2014 Enterra Solutions Interns' Weather Balloon Launch

For their capstone project, the Enterra Solutions interns of summer 2014, in partnership with the Project for STEM Competitiveness, launched a weather balloon into near-space. The project was designed to help the interns learn to plan and execute complex tasks. Moreover, by attaching sensors to the balloon's payload, they would be able to establish the altitude the balloon had reached, as well as analyze the relationships between altitude, temperature, pressure, humidity, and ultraviolet flux. The project was assigned near the end of the summer program. Thus the interns only had 10 days to:

- Compile a shopping list of the necessary components – each of which would have to function in the harsh conditions of the stratosphere – and be within a budget of $500.
- Design the schematics for how the payload, balloon, parachute, and wiring would be connected.
- Design the schematics for how the microcontroller, relay board, sensors, heating wire, heating packs, camera and other components would be connected and positioned within the payload container (see **Exhibit 1**).
- Assemble and test the components, without the ability to fully recreate the harsh conditions of the stratosphere.

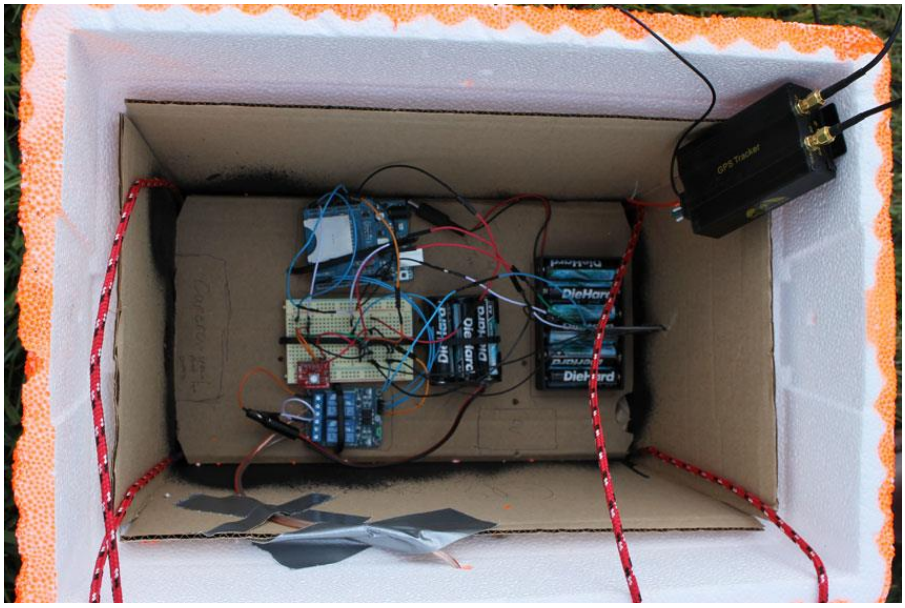

Exhibit 1. Microcontroller and sensor components inside of the weather balloon payload box.

- Program the C code for the microcontroller to read the sensor data and to flip on the kill switch in the event the balloon did not reach the burst altitude and got "stuck" in the atmosphere or stratosphere.
- Calculate the lift, ascent rate, burst altitude, and descent rate of the balloon and payload – and plan how much helium would be necessary.
- Find a suitable launch site which is within an hour drive of Enterra's Newtown, PA office building, but with a projected path which would avoid densely populated areas, nearby airports, and the McGuire Air Force Base.
- File waiver and authorization forms with the Federal Aviation Agency and contact the appropriate air traffic controllers the day of the launch.

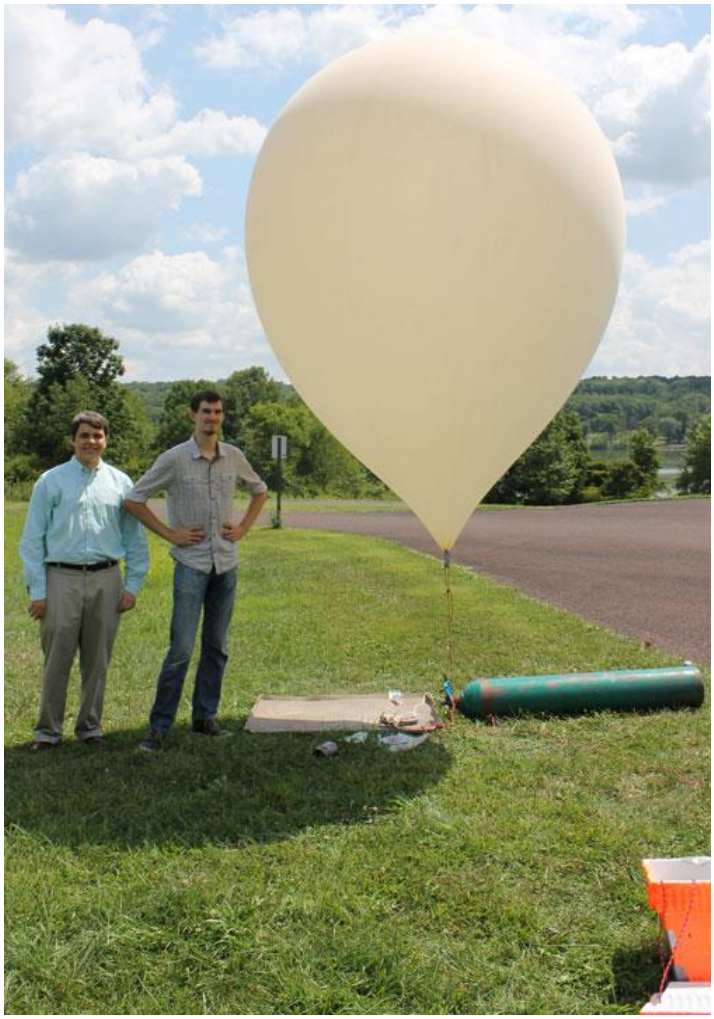

Exhibit 2. Photograph of the weather balloon before its launch.

The balloon was launched successfully (see **Exhibit 2**). Once it completed the 2 hour ascent and 1 hour descent, the payload was retrieved near where the interns predicted it would land. According to the altimeter, the balloon went up to an altitude of approximately 85,000 feet, and the camera was able to record land masses as far as South Hampton, Long Island (see **Exhibit 3**).

Despite the challenges the interns faced, they were able to keep the project on course, and within the budget and time frame, successfully launching and retrieving the balloon. Moreover, the interns completed the project without being given step-by-step instructions. They were able to plan and execute the project with minimal supervision.

Exhibit 3. In-flight photograph showing the Mid-Atlantic coastline and Long Island sound.

In summary, the project demonstrated the following:

- Even with a limited budget and time frame complex STEM projects can be planned and executed.
- Students tend to be more motivated when they are given creative freedom and ownership of their projects rather than being given step-by-step instructions but still being responsible for failure.
- The ability to interact with their environment in a novel manner, such as sending a balloon to near-space, gives students intellectual confidence and is a great motivator for sparking interest in STEM fields.