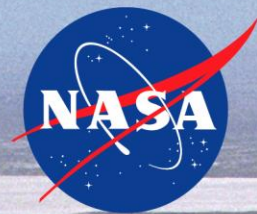


National Aeronautics
And Space Administration



2021
INTERN EXPERIENCE

A Message from the Center Director

Congratulations to the NASA Armstrong Flight Research Center 2021 Student Programs Cohort! Thank you for working with us this year as things start to return to something closer to “normal”.

The progress NASA continues to make through the pandemic is due to the contributions of the NASA workforce – and that includes your contributions as students. NASA and Armstrong have done well this past year and has been recognized, for the 9th time in a row as the best place to work in the federal government.



With your help, are making great progress on the X-59 Low Boom Flight Demonstrator, the X-57 Maxwell all-electric aircraft, SOFIA, airborne science, and the multitude of other technical work at the center.

In the face of the COVID-19 pandemic, you are continuing to help NASA and Armstrong make progress in our missions. As we move forward, I am excited to see where your generation will take NASA and our mission as we recover from the pandemic.

The country and the world are changing, and you will be an important part of that change.

Stay safe, stay healthy, and continue learning.
Thank you for all that you are doing.

David D. McBride
Center Director

A handwritten signature in black ink, appearing to read 'D. McBride'. The signature is stylized with a large, looping 'D' and a series of connected, fluid strokes for the rest of the name. It is written on a light-colored, slightly textured background.

Program Description

Student internships provide the opportunity for students to work side by side with a mentor to contribute to the National Aeronautics and Space Administration (NASA) mission. During Fiscal Year 2021, NASA Armstrong Flight Research Center (AFRC) welcomed students from universities across the nation. Interns were represented in different organizations across NASA AFRC and supported exciting projects – such as THOR, FOSS, CIF, X-59, LBFD, RVLT, PMSM, and several PRANDTL projects.

We would like to recognize the many funding sources that came together to make this possible for the student interns. These sources include NASA AFRC mentor project funding, Universities Space Research Association (USRA), Minority University Research and Education Projects (MUREP), National Science Foundation Centers of Research Excellence in Science and Technology (NSF-CREST), MUREP Institutional Research Opportunity (MIRO), National Space Grant Foundation, Space Grant – California, National Space Grant Foundation - Space Law, Space Grant – Maine, Space Grant - South Dakota, and Space Grant – Indiana.



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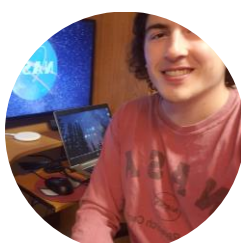
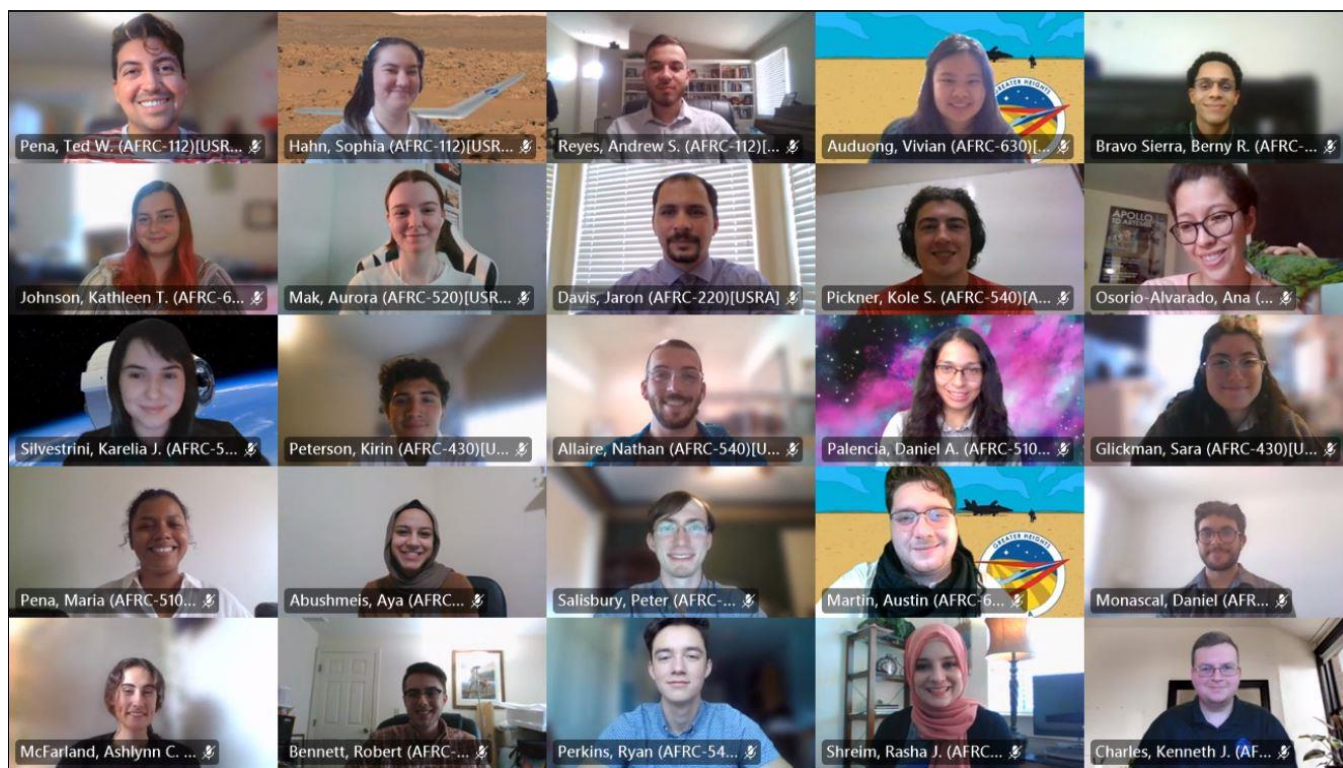
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Summer 2021 Abstracts



**Aya Abushmeis**

University of Houston

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering****Mentor: Kurtis Long
Code: 430
Operations Engineering****X-59 Panel-Mounted Breathing Regulator Tester Development**

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) Life Support System (LSS) team works to ensure the health and safety of the pilot of the X-59 Low Boom Flight Demonstrator (LBFD). An integral part of the LSS is the Panel-Mounted Breathing Regulator (PMBR) which ensures adequate oxygen volume and pressure supply for the 60,000-ft flight altitude of the X-59 LBFD. The PMBR, however, is the only component that does not have testing procedures or mechanisms to validate its performance before flight. The objective of this project is to develop a tester unit for the PMBR using information from similar, but outdated, systems. To ensure proper piping design, schematics of similar units have been drafted to model the flow, and are being compared, and modified as needed, for the PMBR tester. Research into manufacturers and equipment is being conducted and documented for product recommendations of the tester. Detailed analysis of the fluid mechanics of the tester will be conducted using MATLAB® Simulink (The MathWorks, Inc., Natick, Massachusetts) to ensure its capabilities match those of the PMBR. At the conclusion of the tester design, operating procedures will be drafted for the PMBR tester, giving AFRC increased confidence in the X-59 LSS before flight.

**Nathan Allaire**

California State University, Long Beach

NASA Armstrong Internship Program**Undergraduate Intern
Aerospace Engineering****Mentor: Paul Bean
Code: 540
Sensors and Systems
Development****Mothership Drone Capture and Release System**

The National Aeronautics and Space Administration (NASA) Mothership Drone Capture and Release System (MSCARS) program will focus on the further development and testing of in-flight systems required for programable and autonomous release and recapture of various types of unmanned aircraft systems (UASs). The system is composed of a moveable support gantry outfitted with end effectors capable of yaw and pitch rotational movement with an attached magnetic based release-and-hold mechanism. This method helps capture UASs at angles other than normal steady flight in addition to aiding in exploring numerous technical areas beneficial to future atmospheric flight such as: launch and recovery techniques; and advancing the development of sensors used for analysis, control, and navigation. The system is moving forward with procurement, assembly, and preparing to perform a proof-of-concept demonstration utilizing patterned magnets, robotically-driven mechanisms, and drone-shaped models. Concept models and motion studies are being performed in three-dimensional computer-aided design (CAD). Prototype development includes additive manufacturing (3D printing), as well as software and mechanical development.

**Vivian Auduong**

Stanford University

NASA Armstrong Internship Program**Undergraduate Intern
Electrical Engineering and
Computer Science****Mentor: Aamod Samuel
Code: 630
Simulation Engineering****“Greater Heights” Narrative VR Experience Development**

In celebration of the Armstrong Flight Research Center (AFRC) (Edwards, California) 75th anniversary in 2021, the simulation team at AFRC is in the production phase of a narrative virtual reality (VR) experience of Neil Armstrong’s historic X-15 test flights. The experience is being developed for the Oculus Rift® (Oculus VR, Menlo Park, California), XTAL® (VRgineers, Prague, Czech Republic), and other head-mounted displays (HMD) using a Blender® (Blender Foundation, Amsterdam, Netherlands) and Godot development pipeline. Attention to detail, research of historical documents, and consultation of documentation is being used to implement hand-tracking and controls in VR, as well as to accurately and realistically simulate the experience of piloting the X-15 hypersonic rocket-powered aircraft. The “Greater Heights” project showcases the Simulation Engineering team’s ability to calculate the dynamics of an aircraft and provide users at all levels the experience of piloting an aircraft. In doing so, the Greater Heights experience seeks to celebrate the AFRC role in pioneering aerospace technology, while inspiring future innovation.

**Robert Bennett**

University of Massachusetts Amherst

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Chris Kostyk
Code: 560
Aerostructures

Thermostructural Analysis for CHeLo

The Coincident Heating and Loading (CHeLo) project is a ground test system for high temperature structures. This project contributes to the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) mission to study high-speed aeronautics by developing a novel approach for combined thermal and structural testing of test articles. A higher fidelity simulation of flight vehicle response to the high-speed flight environment is thus enabled, while also allowing for the evaluation of the numerous assumptions present in design models. Thermal analyses are performed using PATRAN®/NASTRAN® (MSC Software Corporation, Newport Beach, California), along with spreadsheet and hand analyses, for the purpose of evaluating the heat transfer through the system and any potential methods for improvement. The thermal analyses involve all three modes of heat transfer (conduction, convection, and radiation) and will evaluate a variety of design options (that is, material changes, additional features, modified geometry, and surface enhancement). The results of these analyses will directly contribute to the advancement of the state of the art of ground testing high-speed flight structures.

**Berny Bravo Sierra**

Universidad Ana G. Méndez, Recinto de Gurabo, Puerto Rico

NASA Armstrong Internship Program

**Undergraduate Intern
Computer Engineering**

**Mentor: Paul Bean
Code: 540
Sensors and Systems
Development**

Magnetic Two-Body Separation Techniques

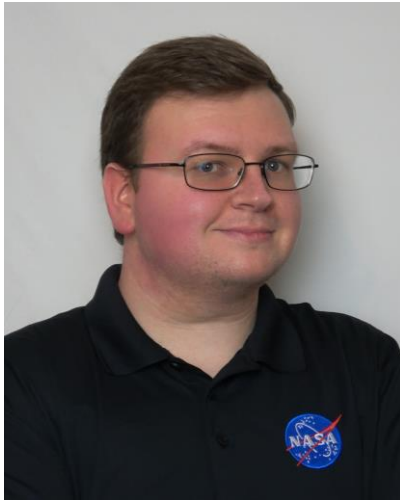
The development and testing of two-body separation techniques is based on the application of patterned magnets for the release and recapture of aircraft. To achieve these objectives, an experimental robotic gantry is being developed in the laboratory to track and capture simulated aircraft shapes. These efforts aim to make the process of recapturing and releasing aircraft faster and easier, while at the same time reducing the costs of missions. Current research is focused on designing, developing, and testing the recapture gantry using state-of-the-art technologies to make it fast, precise, and reliable. Different types of software are being used for the design and development of this system. In addition, different types of microcontrollers and microprocessors are being used with the purpose of running the system efficiently. The focus of this internship is to design the recapture gantry to establish a solid foundation which is composed of specifying software requirements, identifying software limitations, defining software architecture, creating a software development plan, and producing the base control algorithm. The next steps include testing, adding features, and defining the limitations of the system. These efforts contribute to the mission of the center by creating new ways of capturing, holding, and manipulating human-made free flying objects.

**Alek Cerne**

University of Michigan

NASA Armstrong Internship Program**Undergraduate Intern**
Major: Computer
Engineering**Mentor: Sky Yarbrough**
Code: 540
Sensors and Systems
Development**Mesh Deployment Simulation**

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) is developing a new acoustic ground recorder system called the Ground Recorder System (GRS) to record the sonic boom signature of the Lockheed Martin X-59 Low Boom Flight Demonstrator (LBFD). The GRS units are deployed over 600 square miles. In order to attain boom signatures and control the GRS units a mesh network between units is required. This network between the GRS units must have the capabilities to: interface with the Mobile Operations Facility (MOF) from a distance of 100 miles, upload files of 100 kB to each unit within 5 minutes, and return 2.5 GB of flight data to the MOF, with every packet being encrypted as well. A computer simulation using as MATLAB[®] (The MathWorks, Inc., Natick, Massachusetts) was created to simulate the network between the GRS units to test the feasibility of a mesh network solution. Emphasis is placed on the user interface of the simulation in order to accurately depict the functionality of free-form or uniquely structured meshes, along with accounting for the topography of where the GRS's are being placed. Network traits such as path loss, probabilistic broadcast, structure interference, and packet drops will all be considered. The goal is to be able to simulate all relevant aspects of a mesh network that is able to deliver the data transfer benchmarks for the GRS units.

**Kenneth Charles**

California State University, Long Beach

NASA Armstrong Internship Program**Undergraduate Intern
Electrical Engineering****Mentor: Allen Parker
Code: 540
Advanced Systems
Development****Analog Input Upgrade for Temperature-Tuned FOSS**

The Fiber Optic Sensing System (FOSS) is a revolutionary sensing technology that provides real-time monitoring of structural conditions including, but not limited to, strain, shape deformation, strength, liquid level, and temperature. The FOSS has a wide range of potential application areas, some of which include transportation, infrastructure, energy, medical, and aerospace. One of the latest possible applications for FOSS is to support the National Aeronautics and Space Administration (NASA) Artemis program by measuring cryogenic fluid levels. To this end, a new Advanced Cislunar and Surface Capabilities (ACSC) enhanced Temperature-Tuned FOSS (TempTuned FOSS) system is being developed to withstand extreme temperatures while maintaining a compact form factor. The latest iteration of this system upgrades the existing input circuit board to have a faster sampling rate of the analog inputs, providing a larger data set, thus increased accuracy of temperature readings. The process of upgrading the input board includes choosing new hardware such as an analog-to-digital converter (ADC), microcontroller unit (MCU) and other integrated circuit (IC) chips, all conforming to updated performance requirements and size constraints. Next, the assorted components are assembled onto a redesigned printed circuit board (PCB) and finally, the MCU is programmed to properly interact with and dictate all circuit components, ultimately processing the analog FOSS input data stream into usable digital data for further analysis.

**Christina Closson**

University of Maine Orono

NASA Armstrong Internship Program**Undergraduate Intern
Electrical Engineering and
Computer Science****Mentor: Allen Parker
Code: 540
Sensors and Systems
Development****Web Interface Development for Micro FOSS**

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) is developing a groundbreaking Fiber Optic Sensing System (FOSS) called the μ FOSS. This system will be improving features of the current FOSS system such as reduction in cost and size, as well as simplification of overcomplicated optical networks. This internship was spent developing a web interface for user-controlled manipulation of the μ FOSS system. The application includes a Flight Mode, Ground Mode, and Post-Process Mode. The Flight Mode will allow laser operation as well as Field Programmable Gate Array (FPGA) control without any user interaction. The process will continue to operate until the system is shut down or terminated by the web interface application. In Ground Mode operation, the user will be able to interact with the μ FOSS configuration parameters and begin data acquisition within those parameters. Laser operation and operation of the FPGA are also included in this mode. Finally in the Post-Process Mode of operation, the user will be able to access previously recorded data located on the μ FOSS unit. These data will be presented through a graphical plot display, allowing the user to simulate real test broadcast over the network and save the recorded data to CSV or bin file formats.

**Jaron Davis**

San Diego State University

NASA Armstrong Internship Program**Undergraduate Intern
Aerospace Engineering****Mentor: Daniel Bartlett
Code: 220
Logistics Management****Project Management and Lean Six Sigma Study on Logistics**

The objective of this project is to view, analyze, and validate the logistical processes used by local and adjacent departments within the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California), and identify discrepancies or mismatched or duplicate logistical processes. This objective is accomplished by researching all relevant Armstrong Flight Research Center Operational Procedures (AFOPs) and referencing any other supporting documentation. By applying the principles found within Lean Six Sigma (LSS), specifically the Define, Measure, Analyze Improve, and Control (DMAIC) method, to the affected areas, the logistical process can then be improved upon by eliminating waste and defects, which will subsequently improve the performance of the affected processes. Overall, this project will greatly support AFRC by assisting the Logistics Department in helping with the Mission Support Future Architecture Program (MAP) transition. Since the Logistics Department is present within every level of the MAP transition, identifying any discrepancies or mismatched and duplicate logistical processes will greatly improve the provided services. At the conclusion of the project, each affected department will then be presented with the results of the conducted analysis.

**Sara Glickman**

Florida Atlantic University

NASA Armstrong Internship Program**Undergraduate Intern
Neuroscience and
Behavior****Mentor: Kurtis Long
Code: 430
Operations Engineering****X-59 Control Room Emergency Procedures and Training**

The X-59 QueSST (Quiet SuperSonic Technology) aircraft is the National Aeronautics and Space Administration (NASA) new supersonic aircraft, being manufactured by the Lockheed Martin Skunk Works (Palmdale, California). The X-59 aircraft was designed and is being built with QueSST with the goal of proving that not all supersonic aircraft make sonic booms. The X-59 flight simulator, located at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California), is attached to a Flight Mission Control Center (MCC). The flight simulator will be used to practice various emergency in-flight scenarios in order to train pilots and MCC personnel. Scenario inputs and descriptions were collected from control room stakeholders and then organized in a master spreadsheet. Control room stakeholders include those representing flight dynamics, propulsion, avionics, and other areas of flight test engineering. There is a limited number of scenarios that may be simulated due to time and hardware capabilities, so scenarios will be prioritized to determine which will be implemented in the flight simulator. This project and the low-boom supersonic flight research that comes out of it will introduce the world to a new future of supersonic passenger flight.

**Sophia Hahn**

San Jose State University

NASA Armstrong Internship Program**Undergraduate Intern
Aerospace Engineering****Mentor: David Berger
Code: 112
Office of STEM Engagement****Analyzing and Reiterating Designs for PRANDTL-M**

The Preliminary Research AerodyNamic Design to Land on Mars (PRANDTL-M) team objective is to create gliders that will fly on and survey Mars. The PRANDTL-M gliders utilize the proverse yaw effect that is created by the bell-shaped lift distribution that is highlighted in a paper written by Al Bowers. The team is currently in the process of testing and reiterating the 8 series of designs. The 8 series is a test series that contains a control glider as well as a glider that will vary other aspects such as aspect ratio and the dihedral angle to understand the effects on stability. This session will put its emphasis on translating the aircraft computational design from MATLAB® (The MathWorks, Inc., Natick, Massachusetts) to SOLIDWORKS® (Dassault Systèmes Solidworks Corporation, Waltham, Massachusetts), where it will then be analyzed and formatted for manufacturing. At session's end, the PRANDTL-M team will be left with the computer-aided design files, computer-aided manufacturing files, and manufacturing instructions for the 8 series designs so that the next in-person session will be able to fabricate, and test fly the 8 series. Looking forward for this project, a 9th series is planned to be designed using data from the 8th series flight tests and will undergo the high-altitude tests. Once the 9th series performs within limits, the next stage would be to send the glider to Mars.

**Adam Hooker**

University of Texas at San Antonio

NASA Armstrong Internship Program**Undergraduate Intern
Electrical Engineering****Mentor: Allen Parker
Code: 540
Advanced System
Development****Multi-threaded Parallel Processing for Improved System Efficiency**

The Fiber Optic Sensing System (FOSS) is designed for monitoring thermal and structural response in real time with significantly reduced hardware requirements when compared to traditional approaches (thermocouples, strain sensor, et cetera). A newly developed Doppler FOSS algorithm has been implemented on the X-56 unmanned aerial vehicle (Lockheed Martin, Bethesda, Maryland) to create real-time velocity profiles of wing structures. These velocity profiles allow for full state feedback control based on direct measurements. System performance is based largely on software optimization. To expand the utility of this algorithm, a multi-core multi-threaded efficient code base is proposed. Developing this efficient code base requires establishing a network for simulating the specific communication protocol, Transmission Control Protocol/Internet Protocol (TCP/IP), that the FOSS would utilize during its deployment. Additionally, metrics are needed to be established to determine the time it takes for the Doppler FOSS algorithm to execute. These metrics will then be referred to during the multi-threading and multi-core implementation. Applications of this technology span three generations of FOSS systems. By improving an already well-established technology, mission-critical data become a more viable resource for decision making capabilities.

**Kathleen Johnson**

Purdue University

NASA Armstrong Internship Program**Undergraduate Intern
Aerospace Engineering****Mentor: Aamod Samuel
Code: 630
Simulation Branch****History Through Virtual Reality**

The mission of the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) is to advance technology and science through flight. The Greater Heights project was established to showcase some of the most successful research missions at AFRC. The Greater Heights project seeks to immerse users in a virtual reality (VR) experience that places them in the pilot's seat for Neil Armstrong's final flight of the North American X-15-1 hypersonic rocket-powered aircraft. The experience is being coded using software such as Blender[®] (Blender Foundation, Amsterdam, Netherlands) and Godot[®] (Juan Linietsky, Ariel Manzur and contributors). Since the project places a large emphasis on real-to-life feel, one of the goals is to increase accuracy of the physics model for the plane in the game engine. After investigation, it was found that much of the original data and equations of motion for the X-15 aircraft have been lost to time, so X-Plane 11[®] (Laminar Research, Columbia, South Carolina) will be used to iterate on designs of the X-15 aircraft to obtain initial equations of motion followed by flight data. That information can be used with the game engine to ensure authenticity in the flight dynamics. Accuracy of flight behavior will become increasingly important as the project progresses to include other airplanes, as it will help users sense the difference in handling for each airplane.

**Aurora Mak**

Portland State University

NASA Armstrong Internship Program**Undergraduate Intern
Mathematics****Mentor: Jason Lechniak
Code: 520
Aerodynamics and
Propulsion****Prandtl Propeller Modelling and Evaluation**

As part of the Center Innovation Fund (CIF) Prandtl Propeller Design Project, the viability of Prandtl propellers has been shown through previous modellings. The current goal is to expand on the research of Prandtl propeller designs. The design methods of a Prandtl propeller are being researched to verify that the efficiency improvement is significant. Further, analytical design methods are being applied to the current method to ensure fidelity. The project is two-fold: develop modeling and analysis code using MATLAB® software (The MathWorks Inc., Natick, Massachusetts); and physical experimentation of these Prandtl-Inspired Propellers. The code will offer the ability to design new propellers as well as modify existing propeller designs, and will enable the comparison of traditional propeller design performance against these new designs that incorporate the Prandtl twist. Another objective of the code is to relate new analysis methods with traditional analysis. The physical experimentation will assist in the verification of the design methods as well as produce valuable information about the performance of this design in varying conditions of flow.

**Austin Martin**

University of Central Florida

NASA Armstrong Internship Program**Undergraduate Intern**
Digital Media, Game
Design**Mentor: Aamod Samuel**
Code: 630
Simulation Engineering**Sharing History with Virtual Reality Simulations**

With the 75th anniversary of the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) approaching in 2021, AFRC is working on a narrative Virtual Reality (VR) experience that will allow users to step into the boots of Neil Armstrong as a test pilot for the North American X-15 hypersonic rocket-powered aircraft. The experience is planned to be expanded to include many different options for users to experience flight. The experience is being developed for the Oculus Rift® (Oculus VR, Menlo Park, California) utilizing a Blender® (Blender Foundation, Amsterdam, Netherlands) and Godot® (Juan Linietsky, Ariel Manzur and contributors) production pipeline. Currently, the project is in production. A scrum-style workflow is being used to work through the designs set forth in the game design document to bring scenes to life through modeling, creating scripts, level design, and working through lighting to give every scene a realistic feel. Because Neil Armstrong's experience as a test pilot was so compelling, the story designed around this experience will proudly display AFRC achievements, ingenuity, and its history to center visitors, inspiring a new generation to look to the stars.

**Ashlynn McFarland**

The University of Washington

NASA Armstrong Internship Program

**Undergraduate Intern
Aeronautical &
Astronautical Engineering**

**Mentor: Kurtis Long
Code: 420
Operations Engineering**

Low Boom Flight Demonstrator Air Data Probe

The National Aeronautics and Space Administration (NASA) X-59 Low Boom Flight Demonstrator project is planned to be an airplane with supersonic capabilities, exploring supersonic flight with a quieter sonic boom. An air data probe will be positioned at the front of the X-59 airplane and will play a crucial role in collecting data on flight and aircraft conditions. Subsonic and supersonic wind-tunnel tests were conducted with the primary air data probe and its backup at the NASA Glenn Research Center (Cleveland, Ohio). A report on the results of these tests is planned to be completed by October for Lockheed Martin (Bethesda, Maryland), the manufacturer, requiring substantial data processing before submission. These data will be analyzed and searched for errors using MATLAB® (The MathWorks, Inc., Natick, Massachusetts) and outside data sources. Disparities in what is expected of data patterns and their causes will need to be identified for recognition of unnecessary data. Analytic models and candidate neural network models will be evaluated for accuracy and will allow for a variety organizational models from different perspectives. The wind-tunnel data will also be processed for use in different calibration models needed for flight.

**Daniel Monascal**

California State University Northridge

NASA Armstrong Internship Program**Undergraduate Intern
Computer Science****Mentor: Nelson Brown
Code: 510
Systems Engineering and
Integration****Obstacle Detection for Autonomous UAS Obstacle Avoidance**

The Resilient Autonomy (RA) team at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) has planned a test flight for an autonomous aircraft in the area surrounding Edwards Air Force base. The flight requires a reliable obstacle database of the area for the aircraft to avoid collisions. The currently available databases are outdated and often omit smaller objects that low-flying aircraft require for proper avoidance. Previously this database was being developed manually, but because of the large number of obstacles in the target area the team is seeking a more efficient method. Therefore, the creation of this database will be achieved automatically with an obstacle detection machine-learning model. The model will be trained on light detection and ranging (LIDAR) data in MATLAB® (The MathWorks, Inc., Natick, Massachusetts). The objects detected from the model will then be displayed on top of a map for human verification in the open-source mapping tool, QGIS. This project will assist any autonomous aircraft that require a database to properly avoid obstacles. Once complete, the process can be easily replicated in any area in which LIDAR data have been collected.

**Jonathan Ortiz**

California State University, Northridge

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical & Aerospace
Engineering****Mentor: Kurt Kloesel
Code: 520
Aerodynamics & Propulsion****Engine Model and Controls Integration for Quadrotor Flight-Sim**

The Revolutionary Vertical Lift Technology (RVLT) project is a multi-Center campaign of the National Aeronautics and Space Administration (NASA) Aeronautics Research Mission Directorate (ARMD). The project goal is to develop software tools and technologies that enable expanded use of advanced vertical takeoff and landing (VTOL) aircraft needed for urban air mobility. The RVLT team at NASA Armstrong Flight Research Center (AFRC) (Edwards, California) is currently developing a high-fidelity model of a 4-6 passenger quad-rotor VTOL aircraft with integrated flight controls and turbo-generation propulsion. The vehicle power system was originally modeled with simple batteries, but in order to provide better vehicle dynamics to the simulation, the battery models are being replaced with a 650 shaft-horsepower turboshaft engine model. The powerplant was modeled using Numerical Propulsion System Simulation (NPSS); the engine's performance is similar to modern Safran/Rolls-Royce helicopter engines. The NPSS engine model will interface to the MATLAB® Simulink (The MathWorks, Inc., Natick, Massachusetts) quad-rotor simulation via the NPSS S-Function. RPM speed limiters and redline protection are being added to the engine simulation to control the fuel flow input. The comprehensive aircraft model will be integrated into a six-degree-of-freedom (6-DOF) full motion flight simulator.

**Ana Osorio-Alvarado**

St. John's University, New York City

NASA Armstrong Internship Program**Graduate Intern
Data Science****Mentor: Shideh Naderi &
Scott Stebbins
Code: 540
Sensors & Systems
Development****CryoMag Coupler Early Career Initiative**

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) was awarded an Early Career Initiative (ECI) in 2020 to develop a magnetic, dust-tolerant, cryogenic coupler for lunar environments. The coupler uses programmable, multi-pole magnets as the mating and demating mechanism. The concept of operations is to develop a coupler that can transfer cryogenic fluid (liquid nitrogen (LN₂)) between vehicles in a lunar environment, while tolerant of the local regolith. The final product will be a functional prototype that targets a Technology Readiness Level (TRL) of 5, but not flight- or space-rated. The coupler will demonstrate the integration of three subsystems: the core Low Force Disconnect (LFD) coupler; the magnetic subsystem; and the dust mitigation subsystem. The magnetic subsystem will be built by the Correlated Magnetics Research (CMR) company (Huntsville, Alabama). The dust mitigation system will be designed at AFRC, and several mitigation solutions are in development. This technology targets a technology gap since there is currently no cryogenic coupler that is acceptable for use in the lunar or Martian dusty environment. The CryoMag Project must overcome the following combined challenges: create a magnetic-based mate, persist under temperature extremes, and endure the lunar regolith.

**Daniel Palencia**

California State University, Northridge

NASA Armstrong Internship Program**Undergraduate Intern
Computer Science****Mentor: Nelson Brown
Code: 510
Systems Engineering &
Integration****Obstacle Detection Tool for Autonomous UAS**

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) is developing algorithms to ensure the safety of autonomous unmanned aircraft systems. One of the key algorithms is obstacle avoidance, which requires the use of an obstacle database. This internship project aims to produce a software tool that will assist engineers in creating such an obstacle database and will utilize machine learning algorithms to detect obstacles from large scale Light Detection and Ranging (LIDAR) point cloud data. The deep learning models utilized will include PointNet++ (Stanford University, Stanford, California) for semantic segmentation; other algorithms include clustering algorithms such as DBSCAN (Ester, Kriegel, Sander, and Xu, 1996). The Dayton Annotated Laser Earth Scan (DALES) semantic segmentation dataset produced by the University of Dayton (Dayton, Ohio) will be used for training deep learning models. Geographic information system software will be utilized as a framework for the graphical user interface of the tool. The resulting tool will enable improvements in the quality and extent of AFRC obstacle databases; the obstacle detection algorithms explored will inform AFRC research in automated obstacle detection for aircraft.

**Maria Pena**

California State University Northridge

NASA Armstrong Internship Program**Graduate Intern**
Psychological Science**Mentor: Nelson Brown**
Code: 510
Systems Engineering &
Integration**Human Machine and Team Interactions with EVAA**

The Resilient Autonomy team at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) will test the maturity of technology and inform airworthiness requirements to enable future autonomy, such as link-less operations in an unpowered aircraft, while at the same time providing enhanced automatic safety to modern piloted aircraft. The system that spans this wide range of autonomy is the Expandable Variable Autonomy Architecture (EVAA). In parallel, the Federal Aviation Administration (FAA) is developing a certification approach that could leverage a common framework of the EVAA system for potential use on aircraft ranging from general aviation retrofit to future autonomous aircraft. This internship focused on observing and providing previously unknown insight that could improve the bidirectional relationship in human machine interactions with EVAA and team interactions in response to the developing technology. Data collection will be based on analyzing simulation and evaluation systems videos and notes weekly and synthesizing qualitative data in an Excel spreadsheet (Microsoft Corporation, Redmond, Washington). Reviewing all simulation and evaluation systems videos and notes could lead to identified themes within these human machine and team interactions which can lead to generating potential hypotheses for future follow-ups.

**Teddy Peña**

California Baptist University

NASA Armstrong Internship Program**Undergraduate Intern
Public Relations****Mentor: Lisa Illowsky,
Veronica Wilson, and
Carmen Cruz****Code: 112****Office of STEM Engagement****Office of STEM Engagement Assistant**

The Office of STEM Engagement at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) has the objective of enriching the internship experience through educational events, intern meetings, and academic resources. The Intern Program Coordinator and Assistant work together to plan intern lectures, organize Center-wide events including a virtual tour of AFRC, and schedule activities for interns including bi-weekly “Coffee with the Mentors” and mentor presentations. Additionally, the Office Assistant designs, edits, and assembles the Fiscal Year 2021 Intern Experience Abstract Book. The book is an exhibition of all the interns’ work for the entire fiscal year and includes a letter from the Center Director, design elements, and photographs. The Office Assistant has other duties which include creating and editing documents, corresponding with various professionals from AFRC, interpreting and organizing data, and tracking deliverables. The Office Assistant also works with professionals under the National Space Grant College and Fellowship Project in order to develop flyers and promotional material for events and design the initial mockup of the West Coast Space Grant year-in-review presentation.

**Ryan Perkins**

University of California, Santa Barbara

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering****Mentor: Allen Parker
Code: 540
Sensors and Systems
Development****Development of Ruggedized Enclosure for FOSS**

The main priority of the Fiber Optic Sensing System (FOSS) project is to develop a technology that offers an alternative to strain gages used in aircraft, United States Navy vessels, hermetically sealed vehicles, et cetera. The technology offers more discretized measurements of the area where strain is being measured, as well as temperature measurement and three-dimensional mapping capabilities of that area. The data collected from the systems will be helpful in maintaining a safe environment for the aircraft pilots, providing helpful information for finding flaws in current mechanical designs, and helping to develop safer future mechanical designs. The project coincides with the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) mission of supporting flight research and low-Earth-orbit missions. The FOSS system utilizes a fiber optic network and fiber Bragg gratings which reflect certain wavelengths of light to determine the strain at discrete points. The development of the FOSS system requires collaboration between the mechanical and electrical aspects of the project. The focus is to create an enclosure that can withstand abuse from temperature and vibration.

**Kirin Peterson**

University of Southern California

NASA Armstrong Internship Program**Undergraduate Intern
Aerospace Engineering****Mentor: Kurtis Long
Code: 430
Operations Engineering****Computer-Aided Design and Analysis of X-59 Life Support Systems**

The X-59 Low Boom Flight Demonstrator (LBFD), a quiet supersonic aircraft being developed by the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) and Lockheed Martin (Bethesda, Maryland), requires well-engineered life support systems (LSS) to ensure pilot safety and mission completion when cruising at altitudes of up to 60,000 feet. Existing National Aeronautics and Space Administration (NASA) computer-aided design (CAD) models of the ejection seat, regulated emergency oxygen system (REOS), pilot, and seat survival kit (SSK) need to be integrated with LSS models from Lockheed Martin. Using this new cohesive model, oxygen flowpaths will be measured and tabulated for pressure and temperature calculations. A mirror or borescope system must be designed to allow for visibility of the REOS gauge indicator in the dark and confined space under the ejection seat. Furthermore, extensive testing of LSS components at KBR require CAD modelling of component modifications and test configurations. All CAD design and analysis will be done with Solidworks® (Dassault Systèmes Solidworks Corporation, Waltham, Massachusetts). Completion of these projects will support the X-59 mission by ensuring that the pilot will return to Earth safely, even in the event of an emergency.

**Kole Pickner**

South Dakota School of Mines and Technology

NASA Armstrong Internship Program

**Undergraduate Intern
Mechanical Engineering**

**Mentor: Paul Bean
Code: 540
Sensors and System
Development**

Magnetic Coupling for Cryogenic Fluid Transfer

The objective of this project is to investigate and develop various methods of using magnets to couple a probe and socket system for transferring cryogenic fluid. This project, referred to as Cryomag, is a group collaboration involving several engineers and interns at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (Edwards, California) and the Kennedy Space Center (Kennedy Space Center, Florida), as well as Correlated Magnetics Research, LLC (Huntsville, Alabama), an independent contracting company. Correlated Magnetics will develop patterned magnets (Polymagnets[®]) to allow increased field density and unique applications. Various mechanisms are being researched and modeled in SOLIDWORKS[®] (Dassault Systèmes Solidworks Corporation, Waltham, Massachusetts) and Creo (Parametric Technology Corporation, Boston, Massachusetts) to facilitate magnetic mating within separation distance requirements. The various methods are compared using a trade study to determine the optimal selection based on several criteria, and a report of this trade study is to be written.

**Samiha Raisa**

Victor Valley College

NASA Armstrong Internship Program**Undergraduate Intern
Civil Engineering****Mentor: David Berger****Code: 112****Office of STEM Engagement****Mars Exploration through PRANDTL-M**

The Preliminary Research AerodyNamic Design to Land on Mars (PRANDTL-M) internship consists of a series of projects that is set to support the Mars exploration mission through a Prototype Swarm Glider that develops various trials in attempts to achieve stability through Al Bowers' bell curve lift distribution theory; promoting proverse yaw. The swarm gliders mission to Mars includes gaining insight and conducting observations by collecting data to determine the geological and atmospheric conditions of the planet. With this generational series of the swarm glider being observed and conducted, the 8th series aerodynamic data analysis is currently undergoing computational tests in order to determine the difference in lift, drag, and coefficients that affects proverse yaw. The designing and utilization of tools such as the Massachusetts Institute of Technology (MIT) Athena Vortex Lattice and MATLAB[®] (The MathWorks, Inc., Natick, Massachusetts.) aids to identify the glider's wing specification, with the intended goal to strengthen the affects of lift distribution to promote stability through Bowers' configurations. The data collected will then move on to the 9th series within which a high-altitude glider will be created. With successful results, development will continue for Mars.

**Andrew Reyes**

Victor Valley College

NASA Armstrong Internship ProgramUndergraduate Intern
Computer Science

Mentor: David Berger

Code: 112

Office of STEM Engagement

Analyzing and Testing of PRANDTL-M

The Preliminary Research AeroDynamic Design to Land on Mars (PRANDTL-M) project is to develop a swarm of gliders that will collect data on Mars that will advance missions on the planet. The unique design of the glider is for it to utilize proverse yaw, which is roll in the same direction as a turn. This theory is supported by Al Bowers' bell-shaped lift distribution paper. The PRANDTL-M team is currently in the stage of testing the 8-series designs. These tests consist of using tools such as the Langley Asymmetric Vortex Lattice (LAVL) (Langley Research Center, Hampton Virginia) and MIT Athena Vortex Lattice (MAVL) (Massachusetts Institute of Technology, Cambridge, Massachusetts). These tools are used to gather data for lift distribution, drag, and coefficients of lift. Langley Asymmetric Vortex Lattice (LAVL) and MATLAB® (The MathWorks, Inc., Natick, Massachusetts) are essential tools in finding out the relationship between coefficient of lift and proverse yaw. Using these tools with quantifying the differences with wing geometries will create a module that generates lift distributions by altering the twist of the geometry. At the end of the session, the data collected from the 8-series designs will lead to the flight tests for the 9-series designs. The ultimate end is planned to be to send these swarm of gliders to Mars for further study.

**Peter Salisbury**

Purdue University

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering
and Applied Physics****Mentor: Paul Bean
Code: 540
Advanced Systems
Development****Magnetic Two-Body Separation Techniques**

The objective of this project is to develop novel magnetic separation solutions for cryogenic fluid coupler mating, mothership-drone separation, and in-flight release of heavy stores. The corresponding efforts at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) are the Cryogenic fluid Magnetic coupler (CryoMag), Prandtl-M (Preliminary Research AerodyNamic Design to Land on Mars) magnetic release, and the Heavy-Lift Magnetic Release (HLMR) system, respectively. These projects are all part of an ongoing effort to deploy magnetics to achieve improved performance, flexibility, safety, and simplicity for mission applications. Work for CryoMag centered on the generation and evolution of multiple concepts utilizing Computer-Automated Design (CAD) for the magnetics system. A trade study was conducted to define the criteria needed to compare the concepts and choose a final approach. The CryoMag project also involved direct collaboration with Correlated Magnetics Research, LLC (Huntsville, Alabama), whose novel high pole density magnets were critical in each project. The HLMR design involved detailed CAD and structural analysis, design for test integration with load cells for temporal force data acquisition, and communication with manufacturing and testing facilities.

**Rasha Shreim**

University of Houston

NASA Armstrong Internship Program**Graduate Intern
Master of Science
Technology Project
Management****Mentor: Daniel Bartlett
Code: 220
Logistics Management
Specialist****Project Management and Lean Six Sigma Study on Logistics**

The project aims to authenticate, enhance, modernize, and streamline processes to improve operations for the logistics department at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California). Local policies and procedures are validated and updated as linked to agency policies. Identifying and eliminating repeated efforts and processes that do not match departmental operational procedures supports the financial success of the departments. Creating a more efficient method for local logistics will increase productivity and minimize the number of errors in each path. The team used the Lean Six Sigma methodology to identify waste and eliminate process variations. The team applied the Six Sigma DMAIC (Define, Measure, Analyze, Improve, and Control) method in this research project. Using this methodology, the team has defined errors and mismatches in documents that create unnecessary extra steps and conflicts within the logistics process. The team measured the project's scope, identified the urgency of the issues, and brainstormed solutions to address discrepancies. This project will assist AFRC during the Mission Support Future Architecture Program (MAP) transition. The team provided resolutions, such as forecasted cost savings, reduced time waiting, and other processes affected by variation within documented procedures.

**Karelia Silvestrini**

Universidad Interamericana de Puerto Rico – Recinto Bayamon

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Paul Bean
Code: 540
Advanced System
Development

The Heavy Lift Magnetic Release Project

As innovation keeps impacting the astronautics and aeronautics industries, the Magnetic Separation Team is contributing to the progress of innovation by implementing custom-made magnets into different types of systems. The Heavy Lift Magnetic Release (HLMR) is one of the projects that is under design development. The purpose of this system is to provide an innovative yet safe alternative to hold and release payloads of up to 500 pounds by utilizing sets of Magnetic Actuators. The most important element of this system, however, is its structure, because it will be exposed to various loads. Applying concepts of mechanical design and aircraft structural design, critical parameters are calculated and analyzed. One of the principal parameters is the moment being generated by the loads; as well, the yield and ultimate stress points for the system, and, most importantly, its margin. Those calculations are essential to proceed safely to the fabrication phase and to assure that the design can be successful during testing.

**Rebecca Tucker**

Lewis & Clark School of Law

NASA Armstrong Internship Program

Postgraduate Intern
Law

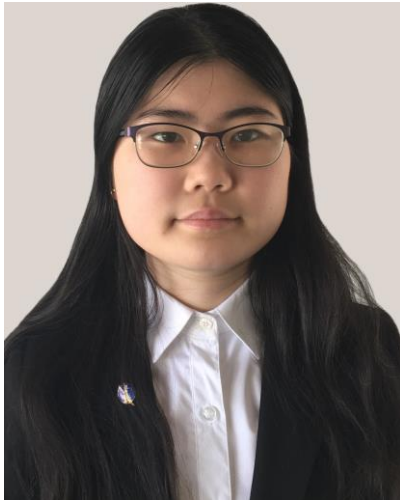
Mentor: Brett Swanson

Code: 120

Title of Branch: Office of the
General Counsel

Legal Internship

Tackling a wide variety of legal issues, the Office of the General Counsel (OGC) provides in-house legal counsel to the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California). The OGC is responsible for ensuring AFRC personnel are fully informed of all applicable laws, regulations, policies, and directives. Should litigation arise, OGC supports AFRC through every stage, fighting for a fair outcome and upholding NASA values. Legal interns step into a junior attorney role, assisting the supervising staff attorneys by drafting memorandums, conducting research, reviewing and revising documents, and participating in meetings. The OGC mainly addresses issues of Ethics, Personnel and Employment Law, Space Act Agreements, Tort Claims, and Procurements. Intern tasks include reviewing acquisition contracts for the X-59 Low Boom Flight Demonstrator, conducting research to ensure smooth coordination among commercial flight providers, NASA, and the Federal Aviation Administration for NASA TechRise Student Challenge, assisting in multiple employment law issues, and interpreting lease agreements to facilitate wider taxiways for the Boeing 747SP modified to be the Stratospheric Observatory for Infrared Astronomy.

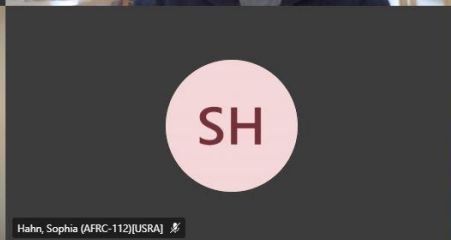
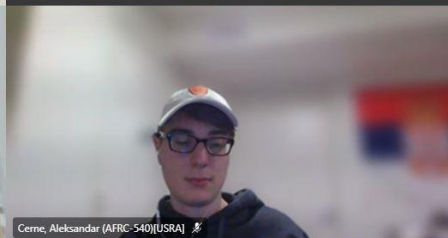
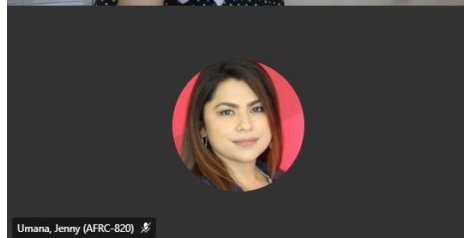
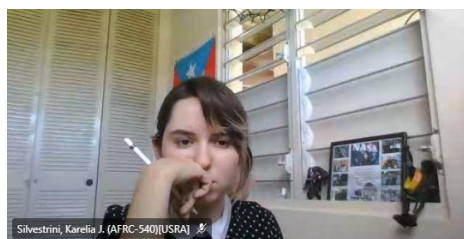
**Wendy Yang**

University of California, Berkeley

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering****Mentor: Jason Lechniak
Code: 520
Aerodynamics and
Propulsion****Prandtl Propeller Modeling and Evaluation**

The project is based on new lift distributions presented in Ludwig Prandtl's 1933 paper on wings and propellers. The project aims to verify the validity of the new lift distribution from the paper by cross referencing existing fluid dynamics literature and develop a propeller using code developed in MATLAB® (The MathWorks, Inc., Natick, Massachusetts) then generate a 3-dimensional computer-aided design model in SOLIDWORKS® (Dassault Systèmes SOLIDWORKS Corporation, Waltham, Massachusetts). The result of the design is then verified in software by using XFOIL and XROTOR (open-source software, Massachusetts Institution of Technology, Cambridge, Massachusetts) and if situation permits, laboratory testing in water tunnels. The performance of the design will be compared against elliptical lifting distribution based propeller design. If successful, the result of this project can be used by the National Aeronautics and Space Administration (NASA) to develop more efficient propellers, rotors, and fans. The codes and deliverables generated will be documented so that work can continue on the project by future interns and researchers.

Spring 2021 Abstracts



**Nathan Allaire**

California State University, Long Beach

NASA Armstrong Internship Program

Undergraduate Intern
Aerospace Engineering

Mentor: Paul Bean
Code: 540
Sensors and Systems
Development

Mothership Drone Capture and Release System

The National Aeronautics and Space Administration (NASA) Mothership Drone Capture and Release System (MSCARS) program will focus on the rapid design and development of in-flight systems required for programable and autonomous release and recapture of various types of unmanned aircraft systems (UASs). The program plans include a system that will utilize magnetic based release-and-hold mechanisms in conjunction with a moveable support gantry outfitted with in-flight tracking software, and magnetic end effectors capable of yaw and pitch rotational movement. This helps capture UASs at angles other than normal steady flight in addition to aiding in exploring numerous technical areas beneficial to future atmospheric flight such as; launch and recovery techniques and advancing the development of sensors used for analysis, control and navigation. The program aims to conduct a compelling proof-of-concept demonstration utilizing novel magnets and robotically driven mechanisms. Concept models and motion studies performed in three-dimensional computer-aided design (CAD). Prototype development includes additive manufacturing (3D Printing), as well as software and mechanical development.

**Samuel Brunkow**

University of Minnesota – Twin Cities

NASA Armstrong Internship Program**Graduate Intern
Robotics****Mentor: Paul Bean
Code: 540
Sensors and Systems
Development****Intermittent Magnetic Coupling Two-Body Systems**

The magnetic two-body separation system development program located at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) focuses on developing and testing two-body separation and recombination techniques utilizing novel magnetic-based hold-and-release mechanisms. Developed systems aim to demonstrate principal advantages of magnetics over current techniques. Focus areas for this session include continued prototype development and testing of a Preliminary Research Aerodynamic Design to Land on Mars (Prandtl-M) in-flight release mechanism and a magnetic space anchoring system. The Prandtl-M in-flight release mechanism has initial lab testing completed, which was determined a success, and is currently coordinating an in-flight release test and updating the system's technical documents. The magnetic space anchoring system has undergone initial testing, including functionality and loading testing for a single latching mechanism and determined successful. Next steps for the system is to complete the system prototype and conduct system functionality testing. This program contributes to NASA goals by demonstrating the functionality of modern magnetics and hold-release techniques to spark future space and flight innovation and research.

**Jackson Button**

University of California, Santa Barbara
University of Michigan, Ann Arbor

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical and Aerospace
Engineering

Mentor: Matt Boucher
Code: 530
Branch: Dynamics and
Controls

Control of Flexible Aircraft using Structural Feedback

Active flutter suppression is a field of controls which is highly researched for many reasons. The primary ambitions of advancing active flutter suppression control technologies, however, are to improve aircraft fuel efficiency through structural weight reduction and to ensure vehicle safety. . The National Aeronautics and Space Administration Armstrong Flight Research Center has previously advanced this objective by stabilizing elastic modes past the flutter boundary through structural feedback on the X-56 experimental aircraft (Lockheed Martin, Bethesda, Maryland) using accelerometers. The use of Fiber Optic Strain Sensors (FOSS) over accelerometers is desirable because FOSS contains hundreds of distributed strain and strain-rate sensors in a single fiber, allowing for potential improvements in modal coordinate estimation and flutter suppression. The goal of this internship is to produce a flight-ready feedback control design using FOSS for structural feedback in order to further explore the capabilities of FOSS to produce robust and responsive controllers for the X-56 aircraft. This will be performed using a linear quadratic Gaussian tracking controller architecture. Lastly, control methods combining accelerometers and FOSS will be explored in order to maximize flutter control capabilities on the X-56 aircraft.

**Sara Caudill**

The Ohio State University

NASA Armstrong Internship Program**Graduate Intern
Design, Digital Animation
and Interactive Media****Mentor: Aamod Samuel
Code: 630
Simulation Engineering****Greater Heights Narrative Virtual Reality Experience Development**

The Armstrong Flight Research Center (AFRC) (Edwards, California) is continuing production of the intern-led virtual reality (VR) experience project, Greater Heights. The intent of *Greater Heights* is to demonstrate the ability of the AFRC Simulation Team to calculate the dynamics of an aircraft in a story-driven flight simulation intended for public outreach and education. The production team is now compositing 3D models and environments in Blender® (Blender Foundation, Amsterdam, Netherlands) and packaging the assets for use in the Godot® (Juan Linietsky, Ariel Manzur, and contributors, FOSS) game engine. Additionally, a New Technology Report (NTR) has been submitted to identify this modification to existing technology. The underlying Application Programming Interface (API) is a lightweight implementation of current simulation technology. This API may prove useful to organizations interested in testing the dynamics of their aircraft in a lightweight simulation, as the Greater Heights API stores all aircraft and environmental data inside the aircraft object itself. Furthermore, a Request for Information (RFI) has been drafted to solicit responses from universities in the United States interested partnering with NASA to continue the vision of the Greater Heights software and engage students with the NASA mission. The potential collaboration would include the development and implementation of new aircraft and narrative modules that integrate computer science, engineering, design, art, and game design disciplines.

**Alek Cerne**

University of Michigan

NASA Armstrong Internship Program**Undergraduate Intern**
Major: Computer
Engineering**Mentor: Sky Yarbrough**
Code: 540
Sensors and Systems
Development**Mesh Deployment Simulation**

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) is developing a new acoustic ground recorder system called the Ground Recorder System (GRS) to record the sonic boom signature of the Lockheed Martin X-59 Low Boom Flight Demonstrator (LBFD). The GRS units are deployed over 600 square miles. In order to attain boom signatures and control the GRS units a mesh network between units is required. This network between the GRS units must have the capabilities to: interface with the Mobile Operations Facility (MOF) from a distance of 100 miles, upload files of 100 kB to each unit within 5 minutes, and return 2.5 GB of flight data to the MOF, with every packet being encrypted as well. A computer simulation using as MATLAB[®] (The MathWorks, Inc., Natick, Massachusetts) was created to simulate the network between the GRS units to test the feasibility of a mesh network solution. Emphasis is placed on the user interface of the simulation in order to accurately depict the functionality of free-form or uniquely structured meshes, along with accounting for the topography of where the GRS's are being placed. Network traits such as path loss, probabilistic broadcast, structure interference, and packet drops will all be considered. The goal is to be able to simulate all relevant aspects of a mesh network that is able to deliver the data transfer benchmarks for the GRS units.

**Hannah Farley**

University of Portland

NASA Armstrong Internship ProgramUndergraduate Intern
Mechanical Engineering

Mentor: David Berger

Code: 112

Office of STEM Engagement

PRANDTL-M Tools and Aerodynamic Analysis

The Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) project aims to design a glider that can produce proverse yaw, defined as yaw and roll moving in the same direction, in flight. Applications for this glider include collecting data from the Martian surface using multiple gliders in a swarm. The swarm can collect geological and atmospheric data that will further knowledge of Mars and assist in finding a landing site for manned missions. Optimization using simulation tools and coding is emphasized to verify bell-shape lift distribution data that was obtained by Al Bowers, with the goal of applying these tools to the PRANDTL-M design. These tools include Langley Asymmetric Vortex Lattice (LAVL) and MIT Athena Vortex Lattice (MAVL). Tools will test many glider specifications that vary angles and lift distribution of the wings to see the effect on yaw moment using MATLAB[®] (The MathWorks, Inc., Natick, Massachusetts). Initial work was done in the application of Aerodynamic Coefficient due to Aileron Deflection (CNDA) and comparison with Bowers' data. Results from MAVL and LAVL will be used to develop a 3D glider wing model which can undergo further testing with changing sweep, dihedral and twist factors.

**Sophia Hahn**

San Jose State University

NASA Armstrong Internship Program**Undergraduate Intern**
B.S. Aerospace
Engineering**Mentor: David Berger**
Code: 112
Office of STEM Engagement**Expanding Aerodynamic Analysis Tool Set for PRANDTL-M**

The Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) team's objective is to design and fabricate gliders that will fly on Mars. The gliders are designed to take advantage of the proverse yaw effect found from Al Bowers paper regarding bell-shaped lift distribution. The current focus is on designing and testing the 8th series of designs by varying the aspect ratio and the dihedral angle to understand the effects on stability. This session had a larger emphasis on testing the designs in various types of virtual simulation software. The softwares used include MIT Athena Vortex Lattice (MAVL), MATLAB® (The MathWorks, Inc., Natick, Massachusetts), and Langley Asymmetric Vortex Lattice (LAVL). New code was developed to run MAVL efficiently and the code written for the LAVL was updated. Currently the MAVL is in its last stage of validation before it will be used on the 8 series designs. The MATLAB® software will then will then be used to help create surfaces in a 3D computer-aided design program to allow for creation of the models. By the end of the session the code will have been used to help test and redesign the 8 series. Future work will include the utilization of these tools to continue redesigns, fabrication, and flight-testing of future models.

**Sara Lancot**

New Mexico Institute of Mining and
Technology

NASA Armstrong Internship Program

**Undergraduate Intern
Mechanical Engineering**

**Mentor: Daniel Bartlett
Code: 220
Logistics Management
Specialist**

Project Management and Lean Six Sigma study on Logistics

The objective of the project is to be able to improve and streamline processes. Part of the requirements for the Logistics Department are to update and deconflict any local policies and procedures with the upcoming Headquarters policies and procedures. This work is vital to the financial success of the project, because it will aid in identifying duplicated efforts and enable identifying processes that are inconsistent from department to department. In order to increase productivity and minimize the number of errors in the processes, the team has used Lean Six Sigma (LSS) methodology in order to identify weaknesses in the procedures. The Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) method has been used in this research. By using this methodology, the Logistics team has defined the errors or mismatches in documentation that create conflicts in the pipeline. The team also measured these errors, by identifying the urgency of the issues and analyzing different solutions to these mismatches. This project will assist the Armstrong Flight Research Center during the Mission Support Future Architecture Program (MAP) transition. A solution will be drafted to present to the affected departments. The solution presented to each department will provide resolutions to pertinent processes that are currently affected by the incompatibility of the written processes.

**Aurora Mak**

Portland State University

NASA Armstrong Internship Program**Undergraduate Intern
Mathematics****Mentor: Jason Lechniak
Code: 520
Aerodynamics and
Propulsion****Prandtl Propeller Modelling and Evaluation**

As part of the Center Innovation Fund (CIF) Prandtl Propeller Design Project, previous modellings have shown the efficacy of Prandtl Inspired Propellers. The goal now is to expand the research of the designs. To accomplish this goal, the design of a Prandtl Inspired Propeller is being evaluated and tested to verify that the improvement in efficiency is significant. Further, the techniques for designing and evaluating conventional propellers are to be mathematically verified for their use with Prandtl Inspired Propellers due to the new assumptions on which Prandtl designs are based. The Prandtl Propeller team is collaborating with the Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) team to further understand these Prandtl design assumptions. The project is two-fold: verifying the underlying mathematics pertaining to propeller design, testing, and optimization and develop modelling and analysis code using MATLAB® software (The MathWorks Inc., Natick, Massachusetts). The code is expected to aid in designing new propellers as well as modifying already developed propeller designs, providing a workflow for comparing traditionally designed propellers to the new Prandtl propeller.

**Casey Merritt**

De Anza College

NASA Armstrong Internship Program**Undergraduate Intern
Computer Science****Mentor: Aamod Samuel
Code: 630
Simulation Group****“Greater Heights” Virtual Reality**

Greater Heights Virtual Reality (VR) production continues! The goal of Greater Heights VR is to create a fully fledged Virtual Reality Experience centered around Neil Armstrong’s historical test flight of the x-15 aircraft on July 26, 1962. The user will be able to experience Armstrong’s very own work space as well as what it’s like to operate and fly the x-15 itself. The original prototype that was developed within The Unity Game Engine (Unity Technologies, San Francisco, California) has since been ported over to the Godot Game engine for the incorporation of a customized physics engine. This physics engine will allow for life like flight simulations of some of Armstrong’s most historical aircraft including the x-15. Many different Virtual Reality software developer kits are being utilized to maximize both user intractability and compatibility across various consumer and enterprise grade headsets. These include OpenVR, Oculus VR (Oculus Studios, Menlo Park, California) and SteamVR (Valve Corporation, Bellevue, Washington).

**Nathan K. Pierce**

University of Texas San Antonio

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering
Aerospace Engineering

Mentor: Paul Bean
Code: 540
Advanced Systems
Development Branch

Mothership-Drone Capture and Release System

The Mothership-Drone Capture and Release System (MSCARS) will focus on the development of in-flight systems required for autonomous release and recapture of various types of unmanned aircraft systems (UASs). The program plans to explore numerous technical areas beneficial to future atmospheric and exoatmospheric flight such as; launch and recovery techniques, equipment and aircraft integration concepts; and advancing the development of sensors used for analysis, control, and navigation. The program system includes magnetic based release-and-hold mechanisms in conjunction with a reconfigurable support gantry outfitted with in-flight tracking software, and magnetic end effectors capable of yaw and pitch rotational movement. Areas of focus include mechanical design and motion controls of a Cartesian-style gantry, fabrication of a prototype demonstrator sourced using standard off-the-shelf components, and 3D printed custom parts. Concept models and motion studies will be performed using computer-aided design (CAD) software. Additional efforts will focus on developing advanced sensors and programming for detection and rapid response to in-flight tracking.

**Brianna Sandoval**

University of California Irvine

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering****Mentor: Paul Bean
Code: 540
Sensors and Systems
Development****Advancing Reconfigurable Technology Through Patterned Magnets**

As the National Aeronautics and Space Administration (NASA) looks forward to exploring further into space, scientists and engineers are working on developing and improving technologies to enable a variety of missions. The Magnetic Two-Body Separation Systems Project aims to explore the use of programmable magnets within structural hardware through the development of the patterned magnet imbedded interface. The interface is a task-versatile component that enables modularity, reconfigurability, and structural stability by using both patterned magnets and conventional mechanical actuation devices. While the project is currently in its early stages, the goal is to develop a working prototype and begin to prove that magnetics can effectively aid in creating structures that can autonomously assemble in a reliable, precise manner. Work being completed includes a finished design for prototype 1 and animations of its conceived maneuvers and interactions. Examples of potential applications include prolonging the usability of space-based telescopes, aiding in-space assembly, and facilitating rescue robots that can morph and adapt to changing environmental conditions.

**Karelia Silvestrini**

Universidad Interamericana de Puerto Rico – Recinto Bayamón

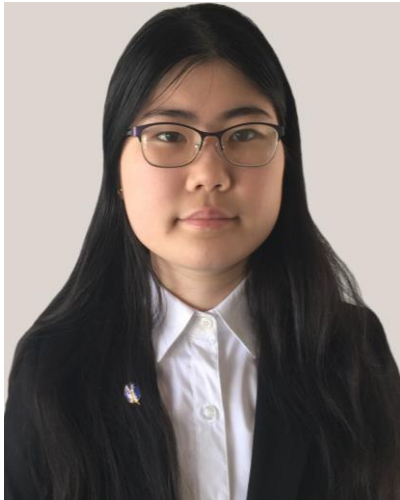
NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: Paul Bean
Code: 540
Sensors and Systems
Development

Heavy Lift Magnetic Release Structural Design

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) Advanced Systems Development team is seeking to develop a new design system that will replace the dual-piston pyrotechnic ejector rack for carriage and release to a Heavy Lift Magnetic Release (HLMR). The HLMR will be eventually integrated into an aircraft after various testing and improvement. The goal of this design is to hold a goal payload without affecting the HLMR structure and materials to the point of potential failure. As well, to use a total of 16 Linear Magnetic Mechanism to provide mobility to hold and release the payload in which the magnets generates a force when its on holding position and when its on release position. Applying structural aircraft design concepts, these three forces will be studied separately as a case study. The structural design includes calculations of the internal forces acting when the applied load is acting on the system, as well as seeking to determine the stress caused and verifying the margin of safety. The design in general will be evaluated in a highly detailed matter to ensure the success of this design and take it to the next fabrication and testing phase.

**Wendy Yang**

University of California, Berkeley

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering****Mentor: Jason Lechniak
Code: 520
Aerodynamics and
Propulsion****Prandtl Propeller Modeling and Evaluation**

The project is based on new lift distributions presented in Ludwig Prandtl's 1933 paper on a wing and propeller. The project aims to verify the validity of the new lift distribution from the paper by cross-referencing existing fluid dynamics literature and develop a propeller using code developed in MATLAB® (The MathWorks, Inc., Natick, Massachusetts) then generate a 3-dimensional computer-aided design model in SOLIDWORKS® (Dassault Systèmes SOLIDWORKS Corporation, Waltham, Massachusetts). The result of the design is then verified by using XFOIL and XROTOR (open-source software, Massachusetts Institution of Technology, Cambridge, Massachusetts). If successful, the result of this project can be used by National Aeronautics and Space Administration to develop more efficient propellers, rotors, and fans. The codes and deliverable generated will be documented so that work can continue the project by future interns and researchers.

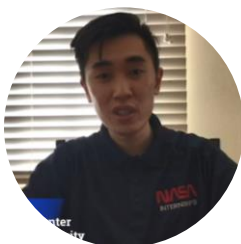
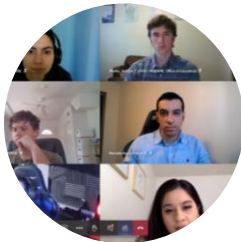
**Mostafa Youssef**

Iowa State University

NASA Armstrong Internship Program**Graduate Intern
Aerospace Engineering****Mentor: Kurt Kloesel and
Jason Lechniak
Code: 520
Aerodynamics and
Propulsion****Propulsion Analysis and Design Simulation of Rotorcraft**

The Revolutionary Vertical Lift Technology (RVLT) project has multiple centers collaborating research to develop tools to better understand the behavior of Vertical Takeoff and Landing (VTOL) on various design configurations. The VTOL results will support the future urban/advanced air mobility in terms of reliability, robustness, performance, and efficiency. NASA Armstrong Flight Research Center (AFRC) (Edwards, California) will analyze and simulate conceptual designs and technologies using NASA Design and Analysis of Rotorcraft (NDARC) software developed at NASA Ames Research Center (Mountain View, CA). The turbine engine modeling is based in Numerical Propulsion System Simulation (NPSS) software in collaboration with NASA Glenn Research Center (Cleveland, Ohio). The NDARC software offers a wide variety of VTOL models and multidisciplinary design to be adjusted and evaluated in various missions and mission segments. A recently developed curve fitting tool (CFIT) allows the use of an existing Turbo engine models from NPSS to be integrated and tested on NDARC designs. The CFIT tool will further be upgraded in the future to a more robust tool. AIDEN software is a graphical user interface for the NDARC software that improve usability and for better visualization and organization.

Fall 2020 Abstracts



**Ramona Barajas-Villar**

Arizona State University

NASA Armstrong Internship Program

Undergraduate Intern
Journalism & Mass
Communication,
Communication

Mentor: Lisa Illowsky
Code: 112
Office of STEM Engagement

Development of Scientific and Technical Information Handbook

The purpose of this project was to support the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (Edwards, California) Office of STEM Engagement (OSTEM) coordinator in planning projects and worked with the Office of the Scientific and Technical Information (STI) administrator to create an STI handbook that current and future interns can utilize throughout their internships. The handbook is a resource for interns to use when completing their STI 20156 Pre-Approval Forms; the handbook will be part of the Scientific, Technical and Research Information discoVERY System (STRIVES). The handbook includes detailed steps of what to do to get projects approved for public release and checklists for both interns and mentors. Past examples of rejected and approved form submissions are included. Strategic planning implementation included creating, editing, and designing the handbook. A secondary project that is being collaboratively worked with the internships program at the National Aeronautics and Space Administration (NASA) Ames Research Center (Mountain View, California) is a documentary about highlighting the experiences of interns while they interned onsite and virtually. The intern also plans and helps facilitate events such as the virtual networking event during which students and mentors have a chance to connect and enjoy coffee with the mentors at bi-weekly meetings.



Juan Battaglia

University of Central Florida

NASA Armstrong Internship Program

Undergraduate Intern
Electrical Engineering

Mentor: Allen Parker
Code: 540
Advanced Sensors and
Systems Development

Development of Next Generation FOSS

The Fiber Optic Sensing System (FOSS) is a system of sensors that employs fiber optic wires to create a lightweight and compact solution to temperature sensing and strain gaging. The latest iteration of FOSS technology is the micro FOSS (μ FOSS). The μ FOSS unit further reduces the weight, form factor, and price of a FOSS system making it ideal for aircraft and Navy vessel applications. Deployment on aircraft and naval vessels comes with new temperature and altitude considerations, which can cause the fiber optic laser to become too hot or cold to operate properly. To mitigate these shifts in temperature, an active cooling and heating circuit is being designed and modeled using the LTspice (Linear Technology Corp., Milpitas, California) simulation software. This circuit implements thermoelectric coolers (TECs) in tandem with fans to cool the system and power resistors to heat the system. The circuit also takes advantage of the bimetallic characteristics of thermostat switches to turn the active cooling and heating components on and off depending on the temperature of the butterfly packet of the laser. Combining all these components will allow the μ FOSS system to reliably operate in a greater range of temperatures and altitudes.

**Samuel Brunkow**

South Dakota State University

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering****Mentor: Paul Bean
Code: 540
Sensors and Systems
Development****Intermittent Magnetic Coupling Two Body Systems**

The magnetic two-body separation system development program located at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) focuses on developing and testing two-body separation and recombination techniques utilizing novel magnetic-based hold-and-release mechanisms. Developed systems aim to demonstrate principal advantages of magnetics over current competing techniques. Focus areas for this session included continued progress of a Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) in-flight release mechanism, initial fabrication for the magnetic space anchoring system, and research into external vision systems and methods to enable automated magnetic drone recapture. The PRANDTL-M in-flight release mechanism and a magnetic space anchoring system are in similar stages of the development process. Both systems have a finalized prototype design and are in the process of fabrication; once completed, the systems will be tested, and results recorded. Further development or direction will be determined after results have been interpreted. This program contributes to NASA goals by demonstrating the functionality of modern magnetics and hold-release techniques to spark future space and flight innovation and research.

**Jackson Button**

University of California, Santa Barbara
University of Michigan, Ann Arbor

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical and Aerospace
Engineering

Mentor: Matt Boucher
Code: 530
Branch: Dynamics and
Controls

Control of Flexible Aircraft using Structural Feedback

Active flutter suppression is a field of controls which is highly researched for a number of reasons. The primary ambitions of advancing active flutter suppression control technologies are, however, to improve aircraft fuel efficiency through structural weight reduction and to ensure vehicle safety. The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (Edwards, California) has previously advanced this objective by stabilizing elastic modes past the flutter boundary through structural feedback on the X-56 unmanned aerial vehicle (Lockheed Martin, Bethesda, Maryland) using accelerometers. The use of Fiber Optic Strain Sensors (FOSS) over accelerometers is desirable because FOSS contains hundreds of distributed strain and strain-rate sensors in a single fiber, allowing for potential improvements in modal coordinate estimation and flutter suppression. The goal of this internship is to make progress toward a flight-ready feedback control design using FOSS for structural feedback in order to further explore the capabilities of FOSS to produce robust and responsive controllers for the X-56 vehicle. A variety of methods, including optimal, full-state feedback control and a proportional-integral-derivative (PID) controller, will be used to accomplish this goal. Lastly, control methods combining accelerometers and FOSS will be explored in order to maximize flutter control capabilities on the X-56 vehicle.

**Sara Caudill**

The Ohio State University

NASA Armstrong Internship Program

Graduate Intern
Design, Digital Animation
and Interactive Media

Mentor: Aamod Samuel
Code: 630
Simulation Engineering

Virtual Reality Storytelling Through Simulations

The Simulations Team and Public Affairs Office at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) are developing “Greater Heights”, a virtual reality (VR) experience that celebrates NASA aerospace innovations by leveraging AFRC high fidelity simulations. The production is developing 3D assets and environments in Blender® (Blender Foundation, Amsterdam, Netherlands) and testing in-progress scenes in Unity® (Unity Technologies, San Francisco, California). Godot® (Juan Linietsky, Ariel Manzur, and contributors, FOSS) is serving as the game engine. The team seeks to not only engage users with an immersive and informative narrative experience, but also to provide the opportunity to test iconic aircraft. The VR experience is divided into two modes: story mode and free flight. In story mode, users assume the role of Neil Armstrong prior to his seventh and final test of the North American X-15 hypersonic rocket-powered aircraft. In free flight, users may elect to fly such aircraft as a lifting body, an electric airplane, or a supersonic airplane. While this will initially be developed on the XTAL™ (VRgineers Inc., Prague, Czech Republic), the project will ultimately be disseminated as both a VR and non-VR experience to allow for the greatest public engagement.

**Dayana Contreras**

California State University Long Beach

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical/Materials
Engineering****Mentor: Paul Bean
Code: 540
Sensors and Systems
Development****Magnetic Two Body Separation System**

Traditional methods of using pyrotechnics for separation events come with shock and debris, and require extra safety measures, increasing cost and time. At the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) a magnetic system that offers simple and reliable connect-and-release designs is being developed, with the use of finely patterned magnetic interfaces as the basis for a novel payload release mechanism. A patterned magnetic face has a near field reach, but significant strength, and can perform functions based on pattern. A staggered or sequenced release of magnetic areas within one such pattern allows for a separation event with reduced or eliminated shock and for reattachment with the use of specially designed magnets that can be used indefinitely. This fall we will aim to complete the stress analysis on the Magnetic Release Mechanism (MRM), also known as Heavy-lift, in order to prove it can hold and release a 500-lb payload with a safety margin of 2.5 yield and 3 ultimate; with similar mounting features to the traditional pyrotechnic method. Testing will be performed to collect acceleration, displacement, and load data. The results will then be compared to the traditional pyrotechnic method of a dual-piston pyrotechnic ejection system. This approach will give AFRC personnel a safer work environment while keeping the payload safe.

**Jackson Daniel**

University of Missouri, Kansas City

NASA Armstrong Internship Program

Graduate Intern
Mechanical Engineering

Mentor: Peter Suh
Code: 530
Dynamics and Controls

PMSM Sliding Mode Estimator Design and Development

The Advanced Air Transport Technology (AATT) Project seeks to enhance the capabilities of fixed-wing subsonic transport through improved energy efficiency and environmental compatibility. One element of this effort is the use of high efficiency Permanent Magnetic Synchronous Motor (PMSM) systems. Understanding the behavior and limitations of these motors allows the National Aeronautics and Space Administration (NASA) to collaborate with and inform its partners worldwide. The PMSM modeling is achieved using MATLAB® - Simulink® (The MathWorks, Inc., Natick, Massachusetts). Through a combination of literature review and the analysis of an existing high-fidelity NASA Electrical Aircraft Testbed (NEAT) PMSM model, a sliding mode estimator is being developed that can determine motor position and speed without the use of a sensor. Efforts to modify and improve the estimator are ongoing. Further investigation will also be made with regard to the estimator efficacy within the flux-weakening mode of PMSM operation and potential variation of estimator performance due to temperature change with varying altitude. Comparisons between estimator designs are intended to yield the highest performing system that can function in the widest array of operating conditions.

**Jessica De la Cruz**

University of California, Irvine

NASA Armstrong Internship Program**Undergraduate Intern
Aerospace Engineering****Mentor: David Berger
Code: 112
Office of STEM Engagement****Aerodynamic Analysis Tool for PRANDTL-M**

The Mars Glider Swarm mission seeks to aid Mars exploration through deployment of a set of gliders. Each glider will scan the Martian atmosphere and surface to construct a mesh grid network while in flight. Valuable data collected will be used and transmitted to aid future missions. Previously, various designs of the tailless wing have been optimized to be aerodynamically more efficient; automating aerodynamic computations using the vortex-lattice method, however, could reduce engineering design time significantly. An analysis tool will continue to be developed in order to confirm Al Bowers' bell-shaped lift distribution, as well as proverse yaw maneuver capabilities. The performance of each design iteration will be analyzed by calculating the aerodynamic moment coefficient due to aileron deflection. Results and aerodynamic characteristics will ensure stable vehicle configurations. The analysis tool will assist and accelerate the design of the next iterations of the Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) vehicle while efficiently reducing development time.

**Eathan Devine**

John Brown University

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering****Mentor: David Berger****Code: 530****Office of STEM Engagement****Aerodynamic and Thermodynamic Analysis for PRANDTL-M**

The goal of the Preliminary Research AerodyNamic Design to Land on Mars (Prandtl-M) project is to send small-scale gliders to be deployed in the Martian atmosphere as a swarm. These gliders will spread out and land on the surface of Mars to collect surface data to inform future missions to Mars. This plan begins with a small and efficient glider design that implements a unique spanload and twist distribution in order to eliminate the need for vertical flight control surfaces and reduce drag. Design, analysis, and flight tests have been completed on 24-inch and 13-inch wingspan gliders to validate and improve aerodynamic performance. The designs for an 18-inch wingspan glider are being completed and a new 31-inch design will soon be implemented using numerical techniques and computer-aided design (CAD). The objective is to find the optimum design for the Mars mission. High altitude tests of the gliders will be completed to simulate the Martian atmosphere. Thus, thermodynamic analysis using numerical techniques, material properties, and standard atmospheric data is being completed to calculate the heat transfer of the glider as it falls through the atmosphere to determine conditions for optimum battery and avionics performance for the high altitude test.

**Akosua Dufie**

Queens College, CUNY

NASA Armstrong Internship Program**Undergraduate Intern**
Pure Mathematics,
Economics**Mentor: John Saltzman**
Code: 520
Systems Engineering**Simulation Verification Planning Project**

Similar to the previous project of the X-59 Flight Simulator Emergency Procedures Training Development, in which the emergency procedures were being determined, this project serves almost as a continuation of the previous task. The Low Boom Flight Demonstration (LBFD) simulation verification task will include working with the requirement owners of each LBFD simulation requirement to construct a verification plan, create verification success criteria, identify and track progress of verification activities, identify and track associated artifacts, and then complete a summary PowerPoint presentation (with the support of associated requirements owners) on the proposed verification close-out of LBFD simulation requirements. As a task rooted in Systems Engineering and ensuring that “mistakes are not designed into the system,” TEAMS will be used as a tool for communication in order to contact stakeholders and other personnel needed for the success of this task. This task will ensure that the simulator for the LBFD does what its design requires it to do. The success of this project will help properly train for the X-59 QueSST (Quiet SuperSonic Technology) (Lockheed Martin, Bethesda, Maryland) - which will change Federal Aviation Administration (FAA) rules governing commercial supersonic flights.

**Jean Ghanous**

California Polytechnic State University,
San Luis Obispo

NASA Armstrong Internship Program

Undergraduate Intern
Aerospace Engineering

Mentor: Kurt Kloesel
Code: 520
Aerodynamics and
Propulsion

Lunar Electro-Magnetic Mass Accelerator

One of the greatest challenges facing human deep space exploration is fuel expenditures. The Lunar Electro-Magnetic Mass Accelerator (LEMMA) project aims to overcome this challenge by moving hydrogen and oxygen (rocket fuel) from the lunar surface into the Earth Moon Lagrange (EML) points. Thus, LEMMA must address how to get the fuel from the lunar surface to the EML points. There are three main avenues that will be explored: a chemical rocket, a rail gun, and a linear electromagnetic launch system. During this term, the chemical rocket concept was studied. The exploration of the chemical rocket possibility was two-fold. First, the concept was approached predominantly using rocket science to predict what payloads could be transported given regular parameters: specific impulse (I_{sp}), dry mass, wet mass, et cetera. A MATLAB® (The MathWorks, Inc., Natick, Massachusetts) program was generated that, given certain parameters of space flight, would return the unknown parameter. Calculations were based upon the Tsiolkovsky Rocket Equation and orbital mechanics principles. The second part of researching this concept was verifying the theoretical results using a space flight simulation software: Orbiter 2016 (Martin Schweiger). In the future, the project aims to compare the results of the chemical rocket case study to the other two options and recommend a course of action.

**Aneliese Hebenstreit**

Missouri University of Science and
Technology

NASA Armstrong Internship Program

Undergraduate Intern
Aerospace Engineering

Mentor: Dave Berger
Code: 112
Office of STEM Engagement

Stability and Design for PRANDTL-M

Over the years, the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) has hosted a rotation of interns who have further developed the Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) project, a project based on Albion Bowers' Bell Shaped Lift Distribution (BSLD) research. The PRANDTL-M goal is to develop a swarm of small aircraft capable of flying in the Martian atmosphere to collect surface and atmospheric data. Using Bowers' data and design process, the team discovered their shrunken BSLD aircraft to be less stable but have not determined the cause. An experimental series of gliders was created to better understand BSLD flight and stability. The experimental series targets specific design characteristics to identify the solution to stable flight. Six nearly identical gliders are planned to be developed using geometry tools. One glider would serve as the control aircraft; the others would test the selected design characteristics. The performance of the gliders would be observed using analytical tools and simulation before flight-testing. The team hopes the results point to one of the targeted design specifications as the solution to stable flight. With desired conclusions reached, future AFRC interns could drive the PRANDTL-M project forward by focusing on high altitude designs instead of aircraft stability.

**Daniel Huynh**

California Polytechnic University, Pomona

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering****Mentor: Allen Parker
Code: 540
Sensors and System
Development****Simple and Reliable Thermal Management System**

A revolutionary sensing solution known as the Fiber Optic Sensing System (FOSS) developed by the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (Edwards, California) uses advanced strain sensors combined with innovative algorithms. The device's wide range of application means that it must be able to withstand an equally wide range of thermal loads. By quantifying the amount of heat generated from the device, a thermal management system is currently being developed to ensure both the survivability of the sensing system as well as the reliability of acquired data in both extreme hot and cold temperatures that far exceed the normal operating temperatures of the device. Utilizing off-the-shelf components such as rugged fans and heat sinks allows for a cost effective thermal management system. The fan and heat sink configuration was analyzed in ANSYS® Engineering Software (ANSYS, Inc., Canonsburg, Pennsylvania) and the results from this were then validated using a Microsoft® Excel (Microsoft Corporation, Redmond, Washington) spreadsheet that was modified to include forced convection. The complex nature of fluid flow and its relationship to heat transfer requires proper heat transfer correlations found from numerous research papers involving impingement flow in finned heat-sink configurations. The resulting work hopes to develop a thermal management system capable of withstanding rugged test environments.

**Nicholas Jensen**

Fairfield University

NASA Armstrong Internship Program**Undergraduate Intern
Computer Engineering
Computer Science****Mentor: Paul Bean
Code: 540
Advanced Development of
Sensors and Systems****Advancing Reconfigurable Technologies With Polymagnetics**

The innovation of Polymagnets inspired the exploration of reconfigurable technologies that encompasses two topics of interest, structures and robotics, which enables both robots that can reconfigure in response to changing needs, as well as mutable structures. The project aligns with the National Aeronautics and Space Administrations (NASA) Technology Taxonomies TX04, TX10, and TX12 in order to address the needs for robust robotics, in-space manufacturing, reliable structures, and mission-enabling materials. Phase 1 of this project, August 2020, was to research and rapid-prototype, in SOLIDWORKS® (Dassault Systèmes Solidworks Corporation, Waltham, Massachusetts), simple machines that integrate magnetic latching systems. These devices eventually were stored as a library of parts in efforts to aid future projects in need of similar apparatuses. In Phase 2, December 2020, we aimed to go beyond the virtual environments and create scaled demonstration units to showcase how a machine can initially appear linearly, in compact two-dimensional form, and transform into a three-dimensional shape upon user command. Having the ability to create numerous basic arrangements from the same materials is a proof of concept that the combination of robotics, structures, and magnetics can increase efficiency through versatility which eliminates the need for costly tailored resources.

**Aurora Mak**

Portland State University

NASA Armstrong Internship Program**Undergraduate Intern
Mathematics****Mentor: Jason Lechniak
Code: 520
Aerodynamics and
Propulsion****PRANDTL Propeller Modelling and Evaluation**

As part of the Center Innovation Fund (CIF) Prandtl Propeller Design Project, previous modellings have shown the efficacy of Prandtl Inspired Propellers. The goal now is to expand the research of the designs, thus, the designs of a Prandtl Inspired Propeller is being evaluated and tested to verify that the improvement in efficiency is significant. Further, the techniques for designing and evaluating conventional propellers are to be mathematically verified for their use with Prandtl Inspired Propellers due to the new assumptions on which Prandtl designs are based. The Prandtl Propeller team is collaborating with the Preliminary Research AerodyNamic Design To Land on Mars (PRANDTL-M) team to further understand these Prandtl design assumptions. Thus, the project is two-fold: verifying the underlying mathematics pertaining to propeller design, testing, and optimization; and developing modelling and analysis code using MATLAB® software (The MathWorks Inc., Natick, Massachusetts). The code is expected to aid in designing new propellers as well as modifying already developed propeller designs. This approach is meant to provide a workflow for comparing traditionally designed propellers to the new Prandtl propeller.

**Casey Merritt**

De Anza College

NASA Armstrong Internship ProgramUndergraduate Intern
Computer ScienceMentor: Aamod Samuel
Code: 630
Simulation Group**“Greater Heights” Virtual Reality**

“Greater Heights” Virtual Reality (VR) is a fully fledged Virtual Reality Experience that is currently being developed for public use. The VR experience will consist of two parts, the first being a story-based experience that will put the user into the shoes of Neil Armstrong on July 26, 1962 during his test flight of the North American X-15 hypersonic rocket-powered aircraft. The user will get to experience firsthand accurate representations of Neil’s desk as well as the test flight of the X-15 aircraft. The second part will consist of a Free Flight Simulator for some of some of the area’s most famous and historical aircraft. Users will be able to choose their favorite aircraft and experience an accurate simulation of that aircraft from takeoff to landing. The Unity Game Engine (Unity Technologies, San Francisco, California) is currently being used for the development of a prototype however, the goal is to transfer the prototype to Godot in the future for the incorporation of a custom physics engine. Both OpenVR and VRTK are being leveraged to allow for user intractability within the experience for the highest degree of immersion. OpenVR is also being utilized to maximize compatibility with most if not all consumer-grade virtual reality headsets.

**Sarkis Serge Mikaelian**

California State University, Northridge

NASA Armstrong Internship Program**Undergraduate Intern
Computer Science****Mentors: Nelson Brown &
Ethan Williams
Code: 510
Systems Engineering &
Integration****Development and Evaluation of Operator Displays for
Autonomous Air Collision Avoidance Algorithms**

The National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (AFRC) (Edwards, California) Resilient Autonomy (RA) – Expandable Variable-Autonomy Architecture (EVAA) project is developing new methods of establishing the trustworthiness of autonomous systems. The EVAA uses advanced deterministic algorithms, leveraging Run-Time Assurance (RTA) networks to safely bound the behavior of highly autonomous Unmanned Aircraft Systems (UAS) and inform Federal Aviation Administration (FAA) certification guidelines. I was tasked to further develop the RTA graphical data displays using the cross-platform game engine Unity® (Unity Technologies, San Francisco, California) into a real-time evaluation tool for iACAS (improved Air Collision Avoidance System) algorithms in simulation and flight test to identify any gaps in the algorithms' safety net; build an interactive post-flight analysis tool using C++ and C# that allows the Test & Evaluation team to repopulate and analyze flight data on the displays using flight logs, test the applications using X-Plane 11® (Laminar Research, Columbia, South Carolina) flight simulation software, and complete design iterations through interviewing project team members to clarify more specific display requirements and collecting user feedback; and write a conference paper about the development and evaluation of the displays.

**Jesse Moody**

University of South Florida

NASA Armstrong Internship Program**Undergraduate Intern
Electrical Engineering****Mentor: Sky Yarbrough
Code: 540
Sensors and Systems
Development****Satellite-Triggered Audio Recorder for X-59 Analysis**

As part of the X-59 Acoustic Validation Test Planning and Execution (AVTPE) project, which aims to demonstrate that supersonic flights over land can be accomplished with minimal noise pollution, a grid of over 100 remotely-triggered audio recording sensors will be arrayed on the ground within the sonic boom corridor at Edwards Air Force Base in order to measure the “sonic thump” produced by the X-59 QueSST (Quiet SuperSonic Technology) (Lockheed Martin, Bethesda, Maryland) as it flies overhead. One way these sensors will be triggered is via satellite modem, which will enable the sensor grid to be used anywhere in the world including places with little to no cellular coverage (such as Edwards Air Force Base). The objective of this internship is to integrate a satellite modem into an existing sensor unit, test the system to ensure reliable operation, and write appropriate documentation. The AVTPE program will help gather real-world data to inform further development of low-boom flight vehicles (as part of the Commercial Supersonic Technology program) and to pass along to government legislatures for opening supersonic flights over land in the future.

**Nathan Pierce**

University of Texas San Antonio

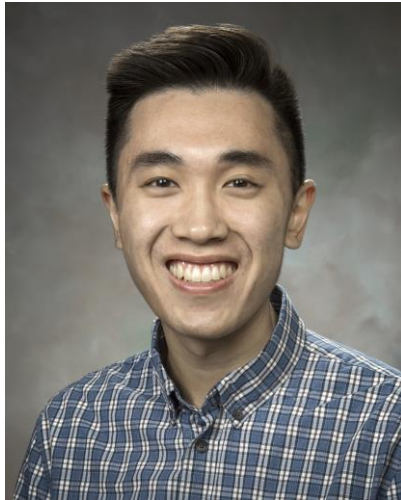
NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering
Aerospace Engineering

Mentor: Paul Bean
Code: 540
Advanced Systems
Development Branch

Mothership-Drone Release/Recapture

The Mothership-Drone Release/Recapture program will focus on the development of in-flight systems required for autonomous release and recapture of various types of unmanned air systems (UASs) utilizing magnetic based release-and-hold mechanisms. The program plans to explore numerous technical areas beneficial to future atmospheric and exoatmospheric flight, such as launch and recovery techniques; equipment and aircraft integration concepts; and advancing the development of sensors used for analysis, control, and navigation. The program aims to conduct a compelling proof-of-concept demonstration utilizing programmable Polymagnets® (Correlated Magnets, Huntsville, Alabama) and robotically driven mechanisms. Phase I will focus on the mechanical design and motion controls of a Cartesian-style gantry docking concept followed by the fabrication of a prototype demonstrator sourced using standard off-the-shelf components and 3D printed custom parts. Concept models and motion studies will be performed using SOLIDWORKS® (Dassault Systèmes Solidworks Corporation, Waltham, Massachusetts) Phase II efforts are planned to focus on developing advanced sensors and programming for detection and rapid response to in-flight tracking.

**Nathan Sam**

California State Polytechnic University,
Pomona

NASA Armstrong Internship Program

Undergraduate Intern
Mechanical Engineering

Mentor: David Berger and
Oscar Murillo
Code: 112
Office of STEM Engagement

Aerodynamic Analysis for PRANDTL-M

The Preliminary Research AerodyNamic Design to Land on Mars (PRANDTL-M) is a proposed Martian prototype glider that is planned to be used as a spinoff for the proposed Mars Glider Swarm mission. The objective of the mission is to utilize multiple gliders to gather toward identifying a possible human landing site and collect atmospheric data to create a weather network on Mars. Plans are to transport the glider swarm with a future Mars rover and deploy the swarm from the spacecraft during entry. The most current version of PRANDTL-M, v6.0, had its first flight test in Spring 2020 and now, as version 6.0 continues to be modified, version 7.0 and version 8.0 are being developed. In version 7.0 twist distribution have was modified because the original distribution not bell-shaped and smooth. From the analysis done for version 6.0, it led to version 8.0 where this series will be used as a testing platform to test the affects of the stability of the glider when changing the dihedral, the aspect ratio, and the design lift coefficient. Analysis and computer-aided design (CAD) models are currently being created, which should enable manufacturing and testing.

**Brianna Sandoval**

University of California, Irvine

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering****Mentor: Paul Bean
Code: 540
Sensors and Systems
Development****Reconfigurable Technology Development for In-Space Assembly**

As the National Aeronautics and Space Administration (NASA) looks forward to exploring further into space, scientists and engineers need to develop and improve technologies to enable a variety of missions. The current approach to creating space-based structures limits the size of those structures to the volume of the fairing of the launch vehicle. Additionally, current space structures are costly to deploy and difficult to service. The Magnetic Two-Body Separation Project aims to help address these concerns by increasing capabilities in space assembly with the help of programmable magnets. While the project is currently in its early stages, the goal is to develop and begin to prove that magnetics can effectively aid in creating structures that can assemble themselves in a reliable, precise manner. Phase I of the project involves completion of a magnet-imbedded structure that reconfigures itself from a simple cylinder to a triangle (1D to 2D), then another structure that reconfigures from a cylinder to a pyramid (1D to 3D). Phase II of the project will consist of preflight testing and a final test in microgravity.

**Jackson Winter**

University of Minnesota

NASA Armstrong Internship Program**Undergraduate Intern
Mechanical Engineering****Mentor: Allen Parker
Code: 540
Sensors and System
Development****Ruggedization of MicroFOSS for Flight**

The Fiber Optic Sensing System (FOSS) developed at the National Aeronautics and Space Administration (NASA) Armstrong Flight Research Center (Edwards, California) is a revolutionary system that uses fiber optic cables to provide high resolution sensing of strain, shape, temperature, and pressure. The next generation of FOSS technology, known as microFOSS, is a lighter and smaller version of the existing system. The objective of this project is to thermally and mechanically ruggedize an existing laboratory microFOSS system in order to qualify it for deployment in flight. The primary consideration is housing the laser used to interrogate the fiber optic sensors. The laser must remain within a reduced operating envelope of 32-115 °F with minimal vibration despite environmental conditions. Analytical and experimental methods will be used to develop a thermal management system (TMS) capable of maintaining this envelope. After completion of the TMS design, the TMS will be mechanically integrated into the microFOSS system, and computational structural analysis will be used to qualify the device. The final deliverable will be complete manufacturing drawings and integration instructions for the ruggedized microFOSS design.

**Mostafa Youssef**

Iowa State University

NASA Armstrong Internship Program**Graduate Intern**
Aerospace Engineering**Mentor: Kurt Kloesel and**
Jason Lechniak
Code: 520
Aerodynamics and
Propulsion**Propulsion Analysis and Design Simulation of Rotorcraft**

The Revolutionary Vertical Lift Technology (RVLT) project, involving research collaboration among multiple NASA (National Aeronautics and Space Administration) Centers, is developing tools to better understand the behavior of Vertical Takeoff and Landing (VTOL) on various design configurations. The VTOL results will support the future urban/advanced air mobility in terms of reliability, robustness, performance, and efficiency. NASA Armstrong Flight Research Center (AFRC) (Edwards, California) will analyze and simulate conceptual designs and technologies using NASA Design and Analysis of Rotorcraft (NDARC) software developed at NASA Ames Research Center (Mountain View, California). The turbine engine modeling is based in Numerical Propulsion System Simulation (NPSS) software in collaboration with NASA Glenn Research Center (Cleveland, Ohio). The NDARC software offers a wide variety of VTOL models and multidisciplinary design to be adjusted and evaluated in various missions and mission segments. A recently developed curve-fitting tool (CFIT) allows the use of an existing turbo engine models from NPSS to be integrated and tested on NDARC designs. Plans are in the works to upgrade the robustness of the CFIT tool.

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*"The probability of success is difficult to estimate;
but if we never search, the chance of success is zero."*

Giuseppe Cocconi

