

# Providing Hands-on STEM Education with High Altitude Balloons in North Dakota

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In an effort to promote science, technology, engineering and mathematics (STEM) learning, the NASA North Dakota Space Grant Consortium (NDSGC) provides an opportunity for all middle and high school students in the state of North Dakota to launch experiments into a near-space environment onboard a high altitude balloon. NDSGC organized our second annual Near-Space Balloon Competition (NSBC) for students in grades six through twelve. Last year, we had four teams involved in a successful balloon launch. This year, we had a total of seven teams awarded payload slots, but only flew three. We duplicated our existing tracking equipment to accommodate the second annual flight. Furthermore, we are promoting STEM education with a seventh-grade class from West Fargo: we are planning to launch eight student-designed payloads on two balloons, involving over eighty students. The author's thesis work will explore the process of using high altitude balloons to teach STEM education with NSBC and the West Fargo launches. The students enjoy their ballooning experience and learn through an hands-on, inquiry-based style that will prepare them for real-world engineering and critical thinking jobs.

## Acronyms

*NSBC* = *Near-Space Balloon Competition*  
*NDSGC* = *North Dakota Space Grant Consortium*  
*STEM* = *Science, Technology, Education, Mathematics*

## I. Introduction

In an effort to promote STEM learning, the NASA North Dakota Space Grant Consortium provides an opportunity for all middle and high school students in the state of North Dakota to launch experiments into a near-space environment onboard a high altitude balloon. NDSGC recognizes the challenge and necessity to encourage more students into the STEM fields. The United States is in a nation-wide struggle to academically keep up with other countries and, thus, an improved system providing quality STEM education is required<sup>6</sup>. Fewer opportunities exist for students and their teachers to explore STEM activities and it is our responsibility to help provide academic activities.

NDSGC organized our second annual Near-Space Balloon Competition (NSBC) for students in grades six through twelve. Students are allowed to put together a scientific experiment in teams of 3-20 students. They are allowed to

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place any device in their payload, as long as it is not a living animal. They are each given a specific maximum weight that they can achieve, depending on how many total payloads are flying on the balloon chain.

The students' payloads will reach an average height of 100,000 ft. into the atmosphere, where the balloon will burst from lack of air pressure. A once five-foot wide balloon will have expanded to about 30-40 feet in diameter high into the stratosphere. These participating students take pride in their projects, later able to say they reached a "near-space" environment, above 99% of the Earth's atmosphere. The thrill and excitement of the chase completes their year-long hard work.

## **II. High Altitude Student Payload Competition**

Established in 2011, the first High Altitude Balloon Payload Competition involved four payload teams. Proposals were accepted in November of 2011, after much publicity, attempting to spread the word out to the appropriate academic venues. The launch was scheduled for late April 2012, providing ample time for the student teams to construct their experiments. The four constructed payloads were connected to one 1500-gram latex balloon and launched out of a field in eastern North Dakota.

The four teams awarded a spot onboard the balloons were Northwood High School (8<sup>th</sup> grade students), Mandan High School, Cavalier High School, and Bismarck-Century High School. Although this was the first attempt at a state-wide balloon competition, everything eventually worked out as perfectly. NDSGC remained in contact with the schools throughout the payload construction process via email. Weather updates were sent out closer to the launch date, which ultimately needed to be pushed back a week due to inclement North Dakotan spring weather. By the second make-up date came around, the weather cooperated and the launch was a great success. The balloon reached an estimated 86,000 feet, ascending into the stratosphere.

After receiving their payloads, the four teams were able to see why some payloads flew better than others. They compiled their data, analyzed their results, and later produced a science report. The judges awarded the Grand Prize to Northwood High School. This award consisted of prize money awarded to their science department as well as a day trip to the University of North Dakota's Aerospace School (that includes the Aviation and Space Studies departments). The Space Studies department will provide them with a tour of the spacesuit laboratory and UND observatory and will also allow them to fly the spacecraft simulators. The award for "best lessons learned" went to Cavalier; best craftsmanship went to Mandan; best innovation went to Bismarck; and best report went to Northwood. Each one of these awards won a smaller monetary prize. (Note: the UND Aerospace Foundation donated these one-time funds).

A documentary of this launch experience can be found on YouTube.com in the account of UND Aerospace. Search parameters include typing in "Reaching New Heights - North Dakota High Altitude Balloon Payload Competition<sup>7</sup>".

## **III. Near-Space Balloon Competition**

The second annual balloon competition recently concluded its year-long process. The competition was based off the same framework as the previous High Altitude Balloon Payload Competition. With a new name – NSBC – seven teams sent in proposals to fly payloads onboard two latex balloons. The expansion of the competition was proof that the students had a fun, exciting, and educational experience in 2012.

Due to uncontrollable circumstances involving weather, senior proms, and hectic high school finals, the actual 2013 balloon launch carried only three of the seven scheduled payloads. These included Northwood High School, Des-Lacs Burlington High School, and Bismarck-Century High School. There was much more involvement and communication with the teams during this second year, because of the lessons learned from the inaugural year.

Early in the academic year, the head NSBC coordinator, Space Studies faculty, and a NDSGC coordinator held a web conference with all seven teams, once they were accepted a spot in the launch. Everyone involved in the meeting, including all the student teams, were able to discuss their payload concepts, past experiences (if they flew the previous year), and ask each other constructive science questions. This was highly beneficial: some teams had overlapping science experiments onboard their payload, including the popular video camcorder or digital camera.

### **A. Involvement with a Cankdeska Cikana Community College.**

NSBC had another change since the first balloon experience. A new collaboration emerged with the Cankdeska Cikana Community College, a tribal college in Fort Totten, located on the Spirit Lake Reservation. They proceeded to observe and learn the techniques and procedures used in a balloon launch this year. They are excited to

collaborate with NDSGC next year, helping spread the importance of STEM education. NSBC's launch site was located south of Devil's Lake on their reservation.

## **B. Logistical Preparations**

All finances are supported by NDSGC, including all hardware needed for a balloon launch. NDSGC uses amateur HAM radios to track and recover the payloads. For the 2012 launch, the *Micro-Trak AIO* – a self-contained portable tracker – was placed on the payload chain. Also used was the car-based Kenwood D700 transceiver. The micro-Trak transmitter was programmed to send out packets containing the balloon's location every 20 seconds.

There is also a redundant system in place, to ensure recovery in case the HAM radio malfunctions during flight. The SPOT tracker is used as the redundant system; this is a GPS device commonly used by hikers. The GPS transmits a location every ten minutes to their website online, which is able to be monitored by family and friends of the students.

After completing the 2012 balloon launch, NDSGC duplicated all of the tracking systems in time for the 2013 launch. There are now two car-systems: the original Kenwood D700, as well as a new Kenwood D710. Also in possession are two handheld radio receivers (Kenwood TH-D72A Dual Band receivers) along with two SPOT trackers. APRSPoint software is used in the cars to monitor the visual progress of the balloon.

The logistics of tracking the balloon are vitally important. If anything malfunctions, the time, effort, and hard work of the middle and high school students will be forfeited. Even though the focus of STEM education is targeted to the middle and high students, the technical side of a balloon launch is an equal learning experience. In order for NDSGC to maintain a successful balloon program, graduate students must learn the ballooning process. This "teach the teachers" approach enforces the STEM cycle. The graduate students study for and obtain their HAM radio license. This legally allows them to operate the tracking equipment. They learn how to set up and complete a balloon launch, communicate these STEM topics to the younger students, and then judge the results.

NDSGC sets up the payload chain containing the 1500-gram latex balloon, parachute, tracking gear, and radar reflector. The student teams are given weight and size restrictions for their payloads but are not given rules of the shape or design. This decision will be analyzed in their final science report, constituting as its own lesson in aerodynamics, physics, and (if flying for a second year) trial-and-error of the science process.

## **IV. Future Endeavors**

New to the NDSGC agenda is the collaboration of a middle school located in West Fargo, ND. The West Fargo STEM Center has an entire class of seventh grade students that will launch payloads onboard two balloons. They have also coordinated a lesson plan with first grade students from Moorhead, MN. Even though NDSGC has been targeting students in the middle to high school age range, any opportunity to encourage even younger students into a STEM field is sought after and is highly rewarding. This launch is scheduled for either a summer or fall 2013 launch.

The author will also pursue the STEM education with ballooning field to produce a master's thesis. She will survey the middle and high students from both the NSBC and West Fargo launch. She plans on delving deep into the issues and personal experiences of the students, proving or disproving the effectiveness of STEM learning on high altitude balloons.

## **V. Conclusion**

There are countless educational benefits of exposing middle and high school students to science, technology, engineering, and mathematics subjects through the use of a hands-on activity such as high altitude ballooning. The North Dakota Space Grant Consortium has implemented an annual Near-Space Balloon Competition that allows students to leave the didactic, classroom-based learning and venture into an area of unfamiliar territory consisting of hands-on, inquiry based problem solving. The students formulate a hypothesis to test in the near-space environment. They design, construct, and fly their scientific experiments onboard the balloon. Upon return, they collect their data, analyze, and produce a final science report. The thrilling nature of a balloon chase hopefully attracts more students into the STEM fields later in their higher education. NDSGC also involves any other school willing to participate with ballooning. The West Fargo STEM Middle School has been collaborating and organizing a late summer or

early fall (2013) balloon launch. Students everywhere across North Dakota have the opportunity to be involved in an unforgettable, educational endeavor.

### **Acknowledgments**

M. E. Saad thanks the North Dakota Space Grant Consortium for providing the opportunity, resources, and time for all of the balloon competitions. Many thanks to helpful UND Space Studies graduate students: Jonathan Schiralli, Brian Badders, and Katrina Jackson. We had the most helpful administrative assistant Bev Fetter. Also, many thanks go out to Mr. Benjamin March for always fixing the technical and software problems that arise.

### **References**

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<http://www.youtube.com/watch?v=eItjEZ9o5e8>