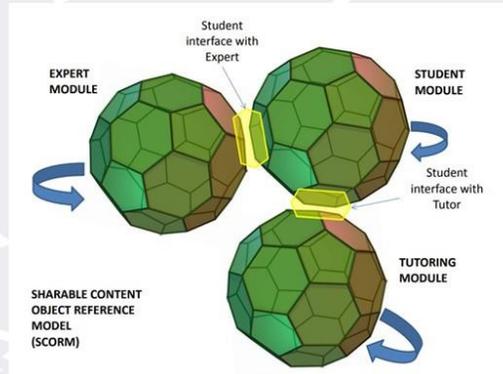
- In this project, we will provide alternative course development strategies that will enhance learning in light of NextGen requirements.

**STATEMENT OF WORK**

- Any progress in meeting the needs of NextGen learners will be made by using an integration of Design Research and the Instructional Systems Design process. The project will consist of 8 tasks:
  - Examine current course development protocols.
  - Examine current use of eLMS for course development.
  - Create standardized ISD protocol for all future course development that is NextGen compatible.
  - Create a Design Research protocol for an existing course that requires the use of educational technology.
  - Combine Design Research and ISD methods to create hybrid learning modules in the eLMS (Blackboard).
  - Write a desk manual on course development, using best practices for both Design Research and ISD methods, as they are combined in the development of courses for NextGen.
  - Determine if desk manual is adequate to ensure consistency across all courses, regardless of contractor.
  - Complete report.



**COURSE DEVELOPMENT STRATEGY FOR SCORM COMPLIANT ELMS**



**STATUS**

- Literature review in Augmented Reality underway
- Literature review in SCORM compliant eLMS underway
- Literature review on Tin Can xAPI development underway
- Initial project briefing report complete and shared with FAA
- Collaboration with *Research Alternative ISD Model* project underway

**FUTURE WORK**

- Use *Research Alternative ISD Model* project concepts to create new course
- Analyze if new course meets requirements
- Complete recommendations report for FAA
- Final project closeout

## TASK # SPTT001. OPTIMIZE SIMULATION

### PROJECT AT-A-GLANCE

- UNIVERSITY: Embry-Riddle Aeronautical University
- PRINCIPAL INVESTIGATOR: Dr. Shafagh Jafer
- STUDENTS: Bharvi Chhaya, Jessica Updegrove

### RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

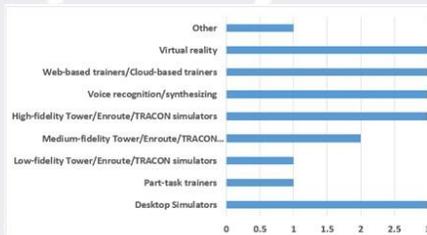
- This project will investigate the use of simulation in FAA ATC training and will report on the benefits, limitations, risks and challenges.

### STATEMENT OF WORK

- Report literature survey on current simulation technologies used for FAA ATC training.
- Report research into the benefit and anticipated ROI of simulation vs. training on live equipment in a technical environment.
- Research and report how to determine whether simulation is the appropriate medium and how it is operationalized into the curriculum development process.
- Report how FAA can optimize the use of simulation and propose a process to ensure updates are made concurrent to equipment changes.
- Research and make recommendations on the actual courses that would benefit from use of simulation over actual equipment training.



TECHNOLOGIES WITH MOST POTENTIAL FOR REDUCING ATC TRAINING TIME AND COST



### STATUS

- Surveys targeting industry partners and simulation vendors have been conducted and results analyzed.
- More than 100 AMA-500 courses have been analyzed.
- Recommendations drafted for incorporating and updating simulation-based ATC training.

### FUTURE WORK

- Interview and survey targeting FAA Academy personnel (ATC training) prepared and awaiting approval to be conducted.
- AMA-500 courses analysis detailing current status and recommendations for improvement.
- Compilation of a process to keep training technologies in sync with real-world devices.

## TASK # SPTT002. EXPLORING THE USE OF GAMIFICATION IN TRAINING

### PROJECT AT-A-GLANCE

- UNIVERSITY: Auburn University
- PRINCIPAL INVESTIGATOR: Dr. JoEllen M. Sefton, ATC
- STUDENT: Rian Ory
- INDUSTRY PARTNER: Army Gaming Studio

### RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

- This project will provide initial training, and improve knowledge, operational skills, and learning engagement in an environment of high diversity and turn over as well as rapidly changing requirements.

### STATEMENT OF WORK

#### Phase I

- Determine current use of gamification, GBL and VR, including use of virtual environments, task trainers and simulators. Provide suggested approaches on a way ahead based on the data gathered
- Develop a prototype of a simulated work environment to demonstrate the feasibility of adding gamification/GBL and/or VR to a common training task. (A modular design will be implemented, allowing for future additional training modules and upgrades.)
- Complete an initial assessment of training efficacy and employee feedback comparing the current training mechanism with the prototype

#### Phase II

- A simulated training environment system will be developed (on-site high resolution simulator with sound, VR), off-site modules for training updates, on-line and device (smart-phone, tablet) modules that allow for training/skill improvement at any location. Please include bulleted phrases that describe the overall scope of the research task. This shouldn't be that different from year to year.



Motion Capture Creation of Game Activity



**TASK # SPTT003-04. ANALYSIS OF A TECHNICAL TRAINING COURSE FOR SPECIFIC PART-TASK TRAINING IMPLEMENTATION AND ENCHANCEMENT BASED ON THE ADDITION OF NEW TECH**

**PROJECT AT-A-GLANCE**

- UNIVERSITIES: Tennessee State University, University of Oklahoma
- PRINCIPAL INVESTIGATORS: Dr. Keith Hargrove (TSU), Dr. Todd Hubbard (OU), Dr. Ivan Mosely (TSU)
- INDUSTRY PARTNERS: Computer System Designers, Leidos

**RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE**

- Part Task Analysis is the first step toward redefining instructor and learner roles for future simulation
- Part Task simulation for NextGen training will involve mobile devices and both augmented and virtual reality

**STATEMENT OF WORK**

- Review NextGen plans for future training
- Produce a list of possible or probable part-task training strategies
- Examine current course methodologies for past-task use, which lead toward full simulation
- Develop NextGen protocols for part-task development
- Create an example course, using NextGen training protocols and ISD best practices
- Test the example course, using ISD principles



**STATUS**

- Analysis of sample of Tech Ops courses complete
- Awaiting FAA documents for further analysis
- Discovery of augmented and virtual reality techniques underway

**FUTURE WORK**

- Analyze FAA courses
- Develop a list of common part tasks
- Establish protocols for instructional technology
- Create an augmented reality scenario
- Provide recommendation report to FAA
- Complete final project closeout



**TASK # HF001. UNIVERSAL DESIGN FOR LEARNING AND MULTI-MODAL TRAINING**

**PROJECT AT-A-GLANCE**

- UNIVERSITY: University of Oklahoma
- PRINCIPAL INVESTIGATOR: Dr. Zihong Kang
- STUDENTS: Mattlyn Drago, Josiah Pipetoe, Lauren Yeagle
- INDUSTRY PARTNERS: Adacel, ATSI, KeyBridge Technologies

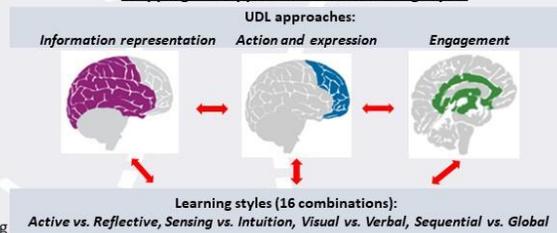
**RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE**

- This project aims to benchmark, adapt, and introduce new approaches in UDL design-based learning and multi-modal training for air traffic controllers through classifying current pedagogical practices, benchmarking existing and new state-of-the-art learning technologies, recommending adapted and new learning pedagogies, and developing protocols for assessing student learning outcomes.

**STATEMENT OF WORK**

- ATC training content analysis: Map UDL principles to current teaching curriculum and develop classification system.
- Learning style evaluation: Investigate and classify preferred learning styles from ATC candidates.
- Benchmark best practices: Investigate UDL and multimodal training practices.
- Recommend approaches: Align the content analysis with the benchmarking study to recommend adapted and/or new ATC training methods.
- Develop protocols: Develop performance evaluation metrics and procedures to assess the learning outcomes.

**Mapping UDL approaches with learning styles**



**STATUS**

- We have been juggling around the milestones to accommodate the delay of the union review process. We should be able to accomplish our goals within the duration; however, we will request no-cost extension if needed.

**FUTURE WORK**

- Upon completion, future work can be developing a software that accommodates the recommended approaches.
- The research was concentrated on ATC training that can be later expanded to other technical training.



**TASK # HF002-04-05. APPLIED GAME THEORY TO ENHANCE ATC TRAINING**

**PROJECT AT-A-GLANCE**

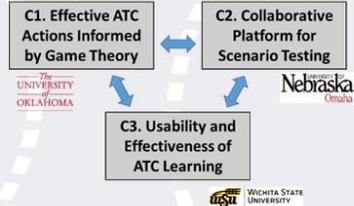
- UNIVERSITIES: Univ. of Nebraska at Omaha, Univ. of Oklahoma, Wichita State Univ.
- PRINCIPAL INVESTIGATORS: Dr. Kash Barker (OU), Dr. Jibo He (WSU), Dr. James Taylor (UNO)
- STUDENTS: Srinath Kosaraju (OU), D. Christiansen (UNO), H. Schleu (UNO)

**RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE**

- This project explores the use of decision analysis techniques (game theory in particular) as well as mixed reality (MR, e.g. Microsoft HoloLens) software platforms to enhance ATC training for addressing such uncertain and “deviations from normal” operating conditions.

**STATEMENT OF WORK**

- C1. Understanding how effective ATC actions can be informed by game theory, including (i) Understanding normal and variations to normal ATC operations, and (ii) Documenting decision analysis and game theory approaches to support training for a variety of operating conditions.
- C2. Developing a platform for scenario testing that examines collaboration and competition involved in ATC, including (i) Understanding the normal collaboration modalities used in ATC operations, (ii) Researching additional collaboration tools and modalities that could be used in ATC operations, and (iii) Developing proof-of-concept demonstrations that evaluate the effectiveness of collaboration tools in decision analysis and game theory exploration.
- C3. Exploring the usability and effectiveness of ATC learning through the game theory-driven collaborative platform, including (i) Creating training materials so users/trainees can learn to use the new mixed reality platform, (ii) Recruiting ATC with diversity in age and technical experience for a usability study, and (iii) Summarizing user study findings using a User-Centered Design approach for feedback.



**STATUS**

- C1 is over half completed with several related game theory approaches to traffic networks being studied.
- C2 has developed an ATC spatial awareness and tracking game using the Microsoft HoloLens Augmented Reality platform. The game challenges users to keep track of the spatial separation of aircraft in a 3D environment, while directing them to land on a runway.

**USABILITY TESTING FOR THE NEW PLATFORM**

1. **ATC recruiting:** Novice and experienced ATC, age groups
2. **Testing materials:** Old ATC system and new platform with 3D environment; Questionnaire
3. **Experiment design:** IV: experience, age, types of system, task complexity, DV: accuracy of task performing, response time, time of training, and strategy
4. **Procedure:** Task: Ensure aircraft separation by direction, speed, and altitude. Complexity: three groups based on the scenarios and number of aircrafts. Time: one hour for each of the six sections, two days for the entire experiment. one hour to finish one section and at least two days to finish the whole training procedure. After training, participants will task a test using the new platform and old ATC system.



**TASK # HF003. CHARACTERIZATION AND APPLICATION OF AIR TRAFFIC CONTROLLERS VISUAL SEARCH PATTERNS AND CONTROL STRATEGIES FOR EFFICIENT AND EFFECTIVE TRAINING**

**PROJECT AT-A-GLANCE**

- UNIVERSITY: University of Oklahoma
- PRINCIPAL INVESTIGATOR: Dr. Zihong Kang
- STUDENT: Saptarshi Mandal
- INDUSTRY PARTNER: Adacel

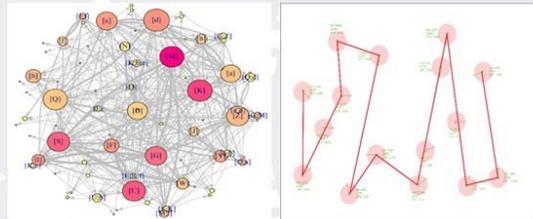
**RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE**

- This proposed project aims to characterize and classify the visual scanning patterns and control strategies of expert air traffic control operators (ATCOs) in order to support the efficient and effective training of air traffic control candidates.
- We will collect eye movement data and aircraft control commands from multiple expert ATCOs, and develop designs to better provide the characterized and classified visual search and control strategies. The research focus is on enroute air traffic control.

**STATEMENT OF WORK**

- Conduct requirement analysis for collecting ATCO's eye movements, retrospective verbal inputs, and mitigation commands.
- Perform experiments on retired expert ATCOs: Record eye movements and verbal commands. Analyze visual scanning patterns and conduct retrospective verbal protocol analysis..
- Characterize and classify expert ATCO's visual search patterns and control strategies.
- Develop designs to provide visualization and classification results.

Analysis examples of visual scanning characteristics



**STATUS**

- We have been juggling around the milestones to accommodate the delay of the union review process. We should be able to accomplish our goals within the duration; however, we will request no-cost extension if needed.

**FUTURE WORK**

- Analyze situation awareness, visual scanning, and aircraft control strategies of tower controllers.
- Develop an automated eye movement analysis software in enroute and tower control environments.





## TASK # AN002-03. ANALYSIS OF TECHNICAL OPERATIONS JOB TASKS

### PROJECT AT-A-GLANCE

- UNIVERSITIES: Drexel University and Purdue University
- PRINCIPAL INVESTIGATORS: Dr. Ellen J. Bass (Drexel) and Dr. Steven J. Landry (Purdue)
- POSTDOCTORAL RESEARCHER: Andrew J. Abbate (Drexel)
- STUDENT RESEARCHER: Nguyen V.-P. Nguyen (Purdue)
- INDUSTRY PARTNER: Benjamin Bell (Eduworks)

### RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

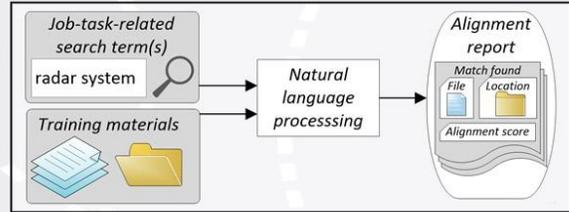
- The training curriculum for technical operations and other mission-critical occupations includes thousands of learning objectives distributed across hundreds of courses. As the learning objectives in the curricula evolve, keeping the course materials aligned with the actual curriculum is challenging. To address this problem, this work will evaluate alignment with respect to matching text in the curriculum files and JTA task statements to help the FAA keep materials and objectives aligned.

### STATEMENT OF WORK

- An analysis will be conducted to identify the state of training and training documentation for the tasks.
- The team will develop a formal definition of alignment between job tasks and training, including developing a method for determining alignment for the task and training materials of interest, using natural language processing techniques.
- The team will make recommendations for integration of current job task analysis into existing courses that have outdated or no task alignment.



### TASK—TRAINING ALIGNMENT ANALYSIS APPROACH



### STATUS

- The team has completed Task 1.
- The team is continuing work on Task 2.

### FUTURE WORK

- The analysis will be extended to incorporate additional elements of context within the learning objectives spreadsheets, to improve conclusions about the existence or absence of alignment
- A user interface to enable the FAA to quickly identify areas where alignment does not exist is being built.

## TASK # AN004. TECHNICAL TRAINING KNOWLEDGE ARCHITECTURE

### PROJECT AT-A-GLANCE

- UNIVERSITY: University of Akron
- PRINCIPAL INVESTIGATOR: Dr. Forrest Sheng Bao, Dr. Shengyong Wang
- STUDENT: Mingliang Liao, Alaa Alghwiri
- INDUSTRY PARTNER: Google

### RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

- Technical Training is dealing with a consistently increasing volume of information.
- Improved knowledge architecture and search engine results can better help manage information and better support the effective communication of knowledge.

### STATEMENT OF WORK

- Understand the needs of FAA on building knowledge search engine and the types of carriers of technical training information
- Understand the state of the art to extract information from the information carrier that FAA uses for technical training (e.g., PDF documents, web pages, scanned images)
- Understand the state of the art to discover knowledge from data, especially from text
- Understand the state of the art to represent knowledge and infer on them, using both data driven and symbolic approaches
- Understand the state of the art to build knowledge search engine, including using user feedback to improve.



Examples of existing AI approaches to construct knowledge and use it to find answers: Left - NLP approach for knowledge extraction; Right - Intelligent search for relationship identification

S1: Here's the question: Which object is the best conductor of electricity? (A) a wax crayon (B) a plastic spoon (C) a rubber eraser (D) an iron nail. I'm not sure of the answer. What do you think the answer is?

U1: iron nail

S2: Why do you think the answer is (D) an iron nail?

U2: electricity goes through metal

S3: I know "metals are shiny and good conductors of electricity and heat," does that mean that the answer is (D) an iron nail?

U3: yeah

S4: Okay, great. What's the relationship between "electricity" and "iron", if any?

U4: iron conducts electricity because its metal

S5: Okay, great. I get it! The answer is (D) an iron nail

Q: In New York State, the longest period of daylight occurs during which month?

Subdivision	Country	Orital Events	Day Duration	Night Duration	(X) December
New York State	USA	Summer Solstice	Long	Short	(B) June
California	USA	Winter Solstice	Short	Long	(A) March
Rio de Janeiro	Brazil	Summer Solstice	Short	Long	(D) September

Country	Hemisphere	North	Summer Solstice	June
United States	Northern	North	Winter Solstice	December
Canada	Northern	South	Summer Solstice	December
Brazil	Southern	South	Winter Solstice	June

Semi-structured Knowledge

### STATUS

- Understand FAA's need – 85% complete
- Information Extraction – state of Art – 65% complete
- Knowledge Discovery, state of the art – 25% complete
- Knowledge Representation and Reasoning, state of the art – 25% complete
- Search result generation and ranking, state of the art – 10% complete

### FUTURE WORK

- Assist the vendor selection process using multi-criteria decision making models
- Implement the recommended system that provides world-class search engine results and enables information sharing and feedback mechanism

### TASK # AN005. AJI-2 CUSTOMER SATISFACTION PROCESS

**PROJECT AT-A-GLANCE**

- UNIVERSITY: University of Akron
- PRINCIPAL INVESTIGATORS: Dr. Chen Ling, Dr. Shengyong Wang
- STUDENTS: Venkata Ganesh, Ashish Akula
- INDUSTRY PARTNERS: CSD, C<sup>2</sup> Technologies

**RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE**

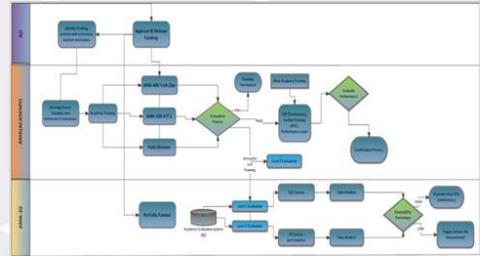
- Customer satisfaction is directly linked to business performance.
- Implementing a customer satisfaction process for AJI-2 Technical Training would create a review and response mechanism to refine AJI-2 products and services and lead to better training quality and delivery

**STATEMENT OF WORK**

- Current AJI-2 Technical Training Customer Satisfaction Process Mapping
- Extensive Literature Review to Identify Industry Best Practices
- Preliminary Design of Customer Satisfaction Surveys and Focus Groups
- Develop Customer Satisfaction Data Analytics Strategies
- Provide comprehensive recommendation of a process for collecting, analyzing, and taking actions on customer satisfaction data (All 5 Levels)



**Preliminary Cross-functional Map of the Current Technical Training Customer Satisfaction Process**



**STATUS**

- Current Process Mapping – 50% complete
- Industry Best Practices – 80% complete
- Surveys and Focus Groups – 50% complete
- Data Analytics Strategies – 35% complete
- Final Report – will work on it after the above tasks complete

**FUTURE WORK**

- Implement the recommended process to collect customer satisfaction data (especially for Levels 4 and 5)
- Utilize advanced analytics to better understand and discover continuous improvement opportunities
- Create a review and response mechanism to refine AJI-2 products and services

### TASK # SA001-02. INTERNATIONAL HARMONIZATION AND INTEGRATION

**PROJECT AT-A-GLANCE**

- UNIVERSITIES: Drexel University, The Ohio State University
- PRINCIPAL INVESTIGATORS: Dr. Adam K. Fontecchio (Drexel), Dr. David A. Delaine (OSU)
- STUDENTS: Wilson Flores (OSU), Rohan Sheth (OSU)

**RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE**

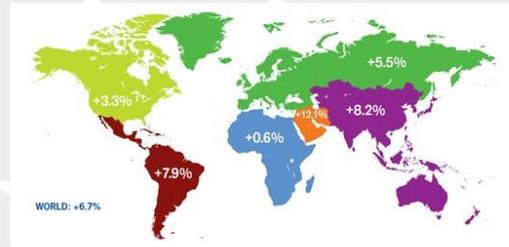
- Within a globalized society and unified airspace the technical training of Air Navigation professionals must acknowledge and reflect these international dynamics. A systematic review of global practice and opportunities for collaboration is used to reveal opportunities to minimize the isolation of FAA ATC technical training.

**STATEMENT OF WORK**

1. Review of existing programs and identification of key stakeholders
2. Identification and scheduling of interview subjects
3. Document review and analysis of existing programs
4. Completion of interviews with global stakeholders in aviation
5. Completed analysis of interviews, documents, and existing programs towards the development of global alignment of aviation education



**INTERNATIONAL SCHEDULED PASSENGER TRAFFIC**  
(source: ICAO 2016 Air Navigation Report)



**STATUS**

- Item 1 is complete
- Items 2 is near completion
- Items 3 and 4 are set to be completed by August
- Item 5 will be completed prior to Dec. project deadline

**FUTURE WORK**

- Phase 2 of this work will advance the Phase 1 outcomes which show strong potential to positively impact the needs of the COE SOAR, as well as the FAA and global ATC technical training community.
- The formation and strategic actions of an international ATC research collaborative – Global SOAR - will be established to implement and advance these outcomes and associated research.

## COE TTHP RESEARCH FACILITIES AND EQUIPMENT



COE TTHP has a variety of unique and diverse research facilities. This list is representative and is not inclusive.

Core Institutions	Facilities and Equipment
Embry-Riddle Aeronautical University (Technical Co-Lead)	The Next-Generation ERAU Applied Research (NEAR) Lab, Advanced Flight Simulation Center, Florida NextGen Test Bed, Computer Security & Forensics Laboratory
University of Oklahoma (Technical Co-Lead)	OU National Weather Center and various radar labs, OU owned and operated Max Westheimer Airport with 23 aircraft, Jim Hamm ATC Simulation Center, two level 3 flight training devices, and a control tower
Wichita State University (Administrative Lead)	National Institute for Aviation Research, FAA COE for Composites and Advanced Materials, and National Center for Advanced Materials Performance
Auburn University	Aviation Center with 17 aircraft, Warrior Research Center, Exercise Psychophysiology Lab, and Rehabilitation Informatics Lab
Drexel University	Cognitive Neuroengineering and Quantitative Experimental Research (CONQUER) Collaborative; Human-System Evaluation and Analysis Laboratory (H-SEAL)
InterAmerican University	School of Aerospace Airways New Zealand's "Total Control Tower Simulator", ALSIM Flight Trainer model ALX, and access to nearby airport and aircrafts
Oklahoma State University	College of Aviation Lab with Redbird MCX simulator, MATRIX graphical flight simulator, and 17 aircrafts (Cessna-152, Cessna-172, Cessna-182RG, and Piper PA-44 Seminoles)
The Ohio State University	Aerospace Research Center (ARC) featuring two subsonic wind tunnels and anechoic chamber; Ohio Supercomputer Center
Purdue University	Fluid Power Lab, Computer Lab, Composite Lab, a Flight Trainer Lab, and an Advanced Simulator lab
Tennessee State University	TSU Interdisciplinary Graduate Engineering Research Institute Facility with Computer Assisted Virtual Environment system from Mechdyne
Tulsa Community College	Aviation Center with an Adacel Maxsim ATC Simulator, RedBird 3-Axis Single and Twin-Engine Simulator, RedBird Cross-Wind Trainer, and 5 leased Cessna aircraft

University of Akron	Computational Mechanics Lab, Materials Testing Lab, and Robotics Lab
University of Nebraska-Omaha	Aviation Institute's Flight Simulation Facility with 3 flight simulators
University of North Dakota	Road Weather Field Research Facility, Glacial Ridge Atmospheric Observatory; Adacel 225 and 360 Tower/RADAR Simulators
University of Wisconsin-Madison	Flight Simulation Research Laboratory, Naturalistic Decision Making & Simulation Lab
Western Michigan University	Hangars to house 35 SE and ME aircraft; ATC tower laboratories; NEST Research Lab

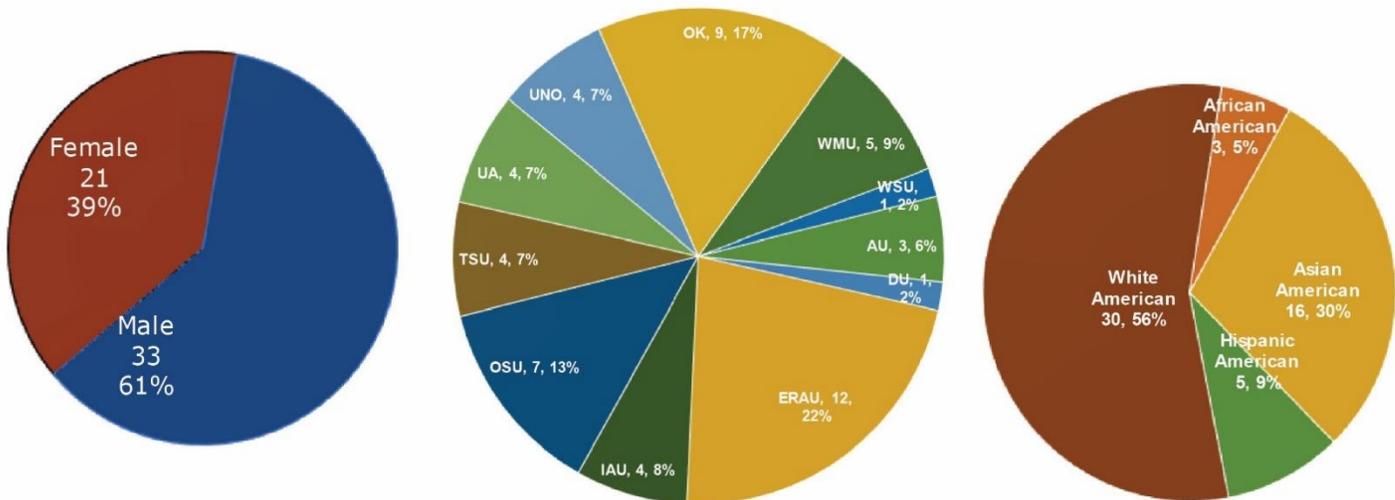
Active research grants from the FAA and other government organizations to investigate air navigation modernization, atmospheric research, the use of unmanned technology, weather analysis and other topics related to aerospace and technology have demonstrated the ability of the universities to successfully work with government entities at a high level. **Core Institution members have over \$4 billion** of aggregated, annual, research expenditures.

## COE TTHP STUDENT RESEARCHERS



The following is a list and demographic information of the 54 COE TTHP students working on research tasks during the year of operation.

### COE TTHP Year 1 Student Demographic Charts



## COE TTHP Year 1 Students

Name	Institution	Mentor
Andrew Abbate	Drexel University	Ellen Bass
Venkata Akula	University of Akron	Shengyong Wang
Alaa Alghwiri	University of Akron	Forrest Bao
Ali Alshaqah	University of Akron	Chen Ling
Keerti Banweer	University of Oklahoma	Christan Grant
Geoffrey Brown	Tennessee State University	Keith Hargrove
Lusine Carlsson	Embry-Riddle Aeronautical University	Steven Hampton
Pearl Chen	Ohio State University	Rachel Kajfez
Bharvi Chhaya	Embry-Riddle Aeronautical University	Shafagh Jafer
Dylan Christiansen	University of Nebraska at Omaha	James Taylor
Dylan Dorman	Tennessee State University	Keith Hargrove
Mattlyn Dragoo	University of Oklahoma	Ziho Kang
Rolando Fernandez	InterAmerican University	Caroline Ocasio
Joseph Fetch	Auburn University	JoEllen Sefton
Wilson Flores	Ohio State University	David Delaine
Venkata Ganesh	University of Akron	Shengyong Wang
Clayton Greenbaum	Ohio State University	Rachel Kajfez
Chelsea Hall	Western Michigan University	Raymond Thompson
Harry Harris	University of Akron	Chen Ling
Hayden Hickey	Auburn University	JoEllen Sefton
Lesheng Hua	Wichita State University	Jibo He
Maziyar Karchegani	University of Akron	Forrest Bao
Srinath Kosaraju	University of Oklahoma	Kash Barker
Sarah Lewis	Western Michigan University	Raymond Thompson
Ming Liang Liao	University of Akron	Forrest Bao
Santosh Maddula	University of Oklahoma	Christan Grant
Saptarshi Mandal	University of Oklahoma	Ziho Kang
Mattie Milner	Embry-Riddle Aeronautical University	Martin Lauth
Nguyen V.-P. Nguyen	Purdue University	Steve Landry
Nicholas Oliveira	Tennessee State University	Keith Hargrove
Rian Ory	Auburn University	JoEllen Sefton
Alyssa Pavlik	Embry-Riddle Aeronautical University	John Griffin
David Perez	InterAmerican University	Caroline Ocasio
Kazi Rahman	University of Akron	Chen Ling
Josiah Rippetoe	University of Oklahoma	Ziho Kang
Alexander Rivera	InterAmerican University	Caroline Ocasio

Joel Rodriguez	InterAmerican University	Caroline Ocasio
Ahana Sabu	Embry-Riddle Aeronautical University	Lulu Sun
Benewende Sam	University of Nebraska at Omaha	James Taylor
Henry Schleu	University of Nebraska at Omaha	James Taylor
Carrie Sekeres	Embry-Riddle Aeronautical University	Kadie Mullins
Nicholas Shawhan	University of Nebraska at Omaha	James Taylor
Rohan Sheth	Ohio State University	David Delaine
Brooke Stieber	Ohio State University	Rachel Kajfez
Katherine Tanner	Ohio State University	Rachel Kajfez
Andy Theiss	Ohio State University	Rachel Kajfez
David Toon	Embry-Riddle Aeronautical University	Mike Wiggins
Jessica Updegrove	Embry-Riddle Aeronautical University	Shafagh Jafer
Paxtyn Wright	Tennessee State University	Keith Hargrove
Chenguag Xu	University of Oklahoma	Christan Grant
Lauren Yeagle	University of Oklahoma	Ziho Kang
Yichuan Zhao	University of Akron	Forrest Bao

## COE TTHP PUBLICATIONS, PRESENTATIONS, AND AWARDS



### Publications

- **Coyne, W. & Metscher, D.** (2017). Airline hub and spoke system. In L. Lowry (ED). *Sage International Encyclopedia of Travel and Tourism*. Thousand Oaks, CA: Sage Publications, Inc. 36-37. doi: <http://dx.doi.org/10.4135/9781483368924>
- **Coyne, W. & Metscher, D.** (2017). Federal Aviation Administration. In L. Lowry (ED). *Sage International Encyclopedia of Travel and Tourism*. Thousand Oaks, CA: Sage Publications, Inc. 475-476. doi: <http://dx.doi.org/10.4135/9781483368924.n179>
- **Coyne, W., Rice, S. C., Winter, S., Tamilselvan, G., & Drechsel, P. V.** (2017). Simulation challenges – student perception of air traffic control simulation. *International Journal of Aviation, Aeronautics, and Aerospace*, 4(3). Retrieved from <http://commons.erau.edu/ijaaa/vol4/iss3/1>
- **Durak, U., & Jafer, S.** (2017). Tackling the Complexity of Simulation Scenario Development in Aviation. Invited Paper. SpringSim 2017, MSCIAAS.
- **Durak, U., Pruter, I., Gerlach, T., Jafer, S., Pawletta, T., & Hartmann, S.** (2017). Elements of a Scenario in a Research Flight Simulator. In AIAA Modeling and Simulation Technologies Conference (p. 1311).
- **Friend, M. A., Stolzer, A. J., & O'Toole, M.** (2017). Air transportation: Actions to improve employee safety. *Professional Safety*, 62(2), 28-31.
- **Ferry, T.S., Friend, M. A.** (2017). *Planning and managing a safety system*. Lanham, MD: Bernan Press.

- **Hubbard, T. P.** (2006). ATC best practices: An opportunity for computer-based scoring. *Journal of Aviation/Aerospace Education & Research*, 15(3), 31-46.
- **Hubbard, T. P.** (2001). *Cognitive issues in aviation*.
- **Jafer, S., Chhaya, B., & Durak, U.** (2017). Graphical Specification of Flight Scenarios with Aviation Scenario Definition Language. In AIAA Modeling and Simulation Technologies Conference (p. 1311).
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- **Mandal, S., & Kang, Z.** (draft). A robust framework of data visualization in eye tracking analysis for a tracking task of multi-element moving targets: A directed network approach.
- **Updegrave, J., & Jafer, S.** Optimization of air traffic control training at the Federal Aviation Administration academy. In preparation. To be submitted to Journal of Air Transportation, AIAA. 2017.
- **Updegrave, J., & Jafer, S.** Recommendations for next generation air traffic control training. Submitted to DASC, 2017
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### Presentations

- **Dattel, A., Babin, A., Li, T., Dong, Z., Fussell, S., & Yang, Q.** A pedagogical approach to teach aviation students how to conduct situation awareness research. 19th International Symposium on Aviation Psychology, May 9, 2017, Dayton, OH.

- **Ding, L.** To improve safety and evaluation of training in ATM using neuroscience-based technology. 19th International Symposium on Aviation Psychology, May 9, 2017, Dayton, OH.
- **Hampton, S., Truong, D., Byrnes, K., Techau, T.** Pilot training metrics at a Part 141 university training program. 17th AIAA Aviation Technology, Integration, and Operations Conference, Denver, Colorado, June 5, 2017.
- **Izzetoglu, K.** Evaluation and experimental use of optical brain imaging sensor in human performance. 19th International Symposium on Aviation Psychology, May 9, 2017, Dayton, OH.
- **Jafer, S.** ATC scenario language (ASL): Towards a common ATC scenario development. SIMULTECH. Madrid, Spain. July 2017.
- **Kang, Z., Dragoo, M., Yeagle, L., Shebab, R. L., Yuan, H., Ding, L., & West, S.** Adaptive learning pedagogy in universal design for learning and multi-modal training. In proceedings of the 2017 National Training Aircraft Symposium, August 14 – August 17, 2017, Daytona Beach, FL.
- **Kang, Z., Mandal, S., Alhashim, A. G., & Dyer, J. W.** Data visualization approaches in eye tracking to support the learning of air traffic control operations, In proceedings of the 2017 National Training Aircraft Symposium, August 14 – August 17, 2017, Daytona Beach, FL.

### Awards

- **Robert Dionne** received the Rufus Hall Outstanding Professor Award at the University of Oklahoma.
- **Saptarshi Mandal** received the Best Student Paper Award (first place) from the Aerospace TG within the Human Factors and Ergonomics Society in October 2016.
- **Randa L. Shebab** was promoted to Associate Dean in the College of Education at the University of Oklahoma.
- **Ziho Kang** was invited as a keynote speaker at the *Proceedings of the 2nd International Conference on Bio-engineering for Smart Technologies*, Paris, France.

### COE TTHP AFFILIATE PARTNERS



Subject matter experts (SMEs) from academia and industry support specific projects within the six core research areas.

#### Academic Affiliate Partners

- Central Washington University
- Louisiana Tech University
- OKC Metro Technology Center
- Polk State College

- Spartan College of Aeronautics and Technology
- Texas State Technical College
- University of Southern California
- University of South Florida
- Vaughn College of Aeronautics and Technology

#### *Central Washington University (CWU)*

Since 1975, Central Washington University has served as a leading professional aviation-education institution. The CWU aviation program is the only fully accredited, public university aviation program in the Pacific Northwest. The institution offers a Bachelor of Science degree with Aviation Management, Flight Officer, and/or Commercial Pilot specialization options. Students train at Bowers Field, north of the main CWU campus.

#### *Louisiana Tech University (LSU)*

Louisiana Tech University's Department of Professional Aviation was the first university FAR Part 141 aviation program to be recognized in the Southwest Region and the second in the nation. The program offers degrees in Professional Aviation or Aviation Management. These programs are all accredited by the Aviation Accreditation Board International (AABI). Louisiana Tech hosts an FAA approved Part 141 and Part 61 Flight School. FAA certificates and ratings are available to include Private, Instrument, Commercial, and/or Certified Flight Instructor and Certified Instrument Flight Instructor.

#### *OKC Metro Technology Center (OKC Metro Tech)*

OKC Metro Technology Centers' Aviation Career Campus was built in 1988 and is located at Will Rogers World Airport in Oklahoma City. The Aviation Maintenance Technician program prepares students to pass both the Airframe Mechanic and the Powerplant Mechanic exams administered by the FAA. The Aviation Maintenance Technician major is certified under Part 147 of the Federal Aviation Regulations with an FAA-approved and supervised curriculum.

#### *Polk State College (Polk State)*

Polk State College's Aerospace Program offers degrees in Professional Pilot Science, Aerospace Administration, and Aerospace Sciences. The program prepares students to earn the Federal Aviation Administration (FAA) Commercial Pilot Certificate, with Single and Multi-Engine Land class ratings, as well as an Instrument Rating. This program also prepares students for additional optional certificates qualifying them to become Certified Flight Instructors (Airplane), Certified Instrument Flight Instructors, and/or Certified Multi-Engine Flight Instructors. These programs are an FAA approved Part 141 and Part 61 Flight School.



### *Spartan College of Aeronautics and Technology (Spartan)*

Spartan College of Aeronautics and Technology has been providing training to pilots and technicians since 1928. These programs include degrees in Aviation Flight, Aviation Maintenance Technology or Airframe/Powerplant Technology, Aviation Electronics Technology, Nondestructive Testing, and Quality Control. All programs are FAA Part 141, 61, and 147 approved. In addition to its degree programs, Spartan College is proud to provide flight and aviation maintenance training for the United States Air Force at the flight facility in Tulsa, Oklahoma located on the Richard L. Jones Airport. Spartan's flight instructors are highly recognized as some of the best in the industry leading to multiple contracts with the U.S. Government.

### *Texas State Technical College (TSTC)*

Texas State Technical College has developed strong aviation programs since 1970. These programs include degrees and certificates in Aircraft Pilot Training (both fixed and rotary-wing), Air Traffic Control, Aircraft Dispatch, Aviation Maintenance (Airframe and Powerplant), and Avionics. All programs are FAA Part 141, 61, 145, and 147 approved programs.

### *University of Southern California (USC)*

University of Southern California is ranked first in the nation among all universities in the size of its computer science research program and has the largest graduate program in engineering of all private research universities. The institution has a long history of partnering with outside organizations and producing scientific advances in areas relevant to air transportation. The Institute for Creative Technologies and School of Cinematic Arts have multiple institutes, laboratories, and resources that can be applied to computer and simulation-based training. The Mixed Reality Lab explores techniques and technologies to improve the fluency of human-computer interactions and create visceral synthetic experiences. Research and prototypes focus on immersive systems for education and training simulations that incorporate both real and virtual elements.

### *University of South Florida (USF)*

University of South Florida offers undergraduate and graduate programs in engineering. Specialization areas include computer science and engineering, industrial and management systems engineering, and mechanical engineering. These programs are all accredited by the Accreditation Board for Engineering and Technology. The institution has worked with FAA databases such as airport system performance metric, airline service quality performance, enhanced traffic management system, the operations network, and performance data analysis and reporting system. USF is currently an affiliate academic partner with the FAA Center of Excellence for Aviation Operations Research. Additionally, USF has worked on multiple projects for the FAA to help understand the correlation of human performance and efficiency and safety of national airspace system.

### *Vaughn College of Aeronautics and Technology*

Vaughn College offers bachelor's and associate degree programs in engineering; engineering technology; management; and aviation, as well as a unique master's degree in airport management. Specialization areas include: electronic engineering, mechanical engineering, mechanical engineering technology, electronic engineering technology, general management, airline management, airport management, aviation maintenance management, aviation maintenance, aircraft operations, aeronautical sciences, aeronautical engineering technology, flight dispatch and air traffic control (non-degree program.) The institution also offers a mechatronic engineering program; one of only three ABET accredited mechatronic engineering programs in the U.S. In addition, Vaughn is home to an FAA Air Traffic Control Collegiate Training Initiative program.

### *Industry Affiliate Partners*

- 1st American Systems and Service
- *Adacel\**
- *Addx Corporation\**
- Air Traffic Simulation, Inc.
- *American Airlines\**
- American Institutes for Research
- ATAC
- AVT Simulation
- *C<sup>2</sup> Technologies\**
- *Chickasaw Nation Industries\**
- Christiansen Aviation
- CI<sup>2</sup> Aviation
- *Computer System Designers\**
- CSSI
- Crew Training International
- *Eduworks Corporation\**
- Florida NextGen Test Bed
- Frasca International, Inc.
- General Dynamics IT
- Heartwood 3D
- Hucon Global
- *Infina, Ltd.\**
- Instructure, Inc. & Canvas Network
- *JMA Solutions\**

- KeyBridge Technologies
- *Leidos\**
- Metacraft
- *Northrop Grumman\**
- Pilot Training System
- Raydon Corporation
- Robinson Aviation
- SkySoft ATM
- Skymantics LLC
- TetraTech
- Textron Systems
- TransLumen Technologies
- UFA, Inc
- *Washington Consulting Group, Inc.\**
- Veracity Engineering
- Volpe Center

“\*” – Serve as voting members of the IAB

## COE TTHP Industrial Advisory Board



Adacel and the Washington Consulting Group, Inc. serve as co-leads of the COE TTHP Industrial Advisory Board (IAB). IAB members assist with reviewing and monitoring of all research grants to ensure research ideas translate into future prototypes and/or products of benefit to the FAA. Several subject matter experts also serve as members of research project investigation teams.



**Jeff Tyrcha, M.S. Industrial Engineering** serves as Co-Chair of the FAA COE TTHP Industrial Advisory Board. He has over 22 years of experience working in the Aerospace and Defense industry in executive, program management, and technical positions. Mr. Tyrcha’s career experience spans all areas of the training and simulation industry and work with the FAA, DoD, NASA, and international aviation organizations. He has a Bachelor’s Degree in Aeronautical and Aerospace Engineering from Purdue University and a Master of Science in Industrial Engineering from the University of Oklahoma. Mr. Tyrcha is also a graduate of the Defense Systems Management College at Fort Belvoir, Virginia and the BAE Systems Executive Institute at the University of New Hampshire. In 2013, he was honored as Purdue University Outstanding Aerospace Engineer. Mr. Tyrcha

also served in the Air Force as Program Manager and Executive Officer for multiple organizations

throughout the Air Force. He formerly served as Chairman of the AFA Junior Officer Advisory Council, and President of the Air Force Association Dallas Chapter. Mr. Tyrcha also served as a board member of the Association for Aerospace Education and is a strong advocate for expanding aviation education around the globe.



**Ned Reese, Ed.D.** serves as Co-Chair of the FAA COE TTHP Industrial Advisory Board. He has over 45 years of experience working with the FAA as an administrator, technical training contractor, and air traffic controller. In 1969, Dr. Reese joined the FAA as an air traffic controller and was assigned to the Memphis Air Route Traffic Control Center. Over the next 36 years he acquired extensive air traffic experience having served in a variety of roles including En Route air traffic controller, data systems specialist, headquarters staff specialist, field supervisor, traffic management officer, operations manager, facility management and division management roles. In addition to Memphis ARTCC, Dr. Reese has work in FAA Headquarters, Kansas City ARTCC, Denver ARTCC and the Mike

Monroney Aeronautical Center. In 1990, he was selected as manager for the National Air Traffic Training Requirements Division (ATZ-100) in Washington Headquarters where he chaired the Air Traffic Training Workgroup and led a major redesign of the air traffic training program. In 1992, Dr. Reese was selected as manager of the Air Traffic Division of the FAA Academy at the Mike Monroney Aeronautical Center. Prior to his retirement from the FAA he served on the committee that developed the Administrator's Air Traffic Controller Workforce Plan 2005-2014. Dr. Reese has an A.S. degree in Computer Science from State Technical Institute at Memphis, B.S. Degree in Organizational Leadership from Southern Nazarene University, and Master of Science Degree in Applied Science from Oklahoma State University. In 2000, he received a Doctor of Education Degree from Oklahoma State University. In addition to his role with WCG, Dr. Reese serves on the adjunct faculty for Southeastern Oklahoma State University where he teaches a variety of graduate level aviation management courses in aviation administration, research methods and decision-making ethics.

**1st American Systems & Services, LLC** is a training solutions provider with deep expertise and capabilities in design, development, and deployment of custom eLearning, mobile learning edutainment games, 3D simulation, and virtual learning environments. The organization's system components provide ease of use, compatibility through multiple mediums, accessibility, and scalability to accommodate unlimited user growth.

**Adacel** is a leading developer of advanced simulation and control systems for aviation and defense. The company operates in the Global Aerospace Systems market including operational Air Traffic Management, Airport and Air Traffic Control Training, and Airborne Vehicle Systems. Within this market space, Adacel focuses on three converging knowledge domains, real time software, simulation and voice activated control technology.

**Addx Corporation** has extensive experience successfully enhancing federal systems from the individual to the enterprise level. From dynamic intelligence to legacy modernization to IT governance, the company offers a comprehensive set of IT and engineering services founded on expertise, strategy, and collaboration to improve business operations and reduce risk. Some of Addx Corporation's clients include the Federal Aviation Administration, U.S. Navy, and the U.S. Coast Guard.

**Air Traffic Simulation, Inc.** specializes in modeling & Monte-Carlo simulation, statistical analysis, data processing automation, and 3D visualization. The company is the creator of SMART, a multi-faceted Air Traffic Control high fidelity simulation system dedicated to the training of Air Traffic Controllers.

**American Airlines** serves as the world's largest airline when measured by fleet size, revenue, and scheduled passenger-kilometers flown and the second largest by number of destinations. The airline operates an extensive international and domestic network with an average of nearly 6,700 flights per day to nearly 350 destinations in more than 50 countries.

**American Institutes for Research** serves as a research organization to the FAA to analyze the performance of air traffic controllers, identify the NextGen technologies impacting airway transportation systems specialists, and conduct usability testing of the new NOTAM data entry tools.

**ATAC** is well known in the aviation industry for aviation modeling, simulation, and developing software to support FAA operations. The company also provides comprehensive operations design and data analysis, including airport and airspace planning, applicable for military and commercial operations.

**AVT Simulation** integrates the upgrades of older outdated training simulation devices; this service includes improving software, modernizing hardware, upgrading the visuals, and re-designing the models and databases. AVT's training solutions division consists of the Collective Aircrew Mission Task Trainer (CAMTT), offering a reconfigurable rotary wing "collective trainer."

**C<sup>2</sup> Technologies, Inc.** provides training, strategic human capital management, mission-critical support services, and information technology solutions to meet the specific needs of civilian, defense, and private-industry clients. The company provides a broad range of education and training services such as virtual task trainers, serious games, simulation and modeling, IMI/WBT/CBT courseware, learning management systems, and performance support tools.

**Chickasaw Nation Industries** provides aviation-related professional services including engineering, technical support, and program management. CNI supports the FAA as a subcontractor on the Controller Training Contract and with second level engineering, development, configuration management, acquisition support, and prototyping efforts of the WAAS. CNI's FAA systems are located across the continental U.S., Alaska, Hawaii, Puerto Rico, Mexico, and Canada.

**Christiansen Aviation** offers flight training, aircraft rental, aircraft leasing, maintenance, sales of new and used Cessnas, pilot supplies, and a full service fixed-base operator.

**CI<sup>2</sup> Aviation** is a full-range aviation facility management, information technology, engineering, and administrative consulting organization, serving more than 25 federal ATC contract towers. The company's contract services specialize in airfield operations, systems engineering and integration, financial administration, and program management services.

**Computer System Designers** currently provides information technology, engineering, training, and eLearning support to Federal clients, including the FAA, the U.S. Department of Agriculture, the U.S. Air Force, the U.S. Army, and the Defense Information Systems Agency. CSD is the prime contractor for the Regulatory Standards Division Instructional Services Training Contract and provides extensive support to the FAA Academy in Oklahoma City.

**CSSI, Inc.** partners with clients to deliver solutions to complex, high-consequence challenges, pioneer innovative analytics and best practices, and enhance productivity and safety through superior engineering and technical solutions. These solutions support the FAA, U.S. Navy, NASA, and other partners in the commercial sector.

**Crew Training International** has developed advanced training solutions for government and commercial agencies to achieve the mission of optimizing performance through cutting-edge learning solutions. CTI's training professionals have developed programs and courseware solutions for the NASA, NATO, U.S. Air Force, and others.

**Eduworks Corporation** creates solutions using artificial intelligence and text mining to improve processes, increase speed and accuracy, and decrease overall cost. The firm also creates performance multipliers to advance training analyses and technologies, simulator training effectiveness, individual and team performance assessment, and the work-practice and activity-based simulation of socio-technical systems for the Air Traffic Organization.

**Florida NextGen Test Bed**, governed by the FAA and used by NextGen stakeholders within industry, academia, and government, provides an integrated NAS based platform for NextGen by leveraging NAS systems augmented by prototype functionality. The Test Bed can be used to evaluate concepts, operational research, capabilities, and technologies prior to these being funded, implemented, or fielded at a NAS facility. It provides an open platform to help evaluate and examine the feasibility of new technologies.

**FRASCA International, Inc.** focuses on designing and building the most accurate and reliable Flight Simulators. FRASCA's training devices meet the stringent requirements of both their customers and the leading regulatory agencies around the world, such as FTD's and FFS's utilizing the latest in avionics, visual systems, motion systems, control loading, and aircraft systems.

**General Dynamics IT** provides information technology, systems engineering, professional services and simulation and training to customers in the defense, federal civilian government, health, homeland security, intelligence, state and local government, and commercial sectors.

**Heartwood 3D** assists the operations and maintenance workforce learn complex procedures by allowing them to practice on equipment virtually. The company's 3D interactive applications enable users to learn on Web, PC, Mobile, AR, and/or VR applications.

**Hucon Global** offers risk-sensitive operation tools, skill assessments, and software development services to corporate and public-sector clients. The company is focused on increasing safety by reducing incident and accident rates.

**Infina, Ltd.** delivers impactful training products via state-of-the-art audiovisual material, progressive graphic art and eye-catching print material. Infina supports the FAA on all recurrent technical training and several other programs for air traffic controllers and technicians.

**Instructure, Inc. and Canvas Network** creates software and learning management systems with open, adaptable, reliable, native cloud technologies that empower learning in every context. In addition, the company offers assessment management systems tailored to individual student and participant needs.

**JMA Solutions** offers cutting-edge products and services that provide safe and efficient air travel on a global scale such as requirements development, systems engineering, human factors research and development, operational improvements, proof-of-concept demonstrations, training development and delivery, and safety risk management. The company's air traffic management expertise extends to System Wide Information Management, Decision Support Systems, Terminal and En Route environments, Unmanned Aircraft Systems, Safety Management, and Technical Training.

**KeyBridge Technologies** specializes in all aspects of instructional delivery, web-based courseware development, and information technology-based training support with a long history of supporting the FAA in various aviation-related endeavors. FAA Academy support includes course development, revision services of course material, integrating current operational and technical lessons, leading-edge technologies, and courseware development.

**Leidos**, includes formerly Lockheed Martin Aviation Division, is a trusted systems integrator serving Air Navigation Service Providers including the Federal Aviation Administration, the Transportation Security Administration, and airport operators. The organization's work in airport modernization helps stakeholders achieve stated objectives including increased operational efficiency and safety, a technology enhanced passenger experience, non-aeronautical revenue enablement, and state-of-the-art situational awareness and security.

**Metacraft**, the creator of SimSuite, is a comprehensive air traffic control training and simulation platform with components for ground, tower, terminal, and en route training. Customers can

select a software-only package suitable for installation on commercial off-the-shelf hardware, or a high-fidelity system comprised of highly-realistic consoles and system hardware.

**Northrup Grumman Technology Services** provides innovative system, products, and solutions for unmanned systems, cyber, C4ISR, and logistics and modernization to customers around the world. Technology Services' three divisions focus on creating innovative, cost-effective solutions for defense, civil, and aviation customers.

**Pilot Training System** is a virtual training center where pilots have access to training modules, videos, and tutorials; discussion forums; an advanced weather simulation technology called ClimaDrive, which produces pre-flight and in-flight weather reports; flight planning technology; and other technology for the modern pilot and aviation student.

**Raydon** provides world class virtual reality based training solutions with an extensive range of trainers including embedded trainers, tabletops trainers, appended trainers, and institutional trainers. The organization's innovative approach to virtual training design has yielded several defense market training firsts including the world's first Convoy Operations Trainer, Route Clearance Trainer, Mounted Machine Gun Trainers, and most recently Stryker Trainers.

**Robinson Aviation, Inc** is an aviation services company that specializes in air traffic control operations; communications engineering, installation, and maintenance; navigation and landing system engineering, installation, and maintenance; aviation safety and CNS/ATM studies; and transportation security studies and planning. RVA operates 97 air traffic control towers under the FCT program and employs 550 controllers, engineers, and technicians.

**RTSync** is a developer of advanced modeling and simulation (M&S) software environments, specializing in Discrete-Event Systems Specification technology; Ballistic Missile Defense System (BMDS) model architectures; and designing and developing M&S solutions and expertise and consultation for commercial, research and development, and governmental agencies.

**SkySoft ATM** designs innovative and customized ATM systems and mobile training solutions that depict real-life conditions and scenarios. The organization offers products such as ATC HTMI, ATC data processing engines, radar data recording solutions, ATC trainer, and radar training.

**Skymantics** provides aviation IT advisory services, specializing in large scale enterprise networks, information exchange methodologies, and wireless data link technologies.

**Tetra Tech** is a leading provider of consulting and engineering services specializing in infrastructure, aerospace, training, procedure development, information technology, safety management, and environmental management support. The organization offers navigation, airspace, and instrument procedure design support for the FAA with special emphasis on development activities supporting both air traffic and flight operations within some of the most complex airspace in the United States.

**Textron Systems** delivers command and control services across manned and unmanned systems, creating an unparalleled operational picture for decision makers, analysts, and dismounted teams. The organization also provides a comprehensive range of capabilities from high-powered exploitation and mapping for geospatial analysts to image analysis tools for tactical users.

**TransLumen Technologies** provides advanced observational training and are pioneers in visualization technologies and mobile app development. The company has differentiated itself in the field through proprietary and patented algorithms to advance dashboard aggregation and navigation toward more actionable graphical user interfaces.

**UFA, Inc.** is a leading, privately-held software engineering firm providing Air Traffic Control Tower and Radar simulation technologies and services to civil aviation, military, and universities worldwide. UFA also provides voice technologies including voice recognition and response and voice communication simulation.

**Veracity Engineering** specializes in NextGen, systems engineering, ATC communications, aviation laboratories, airport surface surveillance, software engineering, program management, business case analysis, asset management, and safety management systems. The company is the prime contractor for several FAA initiatives such as Systems Engineering 2025 and Enterprise Programs, Infrastructure, and Communications Services.

**Volpe Center** partners with public and private organizations to assess the needs of the transportation community, evaluate research and development endeavors, assist in the deployment of state-of-the-art transportation technologies, and inform decision- and policy-making through comprehensive analyses.

**Washington Consulting Group** is a professional services firm offering a wide variety of technical training and consulting services of benefit to the worldwide air traffic system management and air traffic controller training. The organization offers services such as airport and airfield operations support, ATM security and crisis response, and airspace modeling and is a recognized ICAO distributive training center.



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Human Performance**