A Message from the Center Director

Congratulations to the NASA Armstrong Flight Research Center Fiscal Year 2018 Student Programs cohort! You all survived the heat in the Mojave Desert and you contributed in our mission of advancing technology and science through flight.

I am pleased to see students like you—educated in the STEM disciplines of science, technology, engineering and mathematics— excited and curious about the world around them. You are the keys to America's technological leadership and economic growth in the 21st century. A widening gap remains between the need for scientists, engineers, and other technically skilled workers, and the available supply. This crisis has the potential to affect U.S. global competitiveness, industrial base, and national economy. 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 for such work through your experiences here at NASA Armstrong, and we have benefited from your participation.

As Alan C. Kay of Apple said, "The best way to predict the future is to invent it." That is our mission, and that is your assignment.
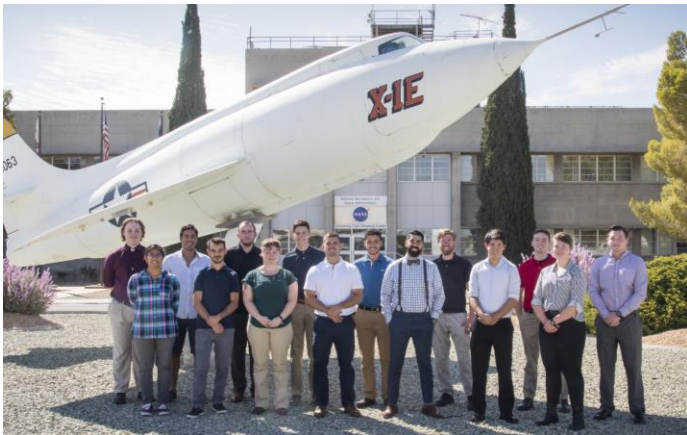
David D. McBride
Center Director

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 2018, 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), STEM Education and Accountability Projects (SEAP), Minority University Research and Education Projects (MUREP), MUREP Community College Curriculum Improvement (MC3I), Space Grant Consortia in Arizona, Arkansas, New York, and South Dakota, and National Science Foundation Centers of Research Excellence in Science and Technology (NSF CREST).

Table of Contents

Summer 2018

Table of Contents

Summer 2018 Abstracts

Olivia Alexander
California State University Channel Islands

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mathematics

Mentor: Steve Sterk
Code: 800
Chief Financial Officer

Predictive Analysis for Future X-plane Programs

As a tax-funded agency, the National Aeronautics and Space Administration (NASA) continually faces budgetary limitations. Therefore, the efficient use of funds must be supported by better record-keeping and more accurate cost and schedule estimations. Accurate estimations help managers understand critical cost-risk information, which improves their perception of the impact project changes have on the budget and schedule. These perceptions have long-term effects on the productivity and success of NASA programs. This research project examined buffer reserves, a key aspect of cost estimation. All NASA programs have cost and schedule buffers built into their baseline project budgets. However, even with these buffers, many projects still exceed both their cost and schedule. The main focus of this project was to utilize historical data to calculate the extent to which NASA programs typically exceed their original buffers. This supplemental buffer was calculated by mining, classifying, and analyzing historical X-plane cost and schedule data. Historical X-plane schedule setbacks were classified then analyzed to determine the frequency, probability, mean duration, and project phase placement of each setback class. Historical cost data was analyzed to determine project cost residuals and burn rates. The cost and schedule outputs were then combined to find a mean percentage of buffer exceedance. This buffer addition was applied to a notional flight research project (NFRP) to determine what the buffer percentage would be and its impact on cost if NASA cost estimators were to consider historical project occurrences along with future risk projections.

Erin Askins
Rensselaer Polytechnic Institute

NASA Armstrong Internship Program

Undergraduate Intern
Major: Civil Engineering

Mentor: Albion Bowers
Code: 500
Research & Engineering

Systems Integration and Pressure Testing on PRANDTL-D3c

The Preliminary Research AerodyNamic Design To Lower Drag (PRANDTL-D 3c) is a low altitude flying wing that utilizes Ludwig Prandtl's theory of bell-shaped spanload and rudderless flight. The type of lift distribution needed is achievable utilizing a slight twist of the wings. PRANDTL-D 3c is also able to demonstrate proverse yaw: the ability of an aircraft to yaw in the same direction that it is rolling. This lift distribution and proverse yaw allow for a stable, efficient, controllable aircraft without the need of a vertical tail. The aircraft is operated remotely by two control surfaces: one on either wing. In order to prove Prandtl's theory, we are using a system called Electronic Pressure Measurement (EPM) to measure the pressure and lift over the wing. These measurements are possible due to 89 ports on the left wing of the aircraft and a series of microcontrollers that turn the pressure readings into valuable data. The data are then sent via Ethernet cable to a Raspberry Pi for storage. Our on-board computer collects data such as airspeed, orientation, and static and dynamic pressure which is used to supplement EPM data. By analyzing these data, we hope to prove that the aircraft is creating sufficient lift while reducing drag. By combining the pressure data with the stress and strain data from last summer, we will hopefully be able to prove and demonstrate Prandtl's theory.

Kyle Barnes
Antelope Valley College

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering

Mentor: Allen Parker
Code: 540
Sensors & Systems Development

Development of Fiber Optics Sensing System Thermal Tuning Laser Control Circuit Board

The Fiber Optic Sensing System (FOSS) can measure strain, bend, temperature, and other measurements, all using a laser that is directed through fibers. This laser is only operable at a steady 25 degrees Celsius temperature, and this needs to be kept consistent as the laser is put into different heated and cooled environments. My project consisted of creating a control circuit board that can keep the laser set at this temperature using the flow of current through a thermal electric cooler (TEC) that is attached to the laser. Depending on the direction of the flow of current, one side of the thermal electric cooler will heat up, and one side would cool down. The design of my circuit board was created on Eagle, a printed circuit board (PCB) design program, and was then printed and assembled so that we had a working prototype. This circuit board is connected to an Arduino, and through the program written on the Arduino, the currents going through the TEC will alternate with changing amperage to create a sweeping temperature, and in turn, sweeping wavelengths. Through analyzing these wavelengths, we can determine what wavelength we have and what wavelength we need, and make the necessary adjustments. With this technology, these adjustments will take place on their own without any personal interaction from a person. This project extends past the FOSS work solely on aircraft; it can be used in many other settings and situations as our work with fiber optics continues.

Josh Barrett
John Brown University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical
Engineering

Mentor: David Berger
Code: 112
Office of Education

Environmental Test Fabrication: PRANDTL-M Release Mechanisms

The goal of the PRANDTL-M (Preliminary Research AerodyNamic Design to Land on Mars) is to fly in the Martian atmosphere using a small glider to topographically map potential landing sites. A unique element of this project is the pursuit of using a tailless vehicle to achieve more efficient flight. The design will keep the glider between certain speeds to ensure stable flight. The Martian atmosphere is much thinner than Earth, so in order to test the glider for operational success, flights near 100,000 feet above ground level (AGL) have to be completed. There are multiple factors to be considered in this challenge, such as temperature, weight, material behavior, telemetry, and more. Servos (motors that operate the elevons) have to be environmentally tested in -70˚ Fahrenheit situations and low atmospheric pressures to verify functional operation considering the freezing of gears and long term flight behavior. Environmental chambers do not permit enough space to do a flight simulation, so there will be a weather balloon drop from a high altitude to simulate the Martian environment. In order to utilize this method, there are specific flight requirements. It is necessary to create cradles for the different gliders, manufacture parts to create a dependable release mechanism, and add in the necessary electronics to keep the glider prepped, warm, and functioning before it is released from the weather balloon.

Ryan Beattie
University of California, Irvine

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical
Engineering

Mentor: David Berger
Code: 112
Office of Education

Fabrication and Environmental Chamber Testing for PRANDTL-M

Named after the initial research done by Ludwig Prandtl, the Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) is a new type of wing inspired by birds that aims to reinvent aerodynamic design for years to come. Compared to flying wings of the past, this new design will allow the National Aeronautics and Space Administration (NASA) to fly in atmospheres that are much less dense than Earth's. Therefore, PRANDTL-M will allow NASA to advance its mission of planetary exploration by obtaining valuable data on the Martian atmosphere. Flight in the Martian atmosphere presents a unique set of challenges, such as extremely cold temperatures and a very low atmospheric pressure. This is where the Environmental Chamber Tests (ECT) comes in. The ECT is a 6 by 6 by 6 foot enclosure capable of going to a low of -100° F or a high of 500° F as well as change pressure. To conduct the tests, an apparatus needed to be designed for the components that control PRANDTL-M in flight. This apparatus will be used to test the components under various configurations in the ECT to ensure continuous operation at Martian temperatures and pressures. Separate from the ECT, a gondola needed to be designed that will release the PRANDTL-M from a weather balloon for an eventual test flight at 125,000 feet above ground level (AGL). The gondola platform will act as the cubesat container that will release the PRANDTL-M on its final descent into the upper Martian atmosphere. As such it must insulate, heat, and power the PRANDTL-M until the moment of release.

Robert Bloom
Victor Valley College

NASA Armstrong Internship Program

**Undergraduate Intern
Major: Mechanical
Engineering**

**Mentors:
Michael Butros, Larry Cliatt, and
Edward Haering
Code: 520
Aerodynamics & Propulsion**

Sonic Booms in Atmospheric Turbulence

The Sonic Booms in Atmospheric Turbulence (SonicBAT) effort aims to assist in the development and implementation of commercial supersonic flights. Numerous flight tests were conducted under various atmospheric conditions at the Armstrong Flight Research Center and Kennedy Space Center. The resulting data were used to develop and validate a numeric turbulence model and a classic turbulence model in order to allow for predicting the effects of atmospheric turbulence on the loudness of shaped sonic booms. In addition, using MATLAB (The MathWorks, Inc., Natick, Massachusetts), the data obtained during the flight tests were analyzed through various statistical methods in order to investigate the extent to which atmospheric turbulence effects sonic boom loudness, to quantify the change in loudness due to turbulence, and to discern how much weather data are needed for future turbulence testing. Ultimately, quantifying the effects of atmospheric turbulence on sonic boom loudness will assist in allowing the Federal Aviation Administration and the International Civil Aviation Organization to specify a maximum allowable loudness for supersonic commercial flight travel.

Nathaniel Boisjolie-Gair
North Dakota State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering

Mentor: Al Bowers
Code: 500
Research & Engineering

Integration of the Electronic Pressure Measurement System on PRANDTL-D 3c

The purpose of this project is to successfully install the Electronic Pressure Measurement (EPM) system on the Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D 3c). By doing so, pressures across the wing will be recorded, confirming PRANDTL- D 3c flies using a Gaussian distribution of lift along the wing rather than the conventional elliptical lift distribution. As a result, proverse yaw is created instead of adverse yaw. Prior to installation, the 96 pressure transducers required validation testing to be sure they measured pressure in per square inch gauge (PSIG) both accurately and precisely. A pressure device was created using a polyvinyl chloride (PVC) pipe as the manifold and a water manometer as the gauge. The pressure transducers were subjected to both positive and negative pressures of 5 in. H2O then the data points in PSIG were graphed against time. After adjusting the initial y-intercept offset and calibration, it was clear each pressure transducer measured PSIG remarkably well to a high degree of accuracy. Next, a shock dampening mounting board was created to mount EPM to PRANDTL-D 3c using foam feet attached to the EPM to absorb force upon landing. The feet were then attached to a board mounted on PRANDTL-D 3c. The pressure transducers were then attached to their prospective ports along the PRANDTL-D 3c wing. The EPM was tested again by directing airflow from a fan along the wing of the aircraft and later spot checking each of the ports by applying a small pressure delivered by a syringe. The next step is to test the EPM during flight. Upon a successful flight, the EPM will record the in-flight pressures along the wing which will confirm or disprove the theory behind PRANDTL-D 3c.

Michael Cantos
University of California, Irvine

NASA Armstrong Internship Program

Graduate Intern
Major: Electrical
Engineering

Mentor: Alaric Sessions
Code: 630
Simulation Engineering

F-18 Simulation Electric Stick Conversion

At the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC), flight simulators are used to research the system response of an aircraft in various environmental conditions. The Cockpit Interface System (CIS) is the main interface between simulations and nearly all the devices in the cockpit. A major subsystem of the CIS is the Simulation Electric Stick (SES). The SES is a force feedback control system that produces the feel that a pilot would experience in an actual aircraft. The SES used in the F-18 (McDonnell Douglas, now The Boeing Company, Chicago, Illinois) simulator was installed in the early 90s and is mainly built of NASA Armstrong manufactured analog circuitry. Electrical components can be hard to procure and therefore maintenance becomes a timely and costly task. This cost issue motivated NASA AFRC to design and develop the Simulation Electric Stick II (SESII). The SESII design improves maintenance and sustainability through greater use of commercial off the shelf products. It has been my assignment to convert the F-18 SES to the SESII. This includes identifying the necessary hardware for the conversion, creating lists of materials that will need to be procured or manufactured (cables, controllers, preamplifiers, et cetera) and ultimately creating design packages for each manufactured item and a Configuration Change Request (CCR) in order to have the modification carried out.

Thomas Cauvel
Rochester Institute of Technology

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical
Engineering

Mentor: Ethan Nieman
Code: 550
Flight Instrumentation &
Systems Integration

Airvolt Testing

The X-57 Maxwell (ESAero, San Luis Obispo, California) is the National Aeronautics and Space Administration's (NASA)'s first attempt at a fully electric airplane design. This concepts is being designed to help improve aircraft efficiency, lower emissions, and reduce noise. The full implementation of the X-57 aircraft has not been completed, with the current stage waiting on the verification of the two large cruise motors. These will be the main method of propulsion for the aircraft. Cruise motor endurance testing is currently underway on Airvolt, which is an electric motor test stand fitted with sensors to measure the performance and stability of the motor under test. These endurance tests involve running the stand-mounted motors for several hours and collecting the data for later analysis to ensure that the motors are flight-ready. This analysis is especially important as the electric motors are an untested technology. These tests generate a large quantity of data, which researchers must analyze quickly to make judgements about the project. Unfortunately, the format in which the raw data are captured is not immediately usable in the software that researchers use for analysis, MATLAB (The MathWorks, Inc., Natick, Massachusetts). For that reason, Technical Data Management Streaming (TDMS) Analyzing Tools (TAT) are being developed to allow researchers to make their analyses quicker and easier, and hopefully speed up the process of validating motors under test.

14

Aubrey Coffey
Agnes Scott College; Georgia Tech

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mathematics;
Physics

Mentor: Ricardo Arteaga
Code: 540
Sensors & Systems
Development

Enhanced Automatic Dependent Surveillance – Broadcast for Supersonic Situational Awareness

The Federal Aviation Administration (FAA) mandated in 2010 that all aircraft in U.S. airspace support Automatic Dependent Surveillance-Broadcast (ADS-B) Out by 2020. ADS-B Out is a technology in which aircraft broadcast their locations in real-time. ADS-B In is a simple technology which listens to ADS-B Out broadcasts sent from other aircraft, and which may supply those broadcasts to another system such as an electronic flight book (EFB). Our team is implementing the first ever enhanced ADS-B In/Out system for supersonic flight and testing it at supersonic speeds on F-18 aircraft (McDonnell Douglas, now The Boeing Company, Chicago, Illinois). Our team is improving ADS-B In software to support improved situational awareness and flight tracking and trajectory prediction at supersonic speeds. In addition, we are developing machine learning tooling for both computer vision and flight trajectory prediction applications. The machine learning tooling for computer vision will be incorporated into future work for emergency response with unmanned aerial vehicles (UAVs). Our team is also collaborating with the Low Boom Flight Demonstrator project so that our ADS-B Out broadcast can be used to trigger the Low Boom microphones to record sonic booms when the aircraft is sufficiently nearby. Finally, we are collaborating with the FAA in order to simulate the efficacy of our ADS-B unit for future aircraft such as rockets and space vehicles using the F-18 aircraft, and to test the efficacy of 10Hz ADS-B broadcasting (over 1Hz, the current standard) to meet the FAA mandated performance.

Todd Coursey

Naval Post Graduate School, Monterey CA

NASA Armstrong Internship Program

Graduate Intern
Masters in Applied Physics

Mentor: Mr. Allen R. Parker
Code: 540
Sensors & Systems Development

Fiber Optic Sensing System in Cryogenic Temperatures

Fiber Bragg gratings (FBG) cause periodic changes in the index of refraction of light as it travels along the length of a fiber optic cable. Light passing through a fiber with a FBG sensor will transmit with little to no reflection losses unless the wavelength of light meets a phase matching condition, in which case the light is reflected. FBG does have thermal sensitivity proportional to its thermal expansion coefficient (TEC), which effects reflected wavelengths. FBG sensors have many advantages over traditional thermal measuring devices; they are unaffected by electro-magnetic interference, lightweight, and have multiplexing capability. However, because the TEC of the sensor (silica glass) becomes insignificant at low temperatures, the sensors have extremely diminishing sensitivity in cryogenic environments. If FBG sensors are attached to a substrate material with a higher TEC, the sensors might become a viable option for monitoring cryogenic systems, such as in spacecraft using liquid hydrogen-oxygen rocket engines. In this experiment we will examine the change in thermal sensitivity of multiple FBG sensors by attaching them to various types of substrate and submerging them into a cryogenic environment. Substrate examined are polytetrafluoroethylene (PTFE), teflon, and polyether ether ketone (PEEK) which have a high potential for thermal expansion and are relatively inexpensive to retrofit.

Kai B. Creason
Embry-Riddle Aeronautical University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aerospace
Engineering

Mentor: Albion Bowers
Code: 500
Research & Engineering

Pitot Tube Integration for PRANDTL-D 3c

The Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D 3c) project is a low-altitude, lightweight glider designed based on Ludwig Prandtl's theory of the bell span load and rudderless flight. In previous PRANDTL-D 3c flights, the pitot tube was mounted to the aircraft via a wood block and applied with thermoplastic adhesive using a hot glue gun. This mounting system was occasionally problematic because it was susceptible to breaking on flight days. When the PRANDTL-D 3c team would work near the aircraft, they would risk accidentally making physical contact with the pitot tube and breaking the hot glue bond. These incidents would waste valuable time and required the hot glue gun to warm up to remount the wood block. My job was to figure out a new way to mount the pitot tube along with a way to quickly mount and dismount the tube. Working collaboratively as a team, I ended up completing my task with another intern and we solved the problem with magnets and additional wood. Once that was implemented, we worked on getting a proper pitot boom with alpha and beta veins. Since that process has finished, I have been working on making a mount and 3-D printing prototypes slowly improving the prototype with each iteration.

Nicholas Cross
New Mexico State University

NASA Armstrong Internship Program

Undergraduate Intern
Majors: Mechanical &
Aerospace Engineering

Mentor: Allen Parker
Code: 540
Sensors & Systems
Development

Development and Fabrication of next generation Fiber Optic Sensing System Enclosures

The Fiber Optic Sensing System (FOSS) is a next generation technology for what is known as the copper strain gauge. However, as more development is put into the FOSS, more capabilities need to be tested for and verified. This process leads to the need for newer systems and an assembly to protect and maintain the system as a whole. A few systems needing assembly and enclosures are the Wavelength-Division Multiplexing System (WDM), redesign for the micro-FOSS, and a redesign of the cFOSS flight box system to convert over to a micro-FOSS system. All the designs and fabrication of these systems go through a series of steps. First, the system components are recreated in computer aided design software along with an enclosure to be designed to fit within the parameter of the system, optimizing for the smallest size while preserving the life of the components and for ease of maintenance. The models are then 3-D printed and tested for fit checking and tolerance. Once the design is finalized, the files associated with the enclosure files are then quoted and sent off to a third party manufacturing firm to be fabricated out of aluminum and anodized. When the parts are mailed back to NASA's Armstrong Flight Research Center, the system and enclosure is assembled and then sent off to laboratory or flight testing.

Evan Cusato
Olin College of Engineering

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering

Mentor: Matthew Moholt
Code: 560
Aerostructures

Spanwise Adaptive Wing Design, Advocacy, and Operations

Shape memory alloys are a rapidly-growing, lightweight actuation technology, with the potential to dramatically reshape aircraft design boundaries. The Spanwise Adaptive Wing project (SAW) is a coordinated program among multiple National Aeronautics and Space Administration (NASA) Centers and industry partners to explore the mechanical capabilities of shape memory alloys and the potential benefits of their application to aerospace engineering design. SAW is currently flight testing a shape memory alloy actuation system to fold the outboard wing sections of the Prototype-Technology Evaluation and Research Aircraft (PTERA) in flight. With the actuators, PTERA has shown improvements in stability and control, leading to higher performance. This application could be scaled to larger aircraft. My goal is to develop a mechanical and graphical display to demonstrate the value of shape memory alloys as a useful technology in the aerospace industry. The physical demonstrations highlight the specific work output, versatility, and applicability of shape memory alloy technology. By demonstrating these aspects, the mechanical systems will provide viewers with an improved understanding of shape memory alloy technology and argue for the importance of shape memory alloy research. When completed, the display will be stationed in the Flight Loads Laboratory for use as an education and advocacy tool.

Alexander DeShields
Prairie View A&M University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical
Engineering

Mentor: Allen Parker
Code: 540
Sensors & Systems
Development

Data Analysis and Lab-Unit Design for Fiber Optic Sensing Systems

Fiber Optic Sensing Systems (FOSS) allow for real time tracking of change in a system's parameters. FOSS's current applications in aviation are most notable at the National Aeronautics and Space Administration (NASA)'s Armstrong Flight Research Center (AFRC). NASA AFRC's X-56 Multi-Use Technology Testbed (MUTT) utilizes flexible wings. Flexible wings allow for less air resistance, which increases velocity and acceleration capabilities while reducing fuel consumption. On this experimental aircraft, FOSS has the ability to sense and display stresses on the aircraft's flexible wing in order to counteract and suppress flutter. Accurate real time stress analysis is essential for commercial integration of flexible wings. FOSS is a lightweight alternative that will soon replace conventional methods of analyzing stress and will allow for reliable commercial integration of flexible wings. My work includes tracking data and ensuring it's accuracy in pursuit of optimizing the system's reliability. Laboratory testing of FOSS is as important as it's field testing. The secondary part of my work revolves around designing a lab unit for housing the fiber optic system. Because this unit will be used for a magnitude of laboratory experiments, the components of the unit must be accessible and interchangeable. An easily manageable lab unit will allow for continual development and optimization of system sensing.

Nicholas Farrell
Irvine Valley College

NASA Armstrong Internship Program

Undergraduate Intern
Majors: Electrical and
Computer Engineering

Mentor: Dave Berger
Code: 112
Office of Education

Avionics System Design

Designing an avionics system for the first glider on Mars starts 120,000 feet above the Armstrong Flight Research Center. System parameters are defined utilizing data gathered through previous research. Avionics package with a very small and flexible footprint must operate within below zero temperatures. Applying bleeding edge manufacturing techniques, a ridged-flexible primary printed circuit board (PCB) is constructed using embedded passive elements. This allows for a form factor which adapts to the aircrafts unique surface while minimizing component footprint density. The application of embedded passives also allows for encapsulated heating elements conducting within layers of the PCB. Targeted internal thermals equate to lower power consumption as this method does not depend on convection in thin atmosphere. A complex power architect compensates for battery voltage sag with an efficient buck-boost switched-mode power supply (SMPS), power sequencing hardware flow control, FMU/IO power management, and hot-swappable source selection. The system autonomously selects between internal battery, gondola power, or ground power. Inbuilt FMU/IO or commercial off-the-shelf (COTS) autopilots have electromagnetic interference (EMI) Filtering and Transient Protection on I/O and peripherals.

Mihai Adrian Floarea
The University of Tennessee, Knoxville

NASA Armstrong Internship Program

Graduate Intern
Major: Aerospace
Engineering

Mentors: Chris Kostyk and
Timothy Risch
Code: 560
Aerostructures

Heat Flux Mapping System utilizing High Density Infrared Heaters

High-speed aircraft entering the regime of hypersonic flight experience intense thermal loading incident on the leading edge and along the span of their wing surfaces. Due to the nature of the physics of compressible flows, the extreme temperatures induced at these velocities pose a concerning threat to the structural integrity of the aircraft flying in this regime. Therefore, the ability of determining a vehicle's response to extreme temperatures is of paramount importance. Scientists and engineers in the Flight Loads Laboratory (FLL) seek to simulate these thermal loads in ground testing to evaluate an aircrafts ability to withstand these thermal loads in flight. The Heat Flux Mapping System (HFMS) was developed to understand and analyze how heat flux is distributed and imparted on a test article when introduced to thermal energy emitted from high density infrared, quartz filament, heaters. The mission of this effort is to not only obtain a clear and accurate understanding of the behavioral characteristics in the distribution of heat flux, but to also have a mastered comprehension of the quartz lamp heaters themselves and their influence on the imparted heat flux. The success of this effort will pave the way for future complex configurations of lamps that will accurately simulate real, in-flight, hypersonic scenarios, and the thermal loading experienced by an aircraft.
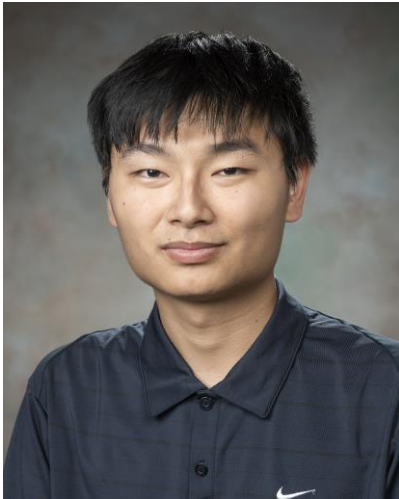
Tomoki T. Fukazawa
University of California, Los Angeles

NASA Armstrong Internship Program

Undergraduate Intern
Major: Computer Science and Eng.

Mentor: Albion Bowers
Code: 500
Research & Engineering

PRANDTL-D3c Flight Data Acquisition System Optimization

When designing a data acquisition (DAQ) system, one important factor is its usability. In order to allow researchers to easily obtain reliable data, DAQ's should be simple to operate and maintain. The current DAQ onboard the Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D 3c) glider uses a microcontroller which collects various flight data through sensors (such as acceleration and static pressure) and stores them in a micro SD card. The purpose of this research is to further improve the usability of DAQ in three ways; better optimization, easier operation, and additional documentation. First, the specification of the microcontroller will be studied in further detail to devise a fully optimized code, allowing faster run times and flexible sensor reconfigurations. This includes direct manipulation of I/O registers, revised code structures, et cetera. Second, a new interface will be designed to allow easier access to DAQ settings and commands. Some planned new features include sensor status indicators and a "monitor" mode for sensor calibration. Third, all of the optimizations and features will be documented in full detail. The documentation will contain enough information to allow future interns to fix bugs or implement new features if necessary. Altogether, these improvements should allow easier, more efficient data collection in the PRANDTL-D 3c research process.

Daniel Gagnon
California State University, San Bernardino

NASA Armstrong Internship Program

Undergraduate Intern
Major: Applied Physics

Mentor: Kurt Kloesel
Code: 520
Aerodynamics & Propulsion

MATLAB/Simulink programming of the Texas Instruments F28379 motor controller

One of the goals for the X-57 Maxwell (ESAero, San Luis Obispo, California) project is to reduce fuel consumption at cruising speed. One measure taken to achieve this is the choice of an aerodynamic wing with a short chord length which reduces overall drag. The currently proposed motors require large nacelle pods which when mounted on the wings will increase drag and decrease fuel efficiency. The proposed solution to this is to design a motor that will better fit the shape of the wing and will improve the performance of the X-57 aircraft. This proposed motor will need to be custom made for the X-57 aircraft. However, preliminary work in the area of motor control can be done with a set of smaller diameter permanent magnet synchronous motors (PMSM) connected to a single driveshaft to emulate this new motor. The planned control method for these motors is field oriented control (FOC). FOC was chosen because it is a sensorless approach and will reduce the amount of feedback sensors needed in the aircraft and still allows precise control of the motors. This method of control is being explored by programming a Texas Instruments F28379 (Texas Instruments Inc., Dallas, Texas) motor controller using both Simulink (The MathWorks, Inc., Natick, Massachusetts) and MATLAB (The MathWorks, Inc., Natick, Massachusetts).

Emily Glover
Georgia Institute of Technology

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aerospace Engineering

Mentor: David Berger
Code: 112
Office of Education

PRANDTL-M Modeling for Stability and Control

The goal of the Preliminary Research AerodyNamic Design to Land on Mars (PRANDTL-M) is to design and test a glider that can be used to collect atmospheric and ground mapping data on Mars. The aerodynamic design of this project focuses on correcting the lift distribution on the wing to match Ludwig Prandtl's bell shaped curve lift distribution that was published in 1933. Prandtl's theory veered away from the traditional elliptical lift distribution to correct for adverse yaw without a vertical tail. Previously, the majority of the aerodynamic calculations were conducted through Athena Vortex Lattice (AVL) which is a 2-dimensional aerodynamic analysis tool. Recently, there was a need to use a program called Open Vehicle Sketch Pad (OpenVSP) to create a three dimensional model of the glider so that the simulation of PRANDTL-M is more accurate. These two types of models are now used to verify their accuracy relative to the manufactured PRANDTL-M. A new feature to both computational models is the addition of the control surfaces. By adding the elevons to the models, trim can be calculated along a range of altitudes and dihedral angles which will facilitate a better understanding the control system and the optimization of the wing design of the PRANDTL-M.

Caleb Gott
Desert Christian High School

NASA Armstrong Internship Program

High School Intern
Desired Major:
Aeronautical
Sciences/Criminal Justice

Mentor: Allen Parker
Code: 540 Branch
Sensors & Systems
Development

Limiting Wing Flutter Using Unmanned Aerial Vehicles

Wing flutter on an airplane can become catastrophic and end in a fatal crash of the aircraft. The goal of the X-56 aircraft is to use the flexible-wing aircraft design to analyze wing flutter, in order to ultimately remove any danger of wing flutter. The Fiber Optic Sensing System (FOSS) provides, in incredible amounts of data, the position of the wings, showing at what points the wings were under strain. Using the fiber-optic technology can prove great dividend in the ultimate goal of an aircraft without any danger of wing flutter. Additionally, while trying to eliminate possible wing-flutter on aircraft, using the X-56 aircraft allows for simultaneous advancement in the field of unmanned aerial vehicles (UAVs). Using UAVs for testing eliminates the risk of fatal danger to a pilot. Furthermore, UAVs provide unique abilities as a result of lighter weight and the absence of an in-aircraft pilot. In addition, the limitations of the aircraft become solely based on the aircraft's capabilities, as opposed to also being limited by the human weaknesses and restrictions presented in flight. Conclusively, without the fear of wing flutter on an aircraft, the designs of aircraft will rapidly change, as previous limitations, such as wing length, no longer prove to be a concern.

Kevin Guerra

California State Polytechnic University, Pomona

NASA Armstrong Internship Program

Undergraduate Intern
Major: Computer Engineering

Mentor: David Berger
Code: 112
Office of Education

Developing an Environmental Test for the Servos of the PRANDTL-M Glider

The Preliminary Research AerodyNamic Design to Land on Mars or PRANDTL-M is a small light-weight glider that is being designed to become the first airplane on Mars. The goal of PRANDTL-M is to be able to collect data from the atmosphere on Mars. As the aircraft descends, the data collected will allow the National Aeronautics and Space Administration (NASA) to better understand the Martian atmosphere. This project faces challenges that exist in both the glider's size and the environmental conditions which exist on Mars. To prepare for this challenge, various parts of the glider must be tested in extreme conditions that the glider may face upon its descent. This translates to Earth-based testing that includes a height of approximately 125,000 feet and temperatures as cold as -70° Fahrenheit. One major concern is how the servos will behave under these conditions. As a result, the servos must be tested using an environmental chamber so the glider can be equipped with the necessary materials to fly. When tested, the servos will be controlled through the use of an Arduino and configured in three ways- without grease, with grease designed to match low temperature needs, and the original manufactured configuration. The results of these tests will reveal which configuration will match the needs of the final glider.

Rachel Haering
California State University, Long Beach

NASA Armstrong Internship Program

Undergraduate Intern
Major: English

Mentor: Laura Fobel
Code: 570
Research Engineering
Operations

Supporting Technology Development at the Armstrong Flight Research Center

The goal of the Technology Transfer Office (TTO) at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) is to aid employees in reporting, protecting, and licensing the technologies they develop in the course of their work, in order to ensure that the public benefits from AFRC's research. To help achieve this goal, my task is to make a number of improvements to the day-to-day operations of the office. My three major projects are improving the peer review form for the evaluation of new technologies, so that subject matter experts can make a better assessment of their technical feasibility; creating a brochure to explain the process of software release, in order to make it more common throughout the center; and writing articles for the TTO newsletter, to increase awareness of past and present innovations at AFRC and to highlight outstanding inventors. I am also working on Technology Opportunity Sheets (TOPS) describing AFRC inventions and their benefits to be presented to potential industry licensees and partners, and designing an updated banner for the TTO's website. By expanding access to and increasing awareness of TTO programs, the hope is that more AFRC personnel will be encouraged to report their innovations, and NASA's positive footprint on the country and the world will increase.

Katelyn Hanks
Texas A&M University, Corpus Christi

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering

Mentor: Jason Lechniak
Code: 520
Aerodynamics & Propulsion

Aerodynamic Modeling and Simulation of a Towed Glider Air Launch System

The Towed Glider Air Launch System (TGALS) could provide a more efficient way of transporting and releasing rockets, or other payloads. The TGALS serves the purpose of being able to launch payloads from a system that can be reused for multiple missions. This system is expected to decrease the cost of launching compared to ground launches, while also increasing the payload capacity and number of locations the aircraft can be launched from. The development of the TGALS is still in progress and has had significant improvements made to the model through Open Vehicle Sketch Pad (OpenVSP) and Athena Vortex Lattice (AVL). The aerodynamic models obtained from AVL and OpenVSP were compared to each other to check and verify the consistencies. The results of the models from OpenVSP are further verified through a flight simulation capability. Each simulator flight of the TGALS is evaluated by pilots, and the model and/or concept of operations is iteratively improved. Each flight is evaluated to find the optimal flight patterns and determine if improvements need to be made to the air vehicle's design.

Stephen Harris
John Brown University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical
Engineering

Mentor: Albion Bowers
Code: 500
Research & Engineering

Electronic Pressure Measurement (EPM) System for PRANDTL-D 3c and In Flight Measurement

The Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D 3c) is a project based on Ludwig Prandtl's 1933 theory on bell shaped spanload and proverse yaw. The PRANDTL-D 3c is a lightweight and low-altitude glider that aims to lower drag and increase controllability without the use of a vertical tail. In order to prove Prandtl's theory, it is important to know what the pressures are along the different parts of the aircraft's wing. The Electronic Pressure Measurement (EPM) system is designed to collect pressures from different ports along the wing of an aircraft. By performing flight testing with the EPM aboard PRANDTL-D 3c, we will gather data that proves a bell shaped lift distribution is present. To get the EPM flight ready, we had to ensure that it operated correctly, had a post-processing program that gave useful data, and integrated it into the aircraft. In addition to EPM, a game controller is being looked at to measure the angle of attack, angle of side slip, and the deflection of the elevons. The controller has two analog outputs which can take in-flight analog data and transfer it to digital through the use of an iPhone and software, removing the need for an Arduino and giving useful flight data.

Victoria Hawkins

Embry Riddle Aeronautical University

NASA Armstrong Internship Program

Graduate Intern
Major: Unmanned and
Autonomous Systems
Engineering

Mentor: Dave Berger and
Albion Bowers
Code: 112
Office of Education

PRANDTL-D / PRANDTL-M 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 Preliminary Research AerodyNamic Design to Land on Mars, or PRANDTL-M, takes the same baseline design and applies it to a smaller wingspan. The goal of PRANDTL-M is to develop an autonomous glider to fly over the surface of Mars, collecting topographical images of potential landing sites. PRANDTL-D 3c is working to install a system to collect pressure data along the wing of the aircraft during flight which will prove the bell-shaped spanload. Ensuring the aircraft was safe and ready to fly involved organizing a tech brief for a new flight request, confirming the Center of Gravity, running a Combined Systems Test before flight, and conducting flight day operations. PRANDTL-M is working to conduct flight tests with various aerodynamic and control system configurations, which required development of flight plans and running flight day operations. The aircraft's avionics need to be tested at an atmosphere similar to Mars. To achieve this, an environmental chamber test was developed and run to check the durability and efficiency of the PRANDTL-M hardware at certain conditions, including the maximum altitude and the most extreme cold temperature the aircraft could experience during flight. In addition, a full system architecture and analysis was created to detail PRANDTL-M's concept of operations and mission requirements.

Hayden Hollenbeck
Virginia Tech

NASA Armstrong Internship Program

Undergraduate Intern
Majors: Physics,
Mathematics

Mentor: Marlin Pickett
Code: 630
Simulation Engineering

HDF5 Support for the Core Simulation

The Simulations Engineering branch at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) developed the Core simulation to model aircraft flight. Core uses data gathered from flights to model aircraft as accurately as possible. When first developed, the Core simulation used the Dryden Time History (DTH) file format to read and record data. DTH was first developed and implemented at Armstrong, but lacked universality in its format. To overcome this issue, Core simulation adopted primitive support for the Hierarchical Data Format 5 (HDF5) file format, which was more widely supported. HDF5 also supports easier configuration and access of file metadata, which is critical to future projects involving the Core simulation. To fully support HDF5, the Core simulation must be thread safe to allow multiple concurrent file input and output (I/O). Furthermore, the files must also be compressed without the I/O performance affecting the simulation runtime. Due to the slow speeds of disk I/O, separate threads were created to buffer I/O calls without causing overruns or underruns, allowing the Core simulation to maintain its hard-real time constraints. The goal of file compression was achieved with a final file size 30% that of the original file size.

Zachary Houghton
Victor Valley College

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering

Mentor: Kia Miller
Code: 560
Aerostructures

DC-8 ND-Max Data Analysis and PAT Wing GVT Support

During the ND-Max project, a collaboration between the National Aeronautics and Space Administration (NASA) and the German Aerospace Center (DLR), NASA's DC-8 aircraft flew into the contrails of DLR's Airbus A320 aircraft in order to evaluate the efficiency of various alternative jet fuels. Because of concerns about a wingtip vortex funneling effect potentially interacting with the airframe of the DC-8 during these flights, the aircraft was fitted with accelerometers in order to record the dynamic behavior of the airframe while flying through the contrails of the lead aircraft. The data was intentionally oversampled during these flights, leading to very large file sizes. Through the use of signal processing techniques, the data will be reprocessed in order to reduce its overall size, while still retaining the information that is of interest. Further frequency analysis of the data will then be conducted in order to gain insight into whether or not the vortex funneling effect interacted with the natural frequencies of the DC-8. This analysis will provide critical insight into whether or not the DC-8 experienced any resonance during these flights, and will assist with dynamic assessments for future flights. Additional work will be conducted preparing for and supporting the ground vibration test (GVT) of the Passive Aeroelastic Tailored Wing (PAT Wing) project.

Deborah Jackson

Embry-Riddle Aeronautical University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aerospace
Engineering

Mentor: Albion H. Bowers
Code: 500
Research & Engineering

Integration and Post-Processing of EPM on PRANDTL-D 3c

Currently, aerodynamic adverse yaw is offset by the drag produced by rudders. In 1933, Ludwig Prandtl proposed a bell-shaped lift distribution as an alternative to the elliptical spanload and a solution to adverse yaw. The bell spanload produces proverse yaw and, as a result, is capable of improving overall efficiency by 11 percent. To further demonstrate the viability of this theory, the Electronic Pressure Measurement (EPM) system will collect the pressures experienced by the Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D 3c) unmanned aerial vehicle (UAV) during flight. In addition to integrating and testing EPM with PRANDTL-D 3c, I am producing code to post-process the flight data collected by EPM and the pitot tube. EPM records the differential pressure between the instrument bay and six chords distributed along the left wing. From these differential pressures, the coefficient of pressure is calculated for each chord. These coefficients of pressure demonstrate the change in pressure distribution across PRANDTL-D 3c's uniquely twisted wing. Furthermore, the sectional and total coefficients of lift is calculated from the differential pressures to reveal the bell-shaped load distribution. These aerodynamic coefficients will complete previously collected data to demonstrate the bell spanload, existence of proverse yaw, eliminate the need for rudders, and increase efficiency.

Christopher Jensen

Embry-Riddle Aeronautical University, Prescott

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering

Mentor: Albion Bowers
Code: 500
Research & Engineering

Electronic Pressure Measurement of PRANDTL-D

The Preliminary Research AerodyNamic Design To Lower Drag (PRANDTL-D 3c) is a remote-controlled, flying wing glider. The main objective of PRANDTL-D 3c is to prove Ludwig Prandtl's 1933 theory that an aircraft designed with a bell-shaped span load will be more efficient than one with a traditional, elliptical span load. The Prandtl design also eliminates the need for a vertical tail or rudder, as the bell span load demonstrates proverse yaw. The presence of this bell-shaped span load can be verified by measuring the pressure distribution over the surface of the wing. The Electronic Pressure Measurement (EPM) system we are utilizing uses individual pressure transducers to measure pressure data at 86 points along the wing 20 times per second. Before the EPM can start recording flight data, each transducer needs to be tested for functionality and then calibrated. I have so far been responsible for designing and conducting calibration tests for the pressure transducers, and using MATLAB® (The MathWorks Inc., Natick, Massachusetts) to apply the calibrations to the output of each transducer. The resulting data can be used to verify the presence of a bell-shaped span load, and confirm Prandtl's theory.

Abigail Kosiak
Utah State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Statistics and
International Business

Mentor: Steve Sterk
Code: 800
Chief Financial Officer

Predictive Analysis: Using Historical Cost and Schedule Data to Predict Cost Risk for Future NASA Programs

As a tax-funded agency, the National Aeronautics and Space Administration (NASA) continually faces budgetary limitations. Therefore, the efficient use of funds must be supported by better record-keeping and more accurate cost and schedule estimations. Accurate estimations help managers understand critical cost-risk information, which improves their perception of the impact project changes have on the budget and schedule. These perceptions have long-term effects on the productivity and success of NASA programs. This research project examined buffer reserves, a key aspect of cost estimation. All NASA programs have cost and schedule buffers built into their baseline project budgets. However, even with these buffers, many projects still exceed both their cost and schedule. The main focus of this project was to utilize historical data to calculate the extent to which NASA programs typically exceed their original buffers. This supplemental buffer was calculated by mining, classifying, and analyzing historical X-plane cost and schedule data. Historical X-plane schedule setbacks were classified then analyzed to determine the frequency, probability, mean duration, and project phase placement of each setback class. Historical cost data was analyzed to determine project cost residuals and burn rates. The cost and schedule outputs were then combined to find a mean percentage of buffer exceedance. This buffer addition was applied to a notional flight research project (NFRP) to determine what the buffer percentage would be and its impact on cost if NASA cost estimators were to consider historical project occurrences along with future risk projections.

Macie Kowalski

Edmonds Community College

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aerospace
Engineering

Mentor: David Berger
Code: 112
Office of Education

PRANDTL-M Environmental Testing and Simulation

The Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) (PM) project aims to become the first glider to fly in the Martian atmosphere. It uses Ludwig Prandtl's theorized non-elliptical lift distribution caused by a non-linear geometric twist along the wingspan of the glider to overcome the effects of adverse yaw during flight. This project offers the National Aeronautics and Space Administration (NASA) the opportunity to advance planetary exploration and secure never before acquired data on the Martian atmosphere. In order to test the effectiveness of the PM glider, it is necessary to simulate the environment in which it will be flying to ensure that the onboard components will continue to function properly. To do that, it must be tested in an environmental chamber where the temperature is lowered to -70°F and the pressure is dropped to simulate Earth's atmosphere at 120,000 ft. Another aspect of this internship is to develop system identification (ID) tools which allow the building of mathematical models that represent the dynamics of the vehicle during flight. System identification is another method for validating the effectiveness of the glider's design by which we can simulate flights with specified maneuvers and retrieve flight data.

Stephen Lantin
University of California, Santa Barbara

NASA Armstrong Internship Program

Undergraduate Intern
Chemical Engineering

Mentor: Kurt Kloesel
Code: RA
Aerodynamics & Propulsion

Hardware-in-the-Loop (HIL) Simulation of an Electric Propulsion System

In the pursuit of safe and sustainable aviation, the National Aeronautics and Space Administration is exploring electric propulsion technologies for the next generation of commuter aircraft. While the prospect of electric flight is not new, the technology has remained in its infancy due to low power density and efficiency losses. To overcome these limitations, the Hybrid-Electric Integrated Systems Testbed (HEIST) project is developing lighter, more efficient wings by employing three-phase motors and propellers in experimental designs. Integral to such designs is the hardware-in-the-loop (HIL) simulation, an approach to development and testing, which aims to interface a mathematical model of the system with physical hardware. HIL expands the scope of testing to include failure regimes that may be dangerous and expensive to test otherwise and allows for the design of codependent subsystems in parallel, decreasing development time. In this project, an HIL simulation is developed on Simulink (The MathWorks, Inc., Natick, Massachusetts), interfacing a control scheme designed at LaunchPoint Technologies (LaunchPoint Technologies Inc., Hollister, California) with an embedded system and motor. C code representing the controller can be generated and ported out for use in other HIL simulations for HEIST motor prototyping.

Jonathan Lokos

California State Polytechnic University,
San Luis Obispo

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical
Engineering

Mentor: Allen Parker
Code: 540
Sensors & Systems
Development

Liquid Metal Strain Gauge Modular Enclosure Development

In the engineering industry, it is often necessary to augment computer models and hand calculations with experimental stress measurements. This is done with devices known as "strain gauges". Strain is a unitless quantity of change-in-length/original-length that relates to stress through the elasticity of the material. Traditional strain gauges use a thin metal wire bonded to the test article in question. Electricity flows through the wire and as the test article stretches (and thus the wire) the resistance of the wire increases by a measurable amount. These traditional instruments have been used for a long time but they have one critical draw back: they can only stretch small distances. For applications that require large amounts of stretch, a new device has been created call the Liquid Metal Strain Gauge or LMSG. LMSGs use an elastic band impregnated with mercury that can stretch just like a rubber band in order to measure large strains. My task has been to create a modular enclosure to hold a variable number of LMSG microcontroller boards. To accomplish this each board is given a "frame" that is designed to nest into the frame above and below it to create a stack of up to nine micro controllers. Each frame is also equipped with "feet" on each corner with alternating high and low orientations. This allows each stack to attach to its neighboring stack creating a single large unit containing as many microcontrollers as are needed.

Brooke Losey
Columbia College Hollywood

NASA Armstrong Internship Program

Undergraduate Intern
Major: Cinematography

Mentor: Steve Parcel
Code: 640
Information Systems

Video Production and Archive Preservation

Working alongside the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) video production team, it is our job to seek knowledge and stories that we can pass onto others. Whether it be videos of flight tests, a recording of children talking to the International Space Station (ISS), or activities around AFRC, all this footage documents the past and tells the story of Armstrong. In my short time here, I focused on the Low Boom Flight Demonstrator Project (LBFD). Beginning with researching sonic boom testing out at here at Edwards as well as interviewing people involved with the new X-59 Quiet Supersonic Transport (QueSST) testing. I also integrated model photography to showcase this aircraft. From there, I edited a story to enlighten a wider audience on one of the many upcoming NASA projects. Along with my personal project, I helped preserve stories of the past by uploading videos to a local server so that future editors will have more of an array of footage and material at their fingertips. During my time here I was able to add another piece to the puzzle that is the history of NASA and the Armstrong Flight Research Center.

Moises Martinez
University of California, Santa Cruz

NASA Armstrong Internship Program

Undergraduate Intern
Majors: Computer
Science & Engineering

Mentor: Jason Holland
Code: 630
Software Engineer

Unity Game Engine, Attractor, and Coresim

The Simulation Branch at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) is planning to work more with the Attractor Framework created by the NASA Langley Research Center. AFRC's goal is to utilize and research the potential of the Attractor Framework for future Core simulator projects. To contribute to this goal, I am assigned three tasks and they will all involve the Unity game engine and the C# programming language. The first project involves creating a Unity environment that represents AFRC and the Edwards Air Force Base (EAFB). The purpose of this is for Unity to receive data from Coresim and replicate the simulation. To do this, the data would be passed via User Datagram Protocol (UDP) to Response to Intervention (RTI) Framework. RTI then posts any announcements and updates for the Unity environment to read. Once the data is collected, Unity will then display visuals corresponding to the simulated aircraft in real time. This leads to the second task, which takes the Unity environment from a monitor screen to Augmented Reality using the Microsoft HoloLens (Microsoft Corporation, Redmond, Washington). The implementation of the HoloLens will enable users to view the simulation in physical space. Documentation and a timeline chart will also be written to provide future developers with information on implementation. The final task is to implement a telemetry data collector for further analysis. The data collector tool will be the CloudTurbine real-time streaming tool that I have helped build during my last internship at AFRC. To do this, I will build and introduce a new specification panel for the CloudTurbine software in order to convert the collected data into HDF5 format.   My contribution helps NASA improve familiarity with extended reality, which allows them to discover new opportunities with augmented reality and the Unity game engine.

Mark Matlack
Lake Area Technical Institute

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aviation Maintenance

Mentor: Herman Rijkogel
Code: 470
Aircraft Maintenance

Aviation Mechanic and Parts Machinist

The objective of my job at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) is to maintain the aircraft. This involves making the necessary parts for the flight research that is conducted at the facility and around the world. Maintenance responsibilities change daily, but team members participate in tasks ranging from large engine changes to checking the air pressure in tires. We also preflight, launch, and recover aircraft on a daily basis. In the fabrication shop, we make the required components (designed internally by NASA engineers) needed to complete their research projects. Some of these parts machined include new landing gear for the micro cub in the model shop, a lens locking lever for the Stratospheric Observatory For Infrared Astronomy (SOFIA), and various fixtures for the flight load testing lab. These parts are made on various machines including both manual and computer numerical controlled (CNC) mills and lathes. The machines are often required to make airworthy parts with extremely tight tolerances within a margin of error of 0.0005%. The accuracy and materials with which parts are made must be safe to fly at high speeds and be tolerant of the hot weather at AFRC. In the end, the most simple way to describe my job is working with engineers, machines, and mechanics to make sure that the experiments that are run are accomplished, most of all, safely but also as timely and as efficiently as possible.

Danielle Meisner
Syracuse University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Physics

Mentor: Steve Foster
Code: 710
Safety & Mission Assurance

Quality Assurance of the X-57 Aircraft

The X-57 Maxwell (ESAero, San Luis Obispo, California) is an experimental aircraft with the goal of lowering energy use by five times at high speed cruise. This aircraft is currently in production through a contractor, and specialized components, such as the electric motors, are being built. The National Aeronautics and Space Administration (NASA) oversight with contract work is required throughout the development of the X-57 aircraft. The Quality Assurance Branch is responsible for the surveillance and inspection of all aircraft and processes to ensure airworthiness of aircraft and a positive safety culture at the center. Surveillance is currently being conducted on multiple systems throughout the build-up of the aircraft. Some current aircraft project activities that require Quality Assurance oversight include Cruise Motor Endurance Testing on the Airvolt test stand, Distributed Electric Propulsion wing development and fabrication, and modification of the baseline aircraft to an electric system. Quality Assurance is also involved with planning of ground and flight testing and the development of maintenance requirements. The Quality Assurance Branch involvement through the entire aircraft development process helps to ensure that the NASA safety culture is maintained through engineering design, fabrication, and modification of systems.

Patrick Noerr

California State University,
San Bernardino

NASA Armstrong Internship Program

Undergraduate Intern
Major: Physics

Mentor: Kurt Kloesel
Code: 520
Aerodynamics & Propulsion

Modeling the Capstone C65 turbo-engine

Numerical Propulsion Simulation Software (NPSS) is a National Aeronautics and Space Administration (NASA) developed thermodynamic simulator that is capable of accurately modeling both steady state and transient solutions of turbo-generator engines. At the boundaries of these transient solutions, regenerative properties of these engines emerge and hybrid fuel efficient technology becomes available. NPSS can execute variable condition predictive iterative simulations that can quickly determine the feasibility of a prospective build and the relevant crucial testing states. With this rapid-fire modeling capability, NPSS is sure to ultimately provide the quickest, cheapest, and most thorough route to assembling the optimal combination of hardware for producing the highest performance system. Once integrated into a Simulink (The MathWorks, Inc., Natick, Massachusetts) model, the NPSS modeled turbo-generator can be represented by a simple S-Function block that acts as a component in a larger dynamic electric propulsion system. A Hybrid Electric Integrated Systems Test (HEIST) can then append these optimized systems onto the framework of live flight simulation, by providing thermal control, contingency management, energy optimization, and run time flight safety, in order to further predict the dynamic response of a future distributed hybrid electric plane.

Mark Noftz

University of Illinois at
Urbana-Champaign

NASA Armstrong Internship Program

**Undergraduate Intern
Major: Mechanical
Engineering**

**Mentor: Dr. Chan-gi Pak
Code: 560
Aerostructures**

Aerostructure Test Wing Analysis – Object Oriented Optimization

The onset of aerodynamic flutter often occurs rapidly and with little warning, and the subsequent structural failure usually results in the catastrophic loss of a wing. Thus, it is imperative for flight engineers and aircraft designers to classify the flutter boundaries on experimental wings and set limits on the Mach-altitude envelope for an aircraft. Aerostructure Test Wing flutter arises from the coupling of the first (bending) and second (torsional) modes when a wing's aeroelastic frequencies converge at a determined critical velocity. Ground vibration tests (GVTs) permit the classification of these inherent natural frequencies, along with damping characteristics and mode shapes, from a test article. Computer based simulations using Finite Element Analysis (FEA) provide powerful tools to analyze new designs, but they rarely provide results coincident with GVTs. A new optimization-based model tuning tool, developed by Dr. Chan-gi Pak, allows users to tweak selected design characteristics of FEA models to better represent the experimental mode shapes, mass distributions, and natural frequencies extracted from GVT data. Using NASTRAN (The MacNeal-Schwendler Corporation, Newport Beach, California) and object-oriented optimization codes, my duties are to tweak the FEA models of two test wings, one traditional and one with unconventional curvilinear spar-ribs, and align them with GVT results. Understanding the dynamic behavior of aerostructures remains a critical component to validating aircraft flight worthiness, and this job plays directly into supporting The National Aeronautics and Space Administration Armstrong Flight Research Center flight research mission.

Kasai Omar

The University of Texas at San Antonio

NASA Armstrong Internship Program

Undergraduate Intern
Major: Computer Engineering

Mentor: Allen Parker
Code: 540
Sensors & Systems Development

Field-Programmable Gate Array (FPGA) System Design of the Fiber Optic Sensing System (FOSS) Thermally Tuned Laser

Real-time acquisition of measurements such as vibration, pressure, strain, and temperature is paramount in the operation and safety of the National Aeronautics and Space Administration's equipment and personnel. The Fiber Optic Sensing System (FOSS) team at the Armstrong Flight Research Center provides novel approaches to real-time data monitoring of such measurements from a wide variety of systems. Among the different systems developed by the FOSS team, the Thermally Tuned Laser is a highly more accessible instrument that provides most of the same functionality as other FOSS instruments. Acquiring data from the fiber optic sensors is accomplished by using multiple high-speed analog-to-digital converters (ADCs) over multiple synchronous Serial Peripheral Interface (SPI) protocol channels. Once these data are acquired, the Field-Programmable Gate Array (FPGA) then communicates with the other platforms in the system for the processing of the fiber optic sensor data. My role in the development of the Thermally Tuned Laser consists of utilizing hardware description and mid-level languages to complete the layout of the FPGA and its configurable interfacing with the multiple fiber optic sensors. As a result, the Thermally Tuned Laser system will provide a state-of-the-art method to achieve high quality data acquisition at a fraction of the required resources.

Joycelin Orellana

Oregon State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Computer Science

Mentor: Michael Ritchson
Code: 630
Simulation Engineering

Developing a System Level Automation Test Framework for the ARMD Flight Data Portal (AFDP)

The Aeronautics Research Mission Directorate (ARMD) Flight Data Portal (AFDP) seeks to increase accessibility of flight data and related documents through a web-based Java Enterprise architecture. AFDP requires a systems-level automated test framework in order to test the system for regression and acceptance. In order to create this framework, a trade study of browser automation tools will be utilized to analyze and compare popular tools. After selecting a tool, a framework consisting of the browser automation test scripts, an object repository, a functions library, a reporting component, and a log delivery system will be created. The framework will obtain scripts either locally or remotely through the eXist database, connect with the selected browser automation test tool, run the test scripts against a browser such as Internet Explorer or Firefox, then store the results either locally or remotely in the eXist database. The use of this framework will increase efficiency when developing, adding new features, or performing regression testing because it will be a one-stop-shop for running multiple tests quickly and automatically without manual input. This will ultimately help AFDP to become a cross-center platform for flight data research and management.

Trevor Parmely
Lake Area Technical Institute

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aviation
Maintenance Technology

Mentor: Walter Kondracki
Code: 470
Aircraft Maintenance

F-15 Supersonic Research Aircraft

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) is currently modifying an F-15 aircraft (McDonnell Douglas, now The Boeing Company, Chicago, Illinois) with a nose probe with the idea to validate the probe itself along with the data collected on test flights. The nose probe is intended for the X-59 QueSST (Lockheed Martin, Bethesda, Maryland). Two years ago test flights were flown with the probe attached to the centerline of the F-15 aircraft. These flights resulted in suitable data and will be performed again to verify. I became involved in the project when the F-15 aircraft was partially through a maintenance cycle. The task of properly removing and installing various engine components such as; Digital Electronic Engine Control (DEEC), Engine to Airframe Manifold (ETAM), and Power Takeoff (PTO) shaft on the aircraft was given to me. During the maintenance cycle there was a check made for any new Time Compliance Technical Orders (TCTO) on the F-15 aircraft. If the final test results of the probe flown on the F-15 aircraft are good the probe will be installed on the X-59 QueSST. Working on a project that will contribute to NASA's future X-plane has been a phenomenal experience!

Michael Vincent Raymer

Oklahoma State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aerospace &
Mechanical Engineering

Mentor: Tiffany Titus
Code: 430
Operations Engineering

Operations Engineering – Beechcraft B200

The Operations Engineer's mission is to provide sound engineering to ensure airworthiness throughout planning, integration, and flight of unique systems and vehicles. The Armstrong Flight Research Center (AFRC) owns and operates two B200 King Air aircraft (Beechcraft, Wichita, Kansas). These research/support platforms have a wide range of mission capabilities that are utilized to serve the needs of engineers, pilots, and scientists. A successful flight mission is dependent on planning and accomplishing tasks effectively throughout the project lifecycle. Some of these tasks are overseeing aircraft modifications, meeting with B200 King Air key personnel, writing flight cards, configuration control logistics, Tech Briefs, maintenance, modifications, and flight operations. One permanent modification completed is the Autonomous Mission & Experimenter Power Switch (AMEPS). This sensor relay system autonomously cuts power to science equipment in the event of sudden cabin pressure loss. This summer, after a formal Tech Brief and a ground test, an unpressurized Operational Test Flight was required to test the Pressure Sensor Switch in AMEPS. Due to the risk of hypoxia during unpressurized flight, the cooperation between the Operations Engineer, Pilots, Life Support, and Safety Officials was crucial. The AMEPS system was installed for AirBOS4, an AFRC project developing technology to identify deviations of the X-59 QueSST (Lockheed Martin, Bethesda, Maryland). Another technology being flown on the B200 aircraft is DopplerScatt, an instrument capable of taking simultaneous measurements of ocean vector currents and winds. DopplerScatt is comprised of a rotating antenna, position encoder, and a 100W Solid State Amplified radio frequency component, all integrated into the B200 King Air's cabin and fuselage. This science platform is creating a foundation for next-generation spaceborne Earth Science Missions that will enable mankind to better understand the Earth's climate, weather, and ocean. The B200 King Air's cabin effectiveness in helping AFRC and benefiting society is much accredited to its Ops Engineer.

Daniel Rosales
California State University, Fullerton

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Kurt Papathakis
Code: 550
Flight Instrumentation &
Systems Integration

Hybrid-Electric and Electric Aircraft Research and Technologies

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) is developing technologies and conducting research to improve hybrid-electric and electric propulsion systems which will reduce energy consumption and emissions of aircraft. These innovations align with the strategic thrusts of "Ultra-Efficient Commercial Vehicles" and "Transition to Low-Carbon Propulsion" of the NASA Aeronautics Research Mission Directorate (ARMD). Research obtained from the Hybrid-Electric Integrated Systems Testbed (HEIST) and the development of the X-57 Maxwell (ESAero, San Luis Obispo, California) experimental aircraft are paramount to the understanding of electric and hybrid-electric propulsion systems. By taking part in the HEIST project and documenting the Failure Modes Effects and Analysis, the architecture of the project was built and viable failure scenarios were taken into account. Through this, it was possible to foresee certain failures and take into account the intensity of those failures. As a Test Engineer and Test Data Analyst, the cruise motors being implemented on the X-57 Maxwell aircraft had to be fully inspected and tested which was accomplished with the utilization of the Airvolt Test Stand. The results of these tests led the X-57 team to distinguish any discrepancies and take any actions as needed. Thus, by developing documents for the HEIST project and testing motors for the X-57 Maxwell aircraft, it was possible to take part in objective 2.1 of the 2015 NASA Armstrong Strategic Plan to "explore and develop efficient air transportation systems technologies and bring them to flight."
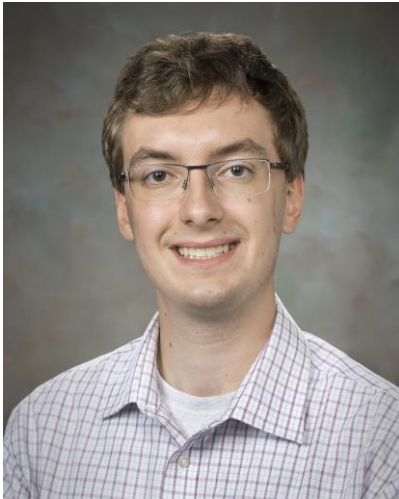
Paul Sampson
Northern Michigan University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Computer
Science/Math

Mentor: Laura Fobel
Code: 570
Research Engineering
Operations

Ground Collision Avoidance System Terrain Compression Algorithm

The National Aeronautics and Space Administration (NASA) Ground Collision Avoidance System (GCAS) is an aircraft safety system that prevents controlled flight into terrain (CFIT). To do this, GCAS compares the aircraft's position and course to an onboard terrain map. If the course would lead to a collision beyond the pilot's ability to correct, GCAS takes over and steers the aircraft to safety. In order to store terrain maps of sufficient size, GCAS employs the Tile Compression Algorithm (TCA). This algorithm replaces the points of the map with a series of tiles such that each tile is within a specified error margin of the points it replaces. This algorithm was licensed by a company that will use the software to compress and decompress data acquired during oil discovery. My task was to ensure that this algorithm passed through NASA's software release process. I documented and ran all relevant functions to ensure compliance with safety standards, and met with project leads to understand the scope of the algorithm. I was also given the opportunity to apply some of the software development knowledge I acquired last year at the Armstrong Flight Research Center to writing software for the current GCAS project.

Daniel Simmons
Lake Area Technical Institute

NASA Armstrong Internship Program

**Undergraduate Intern
Major: Air Frame and
Power Plant mechanic**

**Mentor: Tom Grindle
Code: 400
Aircraft Maintenance**

Airframe and Power Plant Mechanic

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) has many airframes that are used to test everything from weather, sonic booms, loads, and more. Before any of these tests can be conducted, the aircraft must be safe for the pilot in command to operate. During my time here at AFRC, I have been helping with this process; My first task here was to help assist in repairing an F-18 engine that was damaged due to foreign object disposal (FOD). FOD is always a major safety concern and this time it compromised an important aircraft. The engine sucked in some type of hard material and damaged the main inlet guide fan blades, HPT (high pressure turbine) blade stages 6 and 7. The task at hand was to blend out any nicks or dents that could be fixed and to bore scope the entire engine to ensure no other internal damage was done. Learning how to maintain these aircraft is critical in NASA's success for all its current and future missions. These aircraft are essential for the work done at NASA AFRC. I take much pride in the fact that my work directly affects the missions here at NASA, and I look forward to what else is to come during my time here.

Jacob Smith
Kent State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aerospace Engineering

Mentor: Steffi Valkov
Code: 430
Operations Engineering

Unmanned Aircraft Systems Integration into the National Airspace System (UAS–NAS)

On June 12th, 2018, the Unmanned Aircraft Systems (UAS) integration in the National Airspace System (NAS) project took a large step forward with the Ikhana UAS, being the first UAS to fly in the NAS without a chase plane in certain airspace classes while using Detect and Avoid (DAA) technology. This was the capstone for this phase of the project, with eight years in the making. Moving forward, the project is in a transition stage, from large UAS to small UAS, less than 500 lbs. Before the flights with these small UAS can happen, a demonstration of an in-flight aerodynamic termination by simulating crossing a geo-fence will be conducted at the National Aeronautics and Space Administration Armstrong Flight Research Center, using the Dryden Remotely Operated Integrated Drone (DROID). The aero-termination settings that are used by the Piccolo autopilot (Cloud Cap Technology, Hood River, Oregon) that is installed on the DROID UAS are: full flaps, full up elevator, full right rudder, full right aileron, and cut engine. Looking at the data gathered, it will be determined how far the aircraft drifts laterally after the aero-termination has been initiated. Factors that change the lateral drift of an aircraft include aircraft dynamics, winds aloft, wind direction, altitude, and speed of aircraft. From this data, a geo-fence boundary can be created based on where the aircraft trajectory impacts the ground. For these flights, a concept of operations, flight-test plan, and flight-test cards are being created to show how the test is going to be conducted. After these flights have been performed a flight-test report will need to be written, and the Risk Reduction/Flight Test 5 tech brief will be updated to expand the geo-fence envelope of the small UAS.

Hannah Smith

University of California at Irvine

NASA Armstrong Internship Program

Undergraduate Intern
Pharmaceutical Sciences

Mentor: Lynette Jones/Allen Parker
Code: 540
Sensors & Systems Development

The Need for Laboratory Organizers at NASA

Every aerospace organization must have a laboratory to build and test their ideas or parts. In order for the engineers to build their parts, they need to use tools; however, if the laboratory is unorganized, then they cannot build what they desire and it holds up the entire production of the aircraft that the National Aeronautics and Space Administration (NASA) is working on. To solve this dilemma, there needs to be some system to organize the laboratories. Sharepoint (Microsoft Corporation, Redmond, Washington) is a system that is used to organize the labs and take inventory of all of the parts and tools inside the lab. On Sharepoint, there are multiple tabs one can click on to find what they need such as "Lab Inventory" and "Power Supplies." There is also a system that is used to check out workbenches and bigger tools. The laboratory organizers and managers have to keep Sharepoint updated and order parts if needed. They also have to make sure the laboratory cabinet and drawer labels correspond to the information that is on Sharepoint. Some appliances need to be calibrated which is also an important part of laboratory organization. Someone can look on Sharepoint to see if the device they need is being calibrated. If tools are not calibrated, then they will not work properly, which also leads to slower production. The Laboratory Organizer does not have one specific project, but many. If the laboratory is not organized, then the engineers cannot efficiently and effectively work on their tasks. This is why a Laboratory Organizer is essential to any aerospace organization, especially NASA.

Brandon Snyder
San Diego State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aerospace Engineering

Mentor: Julie Bond
Code: 720
Safety and Environmental

Safe practices for the workplace

At Armstrong Flight Research Center (AFRC), the Safety and Environmental department is responsible for regulating that employees follow established guidelines and regulations mandated by the Occupational Safety and Health Administration (OSHA), National Aeronautics and Space Administration (NASA), Environmental Protection Agency (EPA), Department of Transportation (DOT), and several compliance standards when conducting operations at NASA AFRC. Specifically speaking in terms of work accomplished with fixed and portable equipment used in areas such as Fabrication, OSHA has guidelines set that regulate how this work must be done and what precautions must be taken when performing the work. My goal for this summer internship has been to survey machines at both the AFRC and Palmdale location in regards to their forms of machine guarding. As I surveyed the various machines, I took into account data including, but not limited to, the condition of the machine, the type of guard it had equipped, the presence or lack of proper signage for Personal Protective Equipment (PPE), et cetera. I then formatted this data into an Excel (Microsoft Corporation, Redmond, Washington) document and researched whether or not each machine was within OSHA code. I found out that OSHA has a general requirement for all machines, Standard 29 CFR 1910-212, which states that, "one or more methods of machine guarding shall be provided to protect the operator and other employees in the machine area." There are also other regulations set in place that establish stricter requirements on certain machines. What I learned from this research is the importance of machine guarding and all necessary PPE that must be worn when operating this machinery. These factors utilized together as one greatly reduce the risk of injury when operating these machines while also providing a safe workplace for those who work around the machinery.

Erin Solomon
Rensselaer Polytechnic Institute

NASA Armstrong Internship Program

Undergraduate Intern
Majors: Mechanical
Engineering & Design,
Innovation and Society

Mentor: Aamod Samuel
Code: 540
Sensors & Systems
Development

Mixed Reality Tools for Flight Research

Air Background Oriented Schlieren using Celestial Objects (BOSCO) flight tests attempt to capture air flow patterns around an airplane by photographing that airplane in front of a celestial body. In this case, the celestial body is the Sun. A photo of the Sun without the plane is also taken, and the two images are compared. These images are taken by aligning the Sun, the target airplane, and a camera airplane; while both airplanes fly at supersonic speeds. Due to the airplane speeds and the amount of time the Sun is low enough on the horizon for the test to run, the window for capturing these images is extremely small. Mixed reality tools may reduce the difficulty of these maneuvers by projecting a three dimensional target into the sky, in front of the camera airplane. The target provides the pilot of the camera airplane a point of reference for their location relative to the target airplane. In this case, the target is a hollow tube which adjusts in real time to the location of the target airplane. The pilot of the camera airplane need only to fly toward, and then into, the tube to ensure the capture of the required photographs. If this technology tests well in the flight simulators, implementation in cockpits via an augmented reality headset is the next step.

Brenden Stevens
College of the Sequoias

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical Engineering and Embedded Systems

Mentor: Aamod Samuel
Code: 540
Sensors & Systems Development

Global Positioning System Tracking and Long Range Radio Networking

Very few open source software exist involving Global Positioning System (GPS) data transmission over long range radio networks. Radio is preferable over traditional cell network data transmission due to the subscription based fees that accompany sim cards and cell networks. LoRa is an open source hardware made for the Arduino and Raspberry Pi used for long range radio transmissions at high frequency and short wavelength that can reach up to 22-km line of sight. The explosion of the microcontroller market led by the Arduino and its Atmel (Atmel Corporation, San Jose, California) architecture has been paralleled by a consequently large public domain of advanced embedded hardware and software to match. Using the Arduino, GPS can be used as a peripheral data gathering device that can store its information on board. The other peripheral device connected would then be the LoRa long range communication device that will send the GPS data to a gateway. The gateway, also based on Arduino Atmel architecture, will gather data from all of the nodes or clients (Arduino/LoRA) and process the data on a personal computer. Ultimately, this combined system using cheap, low power microprocessors can be used to track a fleet of vehicles, bicycles, or other wandering objects in an energy efficient and cost efficient manner without a monthly subscription to a cell network.

Hannah Stoll
Michigan Technological University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering
Minor: Electrical Engineering

Mentor: Kurt Papathakis
Code: 550
Flight Instrumentation & Systems Integration

X-57 Maxwell (SCEPTOR) & Airvolt Electric Cruise Motor Testing

The National Aeronautics and Space Administration (NASA) is continually working to inspire people and expand human knowledge with their cunning innovation. Scalable Convergent Electric Propulsion Technology and Operations Research (SCEPTOR) is one of the cutting-edge projects making a name for itself here at the Armstrong Flight Research Center (AFRC). The X-57 Maxwell (ESAero, San Luis Obispo, California) will pave the way in industry for being the first fully electric airplane, showcasing a 5-time reduction in energy usage with zero in-flight emissions through electric propulsion airframe integration. Standards on electric cruise motors for the X-57 aircraft are being created, so that the work being done at AFRC can be referenced for future technological advances. NASA is working alongside the Federal Aviation Administration (FAA) to develop these guidelines. In order to write the standards, electric cruise motor testing is done on the Airvolt test stand. Each of the five motors will undergo an airworthiness test, while data are recorded and carefully analyzed. Getting these motors to pass testing on Airvolt is a vital task as it helps certify them as flightworthy. In parallel with this, a Failure Modes & Effects Analysis (FMEA) is in progress to assess everything that could go wrong with the system. It directly informs the user of emergency procedures and is crucial in getting to the Flight Readiness Review (FRR). Completion of this document and testing of the cruise motors on Airvolt will lead the way for the X-57 aircraft to get in the air.

Rachel Suitor
University at Buffalo

NASA Armstrong Internship Program

Undergraduate Intern
Majors: Aerospace Engineering & Mathematics

Mentor: Albion Bowers
Code: 500
Research & Engineering

PRANDTL-D Electronic Pressure Measurement Data Analysis

The Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D 3c) research project is an endeavor which aims to demonstrate the proverse yaw effects that occur on an aircraft with a non-linear wing twist. The PRANDTL-D 3c aircraft is designed to have a bell-shaped span load as detailed in a 1933 paper written by Ludwig Prandtl. Prandtl's theory showed that a bell-shaped span load would minimize drag as compared to the standard elliptical span load. To validate the theory behind the aircraft's design, tests must be conducted to collect data during flight. An Electronic Pressure Measurement (EPM) system has been developed and installed on the aircraft to collect pressure data from sensors installed at several points on the left wing of the PRANDTL-D 3c aircraft. The pressure data are then used in conjunction with Pitot tube flight data to calculate the load distribution over the wingspan during flight. The span load data calculated from pressure, as well as span load data from the strain measurements obtained with the compact Fiber Optic Sensor System, will be compared to show that the tested design matches up with the bell-shaped span load in Prandtl's theory.

Kylie Vandenson
Saint Mary's College of California

NASA Armstrong Internship Program

Undergraduate Intern
Major: Business Administration-Digital Media

Mentor: Lisa Illowsky
Code: 112
Office of Education

Coordinating the NASA Armstrong Internship Program

Engaging student learning in the subjects of Science, Technology, Engineering, and Mathematics (STEM) is a primary objective for the Office of Education at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC). Coordinating orientation for new students, actively engaging in the student onboarding process, tracking deliverables, and organizing student tours make the Student Coordinator Assistant intern a valuable asset to AFRC. Other responsibilities include organizing Brown Bag Seminars and supporting Office of Education outreach events. Additionally, the Student Coordinator Assistant Intern was responsible for ensuring completion of the intern challenge video. This internship also involved compiling and assembling the Fiscal Year 2018 Intern Experience Abstract Handbook by working closely with Graphics, the Technical Publications Office, and the Scientific and Technical Information Office. This handbook allows for the external release of information detailed by student interns. Extensive reporting was necessary by documenting student demographics and writing summaries about student activities. The results of these statistics are documented to be used in various different reports such as Armstrong Monday Management Meeting Notes and NASA Education Activity Reports.

Steven Vanderlaske
University of Michigan

NASA Armstrong Internship Program

Graduate Intern
Major: Industrial Hygiene

Mentor: Barton Henwood
Code: 700
Safety & Mission Assurance

Aviation and Occupational Safety

Working with both the Safety & Mission Assurance (S&MA) Directorate and the Industrial Hygiene Office allows me to participate in different projects and to experience a broad diversity of safety operations at the Armstrong Flight Research Center (AFRC). These various assignments afford me the opportunity to interact with people from many AFRC codes & projects, and external agencies or companies. Emergency Aircraft Data Books help emergency responders know how to rescue aircrew after a mishap while also protecting themselves from the aircraft hazards. The development of a book for each specific airframe is a team effort. This project involves crew chiefs and Life Support personnel to identify each particular threat and the appropriate method to mitigate it. The Photo Lab and the Graphics then assist to convey the information in an easily understood manner. The upcoming biennial aircraft mishap drill requires coordination with community partners to establish a simulated crash site and train with response personnel from other agencies. An in depth review of the hydrazine emergency procedures is an opportunity to exchange ideas with multiple National Aeronautics and Space Administration (NASA) centers to share best practices. This process has identified tools to increase worker protection and enhance the training experience. Each project strives to protect the safety of NASA personnel and the community.

Max von Hippel
The University of Arizona

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mathematics

Mentor: Ricardo Arteaga
Code: 540
Sensors & Systems Development

Enhanced Automatic Dependent Surveillance-Broadcast for Supersonic Situational Awareness

The Federal Aviation Administration (FAA) mandated in 2010 that all aircraft in U.S. airspace support Automatic Dependent Surveillance-Broadcast (ADS-B) Out by 2020. ADS-B Out is a technology in which aircraft broadcast their locations in real-time. ADS-B In is a simple technology which listens to ADS-B Out broadcasts sent from other aircraft, and which may supply those broadcasts to another system such as an electronic flight book (EFB). Our team is implementing the first ever enhanced ADS-B In/Out system for supersonic flight and testing it at supersonic speeds on F-18 aircraft (McDonnell Douglas, now The Boeing Company, Chicago, Illinois). Our team is improving ADS-B In software to support improved situational awareness and flight tracking and trajectory prediction at supersonic speeds. In addition, we are developing machine learning tooling for both computer vision and flight trajectory prediction applications. The machine learning tooling for computer vision will be incorporated into future work for emergency response with unmanned aerial vehicles (UAVs). Our team is also collaborating with the Low Boom Flight Demonstrator project so that our ADS-B Out broadcast can be used to trigger the Low Boom microphones to record sonic booms when the aircraft is sufficiently nearby. Finally, we are collaborating with the FAA in order to simulate the efficacy of our ADS-B unit for future aircraft such as rockets and space vehicles using the F-18 aircraft, and to test the efficacy of 10Hz ADS-B broadcasting (over 1Hz, the current standard) to meet the FAA mandated performance.

Abbigail Waddell
North Carolina A&T State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical Engineering

Mentor: Albion Bowers
Code: 500
Research & Engineering

Electronic Pressure Measurement System for PRANDTL-D 3c

Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D 3c) is an aircraft designed to research the concept of proverse yaw as a way of reducing drag. The Electronic Pressure Measurement (EPM) system will be used to measure pressure in PRANDTL-D 3c aircraft in order to collect data about how air is moving around the wings. EPM has a total of 96 pressure transducers; 89 of these have been connected to pressure ports that are located in various places across the left wing of the PRANDTL-D 3c. The system uses three Beaglebone Black microcontrollers each attached to a different printed circuit board (PCB) with 32 of the transducers to collect data from the sensors and a Raspberry Pi running a user datagram protocol (UDP) program to retrieve the data from the boards and store all the data in a singular file. The EPM system is significantly cheaper than other devices that serve the same purpose making it an effective solution for cutting overall costs. The system has been integrated on PRANDTL-D 3c and will be collecting data on the next flight. As part of the PRANDTL-D 3c research, EPM will contribute to a project that is advancing the understanding of the dynamics of flight.

Michael Wallace
University of California, Merced

NASA Armstrong Internship Program

Undergraduate Intern
Majors: Computer Science & Engineering

Mentor: Jason Holland
Code: 630
Software Simulation

Software Engineering for the ARMD Flight Data Portal

The main areas of interest for the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) are atmospheric flight research, operations, and testing. The Flight Data Archival System (FDAS) is currently used to retrieve flight-test data that is recorded for every AFRC flight mission. The ARMD Flight Data Portal (AFDP) software engineering team is tasked with replacing this system with Java Enterprise Edition (JEE) architecture. This project will benefit the researchers that use FDAS to analyze flight-test data by providing the application as a service. Flight Test Data Processor (FTDP) provides FDAS capability compatible to a JEE infrastructure. The first assigned task is to write and integrate code to further develop the FTDP portion of the system. The second assignment is to prototype a download web service. This will help the AFDP project determine the feasibility of utilizing RESTful web services as a means to efficiently download large amounts of data. As an intern, the most impactful lesson learned would have to be the importance of creating documentation when working with software so that another developer can thoroughly understand a topic and save valuable time and effort.

Cole A. Walls
University of California, Berkeley

NASA Armstrong Internship Program

Undergraduate Intern
Major: Physics

Mentor: Aaron Rumsey
Code: 560
Aerostructures

Student Engineering Technician for the Flight Loads Laboratory

In the Flight Loads Laboratory (FLL), a multitude of disparate tests are conducted to gather data for the advancement of aerostructures. Two of the tests I was involved with are: ground vibration test (GVT) and a structural loads test. These experiments are instrumental in the design process of aircraft structures, as they provide engineers with data that details the amount of strain an aerostructure can undertake in either extreme or controlled conditions. To conduct these experiments, engineers and technicians alike work together to instrument the test article with structural support, data acquisition materials, and the proper testing apparatus depending on the experiment being conducted. In particular, I worked with the technicians and engineers in the FLL on the instrumentation and testing of the Passive Aeroelastic Tailored (PAT) Wing. I also worked with an Electronic Information Systems Engineer on a calibration fixture that calculates the volume of a camera's designated field of view. This calibration fixture is a test article in development to study the displacement and velocity of particles that may possibly arise upon an astronaut arc welding on the International Space Station (ISS). The motivation behind this project is to ensure these particles cannot harm astronauts aboard the ISS. Thus, if the test results indicate the particles could indeed harm an astronaut, preventative, precautionary measures can be taken.

Christine Yang
University of Georgia

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical
Engineering

Mentor: Kia Miller
Code: 560
Aerostructures

Post-Data Analysis of X-57 and CReW Ground Vibration Tests

The primary project is to conduct the post-data analysis of X-57 Maxwell (ESAero, San Luis Obispo, California) and CReW (Calibration Research Wing) ground vibration tests (GVT) for identifying the modal characteristics as well as to assist the mentor to organize all the findings into the reports. The software utilized to perform post-processing is called BK Connect (Brüel & Kjær, Copenhagen, Denmark). The process includes exporting Frequency Response Function (FRF) from GVT, parameter estimation, examination of synthesis, and determination of mode shapes. X-57 ground vibration tests include both propeller and isolator tests. To help determine the best configuration of the isolator, the main task is to define the modal characteristics of the truss and the isolator for three configurations. The difficulty is that the mode shapes of the strong back, isolator, and truss are sometimes coupled. For X-57 propeller testing, determination of modal characteristics of three configurations with different blade angles is also a similar process to the isolator data post-processing. CReW GVT was conducted in summer 2017 which utilized fixed-base mode method developed by an outside company, ATA. Although ATA has finished the preliminary review during the testing, an official review generated by AFRC is still required. The task includes not only determining mode shapes but also reviewing the ATA supplied MATLAB(The MathWorks, Inc., Natick, Massachusetts) code.

Dann Young
Antelope Valley Community College

NASA Armstrong Internship Program

Undergraduate Intern
Major: Airframe
Manufacturing Technology

Mentor: Aaron Rumsey
Code: 560
Aerostructures

Flight Loads Lab Engineering Technician

Within the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC), there are numerous active tests including those in the Flight Loads Laboratory. These tests include the Ground Vibration Test (GVT), wing load tests, thermal testing, and many more to observe how a certain part or assembly reacts to possible scenarios. Currently we are using the Data Acquisition System to gather data on the Passive Aeroelastic Tailored (PAT) wing for the GVT, and wing loads. This test is used to determine the PAT wing's strengths and limits, as well as how to maximize its limits. Before these tests are conducted, we have to confirm that the test equipment is calibrated, the connectors are wired correctly, and the support structure accommodates for its designed purpose. The support structures include the shaker table, which is parallel to the PAT wing with triangular attachments to create a perpendicular face for the wing to mount flush to; a few sturdy shelves to hold up the shakers perpendicular to the shaker table/wing; and structures need to support any further equipment. The pretest readings of the connectors are recorded to determine the difference between the initial strain and the final strain measurements. These tests will help with the advancement in wings for future aircrafts.

Spring 2018 Abstracts

Alaa Barakat

The City College of the City University of New York

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering

Mentor: Steffi Valkov
Code: 430
Operations Engineering

Unmanned Aircraft Systems Integration in the National Airspace System

The primary goal of the project is to encourage and implement the integration of Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) by conducting a series of flight tests to demonstrate the viability of this objective. Sensors on the UAS grant the pilot situational awareness and guidance on maneuvers to Detect And Avoid (DAA) possible incoming collisions. Flight tests consist of performing intercept-type maneuvers called encounters, where the UAS flies a scripted line against a piloted aircraft. Each encounter has its own dedicated set of flight cards—one for the ownship UAS, and one for each intruder involved in the encounter. Flight cards lay down the entire procedure, set up, and specifications for a given encounter, which is followed and/or monitored by pilots and mission operations during the flight encounter. I will assist with the generation of these flight cards for the upcoming Flight Test 5 (FT5) and FT5 MicroCub Risk Reduction by tailoring a well-developed MATLAB (The MathWorks, Inc., Natick, Massachusetts) code (recently provided to the National Aeronautics and Space Administration (NASA) by MIT-LL in the summer of 2017), which generates the cards. During flight-test missions, I will act as Test Coordinator in our Mission Control Center 3. I will record key information to help with the evaluation of DAA and Traffic Collision Avoidance System algorithms, and help to inform flight-test reports.

Karen B. Brun

Embry-Riddle Aeronautical University

NASA Armstrong Internship Program

Graduate Intern
Major: Unmanned Systems – Space Operations

Mentor: Steven Foster
Code: 710
Quality Assurance

Human Factors Integration

The Armstrong Flight Research Center Safety and Quality Assurance Branch (AFRC-710) enhances mission success by providing independent analysis through audits, and surveillance and inspections of (AFRC) aircraft and processes. Because these actions require the highest level of integrity and technical expertise, as innovation within the flight research industry grows, so must the auditing and analysis criteria for AFRC-710. Overall, one of the areas of increased focus has been how the effects of human factors impact everyday operations throughout the National Aeronautics and Space Administration (NASA) centers. In response, NASA has established a Human Factors Task Force (HFTF). As a key component of the HFTF, AFRC-710 plans to apply the Human Factor Analysis and Classification (HFACS) tool for analysis, trending, and benchmarking to pinpoint specific acts, preconditions, and organizational norms which lead to human errors. The results will then be used to expand awareness to help minimize human error occurrences at the center. For the duration of my internship, I will be a member of the AFRC Aviation Safety Council, actively planning and executing an AFRC BETA testing event. The project will incorporate HFACS tools along with formal human factors training. My mission is to identify techniques, procedures, and lessons learned which can be seamlessly implemented throughout the Safety and Quality Assurance Program, that can serve to enhance the auditing processes for AFRC aircraft.

Kevin Burns
Santa Monica College

NASA Armstrong Internship Program

Undergraduate Intern
Major: Astrophysics

Mentor: Jason Lechniak
Code: 520
Aerodynamics & Propulsion

Towed Glider Air Launch System and Spanwise Adaptive Wing

The Towed Glider Air Launch System (TGALS) is a reusable two-stage launch system designed to augment the capabilities of a standard ground-based launch vehicle, allowing for main engine ignition to occur at higher altitudes, dramatically increasing the payload mass to orbit. The current aircraft iteration features a 100-ft wingspan and tri-fuselage design with the ability to support a variety of launch vehicles. To ensure the stability of the aircraft during each stage of flight, mass properties must be determined and compared in order to establish the correct weight and balance. Programs such as Vehicle Sketch Pad (VSP) can be used to verify and corroborate those results. Additionally, building upon the success of the sub-sonic Spanwise Adaptive Wing (SAW) project, a follow-on project is entering the proposal stage intent on incorporating a similar adaptive wing design with a supersonic test vehicle. In order to determine the viability of expanding the envelope of this adaptive wing technology and justify further flight testing, strong supporting evidence must first be gathered from prior works showing that the data generated will be beneficial. Based on these findings a flight-test architecture will emerge and focus on either a high-altitude balloon drop or a supersonic tow of the test vehicle. These programs have the potential to broaden our capabilities in the field of aerospace by increasing launch capacity and flexibility as well as acquiring critical data for more efficient supersonic transport.
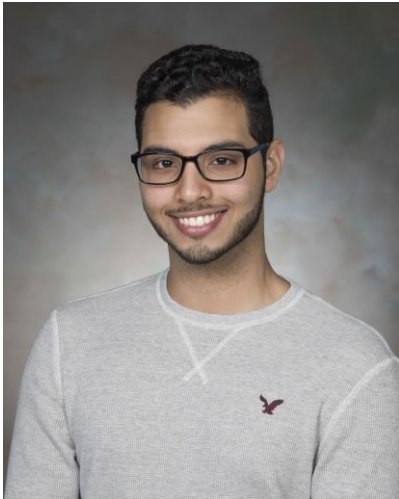
Johncarlo Cerna
University of Florida

NASA Armstrong Internship Program

Undergraduate Intern
Major: Computer Science

Mentors: Oscar Murillo and Albion Bowers
Code: 530
Dynamics & Controls

iOS App Development for PRANDTL-D Flight Data Acquisition

The primary purpose of the Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D 3c) aircraft is to research and test bell-shaped lift distribution, proverse yaw, and rudderless flight with its revolutionary wing design. As part of our research, it is imperative to gather flight data from the aircraft using a flight data acquisition unit (DAQ). I will be developing a custom DAQ for the iPhone (Apple, Incorporated, Cupertino, California) to be used onboard PRANDTL-D during flight. Written in Swift programming language, the app will allow us to gather data about the performance of the aircraft using the built-in sensors of an iPhone and an Arduino computer working in tandem. The DAQ will store measurements at the desired frequency from the gyroscope, accelerometer, and barometer from the phone as well as from the boom of the aircraft and other analog inputs gathered from hardware. In addition, I will be using a Gamevice® (Gamevice, Incorporated, Simi Valley, California) gamepad to simulate analog inputs from the Arduino computer, which will allow the two devices to talk to each other and aggregate data. The measurements taken by the DAQ will be stored in a .csv file and then can be used to extrapolate data and conclusions about the wing design and aircraft. The creation of this app will allow researchers to gather flight data in a lightweight, fast, and easily accessible way.

Nicholas Farrell

Irvine Valley College

NASA Armstrong Internship Program

**Undergraduate Intern
Majors: Electrical and
Computer Engineering**

**Mentor: Dave Berger
Code: 112
Office of Education**

System Integration

Albert Einstein said; "A person who never made a mistake never tried anything new". Designing a sUAS absent vertical control surfaces, Preliminary Research Aerodynamic Design to Land on Mars (PRANDTL-M) is the personification of innovation. The PRANDTL-M 4.0 and 4.2 series experimental aircraft system has demonstrated multiple successful flights; validating airfoil, avionics, and controls evolution. By nature, experimental sUAS are under a constant design cycle: hypotheses, test, analyze, and redesign. While impossible to completely account for every scenario, attention to detail and well thought out mitigation ensure hazards and unforeseen situations are manageable. When the unexpected occurs, it's important to expose the underlying causes and develop strategies to improve on system vulnerabilities. A great deal of effort has been spent identifying failures through root cause analysis and regression testing. Collecting, validating, and analysis of data enabled the draft of robust procedures which aid in risk reduction. Collaboration between disciplines is vital for a projects success. System integration hinge on accounting for firmware, form-factor, policy, and technology requirements.

Tanya Gupta
New York University

NASA Armstrong Internship Program

**Undergraduate Intern
Major: Mechanical
Engineering**

**Mentors: Dave Berger and
Al Bowers
Code: 112
Office of Education**

Parameter Identification and Testing of PRANDTL-M

In 1933, Ludwig Prandtl, a pioneer in aerodynamic research, published a paper introducing the design of a wing that is 11 percent more efficient and has 22 percent greater span than a standard wingspan design, but uses the same amount of structure. The mission of the Preliminary Research AerodyNamic Design to Land on Mars (PRANDTL-M) is to implement Prandtl's 1933 theory to an aircraft with the purpose of performing the first Martian flight sometime between 2022 and 2024. The Curiosity mission to Mars jettisoned its rover with two 165-pound tungsten weights from its back shell in 3U CubeSats in order to balance the asymmetrical weight of the device. PRANDTL-M hopes to replace this dead weight in future missions with something more useful, like a glider intended to take data of the Martian atmosphere and perform spatial mapping of the surface. As Operations Engineering Lead on the PRANDTL-M, my role in this project is to coordinate the design, fabrication, testing, and flight data analysis of the prototype aircraft. Among my responsibilities, I am in charge of preparing tech briefs and writing up environmental test procedures, resulting in presentations to the board requesting authority to proceed with each unique PRANDTL-M-related flight. Our primary objective for this term is to complete a 100,000-foot flight.

Kyle Harper

Kansas State University Polytechnic

NASA Armstrong Internship Program

Undergraduate Intern
Major: Unmanned Aerial
Systems Engineering

Mentor: Craig Griffith
Code: 720
Safety & Environmental

Safety and Mission Assurance in relation to Building 703 Operations

The National Aeronautics and Space Administration (NASA) makes safety the top priority on any mission. The Safety and Mission Assurance (S&MA) department of Building 703 (B703) oversees the safety of all projects taking place at the B703 facilities. As part of the S&MA team, I am involved in mishap investigations, safety promotion, Systems Safety Working Group (SSWG) meetings, and pressure vessel safety and engineering. Mishap investigations include determining causes, hazards, and further mitigations or training. General safety projects include verifying proper condition of fire extinguishers, eye wash stations, fire suppressant systems, and personal protective equipment. The SSWG meetings focus on bringing the opinions and concerns of pilots, engineers, and safety personnel together in order to assess and mitigate hazards related to aircraft and systems. A portion of my project is also dedicated to pressure vessel safety and engineering, which. This includes reviewing proposed pressure vessel systems and determining safety concerns and mitigations. In addition, current pressure vessel systems are inspected and tested to confirm safe operation. Since a majority of aircraft and related operations contain a pressure vessel system, it is important to implement safety protocols in order to avoid incidents. A high standard of safety is crucial in order to maintain the agency's respectable reputation.

Victoria Hawkins

Embry Riddle Aeronautical University

NASA Armstrong Internship Program

Graduate Intern
Major: Unmanned and Autonomous Systems Engineering

Mentors: Oscar Murillo and Albion Bowers
Code: 530
Dynamics & Controls

Prandtl-D Flight Testing and Operations

The Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D) aircraft is an ongoing research project that has been led by interns for some time now. The aircraft seeks to overcome adverse yaw effects and produce proverse yaw by using a non-linear aerodynamic twist within the 25-ft. wingspan of the aircraft. As well, the distinct bell-shaped span load of the aircraft reduces drag in ways an ellipsoid span load cannot. To validate the features of this aircraft, data must be collected during flight to confirm the theory. An onboard Arduino data acquisition unit (DAQ) was updated and a separate Electronic Pressure Measurement (EPM) unit was installed onto the aircraft. The DAQ collects basic flight data, while the EPM collects the pressures from the ports in the wings. Prior to flight, a center of gravity (CG) test, a moment of inertia test (MOI), and a combined systems test (CST) were performed to ensure that the aircraft was flight ready. On the day of flight testing, preflight operations were performed to prepare for takeoff and a safe flight. With the data collection and analysis for this aircraft, PRANDTL-D continues to push the boundaries of aviation.

Jessica Kenny

Austin Peay State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Physics

Mentors: Chris Kostyk and Tim Risch
Code: 560
Aerostructures

Mapping Heat Flux Distribution of High Density Infrared Heaters

During hypersonic flight, parts of the wing and body of an aircraft experience extreme temperatures that can be thousands of degrees Fahrenheit. Ground testing before flight is an essential step in evaluating the ability of an aircraft to withstand this thermal load. Using tools like High Density Infrared Heaters with quartz filaments, Flight Loads Laboratory (FLL) engineers raise the temperature of materials to in-flight temperatures to evaluate the structural response. Knowing the heat flux distribution imparted to the test articles by the heaters will help the engineers to more accurately design the heater arrays, and enable analysts to more accurately interpret test data. A Heat Flux Mapping System (HFMS) was developed to evaluate the influence of several variables on heater performance. The information produced by the HFMS about the heat flux distribution will increase the efficiency of the thermal testing process, which translates into providing data to customers faster. The knowledge generated by the HFMS will increase the insight that the FLL provides to customers who need the knowledge gained from ground testing to determine performance margins or safety of flight.

Jose Manriquez

California State Polytechnic University, Pomona

NASA Armstrong Internship Program

Graduate Intern
Major: Aerospace Engineering

Mentor: Dave Berger
Code: 112
Office of Education

Using Embedded Coder to Quickly Develop Non-Linear Flight Control Systems for the PRANDTL-M Glider

The Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) project aims to reach a new boundary of tailless vehicle flight and challenge the notion that the elliptic lift distribution is optimal for non-span limited cases of Prandtl's lifting-line theory. The PRANDTL-M attempts to mimic the wings of birds by applying a non-linear geometric twist throughout the wing span to generate proverse yaw to overcome adverse yaw effects during flight. This method of flight could benefit from a non-linear flight control system to incorporate the flight dynamics of a tailless flying wing. Development of the flight control system would take place in The Mathworks, Inc. (Natick, Massachusetts) Simulink block diagram environment utilizing the Pixhawk® PX4 support package (PSP) for the Embedded Coder® (The MathWorks, Inc., Natick, Massachusetts) toolbox. The glider is equipped with the Pixhawk® flight management unit (FMU), a high performance autopilot hardware that runs a real-time operating system and a full stack, open source, PX4 autopilot software. The PSP would convert a flight control system in the form of a block diagram into a C++ code application. The application could then be implemented into the PX4 source code, and then built and deployed into the FMU. This process would allow for a faster development process of designing, building, and deploying the flight control system in a prototype glider for testing and debugging.

Moises Martinez
University of California, Santa Cruz

NASA Armstrong Internship Program

Undergraduate Intern
Majors: Computer
Science & Engineering

Mentor: Sky Yarbrough
Code: 540
Sensors & Systems
Development

Software Development for Airborne Data Communications

CloudTurbine (CT) is an open source software used by the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center. The CT open source software uses incremental files for communication which enables users to stream data in real time via file sharing systems. A user can theoretically pick many data sources to stream simultaneously. Data sources range from cameras, microphones, video screen captures, webcams, text files, and even archived data. Once streamed, another device can display the data with a data viewer application. The CT open source software lacks friendly usability. To fix this problem, I will eliminate the terminal/command prompt needed to perform CT operations and replace it with a graphical user interface (GUI). The GUI will display a main settings window for configuring application settings, such as the output folder and specifications for each data format. The GUI will also provide a plus (+) button, which adds another channel when clicked. By splitting the app up into modular channels, a user can have several channels of each type streaming simultaneously. A timeline chart will also be provided to allow users to view different time segments of the captured data. The GUI will also include the ability to arm and disarm each channel individually so users do not have to stream everything at once. By making CT easier to use, it will not only allow NASA, but other institutions as well to stream, view, and record live or archived data seamlessly.

Hussein Nasr

California State Polytechnic University, Pomona

NASA Armstrong Internship Program

Graduate Intern
Major: Aerospace Engineering

Mentor: Dave Berger
Code: 112
Office of Education

PRANDTL-M Simulation Development

The Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M), planned to be the first glider to fly through the Martian atmosphere, is a small vehicle with folding wings allowing it to fit inside a small 3U CubeSat. The PRANDTL-M mission is to collect ground mapping and atmospheric data on Mars. The main objective of this internship is to perform system identification (ID) on several wing geometry designs, simulate them, and compare the results with flight data. System ID, in short, is the building of mathematical models that represent the dynamics of the vehicle during flight. More specifically the objective for this internship is to retrieve the stability and control derivatives of the vehicle. To start, eight equations of motion are used and then linearized around trim conditions to create state space models in the longitudinal and lateral directions separately. The most critical and challenging part in performing system ID for this project is retrieving essential flight data during specified maneuvers. The PRANDTL-M is very small and does not produce its own thrust, so holding steady altitude or having an alpha-beta vane is not feasible. Many workarounds must be implemented and assumptions made to get the best possible estimation of aerodynamic coefficients. Finally, coefficients will be compared with results found from using computation fluid dynamics software.

Joycelin Orellana

Oregon State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Computer Science

Mentor: Michael Ritchson
Code: 610
Range Engineering

Developing a Search Page Graphical User Interface for the ARMD Flight Data Portal

The Aeronautics Research Mission Directorate (ARMD) Flight Data Portal (AFDP) seeks to increase accessibility of flight data and related documents through a web-based Java Enterprise architecture. The method of access to data files will take place primarily via a search page on the portal that displays a facet-bar with search criteria. Selecting a particular flight will result in any associated files being displayed in the body of the page for further interaction. This interface will be achieved using a Java Server Faces (JSF) page that will link a managed bean to the eXist XML database via the eXist XML-RPC API. The file names are located in an XML file associated with the selected flight. Therefore, using an xQuery statement in the bean, I can extract the file names and display them on the search page so a user can select which file to investigate. The accessibility and ease of use of the search page will make progress for the National Aeronautics and Space Administration Armstrong Flight Research Center AFDP to become a cross-center platform for data research repositories.

Samuel Parker
The University of Newcastle, Australia

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical
Engineering

Mentor: Kurt Papathakis
Code: 550
Flight Instrumentation &
Systems Integration

X-57 Cruise Motor Testing for the Development of Airworthiness Standards for Electric Propulsion Units

Given the experimental nature of electric aircraft propulsion, documentation published by regulatory bodies such as the Federal Aviation Administration (for example, FAR Part 33) does not contain criteria directly relevant to the airworthiness of an electric propulsion unit (EPU). Thus, it is necessary to determine the applicability of FAR Part 33, other existing standards, and any necessary test rationale. This applicability document will be used as a guideline for the X-57 Maxwell (ESAero, San Luis Obispo, California) cruise motor endurance tests (CMETs), allowing test profiles to be generated and run in the Procedure Integrated Development Environment (PRIDE). Appropriate sensors will be installed and a wide range of data will be recorded. Data analysis will be conducted offline, with the "as-run" test data compared to the ideal test profile established in the applicability document. This analysis will be completed through the parsing of data into files readable by a MATLAB (The MathWorks, Inc., Natick, Massachusetts) script, which will comparatively plot the two data sets (actual versus ideal). Lessons learned during the testing process and after the completion of the data analysis will guide CMETs of future X-57 motors and be compiled into the applicability document to serve as a standard that future EPU tests can follow. The standard will accelerate the introduction of EPUs as a mainstream propulsion method. Successful testing of the cruise motors will allow for integration into the X-57 aircraft.

Alex Passofaro
University of Minnesota, Duluth

NASA Armstrong Internship Program

Undergraduate Intern
Major: Management
Information Systems

Mentor: David Tow and
Becky Flick
Code: 610
Range Engineering

NASA Aeronautics Augmented Reality Application

To increase outreach and awareness of the National Aeronautics and Space Administration (NASA) aeronautics, a mobile application is being developed to deliver an augmented reality experience to the public, featuring a selection of NASA aeronautics vehicles. Using a business card sized target image, the mobile application is able to detect and interact with the target image through the phone's camera, displaying a 3D model of the vehicle that the user selected in the application's graphical user interface (GUI). This augmented reality experience is being accomplished using the Unity (United Technologies, San Francisco, California) and Vuforia (PTC, Inc., Needham, Massachusettes) software development kit (SDK). Unity, a 2D and 3D game engine, is the platform being used to create the application's GUI and being built to support Android and iOS mobile operating systems. Vuforia is an augmented reality camera SDK that is enabled within Unity and allows for real world changes to interact with the digital platform. In the camera view, a selection of buttons will be available depending on the type of vehicle currently on screen. Such options include, but are not limited to the following: propeller animations, landing gear deploying and retracting, sonic boom demonstrations and comparisons, and aircraft surfaces movement. With these interactions, along with informative pages on each vehicle, we intend to deliver an educational and unforgettable experience to users and further expand the public awareness of NASA aeronautics.

Rachel Suitor
University at Buffalo

NASA Armstrong Internship Program

Undergraduate Intern
Majors: Aerospace
Engineering &
Mathematics

Mentor: Kurt Papathakis
Code: 550
Flight Instrumentation &
Systems Integration

Validating Airworthiness of Cruise Motors for the X-57 Distributed Electric Propulsion System

The Scalable Convergent Electric Propulsion Technology Operations Research (SCEPTOR) X-57 Maxwell airplane (ESAero, San Luis Obispo, California) is the National Aeronautics and Space Administration's (NASA)'s first all-electric experimental airplane (X-plane), and the first manned X-plane in two decades. The X-57 Maxwell airplane aims to demonstrate the potential of high efficiency flight with reduced carbon emissions, as well as a lower total operating cost for aircraft. With a pilot on board the X-57 Maxwell airplane, it is imperative to confirm that the electric motor system is as safe as possible prior to flight testing, especially since distributed electric propulsion is an experimental technology. The primary objective of Airvolt cruise motor endurance testing (CMET) is to verify that the Joby JM-X57 (Joby Aviation, Santa Cruz, California) electric motors for the X-57 Maxwell airplane are flightworthy. Each cruise motor will undergo seventy-nine hours of endurance testing on the Airvolt test stand, which has instruments to monitor system voltage, current, temperature, vibration, torque, and thrust. Motor testing includes exposing the motor to various levels of vibration and temperatures, including the nominal and maximum operating temperatures. In order to determine whether the motor can be deemed flightworthy, CMET data are used to analyze the ability of the motor to remain operational through those testing conditions. CMET data for the X-57 Maxwell airplane will also help to identify and establish airworthiness standards for future electric flight.

Robyn Torregrosa
Rice University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical Engineering

Mentor: Ricardo Arteaga
Code: 540
Sensors & Systems Development

Demonstrating Automatic Dependent Surveillance-Broadcast for Supersonic Aircraft

Automatic Dependent Surveillance-Broadcast (ADS-B) is a system that reports location, altitude, velocity, and other information to nearby aircraft and ground stations. So far, ADS-B has only been incorporated into subsonic aircraft, but the Federal Aviation Administration (FAA) requirements coming into effect in 2020 require all aircraft to use ADS-B. The main goal of my internship is to demonstrate a pre-production prototype ADS-B transmitter on a supersonic aircraft. Some of the problems specific to supersonic aircraft which need to be addressed include: latency in position information, air pressure measurement errors at supersonic speed, and greater power requirements for long-range communication. The objective is to complete the lab, van, and ground testing of a prototype supersonic ADS-B unit, ensuring it meets FAA and National Aeronautics and Space Administration (NASA) requirements before the ADS-B hardware may be installed and tested in supersonic flight on an F-18 airplane. To support this project, I will enhance the user interface software, test the equipment rigorously, present the findings of these pre-flight tests to a team of NASA researchers, and develop the test flight plan for the F-18 airplane. This work will ensure we uncover and address the unique challenges of supersonic flight so the technology can be used for flight tracking in research, and eventually, commercial fields.

Michael Wallace

University of California, Merced

NASA Armstrong Internship Program

Undergraduate Intern
Major: Computer Science
& Engineering

Mentor: Jason Holland
Code: 630
Simulation Engineering

Developing Software for the Flight Test Data Processor Engine

The National Aeronautics and Space Administration's Armstrong Flight Research Center (AFRC) primarily focuses on atmospheric flight research, operations, and testing. Every aircraft that takes off from AFRC produces an HDF5 data file that is received by the Flight Data Archival System for research. The purpose of the project I am working on is to replace the current system with J2EE architecture and the Flight Test Data Processor (FTDP) engine. The first task I was given was to develop test architecture, test cases, performance testing for throughput and capacity, as well as system level testing for the FTDP side of the project. There are now have documents that assist in writing unit tests, integration tests, and functional tests for the application with the possibility of automating the tests so that they routinely run overnight. The next task is to do research on Docker and figure out how to install the FTDP onto it. Docker is a computer program that specializes in performing containerization and shares a great deal of the host operating system resources instead of having its own set of resources allocated to it like a virtual machine. Working on a project that practices agile development has been a very rewarding opportunity. This internship has also taught me the importance of always creating documentation when working with software so that another developer can thoroughly understand a topic and save valuable time and effort.

Megan Waller
University of the Pacific

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical
Engineering

Mentors: Timothy Risch and
Chris Kostyk
Code: 560
Aerostructures

Modeling and Fabricating a Cold Plate for the Heat Flux Mapping System

Many components of hypervelocity aircraft and spacecraft are subject to temperatures exceeding 2500 Kelvin. Ground testing is essential in determining the structural soundness of these components to ensure that they will not fail. The Heat Flux Mapping System (HFMS) is designed to measure the heat distribution of high-density infrared heaters with quartz filaments used to simulate the high heat flux environment. Results from the mapping system will allow engineers and analysts to model the heating setup of lamps prior to testing, creating an accurate heat flux profile. A main component of the HFMS is a water-cooled aluminum plate that supports heat flux gauges and dissipates the heat from the lamps. The plate is designed to maximize heat transfer through the use of water-cooled channels. The cooled plate allows testing to be conducted at higher lamp powers than with the ceramic plate currently being used and will provide data on lamp performance at levels not currently achieved. The plate is modeled with PTC (Needham, Massachusetts) Creo Parametric 3.0 and is fabricated both in-house and outside the National Aeronautics and Space Administration. Measurements of the water flow and temperature change across the plate will be performed and compared to previously made predictions.

Elizabeth Wig
Northeastern University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical
Engineering

Mentor: Ricardo Arteaga
Code: 540
Sensors & Systems
Development

Integrating Automatic Dependent Surveillance – Broadcast Systems into Supersonic Aircraft

Automatic Dependent Surveillance-Broadcast (ADS-B) is a surveillance method that provides accurate tracking information of nearby aircraft and ground stations. The aircraft receive their positions from a global positioning system, and broadcast their location information to other airplanes and ground stations. The National Aeronautics and Space Administration Armstrong Flight Research Center is working toward implementation of ADS-B on supersonic aircraft as a safer alternative to radar. I will integrate the electrical systems necessary to deploy the ADS-B system as a pre-production prototype in an F-18 supersonic aircraft. Given the highly dynamic nature of supersonic flight, this system must be more ruggedized and have lower latency than on commercial, subsonic aircraft. The system must ensure accurate and consistent output and broadcast of location, altitude, and velocity data, as well as input to the pilot from the ADS-B systems of other aircraft. I will develop the electrical design of the F-18 ADS-B installation, and plan and execute test procedures to verify the design in the lab, in a van, and on the ground, as well as in the air. This prototypical supersonic ADS-B system will pave the way for commercial supersonic flights and better-tracked spaceflight.
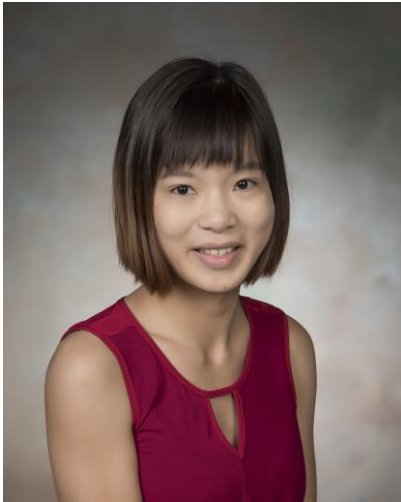
Christine Yang
University of Georgia

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering

Mentor: Chan-gi Pak
Code: 560
Aerostructures

Ground Vibration Test of Two Aerostructures Test Wings

The Aerostructures Test Wing (ATW) is the 18-inch long, 13-inch wide test article for studying effect of a curvilinear spar and rib on the flutter boundary of an aircraft. The ground vibration test (GVT) is required to validate a finite element (FE) structural model. The objective of this project is to measure and compare mode shapes and natural frequencies from FE model and GVT. The original FE models from small business are updated by making the brackets jointed to the test article and attached to the ground, fixed in order to meet the reality. The simulations of the modified models are performed on MSC/Nastran (The MacNeal-Schwendler Corporation, Newport Beach, California). After the analytical data are generated from MSC/Nastran, the GVT will be conducted for validation. For GVT, the measurement hardware comprises four main components: the mounting system, means of excitation, transducers, and means of recording and analyzing data. In the experiment, the ATW4 is clamped on the lift table as the mounting method, and the way of excitation is an impulse hammer. There are 11 accelerometers attached to the desired points. When hitting the impulse hammer on the ATW4, the accelerometers will transfer signal to the software which will measure frequency response function. Comparing to the original FE model, it can be said that the data obtained from the GVT approach the analytical data of the modified FE model more.

Fall 2017 Abstracts

Skender Alickolli
New York University

NASA Armstrong Internship Program

**Graduate Intern
Major: Mechatronics &
Robotics**

**Mentor: Philip Hamory
Code: 540
Sensors & Systems
Development**

Software Developing for Fiber Optic Sensing Systems

The Fiber Optic Sensing Systems (FOSS) utilizes fiber Bragg gratings embedded within fiber optics to measure elements such as temperature, strain, vibration, and pressure. Data processing is an essential part of FOSS, and it is often achieved using Fast Fourier Transform (FFT) algorithms. The FOSS team is currently exploring a new processing algorithm called the Wavelet method. The prototype of this algorithm has been created using LabView™ (National Instruments, Austin, Texas) and C programming language. The Wavelet method has two modes: Static Mode and Adaptive Mode. Static Mode processes all the incoming data and is written in both LabView™ and C programming language, however, the more efficient Adaptive Mode, which has selective data processing, only exists in LabView™. My task is to recreate this LabView™ code in C programming language. The FOSS group's vision is to utilize both FFT and Wavelet methods in future iterations of FOSS in C programming language to increase the efficiency and decrease the cost.

Gabriel Almeida
California State University, San Bernardino

NASA Armstrong Internship Program

Undergraduate Intern
Major: Computer Engineering

Mentor: Jeanette Le
Code: 510
Systems Engineering & Integration

SOFIA MCCS Data Extraction Algorithm Analysis and Sustainment Support for Mission Systems

I participated in two primary tasks during my time on the Stratospheric Observatory for Infrared Astronomy (SOFIA) program: software analysis for the Mission Controls and Communications System (MCCS) and categorization of system hardware. The MCCS is the collection of subsystems on SOFIA that operate all aspects of the observatory. One of the subsystems of the MCCS is the onboard Archiver, which is a network-accessible common data storage point for several other subsystems, where mission data can be accessed and stored as needed. The current Archiver software was developed several years ago, and as such, needs to be updated. To do the update, analysis of former data extraction software was performed. Once analyzed, certain aspects of the software, including input / output, command line parsing, and .xml interpretation were maintained for incorporation into an update of the SOFIA image extraction tool. Additionally, categorization and reconfiguration of the onboard subsystem and instrumentation hardware is an important part of mission sustainment and success. Equipment was tested for functionality and categorized accordingly. To do this, research and analysis of hardware were performed, and each item was designated as 'flight-ready' or 'non-flight.' Recording and structuring all of the data will help in annual equipment audits and expedite future hardware buildup and maintenance.

Shubha Bhaskaran
University of California, San Diego

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical
Engineering

Mentor: Ricardo Arteaga
Code: 540
Sensors & Systems
Development

Supersonic ADS-B and Big Data Analysis using Artificial Intelligence

The Next Generation Air Transportation System (NextGen) aims to modernize America's air space and transportation to be more efficient and safe. A crucial element of NextGen is Automatic Dependent Surveillance–Broadcast (ADS-B), however, research on ADS-B for supersonic aircraft flight has not been done until now. The first supersonic ADS-B will be designed and tested for the Low Boom Flight Demonstration (LBFD) project. The system will be installed on F/A-18 and F/A-15 aircrafts and in the near future for reusable space vehicles. The FlightHorizon software (Vigilant Aerospace Systems, Oklahoma City, Oklahoma) ADS-B ground surveillance will be used to support the Conformal, Lightweight Antenna Systems for Aeronautical Communication Technologies (CLAS-ACT) project at NASA Glenn Research Center. The upcoming flight test aims to measure Radio Frequency (RF) emissions from the new conformal antenna design to determine interference levels with the ground. Vehicle position and velocity will be tracked and streamed in real time to point an RF antenna for measurements. After the recent Hurricane Harvey disaster mission using drones, the need for intelligent processing to extract important information from data became evident. This processing can be done with artificial intelligence (AI) to perform object recognition on images and video. With small unmanned aircraft system (SUAS) equipped with ADS-B technology to track vehicles and increasingly more air traffic, it is possible to collect large amounts of big data.

Frank Camargo
University of South Florida

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical Engineering

Mentor: Kurt Papathakis
Code: 550
Vehicle Integration & Test

X-57 Maxwell Electric Motor Endurance Testing / FMEA Power and Communication Architecture

The X-57 Maxwell continues the legacy of innovative plane designs from the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center. The X-57 is the first electric aircraft being developed by NASA as an effort to reduce emissions, fuel use, and noise. In order to verify the electric motors in the plane are ready for flight, I will be assisting with testing each of the electric motors on the Airvolt stand for 76 hours. Data recorded includes temperature, torque, RPM, and power as well as observing overall stability. The data will then be used to create the standard electric aircraft requirements for the Federal Aviation Administration (FAA), so that the general public can benefit. I will also be assisting with Failure Mode and Effects Analysis (FMEA), for the power and communication architecture on the X-57 aircraft. Multiple component failures will be analyzed in order to see how they affect the system as a whole. In response to these failures, revisions will be made to the system architecture in order to increase the safety margin and reliability of the aircraft. I will be personally responsible for editing all schematics of the system architecture as well as actively engaging in discussion with the X-57 Maxwell team on how to improve the overall design.

Erick Castillon
University of Texas, San Antonio

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical Engineering

Mentor: Allen Parker
Code: 540
Sensors & Systems Development

Design and Fabrication of Enclosures for Fiber Optic Systems

The Fiber Optic Sensing System (FOSS) technology developed at NASA is quickly evolving as a new method of measuring strain and deriving other quantities on an aircraft. However, FOSS and its components are highly delicate when installed unprotected onto a vehicle, which may cause hardware failure. To combat these issues, enclosures are used to house the control unit of the system. These enclosures must be certified for flight on experimental aircraft and have the capability of protecting the internal components from outside forces (G-loads, vibrations, etc.) while having a simple installation process. In addition to being certified for flight, these enclosure also have the capability of being implemented in a laboratory setting. An enclosure for the Electronic Pressure Measurement (EPM) system for the Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D) project was designed and revised through the use of a computer-aided design (CAD) software, before being produced on a 3-D Printer. The printed product has been sent to PRANDTL-D and is currently awaiting further testing in February 2018. After successful completion of the EPM, other enclosures were produced in the same manner as before for a Liquid Metal Strain Gauge, which is to measure strain through liquid mercury in a lab setting.

Nicholas Cross
New Mexico State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Mechanical &
Aerospace Engineering

Mentor: Allen Parker
Code: 540
Sensors & Systems
Development

Mechanical Design and Software Analysis of the Fiber Optic Sensing System (FOSS)

The Fiber Optic Sensing System (FOSS) is the next generation technology for measuring deformation, force loads, torque, and temperature of a rigid body. FOSS is currently in development of being downscaled in size and function in order to be cost-effective as well as to conserve weight and space; known as the micro-FOSS (uFOSS). Instead of having a laser built within the uFOSS assembly, the laser will be an independent unit that splits to variable uFOSS's, where more systems can be added or removed for future tests. With changes to design and size, the updated uFOSS will require new enclosures for both the laser and uFOSS network for protection along with maintaining operating temperatures. These enclosures are first designed through computer aided software (CAD) and 3-D printed for a prototype assembly. The prototype is then fit checked and if approved, the parts are sent out to be fabricated at a machine shop. Additionally, one of the microcontrollers within the uFOSS network needs validation of its current software; debugging and ensuring this software works error free. This microcontroller takes processed fiber data, Fourier transforms the data, and sends the new set of data to be used all simultaneously.

Ryan Dunphy
San Jose State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aerospace
Engineering

Mentor: Al Bowers
Code: 500
Research & Engineering

Analysis of Load Distribution with Fiber Optic Shape Sensing on PRANDTL-3c Wing

The standard elliptical load distribution as explored by Ludwig Prandtl and researched by the National Aeronautics and Space Administration (NASA), is not the most efficient load distribution. A more efficient load distribution that draws from nature and the flight mechanics of birds as inspiration is illustrated as one that distributes the load along a bell curve with zero lift at the tip of the wing. This distribution not only significantly reduces drag, but also eliminates the need for vertical tails on aircraft by coupling yaw and roll, further increasing efficiency. In order to measure this load distribution in real time and in post processing of acquired data, fiber optic cables were integrated into the wing of the aircraft in a relatively new strain sensing system, Fiber Optic Sensing System (FOSS). The FOSS system measures the distance that a fiber is stretched and interprets this data as strain, with which we are then able to relate to bending moment, shear, and finally load through integration and application of structural characteristics. We then compare this in-flight strain data to our expected load distribution and expected strain values obtained through derivation. During upcoming flights, an electronic pressure measurement (EPM) system will be implemented in order to collect pressure measurements along the wing which will then be integrated to obtain load data and compared to the FOSS load distribution data.

Kendy Edmonds
Kansas State University Polytechnic

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aeronautical Technology- Unmanned Aircraft Systems

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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 Detect and Avoid (DAA) and Command and Control (C2) technologies to provide data that will support the development of the Radio Technical Commission for Aeronautics (RTCA) Special Committee (SC)–228 Phase II Minimum Operational Performance Standards (MOPS). To support the UAS-NAS Phase II effort, the UAS-NAS Integrated Test & Evaluation (IT&E) team will perform initial flight testing of a low cost, size, weight, and power (C-SWAP) airborne non-cooperative surveillance sensor that will be eventually integrated on the NASA Ames Research Center Group III (Weight <1320 lb) SIERRA-B UAS platform. A Systems Integration Lab (SIL) will be designed and built to perform software development, systems integration, and verification of the UAS-NAS SIERRA-B payload systems. Prior to flight tests with the SIERRA-B UAS, a risk reduction flight campaign will be performed with the small Unmanned Aircraft Systems (sUAS) Lab's micro-Cub UAS to evaluate visible identification (VIS ID) techniques during encounters with a TG-14 glider, Beyond Visual Line of Sight (BVLOS) C2 datalinks, and operational procedures for BVLOS Class III UAS operations. Lessons learned from the risk reduction flight will be transferred directly to Flight Test 5 (FY18) and Flight Test 6 (FY19) activities.

Gordon Johnny Elder
Antelope Valley College

NASA Armstrong Internship Program

Undergraduate Intern
Major: Computer Science

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Code: 540
Sensors & Systems Development

Liquid Metal Strain Gauge Software

In the summer of 2015, two interns, wrote the software to interrogate a liquid metal strain gauge (LMSG). Conventional strain gauges are small wires that increase resistance when stretched. However, the gauges cannot stretch very far. The LMSG variants are different because they consist of liquid metal encapsulated within an elastic tube. The advantage is that the tubes can stretch much farther than the wires of conventional strain gauges. The LMSGs have an analog to digital converter (ADC or A to D) that measures the voltage drop which increases as the gauge is stretched. The ADCs are controlled by an 8-bit microcontroller which in turn supplies the data to a single board computer. This single board computer can interface to multiple microcontrollers simultaneously, consequently increasing the number of sensors it can monitor. The single board computer then sends the data over the network to a Windows (© Microsoft, Redmond, Washington) computer that is running a LabVIEW™ (National Instruments, Austin, Texas) program, which graphs and records the data. My task is to speed up the code written by previous interns. The techniques that were found to speed up the system without interfering with the hardware have been to change the way loops are called and making some code only run on some iterations of the loop.

Nicholas Farrell
Irvine Valley College

NASA Armstrong Internship Program

Undergraduate Intern
Majors: Electrical and Computer Engineering

Mentor: Dave Berger
Code: 112
Office of Education

Avionics Hardware Examination

Preliminary Research AerodyNamic Design to Land on Mars (PRANDTL-M), endeavors to design a Small Unmanned Aircraft System with the aerodynamic efficiency necessary to navigate the Mars atmosphere at a reduced unit cost. NASA's Chief Scientist Al Bowers is expanding on Ludwig Prandtl's alternative to the lifting-line theory taking advantage of superior span load concepts. Under the assumption that proverse yaw through defining calculated wing twist will allow for control surfaces which do not depend on vertical structure, an estimated 11-percent reduction in drag has been demonstrated. Design of the PRANDTL-M integrates NASA aero advancements and commercial off-the-shelf (COTS) avionics into a small form factor capable of fitting inside a 1U CubeSat. Developing an avionics package around a reduced size vehicle presents a number of challenges. Techniques in reverse engineering through circuit analysis are combined with bench testing to form a complete understanding of both Open-Source hardware and firmware systems. Further developments addressing environmental factors and the avionics footprint will benefit from this research.

Annalise Giuliani
Millersville University of Pennsylvania

NASA Armstrong Internship Program

**Undergraduate Intern
Major: Early Childhood
Education**

**Mentors: Kate McMurtry and
Jim Ross
Code: 430/ 640
Operations Engineering &
Photography**

Providing Mission Support Throughout AFRC

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) specializes in a variety of aeronautics projects and principles. As a mission support intern for the fall term, my focus was split between the Operations Engineering (OE) Branch and the Photography Lab. The OE Branch leads projects to flight and provides sound engineering judgement to prove airworthiness. The primary role of being a mission support intern in the OE branch consisted of organizing and maintaining the employee training database, as well as tracking and compiling metrics to help run an efficient and organized department. To assist in flight operation records management, the NASA Records Management requirement dates were analyzed and organized in chronological order for future disposal. The internship responsibilities for organizing documents carried into the Photography Lab as well. From first flights to retirements, the Photography Lab has captured and documented a lasting legacy of the missions and other moments at NASA AFRC. In order to store decades of memories for future generations, the Photography Lab is in the process of a negatives project, where photographs are carefully analyzed and digitally recorded, dating back from 1949 through current NASA AFRC missions. This project allows for future generations to properly access and use these images.

Jaxom Hartman
Texas Tech University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical
Engineering

Mentor: Allen Parker
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Sensors & Systems
Development

Thermally Tuned Laser System for
Fiber Optic Sensing Systems (FOSS)

Fiber optics are a relatively new medium of transmitting data known for their speed, efficiency, and versatility while maintaining small size and light weight. Used to transmit information about variables including temperature, pressure, and strain from an airplane wing to its central computers, fiber optics offer a less intrusive and more ruggedized method of collecting pertinent data. The lasers used to generate signals in fiber optic communication change output frequency with temperature. This change in temperature can alter critical operating conditions of the system and distort the information sent and received. Deliberately altering the temperature of a laser allows one to observe the corresponding changes in output frequency and system response. A Peltier cooler, a device which uses bidirectional electrical currents to heat and cool metal plates, is digitally controlled to effect the desired laser temperatures. This research will allow thorough testing of the full frequency range of any lasers used by pushing the thermal limits of the device. Knowing this information will allow the design of communication software to reliably send and receive information in adverse operating conditions.

Dawn M. Keiser

Embry-Riddle Aeronautical University

NASA Armstrong Internship Program

Graduate Intern
Major: Systems Engineering

Mentor: Peggy Hayes
Code: 720
Safety, Health, and Environmental

Institutional and Environmental Safety at AFRC

The goal of the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) Safety, Health, and Environmental Office is to, "Promote a culture of world-class safety and environmental programs in all Armstrong activities utilizing industry-wide best practices." There are many programs, policies, and processes within NASA and at AFRC that have been developed with that goal in mind, and one of the many responsibilities of the Safety Office is to ensure that those programs are maintained, evaluated, and revised as necessary. As part of the Safety team, I worked towards gaining the knowledge, skills, and certifications necessary to become a safety specialist, as well as participating in, assisting on the research for, and the assessment and revision of four specific programs: the Institutional Safety programs for Confined Space Safety and Pressure Vessel Systems, and the Environmental Management programs for Environmental Justice Implementation and NEPA compliance. Specific assignments and projects over the course of the internship included the development of a database to track, log, and audit all pressure vessel systems at AFRC; conducting a self-assessment of the Confined Space Safety Program; researching, updating, and suggesting revisions for the AFRC written Environmental Justice Implementation Plan; and assisting in the NEPA environmental review process.

Macie Kowalski
University of Washington

NASA Armstrong Internship Program

Undergraduate Intern
Major: Aerospace
Engineering

Mentor: Albion H. Bowers
Code: 500
Research & Engineering

Analysis of Load Distribution on PRANDTL-D3c

During flight, most aircraft experience an elliptical load distribution. However, the standard aircraft configuration is not one which provides the optimal load distribution on a wing. It was not until Ludwig Prandtl wrote his paper presenting an unprecedented approach to load distribution that researchers began to entertain the idea that a non-elliptical distribution was possible. A non-elliptical span load was unheard of with the exception of bird wings. The Preliminary Research AerodyNamic Design to Lower Drag (PRANDTL-D) project aims to replicate Prandtl's predicted bell-shaped span load by imitating the wings of a bird, taking into account the twist of a wing and the lack of a vertical tail. With this configuration, drag is significantly reduced, lift eludes the wing tips, and the unconventional bell-shaped span load is created. Using data from the Fiber Optic Sensing System (FOSS) embedded in the wings, we have been able to calculate the strain, moment, shear, and load values across the wing. After removing the FOSS system, it was replaced with an Electronic Pressure Management System (EPM) which uses pressure ports organized in rows across the wing to collect pressure data rather than tension and compression data that the FOSS system collects. FOSS and EPM data show that the aerodynamic shape of the PRANDTL-D greatly reduces drag, achieves the desired bell-shaped load distribution, and thus validate Prandtl's theory.

Jose Manriquez

California State Polytechnic University, Pomona

NASA Armstrong Internship Program

Graduate Intern
Major: Aerospace Engineering

Mentor: Dave Berger
Code: 112
Office of Education

Using Embedded Coder to Quickly Develop Non-Linear Flight Control Systems for the PRANDTL-M Glider

The Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) project aims to reach a new boundary of tailless vehicle flight and challenge the notion that the elliptic lift distribution is optimal for non-span limited cases of Prandtl's lifting-line theory. PRANDTL-M attempts to mimic the wings of birds by applying a non-linear geometric twist throughout the wing span to generate proverse yaw to overcome adverse yaw effects during flight. This method of flight could benefit from a non-linear flight control system to incorporate the flight dynamics of a tailless flying wing. Development of the flight control system would take place in the MathWorks® Simulink (The MathWorks, Inc., Natick, Massachusetts) block diagram environment utilizing the Pixhawk (mRobotics®, Chula Vista, California) Pilot Support Package (PSP) for the Embedded Coder® Toolbox (MathWorks®, Natick, Massachusetts). The glider is equipped with the Pixhawk Flight Management Unit (FMU), a high performance autopilot hardware that runs a real-time operating system and a full stack, open source, PX4 autopilot software. The PSP would convert a flight control system in the form of a block diagram into a C++ code application. The application could then be implemented into the PX4 source code, then built and deployed into the FMU. This process would allow for a faster development process of designing, building, and deploying the flight control system in a prototype glider for testing and debugging.

Hussein Nasr

California State Polytechnic University, Pomona

NASA Armstrong Internship Program

Graduate Intern
Major: Aerospace Engineering

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Office of Education

PRANDTL-M Simulation Development

The Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M), planned to be the first glider to fly through the Martian atmosphere, is a small vehicle with folding wings allowing it to fit inside a small 3U CubeSat. The PRANDTL-M mission is to collect ground mapping and atmospheric data on Mars. The main objective of this internship is to perform system identification (ID) on several wing geometry designs, simulate them, and compare the results with flight data. System ID, in short, is the building of mathematical models that represent the dynamics of the vehicle during flight. More specifically the objective for this internship is to retrieve the stability and control derivatives of the vehicle. To start, eight equations of motion are used and then linearized around trim conditions to create state space models in the longitudinal and lateral directions separately. The most critical and challenging part in performing system ID for this project is retrieving essential flight data during specified maneuvers. The PRANDTL-M is very small and does not produce its own thrust, so holding steady altitude or having an alpha-beta vane is not feasible. Many workarounds must be implemented and assumptions made to get the best possible estimation of aerodynamic coefficients. Finally, coefficients will be compared with results found from using computation fluid dynamics software.

Michael Sanchez

Florida Polytechnic University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical Engineering

Mentor: Matthew Waldersen
Code: 540
Sensors & Systems Development

Functional Prototype Development of Wireless Flight Sensor System

The Wireless Flight Sensor System (WFSS) is a project focusing on wireless avionics communications currently being developed at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC). The WFSS is an avionics communication system that provides a means to rapidly integrate emerging wireless sensor technology into any aircraft. I was responsible for developing several functional test systems intended to help demonstrate the ability to rapidly acquire wireless sensor data and distribute that information over a flight network. I designed a wireless sensor that utilized the Institute of Electrical and Electronics Engineers (IEEE) 802.15.4 protocol. I also designed a test system that communicated over the controller area network (CAN) protocol, intended to represent a flight computer on an existing avionics network. This device was able to receive incoming wireless messages, and then relay them over a CAN network. Like with any new system, it is important that the WFSS provides backward compatibility with a wired sensor system. To demonstrate backwards compatibility, I was also tasked with creating a USB data acquisition unit to acquire wired sensor data and relay it back into the WFSS. With these functional test systems, we will be able to demonstrate the capabilities of this system and its potential to increase efficiency and versatility of our current and future test vehicles and test platforms.

Patrick Stockton
The University of Texas at San Antonio

NASA Armstrong Internship Program

Graduate Intern
Major: Computer Engineering

Mentor: Allen Parker
Code: 540
Sensors & Systems Development

Field-Programmable Gate Array (FPGA) System Design of the Fiber Optic Sensing System (FOSS) Thermally Tuned Laser

The Fiber Optic Sensing System (FOSS) team at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) provide novel approaches to the real-time data monitoring from a wide variety of systems. The real-time acquisition of measurements such as vibration, pressure, strain, and temperature are paramount in the operation and safety of NASA equipment and personnel. Among the different systems developed by the FOSS team, the thermally tuned laser is a highly more accessible instrument that provides most of the same functionality as other FOSS instruments. My role in the development of the Thermally Tuned Laser includes the interfacing of the Field-Programmable Gate Array (FPGA) microcontroller with the multiple fiber optic sensors. Acquiring the data from the fiber optic sensors is accomplished by using multiple high-speed analog-to-digital converters (ADCs) over multiple synchronous Serial Peripheral Interface (SPI) protocol channels. Once this data is acquired, the FPGA then communicates with the other platforms in the system for the processing of the fiber optic sensor data. As a result, the Thermally Tuned Laser system will provide a state-of-the-art method to achieve high quality data at a fraction of the required resources.

Jared West
Mississippi State University

NASA Armstrong Internship Program

Undergraduate Intern
Major: Electrical
Engineering

Mentor: Kurt Papathakis
Code: 550
Vehicle integration & Test

X-57 Maxwell Cruise motor Endurance Testing
T-34 ANR installation

The X-57 Maxwell (ESAero, San Luis Obispo, California) is an experimental electric aircraft that has an engine which will be used on future airplanes. Although some electric airplanes already exist, the Federal Aviation Administration (FAA) has yet to establish regulations in order for electric engines to be used commercially. The National Aeronautics and Space Administration (NASA) research and testing of this engine will allow the FAA to understand the regulations needed in order to ensure a reliable, safe, and clean electric engine that can be implemented in small to medium aircraft. Testing is currently underway and being implemented by an automated procedure called Procedure Integrated Developed Environment (PRIDE) in which I have contributed to modifying. As a test engineer, I must constantly monitor incoming data such as torque, thrust, temperature, and RPM to ensure the motor is operating properly. Alongside the X-57 Maxwell, I am also working on the installation of the active noise reduction (ANR) system that will fix noisy communications between the pilots and ground crew. Currently the system is being operated by battery and requires the pilot to carry on extra, unnecessary equipment. My task is to identify all the parts necessary to install the system onto the T-34 aircraft for permanent use and draw a proper schematic in AutoCAD (AutoDesk Inc., Mill Valley, California) to ensure proper installation. The result of this installation is that the avionics communication system will now be able to cancel out unwanted noises and allow for more efficient and precise communication.

Thank You
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Craig Griffith

Tom Grindle

Edward Haering

Philip Hamory

Peggy Hayes

Enrique Hernandez

Jason Holland

Lisa Illowsky

Kurt Kloesel

Walter Kondracki

Chris Kostyk

Jeanette Le

Jason Lechniak

Victor Loera

Kate McMurtry

Kia Miller

Matthew Moholt

Oscar Murillo

Ethan Nieman

Chan-gi Pak

Kurt Papathakis

Steve Parcel

Allen Parker

Marlin Pickett

Herman Rijfkogel

Timothy Risch

Michael Ritchson

Jim Ross

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Sky Yarbrough

Autographs

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