Part 1. Student Researcher Information

1. **Name**: REDACTED
2. **Student ID**: REDACTED
3. **Email:** REDACTED
4. **Major:** REDACTED, **Minor:** REDACTED
5. **Class Status:** REDACTED
6. **Mailing Address:** REDACTED
7. **Primary Phone:** REDACTED
8. **Previous Funding:** Have not previously received funding
9. **Research Conference:** Have not previously presented
10. **Expected Graduation:** Dec 11, 2020

Part 2. MSU DENVER FACULTY MENTOR INFORMATION

1. **Faculty Research Member:** REDACTED
2. **Faculty Research Member Email:** REDACTED
3. **Academic Department:** REDACTED **Campus Box:** REDACTED
4. **Office Phone Number:** Unlisted

Part 3. Opt-in for Specialized Grands

1. Ed Krisor Endowed Urban Hydrology Fund: N/A
2. MillerCoors Endowed Water Steward Fellowship Fund: N/A
3. Wesley and Ethel Temple Endowed School: N/A

Part 4. IRB/IACUC Approval

1. Randall Owen has ensured that the work we are proposing will follow the procedures set forth by MSU Denver’s Institutional Review Board or the Institutional Animal Care and Use Committee

Part 5. Project Description

1. **Title of Project:** MSU Denver CubeSat Launch Foundation
2. **Project Abstract:** Satellite infrastructure is more important than ever, with 15 of 18 essential services reliant upon GPS location data, and the remaining 3 dependent upon GPS timing data. Because of this increased reliance on satellites in our daily lives, students need to be prepared to take on these challenges in computing, engineering, and design.   
   The CubeSat Launch Foundation aims to address this challenge by designing, building, and testing a balloon transmission system that communicates using ham radios at a significantly reduced cost, before transitioning to a protype CubeSat deliverable. The members of the CubeSat Launch Foundation will construct the basic infrastructure of a system that could collect data to better predict and model space weather systems. With the tools developed from this project, MSU Denver can compete with other institutions for NASA’s CubeSat Launch Initiative (CSLI).  
   A CubeSat system must be able to communicate data such as location data, velocity, and radiation dosage to a ground system below. The CubeSat Launch Foundation aims to address these problems by developing a working proof of concept that can be later expounded upon and worked to meet mission requirements set forth by the NASA CubeSat Launch Initiative or another research organization.   
   While the team has already acquired much of the hardware components needed to operate up to 100,000 feet, additional components must be procured in order to satisfy the requirements set forth by real mission directives. This is where funding for the CubeSat Launch Foundation becomes crucial in deploying a system.
3. **Objective:** The objective of the CubeSat Launch Foundation is to utilize student knowledge and skills to build a system protype that not only demonstrates an understanding of data transmission and storage but can also satisfy the requirements set forth by a mission directive. This objective requires the integration of computer science, systems engineering, mechanical and electrical engineering, communication between vendors, and understanding and satisfying FAA requirements. By meeting our primary objective of constructing a prototype CubeSat, students will have gained experience in the aforementioned fields through hands on experience.
4. **Method of Inquiry:**
   1. As stated previously, the requirements for a NASA funded launch are based upon the mission directive; however, the empirical understanding of integrating software, electrical, hardware, and the system chassis will be used in constructing the initial CubeSat prototype. Integrating various hardware pieces (for example solar panels, a power management system, sensors, and data transmission units) requires a working knowledge of those fields and a comprehension of the systems engineering. Through this empirical driven development, the CubeSat Launch Foundation has already proven that a small team of students can produce a system that can transmit and store data with working components.
   2. **Analysis and Interpretation:** The major objective of the CubeSat Launch Foundation is to construct the base tools, procedures, and establish contacts, through the development of a working prototype. The progress that the team has made in a few short weeks demonstrates that this objective is viable for the skillset of MSU Denver’s students. Through two-week sprints using the Scrum framework, the CubeSat Launch Foundation team will build out the procedures for development of a working CubeSat to meet the requirements of a CSLI launch. The CubeSat Launch Foundation is constantly evaluating how to implement off-the-shelf hardware, various data structures, and data transmission protocols to improve the process of building a CubeSat. Documenting and analyzing these processes is crucial to systems engineering and serves as our main source of analysis and interpretation.
5. **Timeline**

|  |  |  |
| --- | --- | --- |
| **Sprint Description** | **Start Date** | **Completion Date** |
| Research hardware limitations and total ionization that hardware is subjected to, consult Randall Owens regarding staging and testing as a balloon satellite, | 17Aug2020 | 31Aug2020 |
| Acquire two RFD 900x RF modems for data transmission between ground station and transmitter, acquire raspberry pi units for ground system, transmitter, data storage and retrieval | 31Aug2020 | 07Sep2020 |
| Integrate modems into the ground station and transmitter, ensure packets of data can be sent and received | 07Sep2020 | 21Sep2020 |
| Research components for data collection (GPS timing and location, pressure, altimeter), construction of balloon chassis, build in sensors and other components into the chassis | 21Sep2020 | 05Oct2020 |
| Complete funding proposal, build in the power management board, check sensor transmission between ground station and transmitter | 05Oct2020 | 19Oct2020 |
| Test and integrate all components in balloon chassis, ensure data transmission, storage, and retrieval and finalize miscellaneous launch items, launch system on 31Oct2020 | 19Oct2020 | 02Nov2020 |
| Recover and retest all components post 31Oct2020 launch, begin the interface control documentation as a guide for component altering based upon mission requirements | 02Nov2020 | 16Nov2020 |
| If funding can be acquired the CubeSat Launch Foundation team will begin to implement space ready hardware | 16Nov2020 | 30Nov2020 |
| Initiate a shared development ecosystem between the American Institute of Aeronautics and Astronautics, MSU Denver Aviation and Aerospace Science program to ensure development of the prototype can continue along the 3-year timeline expected of most CubeSats | 30Nov2020 | 14Nov2020 |

1. **Budget Justification**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Budget Item** | **Justification** | **Detail** | | **Total Request** |
| Atmospheric Pressure Sensor Module Meter Altimeter Sensor Module | The atmospheric pressure sensor will serve as one of the primary data collection tools for the transmission unit | (x1) @ $10.99 per 1 | | $10.99 |
| GPS Module GPS NEO-6M, Drone Microcontroller | An additional sensor that will provide location data in coordination with the altimeter sensor | (x1) @ $12.99 per 1 | | $12.99 |
| MakerFocus Raspberry Pi 4 Power Expansion Board | The power expansion board is a necessary component for the power management of other components | (x1) @ $19.79 per 1 | | $19.79 |
| 1 Watt 6 Volt Solar Panel | The solar panels will be able to power the device and enable the transmitter to send a signal to the ground station | (x4) @ 19.00 per 1 | | $76.00 |
| Elmer's Foam Boards, 11 x 14 Inches, Black/Black Core, 4-Count (950024) | This foam board serves as the chassis for the experimental balloon satellite, and is necessary to safely house all of the hardware | (x1) @ 8.19 per 1 | | $8.19 |
| EBL 9V Rechargeable Batteries NiMH Everyday 280mAh 9V Battery | The batteries supplied to the project must meet specific regulations and guidance set forth by the AES department, and will power both the ground system and the transmitter | (x1) @ 12.99 per 4 | | $12.99 |
| Diymall Voltage Sensor Dc0-25v for Arduino with Code | The electrical power subsystem requires voltage monitors to ensure the components are not overloaded, and the voltage sensors will ensure the system remains within the correct bounds | (x1) @ 5.99 per 2 | | $5.99 |
| RFD900x Modem Bundle | The RFD900x bundle is the key component for the transmission of data between the ground system and the transmitter, the CubeSat Launch Foundation is currently borrowing these from a representative of York Space Systems and will need to be returned, hence our team would need to reintegrate these and return the original RFD900x modems to their owner in December | (x1) 2 x RFD900x Radio Modems, (x1) Antenna, 900MHz Quarter wave monopole 2.1dBi, (x1) Antenna, 900MHz Right Angle Quarter wave monopole 2.1dBi, (x4) Antennas, 900MHz Half wave dipole 3dBi, (x1) FTDI USB cable | | $219.64 |
| ARDUINO UNO R3 | The Arduino board will serve to connect the sensor components to the central CPU (in the form of the raspberry pi) | (x1) Arduino uno board @ $22.00 per 1 | | $22.00 |
|  |  | **TOTAL** | | $388.58 |
| If “TOTAL” exceeds $500, describe your supplemental funding source: | | | N/A, the CubeSat Launch Foundation does not exceed the $500 Undergraduate Research Program allotment | |

Part 6. Level of Student Involvement

1. **Student Role in the Project:**
2. This project was originally conceived as a submission to the CS 4360 course, Technical Software Project taught by Dr. Beaty. As the team of software developers grew, my teammates and I realized that the lengthy timeline for development of a CubeSat would not align with the short 16-week semester. I saw a great opportunity in establishing the CubeSat Launch Foundation to allow the work that is done in this course to continue on through our resources in the AES department and the AIAA organization on campus. This would allow the engineering techniques applied through the development of this prototype to be be expounded upon by others once the prototype is completed. The ability to participate in a real-world mission using the foundational understandings developed with the CubeSat Launch Foundation present limitless opportunities for students who are passionate about developing aerospace technology. As a reservist at Peterson Air Force Base currently working in the space field, I recognize the importance of understanding our satellite infrastructure. From this, I developed the CubeSat prototype project and the CubeSat Launch Foundation as a foundation for missions outlined by NASA, primarily space weather detection as that plays a crucial role in protecting assets like GPS.
3. The methodology used in this project reflects the Scrum framework, as satellites and orbital mechanics are inherently complex and challenging. Through short two-week sprints our team has been able to adapt to changing hardware requirements, new ideas for implementation of data structures, and integration of additional sensors to meet a variety of mission qualifications.
4. Data analysis and final sketches are to be determined based upon final mission guidance derived from NASA, or another research organization.

Part 7. **Research Products, Dissemination of Your Work, and Skills Development**

1. **Publishable Findings:** The progress made by the CubeSat Launch Foundation is currently being published on a GitHub repository. Depending on the mission requirements outlined by a research organization our findings will be published in the applicable journal.
2. **Research Skills:** There are a variety of skills, both hard and soft that the CubeSat Launch Foundation intends to impart on the students participating in the program. These skills include the technical writing required through flight certification documentation, hardware and software implementation for the application of remote sensing, advanced manufacturing for rapid prototyping, communication and networking through external consultations with organizations like the National Reconnaissance Office, the National Aeronautics and Space Administration, launch providers, and systems engineering to ensure the components all operate in the space environment.
3. **Graduate School Application:** I do intend to enroll in graduate school upon graduating from MSU Denver upon the completion of my training with my current reserve squadron.
4. **Type of Graduate School:** My intent is to apply to The Master of Engineering with a specialty in Space Operations (MESO) at the University of Colorado Colorado Springs (UCCS).
5. **Acceptance to Graduate School:** N/A