

High-Altitude Ballooning in a Required Spacecraft Design Course

Jillian Schmidt, Donna Jennings, Yezad Anklesaria, and Henry Pernicka

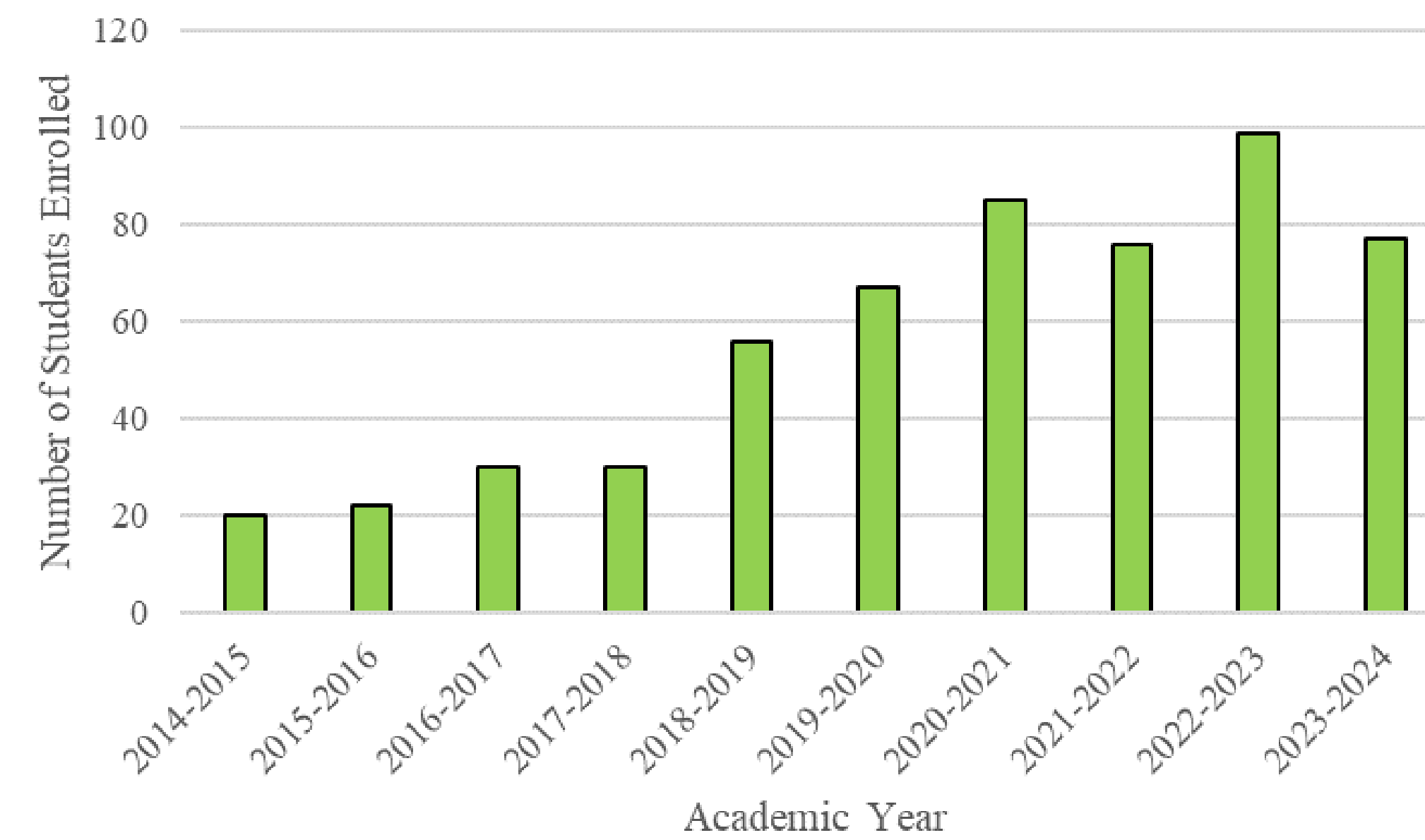
Origins of AE 2790

AE 2790: Introduction to Spacecraft Design was originally introduced as an experimental elective course (AE 2001) in Spring Semester 2015. The goal of this course was to introduce students to a full spacecraft design cycle at the sophomore level. Prior to the introduction of this course, the first time students were exposed to spacecraft design was in the senior design curriculum, so this course aimed to better prepare students to take on more challenging design tasks as seniors.

After three years of running this course successfully, the Aerospace Engineering faculty voted to make it a required course in the undergraduate curriculum.



Undergraduate students launching a balloon



AE 2790 Enrollment

Course Format and Content

AE 2790 consists of **1 hour of lecture** and **2 hours of lab** each week.

Lecture topics include:

- Ballooning basics
- Introduction to sensors and communication protocols
- Spacecraft subsystems
- Space policy

Lab activities include:

- Introduction to soldering, Arduino, and CAD
- Component selection and testing
- Assembly and integration of payload
- Day in the life testing
- Balloon launch and data analysis

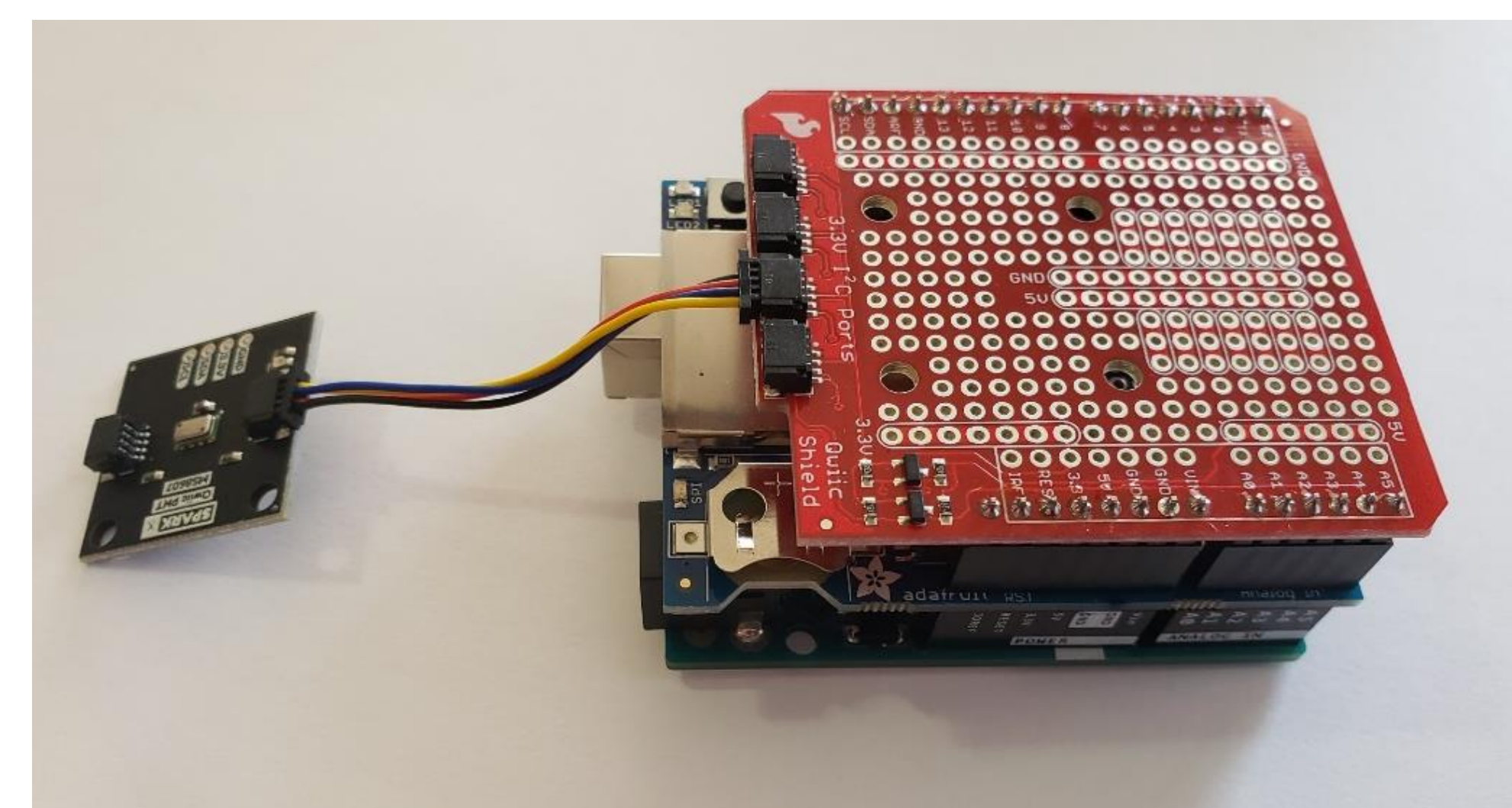
Payload Design for Increased Enrollment

Enrollment in AE 2790 has increased substantially. More than 100 students are expected to take the course in 2024-2025.

We have developed a lightweight and simple base design for the payloads, and student groups customize by choosing their own I2C sensors to incorporate.

Payload features:

- 1U CubeSat size, weight between 200 and 300 g
- ~\$60 per payload, plus cost of student selected sensor
- Arduino Uno (or equivalent)
- 9V Energizer Ultimate Lithium battery
- Adafruit SD card shield
- Sparkfun Qwiic connect shield



Basic flight computer design



Students and faculty retrieving payloads during annular eclipse in October 2023

Course Alumni

Reception of this course has been overwhelmingly positive, and it has been a great tool for us to train students for future participation in ballooning or spacecraft activities. Course alumni have gone on to participate in a variety of projects including:

- Nationwide Eclipse Ballooning Project – this was a required course prior to participation
- Independent ballooning research projects through our undergraduate research opportunity program
- Participation and leadership roles on the Missouri S&T Satellite Research Team