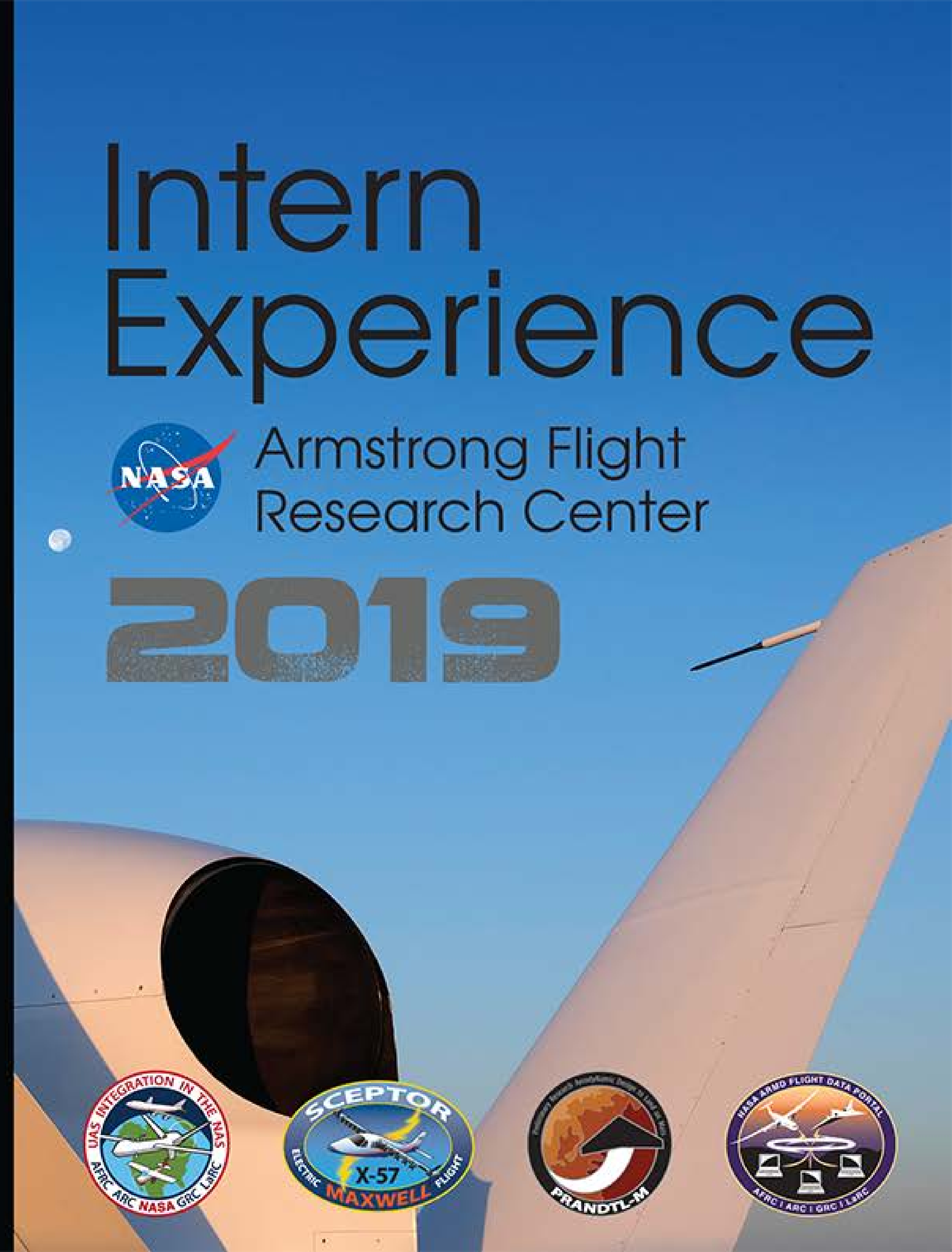
RQ-4 Global Hawk



Intern Experience

NASA Armstrong Flight Research Center

2019

A Message from the Center Director

Congratulations to the NASA Armstrong Flight Research Center Fiscal Year 2019 Student Programs cohort! Thank you for your contributions to NASA and Armstrong Flight Research Center. We as an agency are embarking on a bold new mission to return to the Moon in five years, while we at Armstrong are making great strides in advancing aeronautics technology and science through flight.

Students in STEM disciplines are critical to the future of NASA and the future of the Nation. You are doing your part today by engaging in the future through your studies and work. A gap remains between the growing need for scientists, engineers, and other technically skilled workers, and the available supply. Our economy and our competitiveness hinge on continuing to fill the pipeline with talented future STEM leaders such as you.

NASA has always been blessed with skilled workers who have made us a world leader. Our program mentors represent the best of these skilled workers. Mentoring is about unleashing the next generation to go do great things. Good mentoring is an integrated group activity and one act can propagate through an organization to create synergies. I see the skill of mentoring the development of the next generation as creating bridges between people and providing them an environment to excel. I sincerely thank the mentors this year for their efforts and support.

It's not just our skills that make us the leader, but our passion, our curiosity, our desire to reach the next horizon, our diversity and inclusiveness, and our ability to make something greater of the whole than the sum of our parts. You have continued your education here through your work experiences, and we have benefited from your participation.

Thank you for the gift of your time and energy here at Armstrong.

David D. McBride
Center Director

NASA Armstrong Flight Research Center Fiscal Year 2019

Program Description

Student internships provide the opportunity for students to work side by side with a mentor to contribute to the NASA mission. During Fiscal Year 2019, NASA Armstrong welcomed students from universities in states ranging from Washington to Massachusetts. Student interns were represented in different organizations across NASA Armstrong and supported exciting projects such as SOFIA, X-57 Maxwell, UASNAS, FOSS, X-59 QueSST, TGALS, PRANDTL – M, and PRANDTL-D3c.

We would like to recognize the many funding sources that came together to make this possible for the students. These sources include NASA Armstrong mentor project funding, Universities Space Research Association (USRA), Minority University Research and Education Projects (MUREP), MUREP Community College Curriculum Improvement (MC3I), Space Grant Consortia in California, Iowa, Kentucky, Minnesota, Montana, South Dakota and the Nebraska Space Grant/Space Law Program.

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Samuel Bever
iLEAD Exploration

NASA Armstrong Internship Program

High School Intern
Desired Major: Electrical Engineering

Mentor: Alan Parker
Code: 540
Sensors & Systems Development

Development for Inexpensive Fiber Optics Sensing Systems

The Fiber Optics Sensing System (FOSS) technology enables, among other things, compact, real-time capture of many points of stress on materials with only one fiber-optic cable. The FOSS technology can be used in a wide variety of areas including liquid management, medical applications, aircraft, and space. The latter application is planned to be tested late next year by installing a few FOSS systems onto the Atlas 5 rocket. These systems will take data for roughly 45 minutes after launch. The systems must be robust enough to withstand the harsh conditions of the rocket, thus the systems were subjected to rigorous testing. In order to provide accurate data, various diagnostic sensors were constructed and calibrated to measure accurate temperature and pressure information. Systems like these provide high-quality real-time readings, but they aren't economically viable for many commercial users, limiting worldwide development and use. The new Temperature Tuned FOSS system is designed to be a less expensive and therefore more accessible alternative for third-party use. Production costs need to be reduced by designing, writing software for, and fabricating in-house the parts needed for construction. Among the parts that need to be designed are custom boards for internal communication between the fiber optics and the central processing unit of the Temperature Tuned FOSS.

Rebekah Childers
San Diego City College

NASA Armstrong Internship Program

Undergraduate Intern
Physical Sciences and Astronomy

Mentor: Tom Grindle
Code: 420
Engine Shop

Aircraft Engine Mechanic and Technician

The National Aeronautics and Space Exploration (NASA) Armstrong Flight Research Center (AFRC) is the NASA lead for atmospheric flight research and operations, collecting data critical to NASA plans for scientific discovery and research and development. The AFRC has over 20 different types of aircraft belonging to four platforms necessary to carry out NASA research and development missions. The structural and mechanical integrity of each aircraft must be upheld in order for the aircraft to be safely flown according to the flight schedule necessary to carry out AFRC research missions. In the engine shop at AFRC, aircraft mechanics perform scheduled and emergency maintenance procedures to ensure the aircraft are serviceable for mission readiness. This summer, AFRC needs required the engine shop aircraft mechanics to remove and replace two high-pressure turbines (HPTs) from a General Electric F-404 afterburning turbofan engine (General Electric, Boston, Massachusetts). Components such as the HPT have flight-hour limits, thus aircraft mechanics needed to remove the HPTs from the F-404 engine and replace them with ones having fewer flight hours. This kind of scheduled maintenance is critical for AFRC to safely continue its research and development projects.

Jordan Conner

Embry-Riddle Aeronautical University

NASA Armstrong Internship Program

Undergraduate Intern
Aerospace Engineering

Mentor: Alexander Flock
Code: 430
Operations Engineering

Unmanned Aircraft Systems integration into the National Airspace System (UAS-NAS)

Unmanned aircraft currently are not authorized to operate freely in the National Airspace System (NAS) without authorization and supervision. The Unmanned Aircraft Systems Integration into the National Airspace System (UAS-NAS) project aims to develop and test the technologies and procedures that could make it possible for all classes of unmanned aircraft systems to have routine independent access to the NAS. The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) Integration Testing and Evaluation (IT&E) team is leading this effort by testing Detect and Avoid (DAA) systems to further develop performance standards toward enabling the safe integration of UAS into the NAS. The UAS under test is the TigerShark XP, which is a Class 3 UAS made by NASC (Navmar Applied Sciences Corp., Warminster, Pennsylvania). My task was to assist the IT&E Operations team by performing control room duties as the designated Flight Test Recorder along with creating scenario flight cards for Flight Test 6. This responsibility included loading the coordinates of the flight encounters into the control room computers, recording all flight information gathered during each flight test, and utilizing MATLAB® (The MathWorks, Inc., Natick, Massachusetts) to generate the flight cards used for each test. The testing conducted in this flight-test series can bring UAS much closer to having the right to fly alongside manned aircraft in the National airspace.

Kendy Edmonds

Kent State University

NASA Armstrong Internship Program

Undergraduate Intern
Aerospace Engineering

Mentor: Victor Loera
Code: 550
Systems Integration & Instrumentation

Systems Integration for UAS in the NAS

The National Aeronautics and Space Administration (NASA) Unmanned Aircraft Systems Integration in the National Airspace System (UAS-NAS) project is an ongoing effort to contribute capabilities designed to reduce technical barriers related to safety and operational challenges associated with enabling routine UAS access to the NAS. In the current phase of the UAS-NAS project, the continued focus is on Low Size Weight and Power (SWaP) surveillance sensors and Detect and Avoid (DAA) technologies to provide data that will support the development of the RTCA Special Committee (SC) – 228 (SC-228) Phase II Minimum Operational Performance Standards (MOPS). To support the UAS-NAS Phase II effort, the Integrated Test & Evaluation (IT&E) team will perform flight-testing of a Low-SWaP radar sensor that is integrated on an NASC (Navmar Applied Sciences Corporation, Warminster, Pennsylvania) Group III (weight <1320 lb) TigerShark XP UAS platform. A series of ground and radar characterization tests will be conducted to verify system integration and validate data integrity prior to the Flight Test 6 (FT6) campaign. System checkout flights will also be performed to check integrated system performance in flight against a manned intruder. The data collected during these flight tests will be used to inform and validate the NASA researcher's simulation models for DAA alerting and guidance using Low-SWaP surveillance sensors. Overall, over 150 air-to-air intercepts will performed in FT6 to collect data that will inform the SC-228 MOPS.

Sarah Estep
Morehead State University

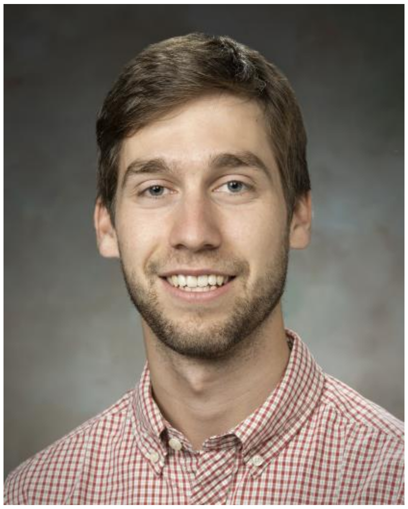
NASA Armstrong Internship Program

Undergraduate Intern
Space Systems Engineering

Mentor: Dave Berger
Code: 112
Office of STEM Engagement

Gondola Design, Fabrication, and Testing

The objective of the Preliminary Research AeroDynamic Design to Land on Mars (PRANDTL-M) is to design a glider that, when combined with others to be a total weight of 10kg or less, will create a sensor network to characterize the Martian atmosphere. The question is, "What size glider could best distribute sensors on Mars?" Various sizes of the PRANDTL-M model will be flown and tested after being hoisted to flight altitude using a weather balloon. The weather balloon currently has no standard release system, known as a gondola. This summer was spent drafting, designing, modeling, fabricating, and finally testing a gondola to meet the requirements for our project. The gondola needed to be able to release four or more gliders, hold them securely, operate remotely, and, with gliders attached, weigh less than 4.8 lb (weight per weather balloon specifications). The final design uses a triangular structure made of carbon fiber and Rohacell® foam core (Evonik Resource Efficiency GmbH, Essen, Germany) with three servomotors operated by remote control. Each servomotor turns on and pulls out a pin that can hold up to two gliders per side. The gliders are attached by a string and a washer that goes around the pin. Using a transmitter with one channel per side of the structure, the gliders are released individually.



Brian Frei
Rutgers University

NASA Armstrong Internship Program

Undergraduate Intern
Meteorology

Mentor: Luke Bard
Code: 520
Aerodynamics and Propulsion

Wind Climatology of Edwards Air Force Base

Seasonal and diurnal fluctuations in weather play an important role in flight planning at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California). Unexpected changes in wind speed and direction, for example, can disrupt flight mission timelines or, in extreme cases, completely shut down runways. Accurate weather forecasts therefore are critical to the efficiency and safety of flight missions at AFRC. This project aims to improve forecast accuracy by developing wind climatologies at several locations within Edwards Air Force Base (EAFB), while studying abrupt wind increases, called ramps, which commonly occur during summer afternoons in Antelope Valley. Meteorological data from twenty-one locations around the EAFB during 2004-2018 were provided by the EAFB meteorology group. These data were formatted and analyzed using Microsoft Excel® (Microsoft, Inc., Redmond, Washington) and MATLAB® (The MathWorks, Inc., Natick, Massachusetts). In addition to developing wind climatologies, these data will be used to study wind variability among different stations throughout the base. Planned future work includes acquiring atmospheric data from the surrounding region and at various altitudes to investigate local processes involved in wind ramps.

Mariah E. Gammill

New Mexico Institute of Mining and Technology

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Alexander Chin
Code: 560
Aerostructures

Mechanoluminescent Optoelectronic Sensors for Structural Health Monitoring

Delamination is an ever-present threat to fiber-reinforced polymer (FRP) composite aerospace structures under high-frequency vibrational loads. The quick propagation of and difficulty in identifying delamination visually makes advanced instrumentation a necessity within these structures. Mechanoluminescent optoelectronic (MLO) sensors have been suggested for use in structural-health monitoring (SHM) due to their self-powered strain-sensing and energy harvesting capabilities; however, more research into how these sensors perform under a variety of vibration profiles is required before they can be considered a viable alternative to well-known damage detection sensors. Mechanoluminescent optoelectronic sensors were mounted onto an aerostructures test wing (ATW) alongside accelerometers and foil strain gages. The non-MLO sensors were used as a baseline for comparison of the viability of the MLO sensor data. A ground vibration test was used to apply a multitude of vibration profiles to the ATW. Data were gathered in DAQExpress (National Instruments Inc. Austin, Texas) and analyzed in BK Connect® (Brüel & Kjær Inc. Holte, Denmark). The MLO sensors responded to mechanical stimuli in the form of voltage readings. The higher the strain on the test article, the higher the voltage reading from the sensors. A self-powered damage detection sensor could be a huge development in structural health monitoring. Many well-known advanced sensor technologies require an external power source, which would be problematic if power were not readily available, such as in space. Mechanoluminescent optoelectronic sensors are an energy efficient sensor technology that could provide a new perspective to damage detection technologies.

Jean Claude Hasrouty

California State University, Northridge

NASA Armstrong Internship Program

Undergraduate Intern
Computer Science

Mentor: Allen Parker
Code: 540
Sensors & Systems Development

Hot-Swapping the Fiber Optic Sensing System (FOSS)

The Fiber Optic Sensing System (FOSS) plays a crucial role in retrieving data and monitoring vehicular health. The FOSS can record shear, strain, temperature, bend, and other vital measurements that could advance the future of robotics and manufacturing. The system operates by utilizing its various hardware components such as fiber optic cables and the Field-Programmable Gate Array (FPGA) which essentially takes the acquired data and communicates it with the other platforms in the system to process the fiber-optic sensor data. Today's systems must be portable and interchangeable; TinkerFOSS provides these attributes. TinkerFOSS, a subset of the FOSS system, enables users to swap out parts on the go, providing versatility. The system utilizes a Linux environment, which is the environment suggested by the United Launch Alliance® (ULA) (Centennial, Colorado) and SpaceX (Hawthorne, California) companies that work closely with the National Aeronautics and Space Administration (NASA). Installing a Linux system consists of porting the code over from the previous environment and troubleshooting any errors that arise. Resolving errors in the FOSS lab can help ensure a smooth 2020 ULA launch that can provide important data for the future of spaceflight.

Alex Healy

Montana State University

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Dave Berger
Code: 112
Education

Mars Glider Swarm Design and Testing

The Mars Glider Swarm is a spinoff of the Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) project. The PRANDTL-M project investigated the concept of a glider design using the proven wing-twist technology from the Preliminary Research AerodyNamic Design To Lower Drag (PRANDTL-D) project that could be flown in the atmosphere of Mars. This summer, the team was tasked with finding the spread and payload of a swarm of gliders sent to Mars, given a set launch mass. In order to investigate this concept, past glider designs were modified and flight-tested to produce familiarity with the system and to put bounds on the controllability of the aircraft. New gliders will be designed and flight-tested to find the spread and payload of a glider swarm. The new gliders must fit in a small enclosure, unfold, and carry as much payload as far as possible in the thin atmosphere of Mars. The gliders will be designed with the wing twist necessary to create proverse yaw, which would allow them to fly without a vertical tail and thus be folded into a smaller package. The data obtained from flight-testing will inform future research into the possibility of flying fixed-wing gliders on Mars.

Garrett Jibrail

Texas A&M University

NASA Armstrong Internship Program

Undergraduate Intern
Aerospace Engineering

Mentor: Kurtis Long
Code: 430
Dynamics and Controls

First Public Model of the X-59 Airplane

Throughout the development phase of an experimental aircraft, factors such as the participation of private contractors can prevent public release of otherwise publicly available information. This problem can often be solved through large buyouts of proprietary information, however, it is not always possible to reach a deal in this regard. Nevertheless, the National Aeronautics and Space Administration (NASA) still maintains the obligation (per the National Aeronautics and Space Act of 1948, Publ.L. 85-568) to publicly release new findings in breakthrough fields such as the Low Boom Flight Demonstration (LBFD). It happens that a consumer-friendly aerodynamic model of the X-59 Quiet Supersonic Technology (QueSST) (Lockheed Martin, Bethesda, Maryland) can be reverse-engineered through careful analysis of publicly available reports. This model can further be developed within the commercially-available flight simulator software, X-Plane 11®, (Laminar Research, Columbia, South Carolina) which uses blade-element theory to produce real-time results within a 20-percent margin of error. Once complete, the simulator model may then be released to the public in anticipation of the first flight of the X-59, which is currently scheduled for 2021.

Christiana Kallemeyn
Southern New Hampshire University

NASA Armstrong Internship Program

Undergraduate Intern
Mathematics

Mentor: Aamod Samuel
Code: 630
Simulation Engineer

SESII Bench Tester Validation

The Simulation Electric Stick II (SESII) provides force feedback to a pilot flying any Armstrong Flight Research Center (AFRC) simulator. In order to ensure proper safety procedures, the temperature of the SESII motor must be monitored. At present, the reported current used to calculate temperature is faulty due to the switching current of the SESII amplifiers. As a result, the SESII software reads an invalid temperature and forces a non-compulsory shutdown of the motor.

A bench tester was built to simulate the temperature-dependent resistance of the SESII motor, allowing a more accurate temperature reading to be obtained. By utilizing the known resistance of the bench tester to calculate temperature, a lookup table that correlates the reported current to the correct temperature can be obtained. To create this look-up table, an Arduino® (Arduino AG, Mainz, Germany) board located inside the bench tester reports relevant values, allowing the operator of the bench tester to easily read all the pertinent information and create the table for the SESII motor.

Ayanna Kimbrough
University of California, Riverside

NASA Armstrong Internship Program

High School Intern
Desired Major: Electrical Engineering

Mentor: Allen Parker
Code: 540
Sensor and System Development

Implementation of FOSS in Space Flight

The National Aeronautics and Space Administration (NASA) has been at the front line of innovation. At the Armstrong Flight Research Center (AFRC) (Edwards, California), the Fiber Optic Sensing System (FOSS) has been updated to curate data on different airborne vehicles more simplistically and at faster rates. The FOSS has provided real-time data on effects such as strain, temperature, deformation, and shape. Now the FOSS is being tested for use outside of the Earth's atmosphere, using one of the derivative FOSS units known as the Rocket Box. Environmental testing has helped to prepare the Rocket Box to withstand different atmospheric conditions. My responsibilities while working with the FOSS team were to create and program different circuits that can provide data about the systems within FOSS, and to generate conversions from analog to digital to provide information to and from the system. I worked with analog-to-digital converters and was tasked with gathering data samples, storing them in groups, sending the data, and saving the data on a computer. I also helped to provide a circuit that would provide information about the Rocket Box. The circuit, which included a microcontroller with temperature sensors appended, ensures that the Rocket Box is stable and that the temperature, atmospheric pressure, and altitude readings on the Box are consistent with the data collected from the vehicle. The FOSS systems play a significant role in measuring the varying effects of our environment on different vehicles such as those used in the NASA Artemis project.

Christopher Lang

University of Minnesota Crookston

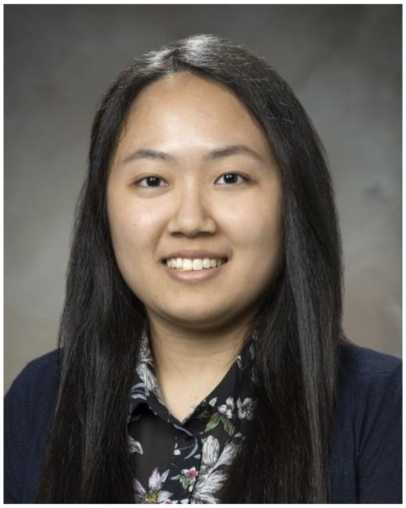
NASA Armstrong Internship Program

Undergraduate Intern
Software Engineering

Mentor: Oscar Murillo
Code: 530
Dynamics and Controls

Flight Data Acquisition Unit Development on the PRANDTL-3c

The Preliminary Research AerodyNamic Design To Lower Drag (PRANDTL-D) is a program developed by the National Aeronautics and Space Administration (NASA) in order to demonstrate a bell-shaped lift distribution of a wing. The PRANDTL-3c and its predecessors have all been built with this goal in mind, taking advantage of this new wing to significantly decrease drag compared to a standard aircraft of a similar size. In order to determine this drag reduction, to demonstrate proverse yaw, and to identify other relevant flight characteristics, a data acquisition unit must be developed. Various options are being investigated and tested over the course of the internship period. An existing derivative Arduino® (Arduini AG, Mainz, Germany) could be adapted for what is needed, or a similar computer could be used to feed data into an iPhone® (Apple Inc., Cupertino, California) for easier collection. Alternative options are to replace the analog controls of a Gamevice® (Gamevice Inc., Simi Valley, California) gamepad with external sensors and program the iPhone® to interpret these signals as actual data, or to use a different system entirely in the form of a BeagleBone® Black (BeagleBoard Foundation, Oakland Twp., Michigan). Any of these methods will lead to obtaining useful data from the PRANDTL-3c sensors, most importantly from the accelerometer, gyroscope, α/β (angle-of-attack / sideslip angle) vanes, and elevon deflection.



Ying Cheng Lin
University of Washington

NASA Armstrong Internship Program

Undergraduate Intern
Electrical and Computer Engineering

Mentor: Allen Parker
Code: RD
Sensors and Systems Development

Polarization Mitigation with Field-Programmable Gate Array (FPGA)

The Fiber Optic Sensing System (FOSS) is a lighter way to monitor the condition of a surface compared to traditional methods. The customized fiber contains many tiny sensors called Bragg gratings, which can sense the condition of the fiber at each location along the length of the fiber mounted to the structural surface. Currently, FOSS can give up to 100 samples per second. As the length of the fiber being used continues to grow, the number of sensors in the fiber and the records received per second also increase, requiring heavy computation which cannot be handled by a general-purpose central processing unit. The team has developed a compact FOSS (cFOSS) with high-end electronics which is capable of doing such heavy computational tasks with eight channels, but the cFOSS is quite costly. The team wants to develop a more cost-effective solution called μFOSS that will be as powerful as cFOSS but use only two channels. A commercially available Zynq® (Xilinx, Inc., San Jose, California) analog-to-digital converter is used to do the initial data processing, specifically the field-programmable gate array chip, implementing a polarization mitigation technique to read alternately between two receiving photodiode sensors for each fiber at a fast rate. Each pair of data will then be analyzed using a C language program to produce a more comprehensive result, providing the user with a good sense of the overall condition of the tested surface.

Jonathan Lokos

California Polytechnic State University
San Luis Obispo

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Allen Parker
Code: 540
Sensors & Systems Development

Alternative Store Separation Mechanism

When an aircraft carries a store (external cargo) that is intended to be detached, a reliable release mechanism is needed in order to ensure a clean separation. At present the most common separation system utilizes explosive cartridges. Explosive cartridges are reliable but they are not without drawbacks. Due to the presence of pyrotechnics, significant safety measures are required to protect those personnel who install and operate the bolts. The cartridges also utilize pistons that generate an enormous “kick” force that is used to jettison the store away from the aircraft, however, this “kick” requires all of the pistons to be mounted in precisely the same direction else the force of separation spin or crush the store. A new technology recently has emerged that uses magnets rather than explosives to carry and release stores, but these magnets must first be tested to demonstrate their ability to withstand a significant load. A test rig is being designed using Solidworks® (Dassault Systemes Inc, Velizy-Villacoublay, France) computer-aided design (CAD) software to hold a 500-lb test load. Another facet of the project involves creating several replica “drone” aircraft that will investigate the capability of the magnets to attach to a store from a variety of angles. The replica drones also can be used investigate the applicability of the technology to other areas of aeronautics as well as space travel.

Kristina Marotta
University of North Carolina at Chapel Hill

NASA Armstrong Internship Program

Graduate Intern
Computer Science

Mentor: Curtis Hanson
Code: 530
Dynamics and Controls

Distributed Electric Propulsion (DEP) Aircraft

Distributed electric propulsion (DEP) aircraft could present many advantages over the traditionally fueled regional airliners in use today. Electric aircraft promise increased efficiency, reduced fuel consumption, less noise, and fewer carbon emissions. Higher efficiency provides the potential to use fewer control surfaces or decrease the size of the vertical stabilizer, both of which reduce the weight of the vehicle. One DEP concept aircraft implements a split-wing design, in which two turboshaft engines power sixteen ducted fans embedded in the inboard wing. In order to understand the potential effects and challenges of DEP on aircraft aerodynamics and controls, there must be an accurate model to study. A three-dimensional model was first built using the open-source software Open Vehicle Sketch Pad (OpenVSP). Basic aerodynamic data were then collected using VSPAERO and integrated into a non-linear, six degrees-of-freedom simulation in MATLAB® (The MathWorks, Inc., Natick, Massachusetts). This simulation uses a four-axis proportional-integral-derivative controller for thrust, pitch, roll, and yaw control. Acting as a toolset to test hypotheses, evaluate the controls system, and assess failure scenarios, the simulation enables a better understanding of the aerodynamics and effects of a split-wing DEP aircraft design. With better performances, higher efficiency, and reduced energy usage, electric aircraft could revolutionize air transportation.

Tristan Minkoff
Embry-Riddle Aeronautical University

NASA Armstrong Internship Program

Undergraduate Intern
Aerospace Engineering

Mentor: Jason Lechniak
Code: 520
Aerodynamics and Propulsion

Prandtl Propeller Modeling and Evaluation

A propeller design concept based on the research of Ludwig Prandtl is being analyzed to demonstrate improvements in efficiency. Aerodynamic benefits have been previously observed on other Prandtl-based projects conducted at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California). These projects, however, were designed and tested only aircraft wings that utilize the bell-shaped loading distribution. A propeller blade is very similar to the wing of an aircraft - their cross sections are both designed using airfoils. The current propeller will be designed to reduce the torque required to produce equivalent thrust. Future Prandtl-based design concepts are expected to increase the thrust and decrease the noise levels produced by the propeller. In order to properly observe the benefits of the Prandtl design on the propeller blade a control analysis must be conducted with the original geometry of the propeller. This analysis will be accomplished using XFoil and XRotor, which are both open-source programs. The XFoil program is able to model the necessary airfoil characteristics; the XRotor program models the propeller geometry and can conduct various types of analyses. When the control analysis is complete, the propeller geometry will be redesigned to demonstrate the benefits of the Prandtl design. The new Prandtl-based geometry will then be modeled and analyzed to identity potential performance benefits.

Aaron Misla

New Mexico Institute of Mining and Technology

NASA Armstrong Internship Program

Graduate Intern
Mechanical Engineering

Mentor: Alexander Chin
Code: 560
Aerostructures

Mechanoluminescent Optoelectronic Sensors

One of the many challenges facing the longevity of human air flight and spaceflight is structural failure due to undetected damage. The threat of unexpected failure is now even more prevalent because metals are often substituted with composites. Composites are more susceptible to crack propagation and delamination, which can result in catastrophic failures that can cause the loss of the aircraft and of human life. Several structural health monitoring methods are being developed to better detect and characterize damage in order to prevent these failures. Mechanoluminescent optoelectronic (MLO) sensors are one such method. The MLO sensors are composed of a poly(3-hexylthiophene-2,5-diyl) base (P3HT), with copper-doped zinc sulfide (ZnS plus Cu) crystals that give off green light under strain. These self-powering and light-emitting abilities give these sensors the potential to revolutionize the future of aerospace structural health monitoring by providing a reliable analysis of the health of the structure. As part of the evaluation process, the MLO sensors will be mounted on an aerostructures test wing and compared to conventional strain data collected by foil strain gages. This comparison will enable the capability of these new MLO sensors to be further refined into a competitive sensor that can enhance the longevity of human flight.

Kevin J Montalvo Vega

University of Puerto Rico, Mayagüez

NASA Armstrong Internship Program

Undergraduate Intern
Electrical Engineering

Mentor: Kurt Kloesel
Code: 520
Aerodynamics and Propulsion

Electromagnetic (EM) Modeling of the Joby X-57 Electric Cruise Motor

The National Aeronautics and Space Administration's (NASA) Aeronautics Mission Directorate (ARMD) is investigating various avenues of aeronautics vehicle efficiency improvement using electric technologies. The X-57 Maxwell aircraft will use Permanent Magnet Synchronous Motors (PMSMs) on the wingtips for cruise and on the wingspan for lift. In order to further understand the behavior of the electromagnetic (EM) field within the motor, sophisticated software can be used to model the conductive components involved and calculate the forces and currents that are generated. Initial modeling was performed with the two-dimensional electromagnetics modeling software, Finite Element Method Magnetics (FEMM). This software simplifies the analysis process and provides a reference point for more advanced 3-D software which can run in-depth analysis regarding the effects of motion and temperature flow throughout the PMSM. The magnets are oriented in a Halbach array - as such, the angles on the magnetic fields must be adjusted to maintain the array pattern while taking into consideration the position of each magnet with respect to the motor. This analysis will provide understanding, which can be used to improve future designs.

Christopher Morales

University of Puerto Rico - Arecibo

NASA Armstrong Internship Program

Undergraduate Intern
Computer Science

Mentor: Rebecca Flick and
and David Tow
Code: 112
Office STEM Engagement

NASA Aeronautics in Augmented Reality

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) office of Science, Technology, Engineering and Mathematics (STEM) Engagement is developing an aeronautics mobile application to deliver an augmented-reality experience to the public, featuring a selection of NASA aeronautics vehicles. Using a phone camera, the application alters the user's perception of the real-world environment, displaying a three-dimensional model of the vehicle that the user selected in the application graphical user interface (GUI). This augmented-reality experience is being accomplish using Xcode (Apple Inc., Cupertino, California) software development kit (SDK). XCode is the platform being used to create the application GUI and being built to support iOS (Apple Inc.) mobile operating systems. ARkit (Apple Inc) consists of a set of software development tools that enable users to perform real-world actions in order to interact with the augmented-reality environment. In the augmented-reality camera, a selection of buttons will be available depending on the type of aeronautics vehicle currently displayed on the screen. Options include propeller animations, sonic-boom demonstrations and comparisons, and aircraft control surfaces movement. These interactions, along with informative pages on each vehicle, are intended to deliver an educational and unforgettable experience to users and further expand public awareness of NASA aeronautics.

Emily Morales

The University of Texas at El Paso

NASA Armstrong Internship Program

Undergraduate Intern
Metallurgical and Materials Engineering

Mentor: Oscar Murillo
Code: 530
Dynamics and Controls

Determining the Mass Properties of the PRANDTL-3c

Ludwig Prandtl proposed a theory in 1933 that a bell-shaped span load would minimize the amount of drag and undesirable yaw present in an aircraft during flight. This theory is the foundation of the Primary Research Aerodynamic Design to Lower Drag (PRANDTL-D) project based at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California). The project aims at confirming Prandtl's theory experimentally by using a bell-shaped span load to demonstrate elimination of adverse yaw with minimization of drag. This summer, sensor and system integration, mass properties testing, and flight research will be performed on the PRANDTL-3c, which is the fourth version of the PRANDTL-D, in order to obtain flight data and aerodynamics characteristics. My personal task focuses on the mass properties tests, to determine the center of gravity of the PRANDTL-3c aircraft, as well as the moments and products of inertia. A series of tests will be performed which involve suspending the aircraft as a pendulum and applying a force. The period of oscillation is then measured using an inertial measurement unit to determine the moments of inertia about the axes. Obtained values are analyzed in order to investigate the potential stability of the aircraft when airborne, as well as how the aircraft might interact under control surface alteration. The values will aid in understanding the motion of airborne vehicles, and enable accurate flight data to be obtained.

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Kevin Moran
Rio Hondo College
University of Southern California

NASA Armstrong Internship Program

Undergraduate Intern
Astronautical Engineering

Mentor: Dave Berger
Code: 112
Office of Education

PRANDTL – M: A One Way Ticket to Mars

Since mankind's first trip into space, many people have gazed up at the night sky pondering the question, "I wonder what going to Mars would be like?" Although humans might not be quite ready to set foot on the "Red Planet," unmanned vehicles provide a great alternative for establishing contact with this Earth neighbor. The Preliminary Research Aerodynamic Design to Land on Mars (PRANDTL-M) project is set out to design and fabricate a revolutionary glider equipped for interplanetary research. A cornerstone of the PRANDTL-M design is a new twisted wing which has been proven to reduce drag and lessen the effects of adverse yaw. This design allows the glider to fly farther and with more control than its elliptically-shaped counterparts, without a vertical stabilizer. Although flight-testing is still being conducted on the PRANDTL-M 5.0 series glider, design plans for a 6.0 and 7.0 series glider are under way. These new designs will feature foldable wings, enabling a swarm of gliders to fit inside a miniature spacecraft during the voyage to Mars. Once deployed, the team of gliders will fly over miles of surface area, collecting data that could one day lead to mankind's first visit to Mars.

Mirin Morris-Ward
University of Alaska Fairbanks

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Kurtis Long
Code: 430
Operations Engineering

Low Boom Flight Demonstrator X-Plane 11 Simulation

X-Plane 11® (Laminar Research LLC, Columbia, South Carolina) is a commercially available flight simulator that allows the user to access, edit, and fly models of commercial, experimental, and military aircraft. The simulation also has a popular online platform in which users share their own aircraft designs. The National Aeronautics and Space Administration (NASA) is interested in using this publicly available simulator and simulation platform to raise interest and support for the development of the Low Boom Flight Demonstrator X-59 (LBFD) experimental aircraft. Our current objective is to take the design of the LBFD and put it in to the simulator so the public may fly it and tweak the model to their liking. We reached this objective by utilizing the X-Plane 11 Plane Maker software to input its instrumentation, hydraulics, electronics, and flight characteristics. To achieve the physical look of the aircraft and the animated dynamics of the aircraft mechanisms, SolidWorks™ (Dassault Systèmes,Vélizy-Villacoublay, France) , AC3D™ (Inivis Limited, Cambridgeshire, England) and Photoshop® (Adobe Inc., San Jose, California) are utilized. This is the traditional way in which most aircraft in the simulator are designed, and by utilizing this method, we can give the public the option to experience the near future of low sonic boom high performance aircraft.

Jacob Pagel

Lake Area Technical Institute

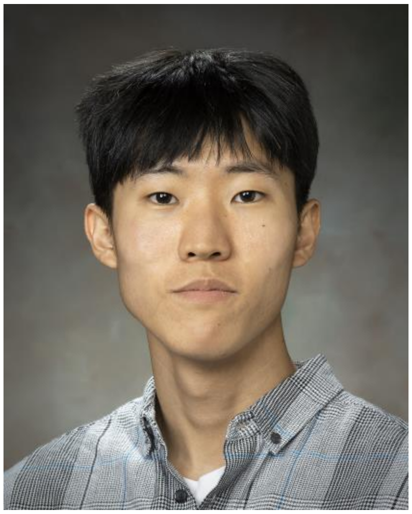
NASA Armstrong Internship Program

Undergraduate Intern
Aviation Maintenance Technology

Mentor: Lorenzo Sanchez
Code: 424
Aircraft Maintenance

DC-8 Airborne Science Laboratory

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) operates a modified DC-8 airplane (McDonnell Douglas, now The Boeing Company, Chicago, Illinois) as a flying science laboratory. This airplane is based at the NASA facility building 703 in Palmdale, California, and is used to collect data for experiments involving the Earth's atmosphere. On July 22, 2019, the DC-8 team will deploy to Idaho and then Kansas for Fire Influence on Regional to Global Environments Experiment – Air Quality (FIREX-AQ). The objective of FIREX-AQ is to provide measurements of trace gas and aerosol emissions for prescribed fires and wildfires in great detail to understand how fires affect the atmosphere. All four engines on the DC-8 airplane have been bore-scoped in preparation for the deployment and will be again after deployment to determine whether engine damage was incurred due to the smoke the airplane will have flown through. The DC-8 is an older airplane, so proper maintenance is critical. Although most of the day-to-day work for maintenance personnel on this project involves installing instrument racks, seats, and paneling, a fair share of time is spent on routine maintenance. Some of the maintenance performed recently has been changing two tires, servicing the hydraulic system, installing various antennas, and running up the engines.



Seung Chul Dean Park
University of California, Irvine

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Oscar Murillo
Code: 530
Dynamics and Control

PRANDTL-D IIIC Operations and Flight Testing Lead

The Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D 3c) is an intern-led research project which aims to prove Ludwig Prandtl's theory of the bell-shaped spanload. The aircraft seeks to produce proverse yaw by using a non-linear aerodynamic twist along its wingspan. The vehicle's bell-shaped spanload reduces drag in ways an elliptical spanload cannot. The PRANDTL-D 3c team is working to install an iPhone® (Apple Inc., Cupertino, California) as a way to collect flight data and store it in memory longer than could previous flight computers in which data were lost when the system lost power. Ensuring safety and flight readiness involved organizing a tech brief for a new flight request, confirming the center of gravity, running a combined systems test before flight, performing many sensor calibration procedures, and conducting flight-day operations. In addition to flight preparation, the data will be post-processed and analyzed to be put into state and response equations. These equations will be used to find the force and moment coefficients and characterize the overall aerodynamics of the aircraft.

Jonathan Richter

Washington University in St. Louis

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Kurtis Long
Code: 430
Dynamics & Control

Simulation of the X-59 in X-Plane 11

The X-59 Quiet Supersonic Technology (QueSST) aircraft (Lockheed Martin, Bethesda, Maryland) is planned to produce a sonic "thump" rather than a traditional sonic boom when flying at supersonic speeds. The X-59 sonic "thump" is 1,000 times quieter than the sonic boom produced by the Concorde (Aerospatiale/BAC, France); by demonstrating QueSST, the X-59 hopes to revitalize commercial supersonic air travel. The objective of this project is to create an accurate simulation of the X-59 in the commercially available X-Plane 11® (Laminar Research, Columbia, South Carolina) software which could later be released to the public toward increasing awareness of QueSST and the X-59. Creating the simulation involves constructing both the underlying mathematical model encompassing aerodynamics, propulsion, electrical systems, and hydraulics as well as the graphical model including the aircraft outer mold line, landing gear, and cockpit. Using two-dimensional airfoil finite slope reduction calculations the main airfoil was selected from a set of supercritical airfoils. Many other parameters were determined after extensive research of aircraft databases. The X-Plane® model matches the multimillion-dollar simulator well within many flight regimes, and when released it will hopefully help reinvigorate the public's taste for commercial supersonic air travel.

Michael Rayvel Salazar
University of Texas Rio Grande Valley

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: John Atherley
Code: 430
Operations Engineering

Designing Mounting Fixtures for Vibrational Testing

The Operations Engineer's mission is to provide sound engineering to ensure airworthiness throughout planning, integration, and flight of unique systems and vehicles. Aircraft in flight are often subjected to significant vibrations which can be detrimental to electrical components; therefore, these components need to be vibration-tested to ensure their reliability during flight. During vibration testing, the electrical component is mounted onto a vibration plate and powered to confirm its functionality. The component is checked with sensors to ensure it is operational for the duration of the vibration test. The fixtures are modeled using Creo Parametric 3.0® (PTC Inc., Needham, Massachusetts). When designing fixtures for vibration testing, it is important to ensure the fixture itself does not amplify or resonate vibrations to the electrical components being tested. A modal analysis thus is simulated to obtain the natural frequencies and determine a general structural characteristic of the design. As well, constraints need to be considered when designing fixtures. Some constraints include the size of the vibration table, how the component is mounted on the aircraft, and the power spectral density curve and frequency range (usually approximately 15 to 2,000 Hz) at which the component will best tested.

Amanda Short
Rio Hondo College

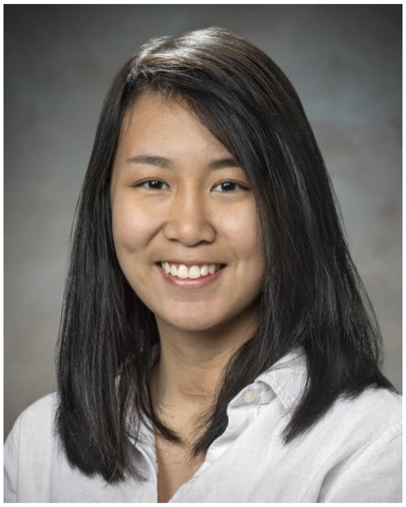
NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering

Mentor: Dave Berger
Code: 112
Office STEM Engagement

Optimizing Mass Distribution to Create a PRANDTL-M Glider Swarm

The Preliminary Research AerodyNamic Design to Land on Mars (PRANDTL-M) is focused on designing a glider with a non-elliptical lift distribution that will be able to fly in the Martian atmosphere. The original concept for this project was based on a single glider being deployed onto Mars in order to collect data that would aid in future exploration of the planet. The current goal for PRANDTL-M is to design a glider with a wingspan smaller than the original 24 inches that can be duplicated and thus operate as a swarm. Deploying multiple gliders instead of one enables exploring a greater area of land and increases the amount of inflight data that can be recorded. Upon minimizing the size of the glider, however, flight instability due to inertial coupling became a problem. The problem was addressed by evenly distributing mass away from the center of gravity of the glider. Increasing the ratio of mass about the roll-to-pitch axes will hopefully create a stable, free-flight glider. This experiment is being performed on the PRANDTL-M 5.0 series; further mass distribution experiments will be carried out on the PRANDTL-M 6.0 and 7.0 series to optimize the distribution and range of the gliders.



Danika Soberano

Rochester Institute of Technology

NASA Armstrong Internship Program

Undergraduate Intern
Electrical Engineering Technology

Mentor: Johanna Lucht
Code: 550
Flight Test and Integration Systems for Low Boom Flight Demonstrator

X-59 Flight Test Integration System Testing and PCB Design

When supersonic aircraft exceed the sound barrier they produce what is called a high super sonic boom, which disrupts life and structures over land. This "boom" is this reason is why supersonic flight over land in the United States has been banned by the Federal Aviation Administration (FAA). The National Aeronautics and Space Administration (NASA) is working toward building an experimental supersonic aircraft, called the Low Boom Flight Demonstrator, or the X-59, that can produce a quiet supersonic boom at Mach 1.4. The X-59 will collect sensor data on the aircraft to measure values such as temperature, pressure, and vibration with devices called encoders. Before the encoders endure functional and environmental testing, they are first subjected to a round of acceptance testing to verify that the device is functional upon delivery from the manufacturer. Along with acceptance testing, a breakout box (BOB) is being developed to streamline the process of checking out encoder flight harnesses. Traditionally, a BOB is manually wired together; which is a time-consuming process. To save time in developing the BOBs, we are designing a printed circuit board (PCB) as a replacement for the hand-wired BOB. This method should dramatically reduce testing and fabrication time, and streamline the efforts to achieve mission success.

Hannah Smith

University of California, Irvine

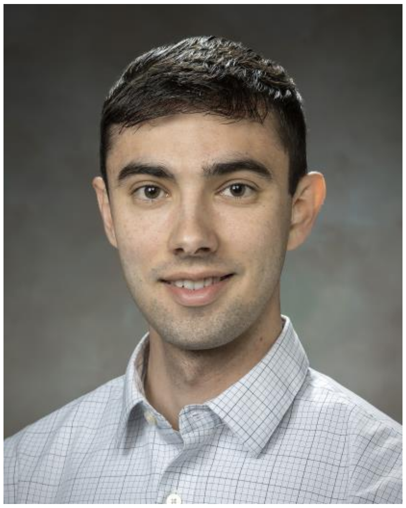
NASA Armstrong Internship Program

Undergraduate Intern
Undeclared

Mentor: Allen Parker
Code: 540
Sensors and Systems Development

Laboratory Organization

Laboratories are necessary for any company that is testing the latest and greatest technologies, and this need is especially true for the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) Fiber Optic Sensing Systems (FOSS) laboratory and the Advanced Systems Development laboratory. Laboratories easily can become messy and disorganized, with equipment difficult to find and the process of finding it time-consuming; under mission deadline it is imperative that no time is wasted hunting for misplaced or lost assets. Many of the tools used in these two laboratories are lost and must be found before they can be organized properly. Tools have not always been returned to their assigned places, and not every piece of equipment has an assigned place. Laboratory organizers and managers are responsible for taking inventory and ensuring that tools and equipment can be easily located. These personnel also must keep the inventory updated and accurate. The organizer utilizes Sharepoint® (Microsoft Corporation, Redmond, Washington) and Excel® spreadsheets (Microsoft Corporation) to keep track of inventory and ensure that the location and quantity in the inventory is accurate and updated so that tools and equipment may be quickly and easily located. The job of the laboratory organizer is never complete, and the service is essential to NASA for safe and timely mission successes.



Justin Vanderveer

University of Denver,
Sturm College of Law

NASA Armstrong Internship Program

Graduate Intern
Juris Doctor

Mentor: Brett Swanson
Code: 120
Office of the Chief Counsel

Office of the Chief Counsel Legal Internship

The Office of the Chief Counsel (OCC) at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) consists of a team of the Chief Counsel and three attorney advisors who are considered generalists and are capable of working on a vast array of matters. The AFRC OCC handles matters regarding employment, litigation, ethics, contracts, procurement, negotiations, and various other matters that may arise. The role of the legal intern is to assist the attorneys. Duties include conducting research and contract review, drafting legal memoranda, participating in meetings and presentations, and assisting with strategic planning. Legal interns are expected to contribute in a sort of junior attorney role, under close supervision and with guidance from a senior attorney. Most of the matters handled by the OCC are sensitive, and legal interns work numerous projects over the course of the internship. One of my primary projects for the OCC was regarding legal issues relevant to the AFRC Building 703 deluge mishap. This mishap resulted in millions of dollars' worth of damage and as such was a top priority for AFRC. As the legal intern, my duties for this case were researching case law, preparing a memorandum of the issues, and working with other members of the team to create a solution to the incident.

Spring 2019 Abstracts

Olivia Alexander

California State University, Northridge

NASA Armstrong Internship Program

Graduate Intern
Applied Mathematics

Mentor: Anthony Moreno
Code: 820
Resource Management Office (RMO)

Resource Analysis for Mission Directorates and Programs

As a federal agency, National Aeronautics and Space Agency (NASA) receives its funding from Congress. The overall budget is partitioned into appropriations to be expended in explicit areas, essentially the NASA directorates. Resource Analysis involves tracking and managing each appropriation to verify that funds are being spent properly in relation to budget authority available and spending activities as well as rates of spending to assure funding through the fiscal year (FY). The objective of this project is to maintain current status for funding tasks such as contracts, phasing plans, and activity sheets. Activity sheets are presented to project managers each month to relay the status of funds for an organization as well as to provide breakdowns within each spending area, that is, procurement, labor, and travel activity. Progression can be demonstrated by producing illustrations mapping where projects started in their funding to where the funding stands by the project conclusion, as well as where they are expected to be in the following months as a form of phasing plans. This permits a preliminary conclusion based on FY funding and to communicate analytical findings with both project managers and funds managers.

Corey K Carter

University of Minnesota – Twin Cities

NASA Armstrong Internship Program

Undergraduate Intern
Computer Science

Mentor: Allen Parker
Code: 540
Sensors & Systems Development

Fiber Optic Sensing System (FOSS) System Migration

Fiber Optic Shape Sensing (FOSS) can provide real-time data of wing flex, fuel levels, and the structural strength of bodies, providing multi-dimensional data to the pilot, crews, and computers aboard air- or spacecraft. The FOSS can lead to more fuel-efficient, safer, and stronger air- or spacecraft and can help support the temperature and flight control systems for future space flights that will help the National Aeronautics and Space Agency (NASA) go back to the Moon and beyond. The FOSS team is improving on the robust development platform by converting the sensor system to an open-source version. This new version provides free, rugged, and scalable alternatives. To transfer the FOSS system from the currently utilized operating system to the open-source version requires the FOSS system to be stripped of currently utilized code and replaced with the open-source code. In addition, the FOSS laser system will also need to be ported. As a result of these software modifications, the FOSS will be easier to deploy in the field, and enable faster and easier incremental improvements for testing or upgrades.

Patrick Gagnon

College of the Canyons

NASA Armstrong Internship Program

Undergraduate Intern
Aerospace Engineering

Mentor: Allen Parker
Code: 540
Sensors & Systems Development

Mechanical Design and Integration Support for FOSS

Conventional strain gage uses dated methods for monitoring the mechanical health of an aircraft. Developed at the NASA Armstrong Flight Research Center (AFRC) (Edwards, California), the Fiber Optic Sensing System (FOSS) uses a modular approach to measure temperature and strain for testing of both flight-proven and experimental aircraft. The system benefits from lightweight construction using serial multiplexibility for greater sensitivity and is highly configurable for use over many applications. The FOSS utilizes fibers comparable in size to a strand of human hair and contains 16,000 sensors; dielectric mirrors throughout this fiber are used to produce a fiber Bragg grating (FBG) when light passes through it. The FBG is then used to determine the experienced strain. Rigid, compact external cases made from aluminum help protect the system hardware, and for space fairing iterations will serve as a means to cool the device. The boxes are modeled in the computer-aided design software Creo (PTC Inc., Needham, Massachusetts) and then 3-D printed to create prototypes. The FOSS utilizes advanced sensor technology to revitalize traditional strain-gage systems; the data collected will help guide the design and engineering of better vehicles for flight either within or outside the Earth's atmosphere.

Jonathan Lopez

California State University, Long Beach

NASA Armstrong Internship Program

Undergraduate Intern
Aerospace Engineering (Astronautics)

Mentor: Allen Parker
Code: RD
Sensors & Systems Development

FOSS Taking the Next Step into Space Flight Application

The National Aeronautics and Space Administration has been developing a strain and temperature measuring system known as the Fiber Optic Sensing System (FOSS) at the Armstrong Flight Research Center (AFRC) (Edwards, California). Various systems have proven successful in both ground and flight units, within the Earth's atmosphere. The next step for the FOSS is to prove its reliability, effectiveness, and value in applications outside of the Earth's atmosphere. A FOSS unit known as the Rocket Box will be taking the responsibility in measuring strain and temperature in a space flight application. The system was designed and modeled in Creo Parametric 3.0® (PTC Inc., Needham, Massachusetts). The Rocket Box was then 3-D printed at the NASA Kennedy Space Center (KSC) (Kennedy Space Center, Florida) to ensure proper fit and clearance of all internal components and cabling. At the moment, the first metal prototype unit is being produced at KSC. This unit will be sent to AFRC, where it will be fully integrated and go through AFRC environmental testing. After integration and testing, an updated design will be sent back to KSC, where four more final units will be produced. The four final units will then be sent to the NASA Langley Research Center (LaRC) (Hampton, Virginia), where they will be subjected to final qualification testing. Finally, the units will be verified by the United Launch Alliance (ULA) (Centennial, Colorado) for final approval, inspection, and installation - resulting in FOSS making the next steps into space flight.

Laura Mak
Century College

NASA Armstrong Internship Program

Undergraduate Intern
Electrical Engineering

Mentor: Jacob Terry
Code: 540
Sensors and Systems Development

X-57 Electric Propulsion Analysis, Test, and Integration

The X-57 Maxwell aircraft is the first all-electric aircraft that is in the initial stages of testing. The use of electric motors can result in cleaner, quieter, and more sustainable flight. The X-57 will have six small motors along each wing, and a larger motor just inboard of each wingtip. Lithium-ion batteries - the current method of power storage in the aircraft - pose new potential threats that require attention. One threat is the possibility of current from the battery leaking into the aircraft chassis due to possible movement out of place during flight. An occurrence of this sort could cause many potential problems, ranging from an electric short to direct harm to the pilot. To prevent these problems, the insulation between the battery and the chassis of the aircraft must be constantly monitored in order to detect any such leakage. The isolation monitoring system functions with the use of a Sendyne® SIM 100 sensor (Sendyne, New York City, New York), which monitors resistance and capacitance between the battery and chassis. This system will be tested in a laboratory setting before being integrated onto the aircraft itself. The use of the isolation monitoring unit will help advance the progression of the X-57 project and is a key component in its safety.

Kristina Marotta
Georgia Institute of Technology

NASA Armstrong Internship Program

Graduate Intern
Analytics

Mentor: Curtis Hanson
Code: 530
Dynamics and Controls

Modeling and Simulating Distributed Electric Propulsion Aircraft

Distributed electric propulsion (DEP) aircraft could present many advantages over the traditionally fueled regional airliners in use today. Electric airplanes promise higher efficiency, reduced fuel consumption, less noise, and fewer carbon emissions. One particular DEP concept is a split-wing design, in which two turboshaft engines power sixteen ducted fans embedded in the inboard wing. In order to understand the effects of DEP on the aerodynamics and controls of an airplane, there must be a tool that can be used to accurately model these effects. A model was first built using the open-source software Open Vehicle Sketch Pad (OpenVSP). Basic aerodynamic data were collected using VSPAERO and integrated into a non-linear, six degrees-of-freedom simulation in MATLAB® (The MathWorks, Inc., Natick, Massachusetts). This simulation acts as a toolset to test hypotheses, evaluate the controls system, assess failure scenarios, and gain a better overall understanding of the aerodynamics and effects of a split-wing DEP design. Electric aircraft could revolutionize air transportation by providing better performance, higher efficiency, and reduced energy usage.

Christopher Morales

University of Puerto Rico - Arecibo

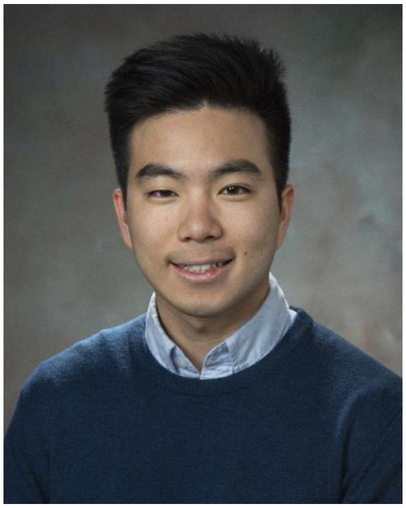
NASA Armstrong Internship Program

Undergraduate Intern
Computer Science

Mentor: Rebecca Flick and and David Tow
Code: 112
Office STEM Engagement

NASA Aeronautics in Augmented Reality

When people think of the National Aeronautics and Space Administration (NASA) they think of spacecraft, but NASA is much more than that. The NASA Armstrong Flight Research Center (AFRC) (Edwards, California) is developing an aeronautics mobile application to deliver an augmented-reality experience to the public featuring a selection of NASA aeronautics vehicles. Using a phone camera, the user is able to detect and interact with a target image display of a 3-D model of the vehicle that the user selected in the application graphical user interface (GUI). This augmented-reality experience is being accomplished using the Xcode (Apple Inc., Cupertino, California) integrated development environment (IDE). Xcode is the platform being used to create the application GUI and being built to support iOS (Apple Inc.) mobile operating systems. ARkit (Apple Inc.) consists of a set of software development tools that enable users to perform real-world actions in order to interact with the augmented-reality environment. In the augmented-reality camera, a selection of buttons will be available depending on the type of aeronautics vehicle currently displayed on the screen. Options include propeller animations, landing gear deploying and retracting, sonic-boom demonstrations and comparisons, and aircraft control surfaces movement. These interactions, along with informative pages on each vehicle, are intended to deliver an educational and unforgettable experience to users and further expand public awareness of NASA aeronautics.



Richard Red
University of Georgia

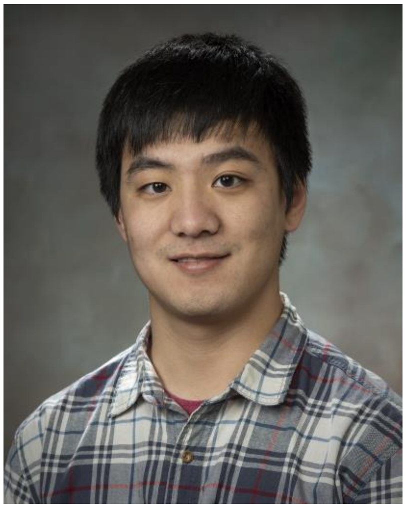
NASA Armstrong Internship Program

Undergraduate Intern
Computer Science

Mentor: David Tow
Code: 630
Simulation Engineering

Redesigning Microservices Software Architecture for the ARMD (Aeronautics Research Mission Directorate) Flight Data Portal

The National Aeronautics and Space Administration (NASA) Aeronautics Research Mission Directorate (ARMD) Flight Data Portal (AFDP) aims to directly support Flight Demonstrations and Capabilities (FDC), a flight test and research project, by improving data management so that data may be gathered and analyzed more efficiently for research purposes. Once development is complete, a consistent data analysis and management portal will serve the NASA Armstrong Flight Research Center (Edwards, California), the NASA Ames Research Center (Moffett Field, California), the NASA Glenn Research Center (Cleveland, Ohio), and the NASA Langley Research Center (Hampton, Virginia) and provide them with a vastly improved enterprise content management system. The system architecture design currently is functional but lacks scalability and maintainability. The codebase is planned to be utilized across multiple Centers for many years to come, thus it was deemed necessary to redesign the software architecture with a skeuomorphic approach by consolidating microservices into a monorepo instead of multi-repos as well as revising the current deployment methodologies. Additionally, the microservices will be individually contained so that modularity is conserved as well as improved; this approach should result in massively upgraded continuous integration / continuous delivery (CI/CD) and increased development speed in the long term.



John Rudy

LeTourneau University

NASA AFRC Internship Program

Undergraduate Intern
Mechanical Engineering/Mathematics

Mentor: Allen Parker
Code: 540
Sensors & Systems Development

FOSS System Design for Space Flight

The Fiber Optic Sensing System (FOSS) developed at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California), has proven accuracy in both flight and ground systems within the Earth's atmosphere, such as on the X-56 Maxwell all-electric aircraft; however, the technology has not been used in a vacuum environment. The primary goal of this project is to demonstrate the viability, efficiency, and economy of FOSS technology to measure temperature and strain measurements during space flights. Some components of the FOSS technology require high-voltage input, which could cause arcing and overheating in vacuum space. To overcome these potential problems, the system enclosure must be hermetically sealed and pressurized and the overall design must be able to cool down the components using conductive cooling. The system is designed and modeled in Creo Parametric 3.0 ® (PTC Inc., Needham, Massachusetts), and 3-D printed for test fitting. The first prototype unit is currently being produced at the NASA Kennedy Space Center (KSC) (Kennedy Space Center, Florida). When the prototype unit arrives at AFRC, we will conduct our own environmental testing. Four more units will be manufactured after we confirm the design according to the test result, and these units will be sent to the NASA Langley Research Center (LaRC) (Hampton, Virginia) for final qualification testing. Finally, the units will be verified by United Launch Alliance (ULA) (Centennial, Colorado) for final approval and installation.

Michael Rayvel Salazar

University of Texas Rio Grande Valley

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Jason Lechniak
Code: 520
Aerospace & Propulsion

PRANDTL Propeller Modeling & AQUIFER

The goal of the (Ludwig) PRANDTL project is to compare results of an original propeller design to an adjusted PRANDTL design. A high-performance scimitar-shape Mejzlik (Mejzlik Propellers s.r.o, Czechoslovakia) propeller is accurately measured in order to draw a 3D model in SOLIDWORKS® (Dassault Systèmes SolidWorks Corporation, Waltham, Massachusetts). The coordinates of the two-dimensional airfoil, which can be found anywhere along the propeller using SOLIDWORKS®, are then analyzed utilizing the XFOIL program (Mark Drela, Massachusetts Institute of Technology, Cambridge, Massachusetts) to calculate the pressure distribution and therefore determine the lift and drag characteristics. The data accumulated in XFOIL are then input to the XROTOR program (Mark Drela, Massachusetts Institute of Technology, Cambridge, Massachusetts), which analyzes the performance of the propeller. The propeller is then remodeled with a PRANDTL design in which the same process is used and results compared. The Aqueous, QUick-Charging Battery Integration for Electric Flight Research (AQUIFER) is an integration project of Nano-Electricfuel (NEF) flow cell batteries with Rim-Driven Motors (RDM) for improved safety, noise, charging time, and range of aircraft electric propulsion. The fuel is an aqueous solution which will provide a shortened charging time and an interchangeable design. My work includes documenting and conducting research in identifying power operations of the aircraft as well as determining what type of changes could be applied.

Dorian Thompson

Butler University, Indiana University
Purdue University Indianapolis

NASA Armstrong Internship Program

Undergraduate Intern
Computer Science,
Computer Engineering

Mentor: Aamod Samuel
Code: 630
Simulation Engineering

Mixed Reality for Flight Development

In order for pilots to collect higher quality data more efficiently, the National Aeronautics and Space Administration (NASA) is exploring the idea of using mixed reality for flight research. In particular, the overall goal is to use an Oculus Rift® Headset (Oculus VR, Menlo Park, California) along with a Zed® Camera (Stereolabs Inc., San Francisco, California) and Unity® (Unity Technologies, San Francisco, California) software to create a visual aid for pilots to use for in-flight guidance. This guidance would appear directly in the sky, instead of on a two-dimensional screen in the cockpit as it currently does. Current steps in the project include integrating mixed-reality hardware into flight simulators to prove the viability of mixed-reality systems and work on designs alongside pilots. Duties of this project include improving the implementation of the mixed reality to make it seamless, because it's common for mixed reality to cause motion sickness. Making flight more efficient would allow NASA pilots to collect more accurate data at a lower cost.

Fall 2018 Abstracts

Kyle Barnes
Antelope Valley College

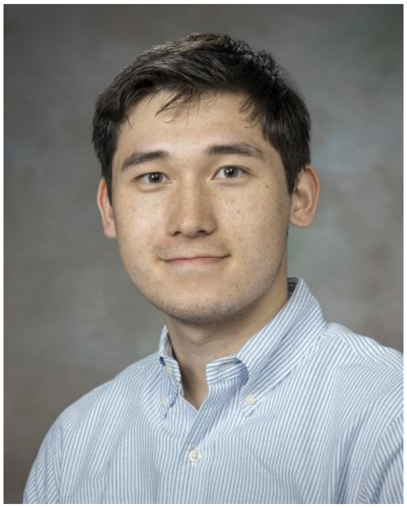
NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Allen Parker
Code: 540
Sensors and Systems Development

Fiber Optic Sensing System Space Vacuum Enclosure Design and X-56 Data Collection

The Fiber Optic Sensing System (FOSS) can determine a variety of parameters including strain, deformation, and shape. The systems provide data collection for aircraft and for ground applications. I am working on the enclosure that will allow the FOSS to determine the desired parameters for a rocket that will be sent into the vacuum of space. This work is different from past FOSS work, and thus requires a completely new design to provide electrical protection from a vacuum environment. The electronics in the system are unlikely to survive in space without the proper protections; one of these protections is to hermetically seal the enclosure as well as pressurize the box with nitrogen gas. This method would protect the system from the vacuum environment, but there are also the potential threats of overheating and vibration, either of which could damage internal FOSS components. I am working to make necessary adjustments to the enclosure that will protect the FOSS. I am also communicating with different companies toward possibly sourcing parts that might be needed for the enclosure. As well, I am representing the FOSS team on the X-56 project. The FOSS is incorporated on the X-56, and I am responsible for connecting the system to the aircraft and collecting the data at the end of each flight. The work with fiber-optic sensing continues to grow as more applications are discovered for this real-time measurement system.



George Eller
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NASA Armstrong Internship Program

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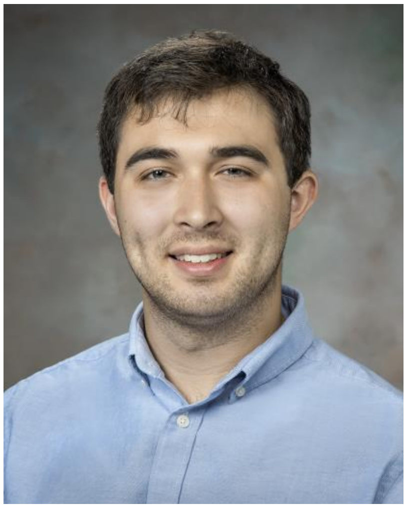
Aerodynamics and Propulsion

Automatic Triggering Through Automatic Dependent Surveillance Broadcast

Recent advances in the understanding of sonic booms has led to the development of the Low-Boom Flight Demonstrator (LBFD). This new aircraft is capable of supersonic flight without the intense sonic booms of traditional supersonic aircraft, offering the possibility of supersonic flight over populated areas without the associated irritation and damage sonic booms can cause. Tests must be conducted in populated areas to ensure that the reduced noise level is acceptable. Tests have been conducted in the past with measuring equipment either manually operated or recorded on a buffer and automatically saved when a sonic boom was detected. Deploying a large team is cumbersome, however, and the low-intensity boom is difficult to discern from background noise, thus, a new system is needed that can reliably record acoustic data from the LBFD. Automatic Dependent Surveillance-Broadcast (ADS-B) is a system used in many aircraft to broadcast flight data from satellite navigation for tracking purposes. This system can be adapted for use in conjunction with acoustic equipment to record the acoustic data of the LBFD. This system can potentially be used in the testing of all future low-boom commercial aircraft. With An installed ADS-B system offers a convenient method of ground-station tracking, and greater situational awareness for ground teams can be produced through the live data feed and real-time graphing of data with no need for large infrastructure.



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Sensors & Systems Development

FOSS Printed Circuit Board Power Design

Fiber Optic Sensing System (FOSS) technology developed at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) is currently being developed to replace traditional electronic sensors. The FOSS technology enables accurately and quickly acquiring sensing data at a more granular level. Multiple devices using a variety of techniques for data collection are being developed in the FOSS laboratory. Next-generation FOSS technology is focusing on reducing the overall size of the system while introducing it to more challenging environments and keeping costs down. Another goal of the FOSS laboratory is to keep power consumption at a minimum. The FOSS power boards are designed in-house as a measure to keep costs down and to ensure the boards are system-specific. The boards are made using the computer-aided design (CAD) software program EAGLE® (Autodesk, Inc., San Rafael, California) and printed on the laboratory-printed circuit-board mill. Further development and research of these systems are planned to continue to reduce system size by considering Advanced RISC (Reduced Instruction Set Computer) Machine (ARM) Architecture processors due to their low power-consumption envelope, and integrate into a Linux environment.

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Systems Engineering for the PRANDTL-D 3c Aircraft

As the Preliminary Research Aerodynamic Design to Lower Drag (PRANDTL-D) project continues to collect pressure and strain data on its research aircraft, a need has developed for a more reliable data acquisition system (DAQ) and for an upgrade to the current pitot-static tube. The new DAQ has been developed, but must now be tested and verified on the aircraft. The system must reliably collect data from the suite of sensors onboard the aircraft (pressure transducers, string potentiometers, et cetera) while being rugged enough to withstand the g-forces and temperature range of the flights. The new air data probe gives the capability to measure more accurate data due to its mounting position and additional alpha-beta vanes. The pressure transducers used for the old pitot-static tube can be reused for the new air data probe, however, the potentiometers that record the position of the vanes must be calibrated. A rate table was used to obtain a data set of voltages and correlated angles; this data set became the basis for a linear model that will be used to post-process the data recorded by the new DAQ. After both systems have been tested and verified, the aircraft will continue to fly and collect more aerodynamic data.

Jonathan Lopez
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Sensors & Systems
Development

WDM System for Flight Application

The conventional Fiber Optic Sensing System (FOSS) Optical Frequency Domain Reflectometry (OFDR) technology that is currently being developed at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) is equipped with hardware that allows high-speed data acquisition from its optical fibers with 1000 sensors in a single fiber. Some of tradeoffs seen in the OFDR system involve the considerable size and high cost of the system, and, in some cases, limited integration in flight-test applications in which the high number of sensors per fiber might not be necessary. The Wavelength Division Multiplexing (WDM) will be key for cases in which fewer sensors are acceptable and efficient.. The goal of the WDM FOSS focuses on redesigning the system in order to reduce both the system size and cost by using smaller and less costly solutions without compromising the overall performance of the conventional OFDR FOSS. The WDM system will consist of 10 sensor fibers rather than the conventional 1000 sensor fibers. The outcome of the simpler fiber system will be reduced cost and much faster sample rates at 5-35 kHz. The reduced cost and size, and the high performance of the WDM FOSS can lead to a higher integration in flight-testing, where its capabilities can further demonstrate this potentially game-changing technology.

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NASA Aeronautics Augmented Reality App

To increase outreach and awareness of aeronautics within the National Aeronautics and Space Administration (NASA), a mobile application is being developed to deliver an augmented-reality experience to the public, featuring a selection of NASA aeronautics vehicles. The application was previously built using Vuforia™ (PTC Inc., Needham, Massachusetts) software development kit (SDK). Vuforia™ relies on a target image to perform the augmented reality features, using a card with a custom image as the target and spawning the model on top of it. The objective now is to replace the Vuforia™ SDK with Google ARCore (Google LLC, Mountain View, California). The ARCore SDK allows the user to perform the augmented-reality feature without relying on the image target. ARCore requires a flat surface that can be either vertically or horizontally oriented. The user would no longer be dependent on the card to use the application and would have more three-dimensional space in which to add features that couldn't be added using Vuforia. The application is being implemented using a video-game engine called Unity3D (Unity Technologies, San Francisco, California) to create the augmented-reality environment. The aircraft models that are featured in the application include the X-59 Low Boom Flight Demonstrator, the X-57 Maxwell, and the Gulfstream III. The application creates an environment that allows the user to animate aspects of the models to enhance their knowledge of NASA research. The final application will be called "Aeronautics AR" and be available for download from NASA applications, Google Play, and the Apple Store (Apple Inc., Cupertino, California).

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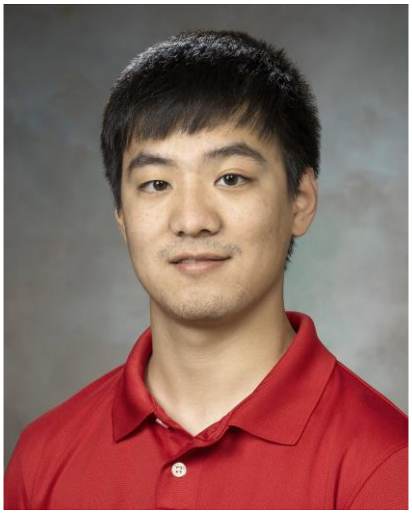
Aerodynamics & Propulsion

NPSS Microturbine Engine Model for Hybrid Electric Propulsion

The NASA Armstrong Flight Research Center (AFRC) is currently conducting research on electric propulsion technologies through the Hybrid Electric Integrated Systems Test-Bed (HEIST) project. The goal of the HEIST project is to research distributed electric propulsion by emphasizing precise motor control as well as overall efficiency for engines and aircraft. The HEIST propulsion team was tasked with selecting and modeling a turbo-generator that feeds power into a hybrid system of batteries and a distributed bank of motors. The Numerical Propulsion System Simulation (NPSS) is an advanced aero-thermo simulation language developed by NASA in conjunction with the Arnold Engineering Development Complex (Arnold Air Force Base, Tennessee), Honeywell International Incorporated (Morristown, New Jersey), Rolls Royce-Allison (Indianapolis, Indiana), The Boeing Company (Chicago, Illinois), General Electric (Boston, Massachusetts), and Pratt & Whitney (East Hartford, Connecticut). The NPSS enables modeling and simulation of entire propulsion systems in order to study steady-state and transient engine performance and behavior under desired flight conditions. A Capstone C65 microturbine engine (Capstone Turbine Corporation, Chatsworth, California) was chosen by the HEIST team and is currently being modeled using NPSS. The C65 model is performing promisingly and is being integrated into MATLAB®-Simulink® (The MathWorks, Inc., Natick, Massachusetts) using the NPSS S-Function to enable compatible simulation with battery and control system models. The model will provide predictions for the real-time testing of the entire hybrid electric system with future plans to be connected to a flight simulator.



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LeTourneau University

NASA Armstrong Internship Program

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Sensors & Systems Development

FOSS System Design for Space Flight

The Fiber Optics Sensing System (FOSS), developed at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California), has proven its accuracy in both flight and ground systems within the atmosphere, on aircraft such as the X56; however, the system has not been used in a vacuum environment. The primary goal of this project is to demonstrate the viability, efficiency, and economics of FOSS technology to successfully obtain temperature and strain measurements during space flights. Some components in the FOSS require high-voltage input, which could cause arcing and overheating in vacuum space. Preventing these potential problems requires the system enclosure to be hermetically sealed and pressurized and the overall design capable of cooling down the components by way of conductive cooling. The NASA Kennedy Space Center (KSC) (Kennedy Space Center, Florida) and the Langley Research Center (LaRC) (Hampton, Virginia) are currently conducting thermal and environmental testing, respectively, and the vibration testing for some components will be conducted at AFRC. The system is designed and modeled in Creo Parametric 3.0® (PTC Inc., Needham, Massachusetts), and 3-D printed for test fitting. The enclosure and housing will be manufactured when the design has passed all testing, and then sent to United Launch Alliance (ULA) (Centennial, Colorado) for final approval.

Thank You
Fiscal Year 2019 Mentors

John Atherley
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Kurtis Long
Victor Loera
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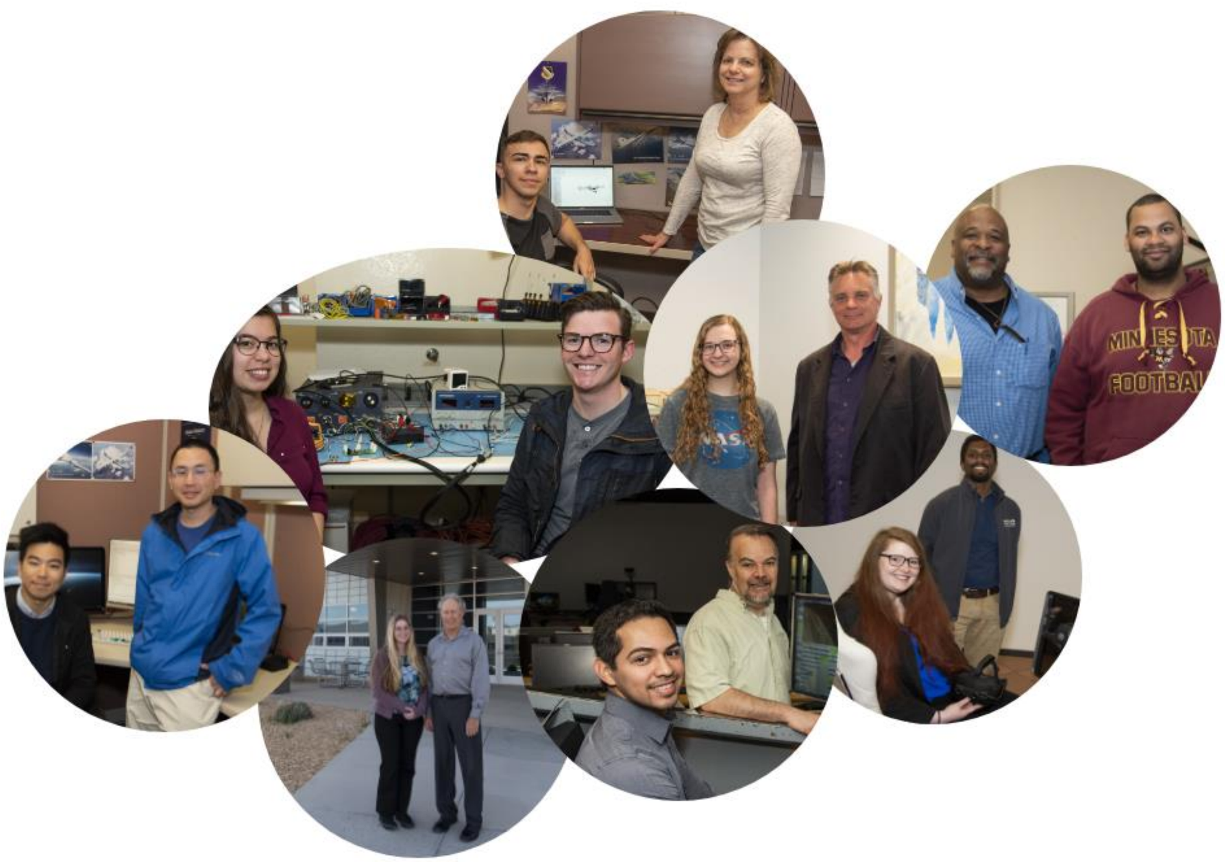

Autographs

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