

# BALLOONS BUILD SATELLITES: THE PROGRESSION OF A STUDENT SATELLITE DESIGN GROUP

Mark D. Becnel<sup>1</sup>

*University of Alabama in Huntsville, Huntsville, AL 35899*

Student groups nationwide are developing satellites, many in the form of a CubeSat. With the third Announcement of CubeSat Launch Initiative by NASA, 43 groups nationwide proposed for launch. These groups have formed under various circumstances, often unique to their university. The students at the University of Alabama in Huntsville were accepted for this launch opportunity. The UAHuntsville students are developing ChargerSat-1, a 1kg, 10cm<sup>3</sup> satellite. ChargerSat-1 is a project of the UAHuntsville Space Hardware Club. I will present the beginnings of the Space Hardware Club and its progression from amateur ballooning to the satellite development group it is today. By understanding the origin of the Space Hardware Club, students with similar satellite ambitions can learn and build the organization necessary to support their own program. With students working on both ballooning and satellite development, the extracurricular participation affects the curriculum. I will also present the relationship this activity has with the curriculum.

## Nomenclature

<i>ASGC</i>	=	Alabama Space Grant Consortium
<i>COTS</i>	=	Commercial Off The Shelf, referring to hardware and software available for purchase and integration
<i>CS1</i>	=	ChargerSat-1, the pico-satellite of SHC
<i>NSSTC</i>	=	National Space Science and Technology Center, cooperation of NASA, UAH, and other universities
<i>SHC</i>	=	Space Hardware Club, a student organization of UAH
<i>UAH</i>	=	The University of Alabama in Huntsville

## I. Introduction

**T**HE Space Hardware Club is a unique, space-related student organization. At the University of Alabama in Huntsville, the current 45 member team works on four major projects ranging from amateur rocketry to orbital satellite development, and it started by building balloon payloads.

## II. BalloonSat

SHC was founded February 8, 2006 as a high-altitude ballooning group. Many project advisers were interested and experienced in ballooning and suggested it as a valuable educational opportunity to the young group. Students began working on payloads. By April 22 of the same year, the inaugural BalloonSat 1 was in the air. This flight reached over 95,000 ft and was successfully recovered.

As the students changed and support grew, a ground station was developed to support the ballooning mission. Now the mobile recovery team and the campus ground station were able to track the balloon live, and help ensure a safe recovery. The initial payloads deployed Geiger Counters through the atmosphere and secured film images during the flight.

By 2010, the skills of the group had grown. Working with the NASA National Space Science and Technology Center, SHC developed a neutron counter payload. This project involved developing pressure housings, integrating thermal control and monitoring, and high-voltage testing. This payload was launched on BalloonSat 15 on August 26, 2011. The team recovered valuable data that successfully demonstrated the effectiveness of the BalloonSat platform for high-altitude experiments like the neutron counter.

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<sup>1</sup> Graduate Teaching Assistant, Mechanical and Aerospace Engineering Department, TH N274, and AIAA Student Member

Most recently on January 28, 2012, SHC launched BalloonSat 17. This was the third flight for CubeSat sub-system testing. We successfully operated a Morse code beacon.

BalloonSat is the foundation for space-like research and mission design. SHC has since developed the ballooning program to complete cubesat hardware and software testing. For a complete list of the SHC BalloonSat program, see Appendix I.

### **III. CanSat**

As the Space Hardware Club grew new endeavours were considered. A team member found the International CanSat Competition in Texas. CanSat is a mock satellite design competition where students develop a payload to perform a satellite-like life cycle in approximately 8 months. Each payload is individually rocket launched to approximately 600 meters, where the payload is deployed. Students from universities around the world are invited to design, test, review, and compete a developed system.

SHC initially joined the CanSat competition in 2008. The club has continued participating in the competition as an opportunity to learn the basics of spacecraft design and system engineering. CanSat is the foundation for software and electrical development. The technologies used here directly contribute to the formation of the cubesat team. For a complete list of the SHC CanSat program, see Appendix II.

### **IV. Planetary Rover**

In August 2011, SHC grew again. The Battle of the Rockets: Planetary Rover Event, similar to the CanSat competition, is a student design, build, compete event. Over the course of 7 months, students design mechanical, electrical, and software solutions to launch, deploy, and recover a rover. The rover must achieve safe landing descent rates and autonomously navigate a target movement algorithm.

Members here directly translate skills learned to the development and testing of the cubesat. The 2012 competition will be the first time SHC competes in the Battle of the Rockets.

### **V. CubeSat**

ChargerSat-1 is the cubesat and pico-satellite project of Space Hardware Club. This flagship project started in 2010, with conceptual work starting as early as 2008. Students have taken on the development of CS1 in the following areas: mechanical engineering, aerospace engineering, electrical engineering, computer engineering, physics, and computer science. With the conceptual understandings of satellite development from the experiences of CanSat, Battle of the Rockets, and BalloonSat, students are able to challenge existing COTS options by developing sub-systems from concept through testing and integration. For example, effective thermal analysis can be a milestone in the development of an orbital satellite, a lesson learned when working with high-power ballooning payloads.

### **VI. Curriculum and Industry Involvement**

As students, it is important to connect the work of SHC to the curriculum. Students in all four projects are able to directly associate project work to classroom work. As a freshman at UAH, mechanical and aerospace students learn how to design and author work in CAD. This proves directly useful in the development of all SHC projects. Electrical engineering students are able to provide educated descisions for wiring and power of the satellite, mock-satellite, rover, rocket, and ballooning payloads. Students are able to connect with faculty and advisers to learn the application of the coursework.

### **VII. Conclusion**

The Space Hardware Club was founded six years ago. The development of a ballooning program led to the initialization and activity of the ChargerSat-1 program. The participation of the student activities and the curriculum is beneficial to students by providing a more stimulating classroom and higher quality products. Teams interested in the development of a cubesat should consider SHC and its foundation to help develop a stable, well defined satellite program.

## Appendix I

The SHC BalloonSat program has had 17 flights as of February 2012. Each mission and mission objective are listed below.

- A. BalloonSat 1**  
April 22, 2006, Film cameras and environmental data recording
- B. BalloonSat 2**  
January 20, 2007, Panoramic cameras
- C. BalloonSat 3**  
May 3, 2007, Heat pipe experiment
- D. BalloonSat 4**  
October 27, 2007, Space billboard flight 1
- E. BalloonSat 5**  
July 19, 2008, Space billboard flight 2
- F. BalloonSat 6**  
October 25, 2008, Environmental sensors, space billboard flight 3, outreach ATV
- G. BalloonSat 7**  
March 10, 2009, Biology and nursing payload
- H. BalloonSat 8**  
October 3, 2009, Panoramic cameras
- I. BalloonSat 9**  
November 6, 2009, Middle school outreach
- J. BalloonSat 10**  
November 21, 2009, Tracker test flight
- K. BalloonSat 11**  
March 27, 2012, Nursing dosimeter flight
- L. BalloonSat 12**  
April 17, 2010, Earth Day outreach
- M. BalloonSat 13**  
March 18, 2011, Moored balloon test
- N. BalloonSat 14**  
April 13, 2011, Middle school outreach
- O. BalloonSat 15**  
August 26, 2011, Neutron counter inaugural flight, cubesat radio test
- P. BalloonSat 16**  
October 28, 2011, Cubesat beacon radio test
- Q. BalloonSat 17**  
January 28, 2012, Cubesat Morse code radio test

## Appendix II

SHC has competed three times with the International CanSat Competition. We are anticipating competing again this year in 2012.

### A. CanSat 2008

Oprimus Prime, target descent velocity, achieve target landing orientation

### B. CanSat 2009

Megatron, target descent velocity, communications through balloon relay, achieve target landing orientation, 3 hour duration active link to ground station

### C. CanSat 2011

Jetfire, target descent velocity, separation, egg return, landing acceleration recording, and live ground station

### D. CanSat 2012

Bumblebee, multiple target descent velocities, separation, egg return, video capture, and live ground station

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### Space Hardware Club

Every club member since the club founding in 2006, when the club consitution was founded.

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