University of Northern Colorado DemoSat Final Report

DemoSat Overview:

The DemoSat project involved a variety of payloads from several Colorado universities and colleges that were tethered to a helium balloon which ascended to ~100,000 feet into the atmosphere and then descended by parachute the to the ground post balloon burst. The DemoSat project from the University of Northern Colorado included three payloads in one protective box: VideoSat, PanSat and data sensors that recorded atmospheric pressure and temperature (interior and exterior) throughout the entire flight. The total weight of the payload was ~1.6 kg.

VideoSat

Team Organization:

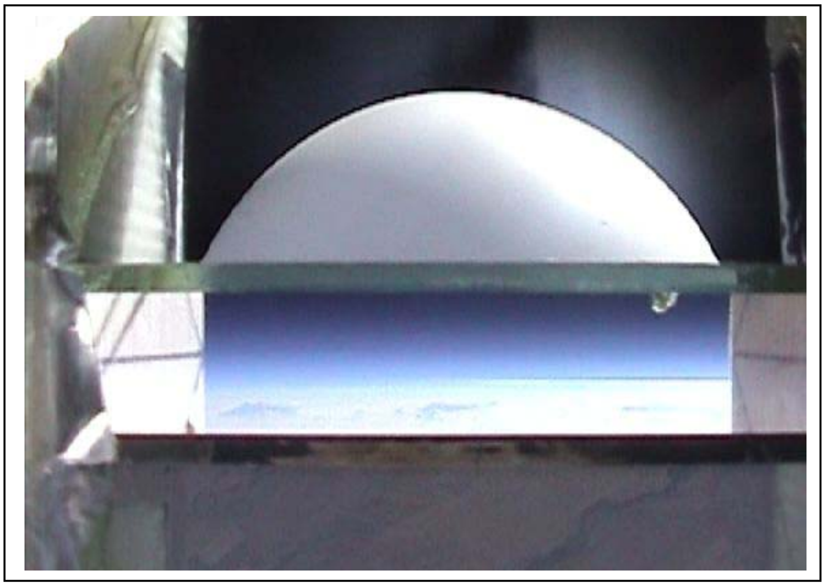
Project Manager:	Bruce Keller
Electronics and programming:	Cory Cook
Mirror Design & Testing, HOBO data collection:	Jessica Thorne
Construction:	Josh Eveslage
Advisor:	Dr. Robert Walch
Other team members:	Erik Peterson

VideoSat Mission Overview:

The basic mission was to design, construct, and launch a payload that would take video footage during most of the flight. In addition to the basic mission outline, our team added the constraints that the video must capture an image of the ground during launch, capture the images of the balloon bursting, capture an image of the horizon at the apex, and capture footage of the landing. The other mission requirements were that our payload must maintain an internal temperature of 0^o, retain structural integrity, and successfully recover the data

VideoSat Mission Critique:

Upon initial recovery of the payload it was obvious that the structural integrity requirement was accomplished. Also, we were able to tell right away that our camera had recorded the entire tape. The footage showed that our worries about timing were relevant. The camera had a 15 minute delay programmed into it so that we would have enough time to turn it on before the balloon was launched. We were given the 15-minute warning only to have the balloon launched 10 minutes early. This timing discrepancy resulted in the mission failure of capturing the image of the ground during launch as well as the balloon burst and landing. We have determined from pressure data that we failed to capture the balloon bursting by 4 minutes. The mission requirement for capturing the horizon at the apex was a success. This is mainly due to the mirror design, which separated the viewing area into three different regions, one vertical upward, one horizontal, and the other vertical downward. The figure below, is one frame from the video (which lasted 1 hour), shows the balloon above, the ground below, and the horizon, all in a single image. Overall, the images are impressive; the clarity is good and the mirror design worked great. The launch timing was the only thing that kept the VideoSat mission from being a total success.



PanSat

Team Organization:

Project Manager:	Julie Smith
Team Members:	Kevin Gutierrez
	Pat Mills
	Carl Saito
	David Tran
	Jon Turner
Advisor:	Dr. Robert Walch

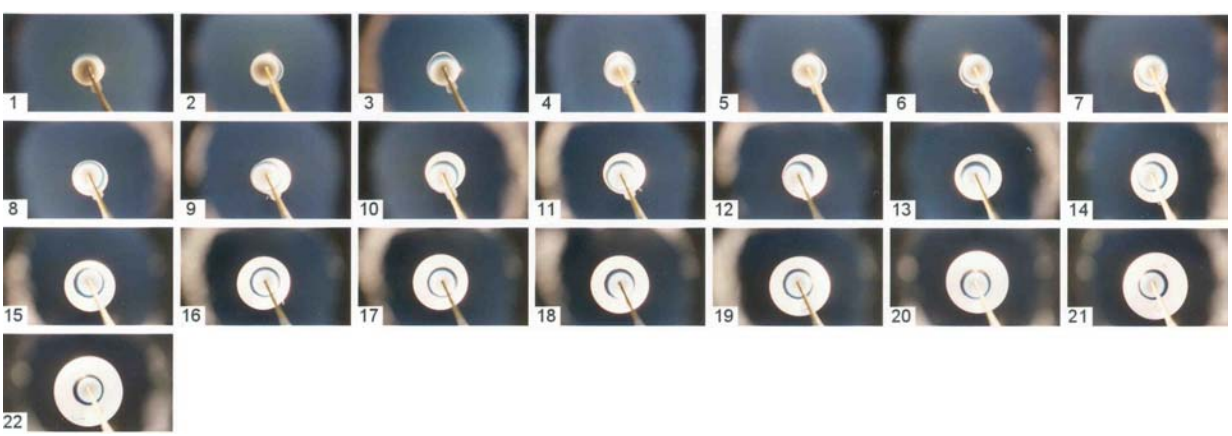
PanSat Mission Overview:

The purpose of PanSat was to obtain still panoramic images of the Earth and its horizon using a parabolic mirror during balloon ascent and descent. The Canon Elf camera and the "One Shot" parabolic dome mirror were part of a brass mount system that functioned as one unit, producing optical stability. The camera, using Kodak Advantix ASA 200 film with 40 exposures, was triggered every three minutes by a Basic Stamp. The insulated camera was mounted in the payload box lid with the lens facing upward toward the balloon. The silvered surface of the parabolic mirror faced Earthward 20 centimeters from the camera lens. A side view of the payload box showing both mirrors for the PanSat and VideoSat payloads is shown below as well as an image of the open payload box showing both cameras, the heater circuit and both HOBO's.

PanSat Mission Critique:

PanSat was a partial success in that we obtained 22 images (collected into the single image below), which showed the mirror images (albeit unclear) and the balloon expansion over time. The camera-mount system appeared to work well, maintaining good camera/mirror alignment. However, two problems prevented total success: 1) the auto-focus was set for infinity; 2) the camera malfunctioned after the 22nd image, resulting in no further photos.

Because the camera focus was incorrectly set, it did not focus on the mirror image and produced out-of-focus photographs. During photographic trials, several focus positions were tried by holding the focus gear in one position with a straight pin. For launch, the best position was held with hot glue; this secure position appears to have failed. When the camera was recovered from the crash, its flash repeatedly discharged, indicating some sort of short circuit. We assume that the camera malfunctioned after the 22nd picture was taken. The cause of the camera malfunction is unknown and will be investigated. The design of the mount was a great success in terms of optical stability and strength. The mount and mirror were intact with little apparent damage or mal-alignment when recovered.

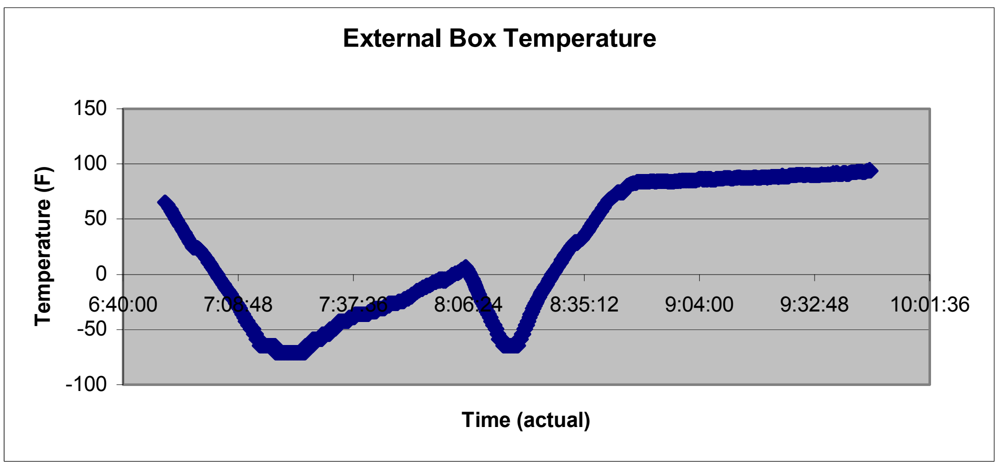


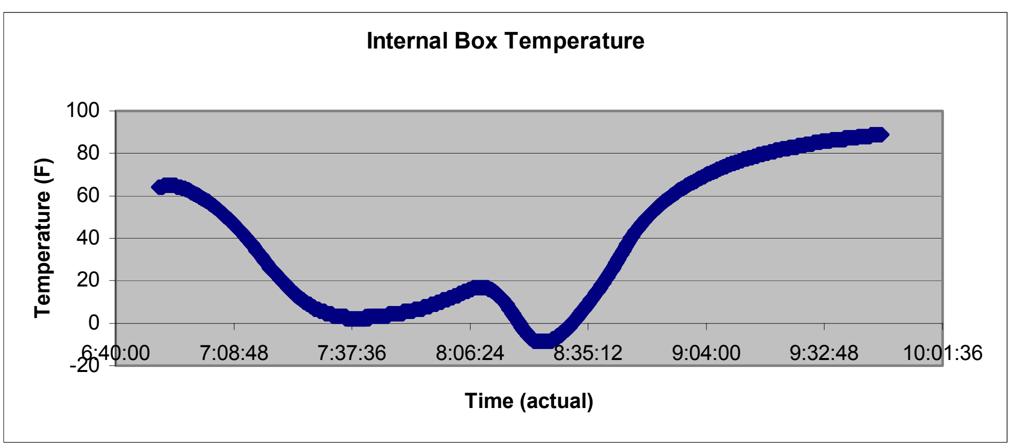
Temperature and Pressure Data:

The following data was retrieved using two prefabricated HOBO's. One was used to measure the internal and external temperatures of the surrounding atmosphere, while the second HOBO was used to detect changes in atmospheric pressure during ascent and descent.

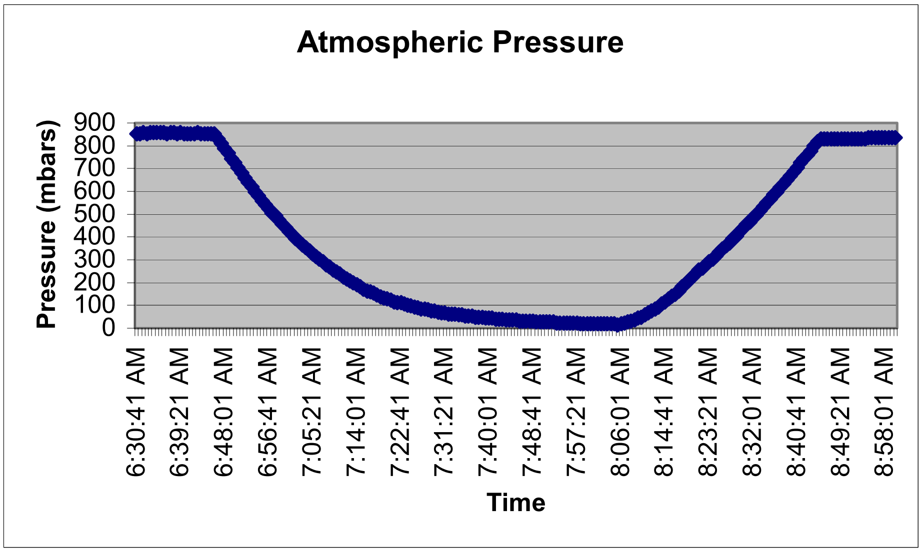
The goal of the UNC DemoSat group was to keep the internal temperature as high as possible, with a minimum temperature of 0° F. Although this was not obtained, the internal temperature did remain above –8.68° F throughout the duration of the experiment, while the surrounding atmosphere reached –71.26° F.

The following temperature graphs depict a basic "W" shape, meaning that the lowest temperature was reached, not at the peak, but rather at a point part way up. The payload then reached these low temperatures again when going back through this stream of cool air. The pattern can be seen in both the internal and external data. When the data is examined closely, one sees more abrupt changes in the external temperature although the basic shape of the graphs is the same. This is because the interior of the box with the heating system would take some time to equilibrate.





The pressure data was taken with the second HOBO. Atmospheric pressure readings were taken every 20 seconds, allowing us to make a rough approximation as to the height of the balloon. The lowest pressure reading was recorded at 8:05:21.0 am with a reading of 14 mbar. This allowed us to establish this point at which the balloon burst with in an error of plus/minus 20 seconds.



~~In order to minimize file size, the above data charts are image files only. The actual data in Microsoft Excel format can be obtained from any of the team members upon request.~~

<u>DemoSat Mission Conclusion</u>:

This has been a great learning experience for all those involved. To actually design, construct, and launch a payload proved to be a difficult but enjoyable task. The lessons learned in-group dynamics are lessons that cannot be taught in any classroom. Even though we did not meet all of our mission requirements, all of us on the UNC DemoSat team consider the mission a success and would recommend similar opportunities to anyone interested.

<u>Acknowledgements</u>:

The UNC DemoSat team would like to thank Andy Loomis and Ted Leber for their help in interfacing both cameras to the Basic Stamp. We would also like to thank Ken Cochran for his help with the vacuum system used for pressure testing and Dr. Rich Jaouen for his assistance constructing the brass mount.