The Student Space Programs Lab: Training the Next Generation for the Space Industry

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Looming workforce issues exist within aerospace industry as “Apollo generation” reaches retirement.

Opportunities for students to obtain hands-on experience with spaceflight hardware have been steadily declining.

- “At present, there are insufficient methods for students to acquire hands-on experience in the scientific and technical disciplines necessary for space commerce and exploration.” — Aldridge Report

Universities have been searching for their role.

- USRA Annual Symposia have addressed aerospace workforce issues with its members.
SSPL Provides
• Hands-on projects to apply classroom knowledge in real world, interdisciplinary settings
• Experience working through a complete design cycle
• Development of systems engineering mindset

Student Space Programs Laboratory

SSPL Resources
• Clean room
• Thermal-Vac
• Cryo Oven
• Anechoic Chamber
• Machine Shop
• Vibration Test

Selected Student Space Projects
• Nanosats
• CubeSats
• Sounding Rockets
• High Altitude Balloons
• Microgravity Flights

http://sspl.psu.edu
Student On-Ramps

Perpetual introductory project independent of other projects

Provides constant influx of experienced students

Connects new students to Lab students and faculty

Fosters strong team relationships

Established as a formal Penn State course
SSPL Integration with Curriculum

- First-Year Seminar
- Honors options
- Undergrad and grad thesis topics
- Independent Studies
- Senior Design Projects
  - Subcontracting model
- Space Systems Engineering Seminar
- Space Systems Engineering Certificate
Certificate in Space Systems Engineering

- For students primarily in College of Engineering who wish to obtain recognition
  - For completing core set of courses in Space Systems Engineering–related topics
  - For significant participation in space systems project—documented through a report on their effort
- Directed and jointly administered by Electrical Engineering Department’s Communications and Space Sciences Laboratory (CSSL) and Aerospace Engineering Department
  - Sven Bilén directs Certificate
- Program designed to prepare students for career in space industry
  - Also of interest to students with more general interest in systems engineering
- Certificate provides employers with credential indicating student has achieved level of competence in space systems engineering
Formal Systems Engineering Training

- Required for mission success at all levels
- Develop strict systems engineering tools for system design
- Adopt industry standards and adapt them for the student lab environment
- Develop a systems engineering training curriculum within the Lab
Linking to Research Objectives

- Relationships with **funding agencies** direct meaningful investigations
  - DOD/AFRL for NittanySat ionospheric research
  - NASA/PSU for HEMI gamma ray burst detector on JANUS
  - NSF for proposed OSIRIS space weather satellite system

- Partnerships to enhance science return and student experience
  - Projects link with **PSU Faculty** research objectives
  - **External organizations** provide additional objectives and capabilities

- Workforce development
  - Builds relationships with future **employers**
“A broadly-based Student Collaboration Program is recommended that would involve undergraduate students in authentic research opportunities that increase their interest in scientific and technical careers and enthusiasm for space exploration, while equipping them with first-class engineering and science skills that are unique to the work that the agency conducts”
JANUS: Joint Astrophysics Nascent Universe Satellite

- **NIRT**: Near Infrared Telescope
- **XRFM**: X-Ray Flash Monitor for burst detection
- **HEMI**: High Energy Monitoring Instrument
HÉMI: High Energy Monitoring Instrument

- Student Collaboration instrument providing education and training
- Characterizes high energy (0.02–1.5 MeV) spectrum of GRBs → complements JANUS science
- Sets upper limit on burst spectra for XRFM
- Simple, low risk design

**Physical Envelope**: 10 × 10 × 20 cm
- Mass: 5 kg
- Power: 5 W average
- Data: 5 MB/day average

HÉMI fits in JANUS margins
SSPL’s GRB Detector (HEMI) on PSU/NASA SMEX JANUS Satellite

Begin HEMI Pathfinder Sept. 2007

Accepted for Balloon Flight Jan. 2008

Included as JANUS Student Collaboration Dec. 2007

JANUS Accepted for Phase-A May 2008

HEMI Pathfinder Balloon Launch Sept. 2008

Second Long-Duration Balloon for TRL-6 (Proposed)

Integration into JANUS, Launch, & Operations

Upcoming . . .
OSIRIS Mission Concept
Orbital System for Investigating the Response of the Ionosphere to Stimulation and space weather

Communications Antennas

HPP Boom

HAARP

EISCAT

Sura

Arecibo

PENNSTATE

OSPL
Industry/Professional Mentoring Program

- Tap into the experience of industry professionals for reviews (reduces project risk)
- Assists students with networking with potential future employers
- Additional source of funding

ARL
Penn State

Penn State

The Aerospace Corporation
Boeing
Star-H Corporation
Data collected to examine impact of aerospace projects on student interest level in entering aerospace field

We sought to quantitatively measure anecdotal evidence that space systems projects are strong motivators for students to enter space-related fields.

We aimed to answer research questions
- Did interest of students who graduated in fields of aerospace and electrical engineering change between the moment they went to college and when they graduated?
- If students’ interest changed, what was impact of their involvement in aerospace project activities?
Penn State CoE administers Senior Exit Survey

- Added questions about students’ involvement in aerospace-related projects and their interest in a career in aerospace field
- Since this is an existing survey that already has many questions, we sought to limit length of additional questions

Our data is from cohort

- Spring and summer 2007 graduating classes
- Aerospace, Electrical, and Mechanical Engineering

Response rates

- Aerospace 47% (36 out of 76 graduates)
- Electrical 54% (56 out of 104)
- Mechanical 6% (10 out of 173)
Survey Questions

» Indicate in which aerospace project(s) you were involved in which year(s) of your study
  ◦ Here students chose from a list of existing projects and had the option to fill in projects not listed

» Indicate your level of interest in working in the aerospace field upon graduation at each of the following times: right before I went to college and currently [at graduation]
  ◦ These results were on a Likert scale with answer options: Not Interested at All – 0, Slightly Interested – 1, Interested – 2, and Very Interested – 3
Summary of Results

- We quantitatively measured anecdotal evidence that space systems projects are strong motivators for students to enter space-related fields.
- Our data confirm that space systems-related activities indeed increased students’ interest in space-related careers.
- Future work will focus on determining what aspects of the projects had the most effect in increasing this interest.
  - May help identify ways that these projects might better attract women and underrepresented minorities to the field.
- For detailed results, see our ASEE 2008 paper.
Extension of Research

- This research was specifically targeted at aerospace field
  - Field is well-defined
  - Space related programs and activities are fairly easy to identify, as are companies in space field
- More general question: how students’ participation in design projects and other hands-on activities affects students’ career choices
- We believe that these experiences have great impact
- Implemented our own Lab tracking system