1. Vision and Objective:

Our project is the development of a lab for MEAM 245 (Introduction to Flight) that will involve the design, analysis and test flight of a balloon into near-space. Our goal is to develop a set of pre-lab questions, design tasks, and a kit containing the basic parts required to build said space balloon. The lab should be able to be integrated into the current 245 curriculum with little to no modification. The full lab kit should be as inexpensive as possible to facilitate classroom use. The basic goal for the balloon is to ascend to 15-20 miles and take pictures of the Earth and space, then to descend safely and broadcast its location for recovery. We plan on demonstrating this functionality in our prototype. We also plan on developing alternative payloads; for example, several instruments taking atmospheric data for students to compare to the standard atmosphere model.

2. Requirements:

Essential requirements: (1) balloon capable of ascending to 15-20 miles with payload, (2) method for safe descent (parachute, etc), (3) method for tracking of balloon and location and recovery of payload, (4) camera capable of automated and continuous operation at high altitudes and low temperatures, (5) lab write-up with pre- and post-lab questions, quantitative predictions and design challenges, (6) exploration of and accordance with FAA regulations and requirements.

Desirable goals: (1) flight data recorder and video camera documentation, (2) stability analysis portion of lab-write up, (3) design to obtain usable video data, (4) design and addition of alternative modules for payload, (5) model for prediction of landing site, (6) full kit should be as inexpensive as possible, (7) addition of a motor to rotate the camera to obtain more pictures of space, (8) method for active control of balloon height (bleeder valve, compressor, etc.) and/or payload landing (active parachute), (9) accurate simulation of flight path based on meteorological data and calculations.

3. Division of Labor:

Alex – Lab write-up, flight simulation, alternative modules and mission profiles

Joey – Meteorology, balloon analysis and design

Glauber – fabrication, safety and flight regulations

Julio - Instrumentation and payload design

4. Nature of Functional Prototype:

We expect to be able to show the functioning of most subsystems of the balloon. We will demonstrate the payload safely landing from a roof or stairwell and broadcasting its location for recovery. We will demonstrate a camera capable of taking pictures automatically for the duration of the ascent and capable of working at sub-zero temperatures, and we will have a rough draft of the lab write-up with the sections of the lab clearly defined.

5. Nature of Final Prototype:

We will deliver a kit that has everything needed to make a basic space balloon. The kit will include at least a balloon, cargo container with insulation, camera, location beacon and landing device. In addition, there will be a full lab write-up with pre-lab questions, predictions of balloon performance, design challenges, and directions for a post-lab report. Students will be allowed to add their own innovations to the basic space balloon model, necessitating stability and weight analysis of their individual configuration. Depending on the final price of parts, there may be a design competition for students to determine which groups get to build their design. Students will be forced to defend their configurations through performance trade-off analysis. The final prototype should be usable as a lab in the Fall 2010 semester of MEAM 245 with little modification.

6. Test Plan:

All subsystem tests able to be performed at sea-level will be performed prior to initial ascent. This will minimize the risk of catastrophic failure and loss of equipment. Our final test will consist of launching a full-scale balloon with all subsystems on board. Success will be measured by meeting the following requirements: (1) the payload returning safely to earth with clear pictures of space, (2) recovery of said payload, preferably in a condition for near-immediate turn-around, (3) adherence to all FAA regulations. Ideally, several test flights will take place to demonstrate repeatability and survival of core components, so that the lab can be used annually.

7. Most Difficult Aspects of the Project:

While the concept has been successfully demonstrated before, we expect several challenges due to the constraints of our project and possible additional requirements: (1) developing a prototype to be as cheap as possible, so as to increase the number of kits in the lab, (2) development of active control of the balloon. This would likely have to be autonomous and would thus require significant design and implementation efforts. (3) Tracking and recovering the payload, for two reasons, foremost being our collective lack of experience in tracking or GPS applications, and the densely populated greater Philadelphia area , requiring that we have a good model of the payload descent to avoid its loss or building/human harm.