NORTHWEST INDIAN COLLEGE
Xwlemi Elh>Tal>Nexw Squl

2522 Kwina Road
Bellingham, Washington 98226
360-676-2772

Northwest Indian College Space Center USLI Team

2010-2011 NASA USLI Post Launch Assessment Review

May 9, 2011

Table of Contents

Northwest Indian College Space Center
RezRiders

Post Launch Assessment Review

Introduction

Our report will be longer than the suggested fifteen pages because of the extra pages analyzing Frankenstein II's launch, the pad collapse and the resultant destruction of our rocket.

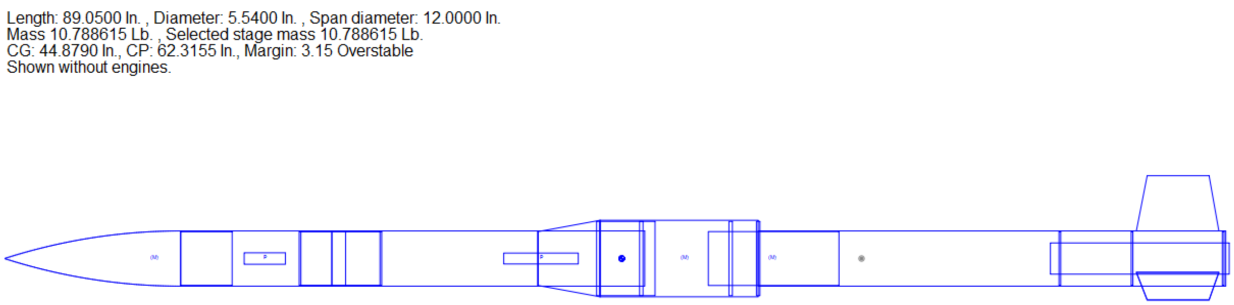
Team name: *RezRiders*

Rocket Name: ***Frankenstein II***
Location: Northwest Indian College, 2522 Kwina Road, Bellingham, WA, 98226 - Lummi Nation Reservation

Team official/Mentors

Gary Brandt – Team Advisor NAR L2
David Oreiro – Assistant Team Advisor – NAR L2
William Munds – Mentor – NAR L2

Launch Vehicle Summary



Size:

89.48 Inches
Diameter: Main Airframe – 4 inches; Science Payload Bay – 5.54 inches
12.00 Inches span diameter
10.69 Pounds – fully loaded w/o motor
44.87 Inches Center of Gravity
62.32Inches Center of Pressure
1.45 Static Margin with CTI K660

Motor choice: CTI K660 Classic

Brief payload description

We did the NASA Science Mission Directorate's scientific payload that monitors several weather and atmospheric phenomena. We are adding two additional measurements to the required list. The measurements that we monitored were:

- Barometric pressure
- Atmospheric temperature,
- Relative humidity
- Solar irradiance
- Ultraviolet radiation

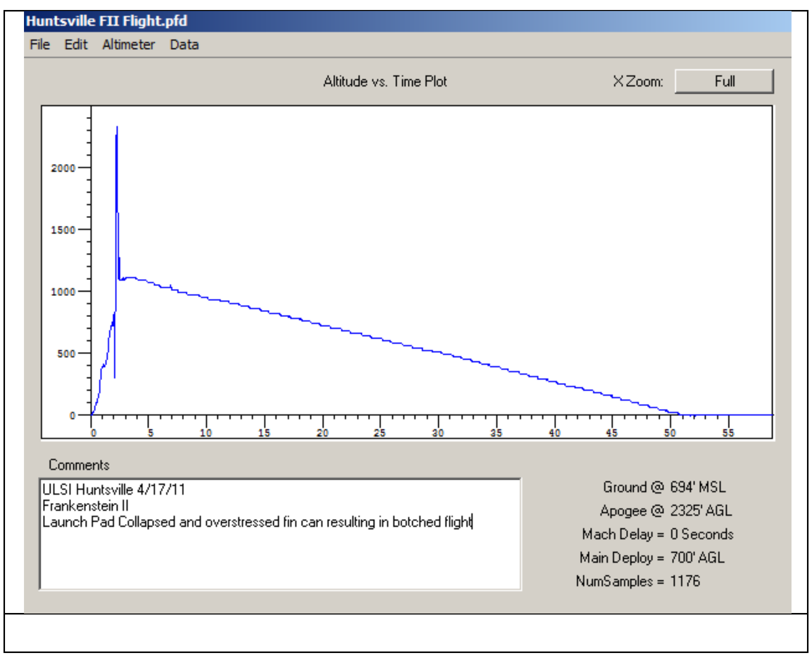
Additional Experiments

- Science payload bay temperature
- Rocket roll detection and measurement

Altitude Reached

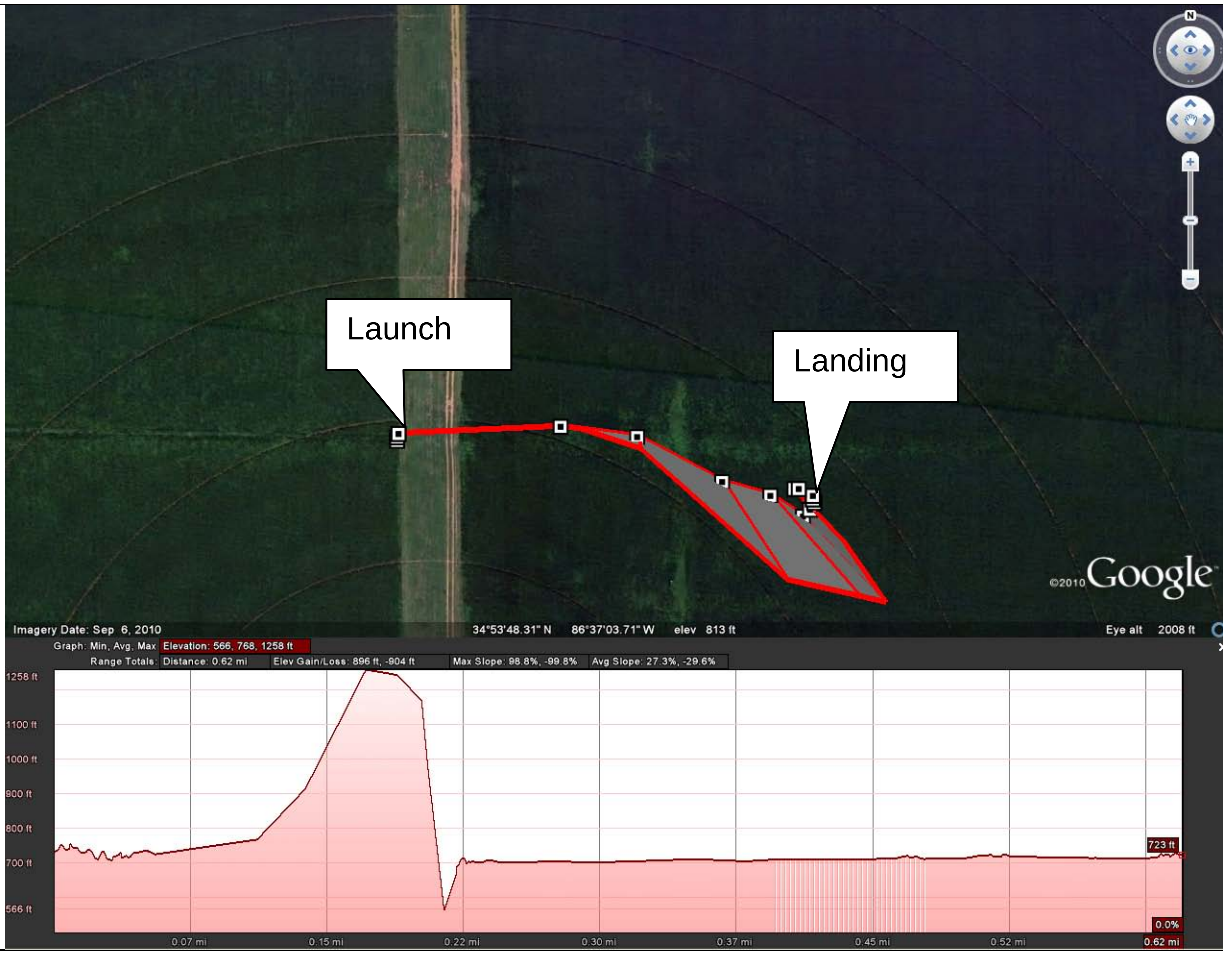
Frankenstein II carried two altimeters: The required PerfectFlite MAWD and an RDAS-Tiny.

The PerfectFlite measured 2,325 feet AGL.



The RDAS, however, failed to record and report any data. We received a flash memory error when we attempted to down load the data.

We also collected altitude and tracking data from our Garmin Astro 220 dog tracking system. The Astro 220 manual indicates that data sampling is 1/second whereas the PerfectFlite manual says that "samples are added every 50 milliseconds for the duration of the flight". This explains the data variation between the PerfectFlite MAWD and the Astro 220.



Flight Path and Elevation Data from Garmin Astro 220 GPS Unit

Data Analysis & Results of Vehicle Flight

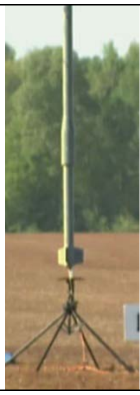
The Flight

Frankenstein II passed the Flight Hardware and Safety Check on Thursday, April 14, 2011 with absolutely no items on its punch list. Needless to say, we were very pleased with our responses to the NAR officials and the soundness of our rocket's design and construction.

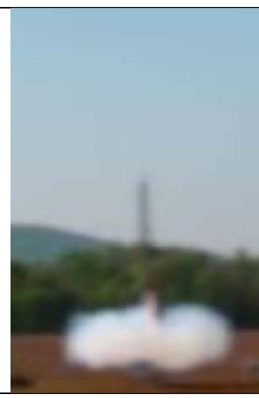
On Sunday, April 17, 7:34 am CST, Frankenstein II was cleared for launch by the RSO's and placed on pad 10. The cameras were turned on and the pad crew returned to the observer's area. After the opening ceremonies, the pad team returned to pad 10 to arm the rocket, the science experiments, and install the igniter. At 9:21 am CDT, Frankenstein II launched. A little over two seconds later, Frankenstein II broke up. Approximately fifty two seconds later, the fin can and harnessed portions of the rocket touched down. We executed our Failed Flight Check List, including the last item, “Fall down on the ground and cry”.

Analysis

Prior to clearing the launch rail, two of the launch pad’s legs buckled and caused the launch rail to pitch to the right.

				
Ignition	Legs Collapsing	Collapsed Pad	Broken Brace Rivit	2nd Broken Brace Rivit

This threw the rocket’s trajectory to the left by about 35 degrees as estimated from a launch video.

		
Ignition – 0.00	Pad Collapse – 0.25 sec	Angled Flight – 0.26 sec
		

Straightened flight – 1.13 sec	Destruct – 2.23 sec

Frankenstein started to straighten and a little over a second later, broke up with the fin can continuing upward and the parachutes being deployed bringing the remaining sections safely to the ground.

	
Fin Can and the rest of the rocket – 2.65 sec	
	
Fin Can in Flat Spin	Rocket sans fin can about to touch down – 0.52 sec

Initial breakup seemed to occur on the fin can between the science payload bay coupler and the motor mount about where the Center of Pressure was calculated. We surmise that drag separation caused the parachutes to deploy which caused the zipper of the drogue parachute bay. One of the fins experienced some cracking at the joint, presumably when the fin can hit the ground after its flat spin from altitude.

Remains of Frankenstein II

	
Break Point and Base of Science Bay	Break Point on Fin Can
	
Zippered Drogue Bay/Transition	Science Payload Bay and Fwd Rail Button (no damage
	
2 of 3Fins and Aft Rail Button (no damge)	Bulkhead/Fin Can Separation at Damaged Fin

Crack Between Fin and Fin Can	Damage to Fin Can from Cracked Fin

Undamaged nose cone & main parachute bay, zippered drogue bay, undamaged science bay, point of breakup on fin can.

Conclusion

One of the RSO's examined Frankenstein II after we had brought it back to the RSO tent. His opinion was that the rocket probably was overstressed at the launch. Perhaps the forward rail button had cleared the launch pad and the rear rail button had not. The collapsing pad and subsequent lateral forces weakened the fin can as the upper portion of the rocket was flying vertical and the aft section was thrown to the right Then as Frankenstein II had tried to straighten its flight path from its angled flight, the fin can failed at that stress point, just aft of the lengthened and fiberglass reinforced science payload bay-to-fin can coupler.

The break point was one inch aft of the calculated Center of Pressure.

Our NAR mentor, Bill Munds, concurs that the Kraft phenolic airframe was unable to withstand the stress from the less than ideal launch. The lack of damage (discounting the zipper) to any other parts of the rocket support the single breakpoint through unexpected stress hypothesis.

We had hoped that the on-board cameras would have supplied more evidence. However, none of the four cameras provided any useful information. We had turned them on when we initially readied the rocket, not remembering that there were to be opening speakers. The batteries failed between 47 and 53 minutes, approximately 3 minutes prior to liftoff. We do have some really nice video of the ground and the team setting up on pad 11, however.

Our rocket roll sensor collects data at two measurements per second. It showed a spike at launch; however, all that does is support the visual launch anomaly.

Lessons Learned

Overbuild. And, experience is a wonderful teacher. We now can plan on an event that we had never anticipated and will build that into future risk assessment. We will carefully examine any launch pad that we use. Our check list didn't plan for an initial setup on the pad followed by an absence and then a return to the pad to complete the launch sequence. We "forgot" about the opening ceremonies and had not deactivated the cameras when we were instructed to return to the staging area for the opening activities.

Flight Analysis

Actual vs. Predicted Altitude

Since our rocket didn't fly as planned, our actual altitude was lower than predicted. Rocksim altitude prediction: 5477 feet

- PerfectFlite MAWD recorded altitude: 2325 feet (50 samples/sec)
- GPS recorded altitude: 2016 feet (1 sample/sec and records every five seconds)

Actual vs. Predicted Descent Rates

We analyzed the discreet data points logged by the PerfectFlite MAWD and extracted the points that lay between the descent beginning and ground contact.

- The MAWD takes 50 samples per second
- 960 Data Points included in descent analysis from 1108 to 0 ft agl
- About 50 seconds calculated for descent (actual was about 52 which includes the time of the forcible drogue ejection.
- Calculated descent rate after main deployed: 22.16 fps
- Rocksim predicted descent rate after main deployed: 21.3 fps

Actual vs. Predicted Drift from Launch Pad

Since Frankenstein didn't fly as planned, the predicted drift doesn't correlate with the actual flight. Drift data from Rocksim calculated in 0-2 Kts of wind that Frankenstein should have landed 81 feet from the launch pad. The GPS unit place our rocket 475 feet east of the launch pad as a result of the abnormal launch.

Payload Summary

Barometric Pressure

Pressure was measured in flight with the VTI SCP1000 which is an absolute pressure sensor which can detect atmospheric pressure from 30-120 kPa (30,000 to -5000 feet). The pressure data is internally calibrated and temperature compensated. Its resolution is 1.5 Pascals. Pressure equalization between the interior of the science payload bay and the external atmosphere is via vents. Data collection started five seconds after liftoff, triggered by an accelerometer which is supplied by the RDAS-Tiny altimeter AD channel.

Atmospheric Temperature

The DS1620 is a digital thermometer. It can measure temperature in units of 0.5° Centigrade (C) from –55° C to +125° C, Fahrenheit (°F), units of 0.9° F and a range of –67° F to +257° F. The fastest the DS1620 can generate new temperature data is once per second. Data collection started when the instrument was turned on at the launch pad. Data collection can last as long as five hours.

Relative Humidity

The Sensirion SHT11 Sensor Module measures relative humidity from 0% to 100%. It has a 3.5% range of accuracy. This module has a heater that in high humidity applications, the heater can be switched on briefly to prevent condensation. The sensor was mounted on the vertical wall of the science payload's top section and it has access to the external atmosphere. Data collection started when the instrument was turned on at the launch pad. Data collection can last as long as five hours.

Solar Irradiance

The solar irradiance unit determines how much available sunlight (solar insolation) there is at its location. The silicon pyranometer is based on a PIC16F88-I/P microcontroller and has its own data logger and power supply. The irradiance range it from 0 to 1520 watts per meter squared (W/m^2). The resolution is 1.5 W/m^2. Readings are taken every 10 seconds. Data collection started when the instrument wass turned on at the launch pad. Data collection can last as long as four hours.

Ultraviolet Radiation

The UV radiation sensor is mounted on the top layer of the electronics stack. The UV range is from 0 to 30 milliwatts per square centimeter (mW/cm^2). The recording level is one reading per second. Data collection started when the instrument wass turned on at the launch pad. Data collection can last as long as four hours..

Science Payload Bay Temperature

The MLX90614 infrared thermometer module is an intelligent non-contact temperature sensor. The temperature output data, ranges from -70 to +380 °C. Data collection started when the altimeter was armed and continued throughout the flight.

Rocket Roll Detection and Measurement

The Texas Advanced Optical Systems (TAOS) TSL230R measures light intensity using an array of photodiodes and outputs a square wave whose frequency is proportional to light intensity striking the surface of the chip. We want to collect roll data because we hypothesize that the rocket's rolling will affect the solar irradiance and ultraviolet readings and perhaps we can use the roll data in conjunction with analyzing the UV and solar irradiation data. The change in light intensity should allow us to determine the roll rate and how long the sensor was aimed in the sun's direction. Data collection started when the instrument was turned on at the launch pad. Data collection can last as long as five hours..

Photography

We used multiple cameras for redundancy. One side-mounted camera was mounted on the side wall of the science payload bay. Three rear-facing cameras were mounted in the aft end of the science payload bay transition. They were aligned with the fins which ensures that at least one of them will be in an upright or near upright position upon landing. The batteries are supposed to last up to an hour. We tested and found that they did, plus or minus 3 minutes

Bragg's farm is relatively flat which indicates that our science payload should land in a nearly horizontal or horizontal position. This will place one of the three cameras in proper orientation for the images.

Aft camera photo, 3/20/11

Data Recovery

Data retrieval took place after recovery. The USB data storage drives were removed from their appropriate sensor modules and the data downloaded to the team's laptop computer. The data was downloaded to two computers for data safety. Camera data was treated the same.

Payload Objectives

RezRider's intention is two faceted: 1) gather atmospheric data and present it in a meaningful format; and, 2) gather data from the rocket itself to learn more about our rocket.

The first objective involves building sensor and probe modules to sample atmospheric temperature, humidity, and pressure. We also built an ultraviolet radiation sensor and a solar irradiance sensor. All six of the experiments are independent of one another.

The second objective was to gather and analyze rocket data from two additional sensors. The first converts light frequency to digital data in order that we can measure the longitudinal roll of our rocket. The second sensor measures and records the temperature within the science payload bay.

Our major reasons for doing this with individual sensor modules is to not only satisfy the SMD goals, but to enhance the learning and knowledge of our team members, none of whom have had any electronic or microcontroller experience prior to this project.

Mission Success Criteria

Can we build the modules? Can we make them work? Can we program them to do what we want? Can we integrate the sensors and data loggers? Can we collect data? And lastly, can we analyze and report the data gathered in a meaningful manner?

A, "Yes" to all of the previous questions was our goal. The team realizes that there are varying degrees of acceptable performance for each of the modules and an overall payload success criteria falls in the range of total failure to perfection, 0% to 100%.

Furthermore, each module had its own degree of difficulty in building, programming, mounting, and sensor/data logging requirements.

Test and Measurement, Variables, and Controls

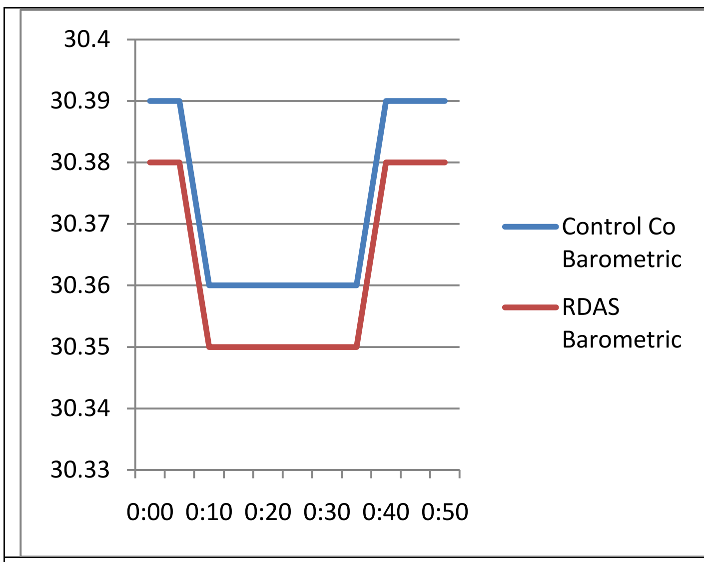
We evaluated our atmospheric sensor modules by comparing the sensor results with standard scientific measuring tools such as laboratory quality thermometers, barometers, and hygrometers. We initially planned to create a device to rotate the science payload at a fixed rpm in order to calibrate our roll detection sensor. However, having to rebuild Frankenstein version II, didn't allow us the time to do this part of the project. Prior to the competition flight and in a controlled environment, we developed a baseline for each of the sensors that.

Data Analysis and Results of Science Payload

The abnormal launch and subsequent breakup has seriously compromised what data we were able to recover. We planned to have the sensors collect their respective data from just before launch through ten minutes after landing. The actual flight last 57 seconds and reached an altitude of 2,325 feet AGL. Each experiment's results are discussed more fully below.

Barometric Pressure

Tied to failed RDAS-Tiny. No data was recovered

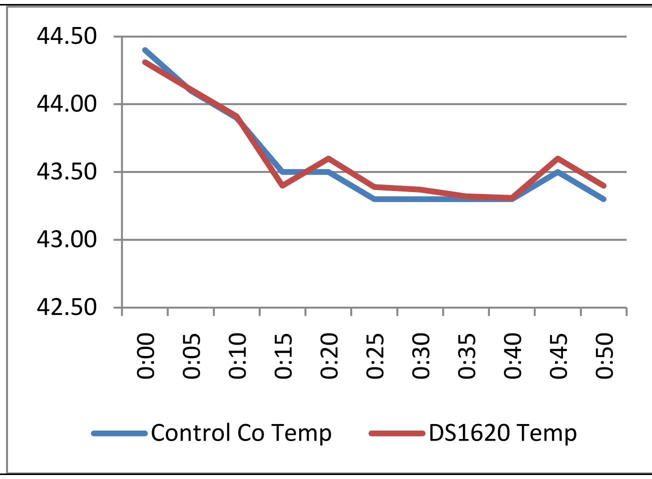


Baseline data from Control Company **Traceable® Digital Barometer Module and RDAS Tiny barometric module - Data sampled 2/15/11**

Our baseline data collection compared our barometric module to Control Company's Traceable Digital Barometer Module. Our module's data paralleled Control Company's instrument but was about 0.01 inches less throughout the test period. This difference was to be factored in with our flight data.

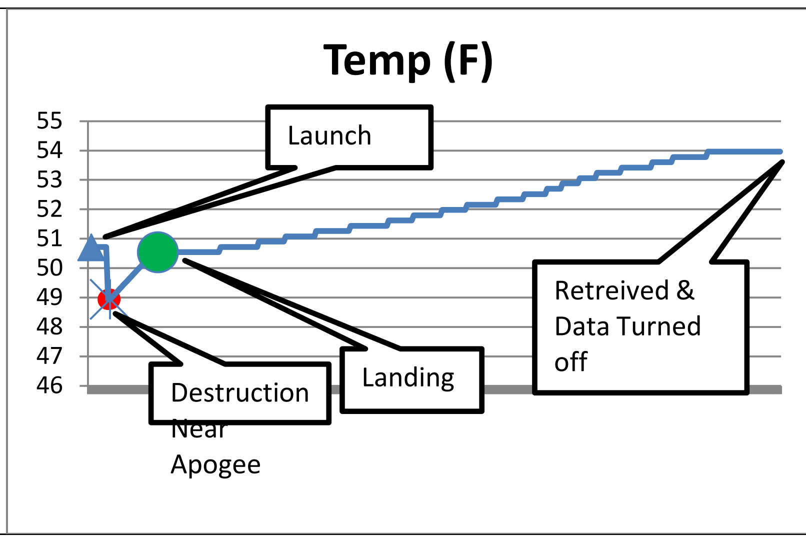
The RDAS-Tiny altimeter and connected modules failed. The ejection charges were not ignited and no data was recovered from it. We have been in contact with the company that manufactures the RDAS. It is based in the Netherlands. No definitive conclusions have been arrived at as of this writing.

Atmospheric Temperature



Baseline data from Control Company **Traceable® Digital Barometer Module and DS1620 Temperature Module - Data sampled 2/15/11**

Our baseline data collection compared our DS1620 temperature module to Control Company's Traceable Digital Barometer Module. Our module's data paralleled Control Company's instrument somewhat but did not exhibit a predictable difference between its temperature data and our standard thermometer.

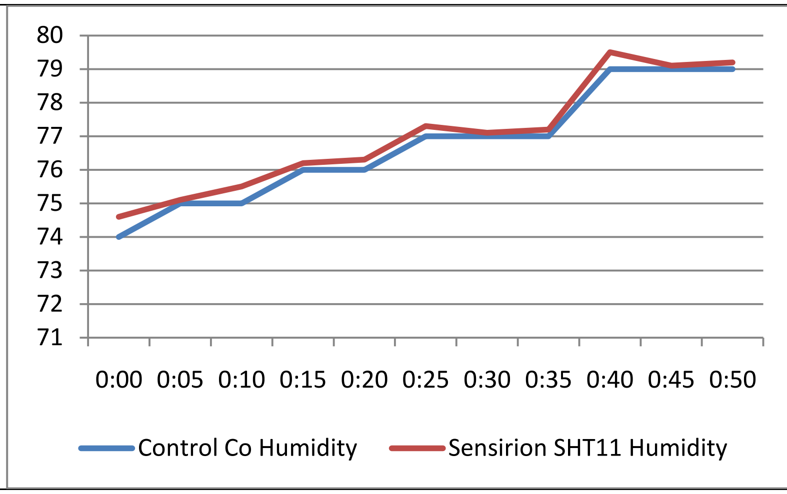


Frankenstein II Temperature Data. 4/17/11 – 07:07'45 – 07:19:47 – Bragg's Farm

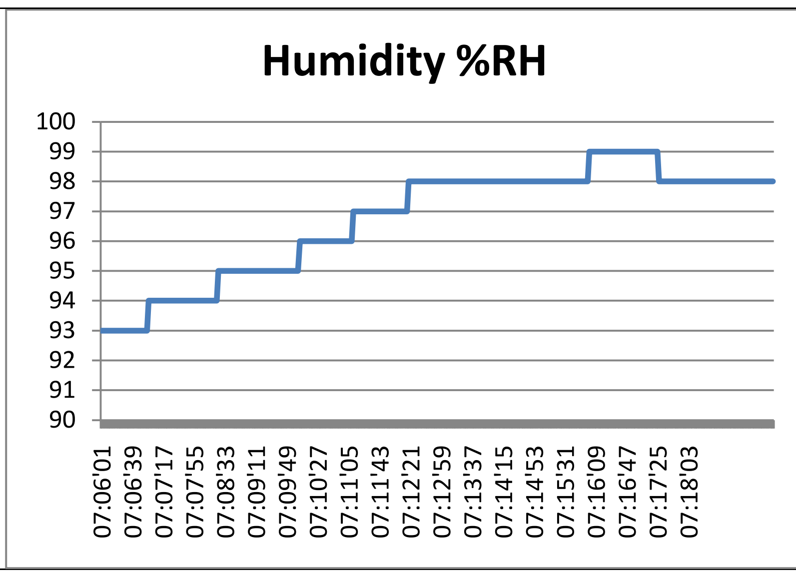
Time	Event	Temperature
07:07'45	Launch	50.72
07:08'05	Destruction (estimate)	48.94
07:08'53	Landing	50.54
7:19'47	Retrieved – data collection stopped	53.96

The chart shows an expected decrease in temperature as the air cools with an increase in altitude. It then increased as Frankenstein II's remains descended to the ground. The temperature slowly increased as the morning progressed and the sun rose higher, warming the ground.

Relative Humidity



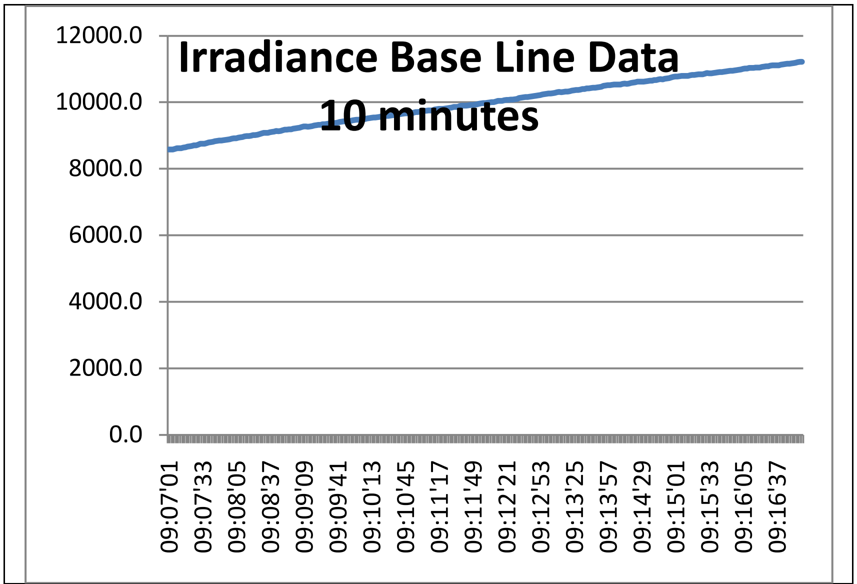
Baseline data from Control Company **Traceable® Digital Barometer Module** and Sensirion SHT11 Module - Data sampled 2/15/11



Relative Humidity Data from Sensirion SHT11 Module from just before launch until 10 minutes after landing

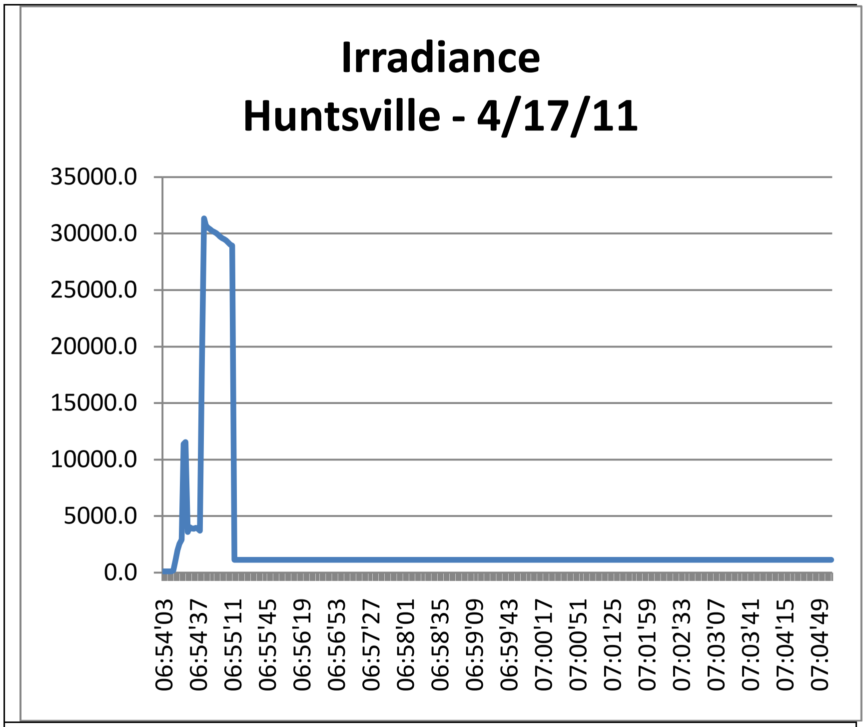
The humidity generally increased and then hovered around 100% during the day. This data is presented with no additional comments.

Solar Irradiance



Base Line Data Collected 2/10/11 on a sunny cloudless morning

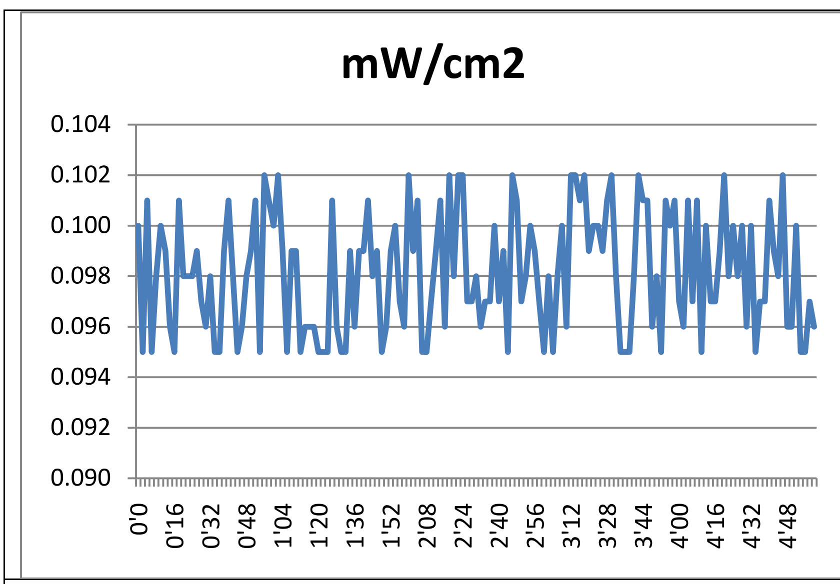
We collected our baseline data using our module to see if it would collect and store the data. We logged data for 10 minutes and then practiced on taking the data and making it into a chart.



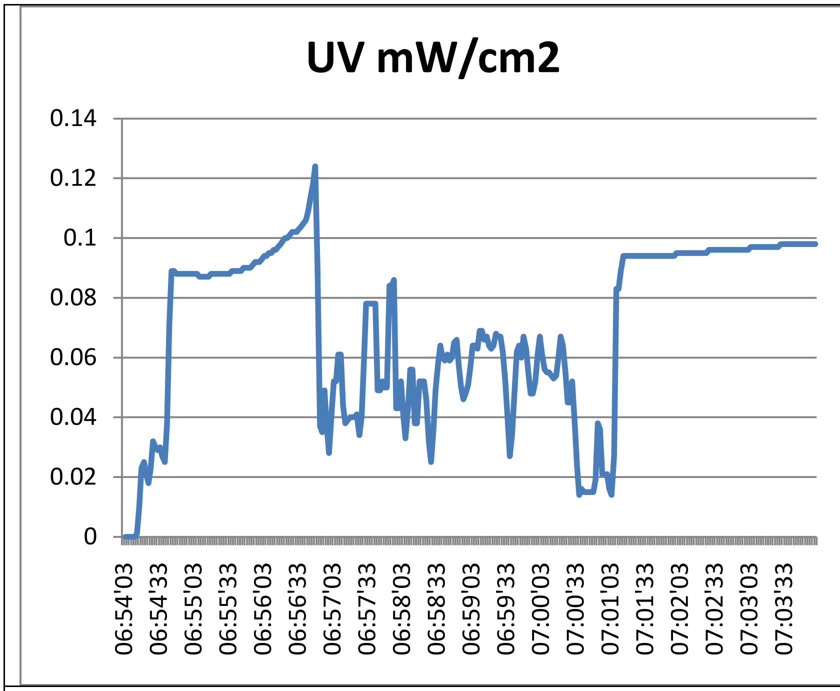
Irradiance Data collected from Frankenstein II's flight, Huntsville, AL

The data from the flight shows the erratic tumbling after Frankenstein II broke up. The rapid drop at about 6:55'15 shows that the science payload bay and the sensor landed on its side with the sensor pointing quite horizontally away from the direction of the sunlight. This sensor is located 90 degrees from the Rocket Roll Sensor.

Ultraviolet Radiation



UV Baseline Data collected 3/8/11



Ultraviolet Radiation – Frankenstein II Flight, Huntsville, AL, 4/17/11

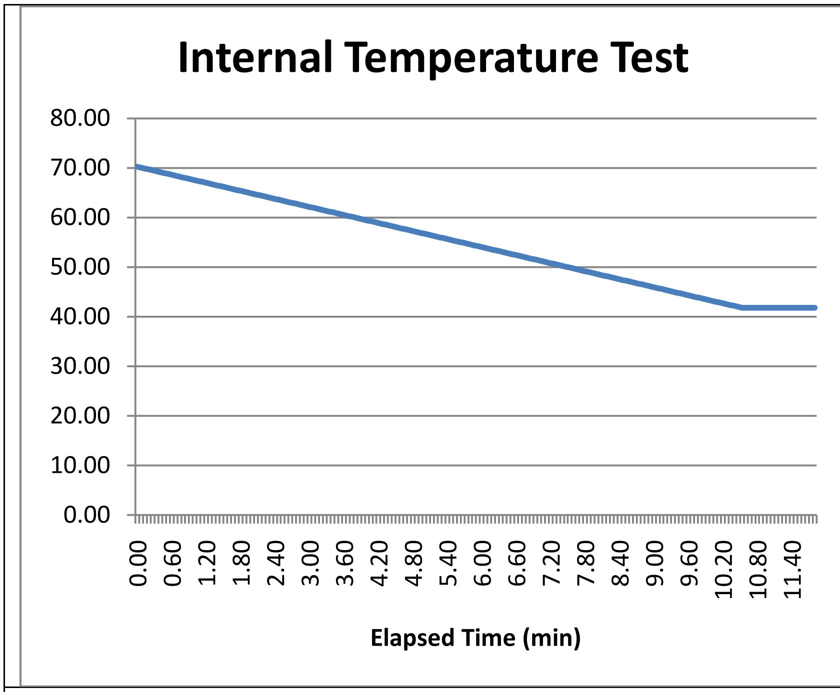
We are not at all certain what this data shows other than a fluctuation in the data during the chaotic tumbling and swinging of the science payload bay.. The data appears to be settling shortly after landing. The sensor landed in a generally up orientation, about 40 degrees above the horizontal.

Science Payload Bay Temperature

Tied to failed RDAS-Tiny. No data was recovered

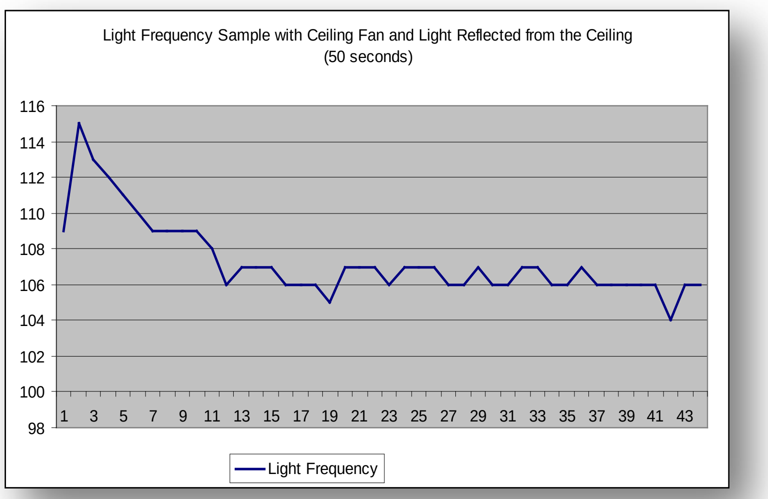
Baseline temp from payload while on the ground

On the 8th of March, 2001, we started our RDAS-Tiny via the G-switch to activate the analog to digital channel for our temperature module. The module was in its flight position in Frankenstein II. We then took our internal temperature sensor connected to the RDAS from our classroom to the outside for ten minutes to record data. This verified that our temperature sensor worked as well as provided data that showed temperature change from a warm room to the cooler outside.

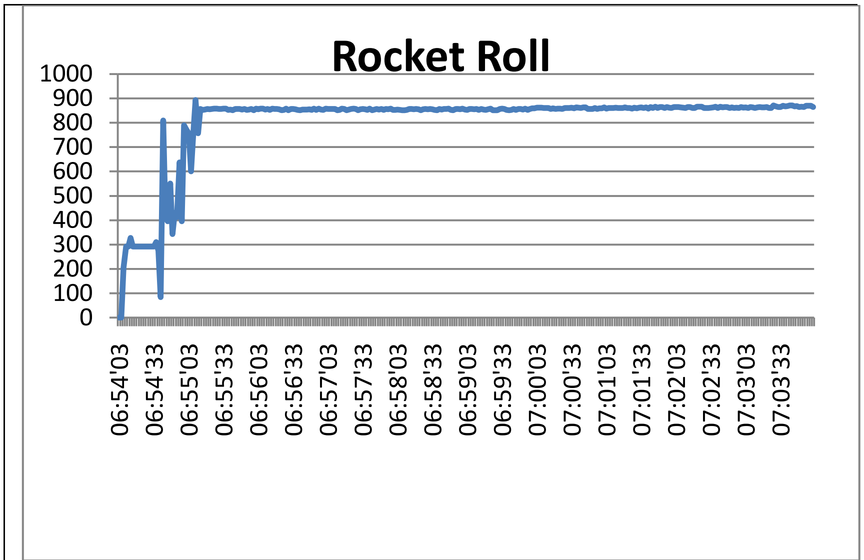


Internal Temperature Module Test – 3/8/11

Rocket Roll Detection and Measurement



Baseline data was collected by aiming the sensor at the ceiling above a lighted ceiling fan. The sensor collected and logged data that represents the interruption of the light by the fan blades. The pattern, as illustrated by the graph above, shows the rhythmic pattern of the fan blades.



Rocket Roll – Huntsville, AL 4/17/11

The data from the flight is very chaotic because of the breakup. After the landing the Rocket Roll Sensor logged high values because it was pointing close to the direction of the rising sun. The values are slowly increasing due to the sun rising and hitting the sensor more directly. This sensor is located 90 degrees from the irradiance sensor.

Scientific Value

In comparing our results to our mission criteria:

> Can we build the modules? Can we make them work? Can we program them to do what we want? Can we integrate the sensors and data loggers? Can we collect data? And lastly, can we analyze and report the gathered data in a meaningful manner?

We believe that we have reached all of our goals of our science mission. None of us had much, if any experience, in any of the tasks that we took on for the USLI project. We learned a lot, we learned teamwork, we learned to work through tough times, and we learned to rely on each other.

> Advisor's comment: The fact that my students had an opportunity to see science as something other than long words in a book is invaluable. Nearly all of my students initially expressed discomfort or dislike in thinking about math and most things science. This project has shifted attitudes, built confidence, built writing and thinking skills, and above all, sharply illustrated the importance of personal relationships and teamwork.

Visual Data Observed

The camera batteries have a tested life of 60 minutes ± 3 minutes. All four camera batteries died several minutes prior to launch. No data was retrieved from them. We speculate that the coolish, 37-41 degrees Fahrenheit, temperatures may have affected the LiPo batteries as well as our turning them on too early and in our excitement we forget about the opening ceremonies and didn't turn the cameras off.

Camera Battery Length via Time Stamp on Video	
Aft-Facing (min:sec)	
Camera 1	47:34
Camera 2	58:05
Camera 3	53: 42
Horizontal Facing (min:sec)	
Camera 4	51:03

We have proven our concept of having three aft-facing cameras in line with fins that would result in images having normal orientation. Test flights with the cameras always resulted in one of the three cameras landing in the proper orientation. Of course, this method relies upon the landing area being relatively flat with few obstacles that would result in the fin can landing in an non-horizontal orientation.

Aft camera photo showing fin nearly vertical, aft launch lug and the horizon, 3/20/11

Lessons Learned

- Relationships are key
- Don't assume anything
- Hard work will not kill a person (at least not yet)
- Plan so that key launches take place prior to the end of December to avoid the rainy weather
- Take more photographic evidence of the rocket and it's position so that science data can be more accurately analyzed.
- "Hack" cameras so that there is more recording time
- Look at body tube materials in addition to Kraft Phenolic tubing

Summary of Overall Experience

Basic student demographics:

Age range: 17-77

Gender: Female – 6, Male – 6
Tribes represented: 5 (1 student not native)
2 High school Running Start students
1 Special needs (autism) student

This has been an amazing adventure! The entire team hung together from the beginning to the end. We've included excerpts of the team member's comments.

Student Comments about the Huntsville Experience

I liked how everything was planned out for us, we had a schedule we had so we always knew what we were doing. The only thing I think that could be better is to have more interaction with other teams. We didn't get much socializing time with them, otherwise I had a great time and I wouldn't change anything. It was an awesome experience and I can't wait to do it again next year.

But the most important thing I learned from this trip was to go out and shoot the moon; even if you miss you will still land among the stars. I had a time of my life while I was there, however I was searching for something and didn't find it, but it was all good. I was lost in the moment with my teammates and had a great time goofing around and learning more about how to be a better rocket scientist.

My most favorite part was talking to the other schools about their rockets at the Rocket fair, it was great because unlike other fairs you ask generalized questions and/or just go to the booths that interest you the most. I was able to go to them in a row and have an enthusiastic conversation with each individual. I had a lot of questions to ask, was able to relate and know what they were talking about. It was cool to hear that each group when thru similar, all, or some of the problems our team went thru. So by the end we were sincerely meaning, good luck because by the end we all wanted to same thing: for the rocket to be successful we all had just went thru the same problems to get there.

Another thing I really enjoyed on the trip was the interaction we got with all the other schools, when we all got a chance to put all of the rockets on display. It really gave us a chance to walk around and see what kind of good ideas all the other schools had been working hard on. And every table seemed really friendly and excited to talk about their projects. If there was something I'd change about the whole event it would be having more time to interact with the other teams.

What I've learned from our trip to Huntsville Alabama was priceless to say the least. This kind of experience within the higher education sector cannot be taught as well as lived. As a group of not only a marginalized race but also tribal college students, I know that we will prevail. The various aspects of this competition made it that much more important for us to support each other because I believe we're setting the tone for future tribal colleges and our common aspirations.

Fun doesn't even begin to express how exciting this whole USLI project & trip has been! Indeed the whole process was empowering because it's made me realize that we're capable of anything we set our minds to and can aspire to our true passions and interests in life.

I think the entire trip was really fun, we had a great time, and we also had a chance to get to know each other while on the trip to, I think it had expanded the team as a whole. it was my job to assist with the explosive charge and to, as well as everyone's task of representing our group and making us look good, the first I know I did poorly, and the second, I believe I was moderately good at.

I am pleased that I made the trip, it was very rewarding, in many was one the team formed a stronger bond, everyone participated in the program making everything much more enjoyable,

We learned more ideas for next year for when we return to the competition again and we got to see those ideas in action as the other teams launched their rockets

Then Sunday we got up really early, like at 4:00 and we were on the buses at 5:00 headed to the launching pad. We readied our rocket and took it to the launch pad, then at 9:00 we launched our. I guess you could say it was a DISASTER!! Our rocket flew and all, but it kind of exploded in mid-flight. But we held our heads high and were interviewed. From there we left at noon and went back to the hotel. Checked out, and went to the airport! Over all it was a MARVELOUS trip!! I really enjoyed it!!!

The funnest part of the trip was interacting with other rocket teams. I stayed downstairs of the hotel with one team for over an hour just talking to them about where they were from and what there majors were. The whole trip was really fun but the most exciting was launch day. We were all so excited and so scared to finally launch our rocket.

I think the SLI Project is very well laid out, I think the persons assigned to manage and judge and run the whole operations and program were very successful and dead on to their tasks it made it all easier. The only thing I would change is possible adding a little more length of how to do the Reports. But I was comfortable enough to ask the employees questions when needed but I know others had even harder time then I did with the reports, they are challenging to write. It was cool to hear the other team leads feedback on how to improve the SLI project and found out we all agree and had the same things to say about the whole Project.

There was only one part of the trip that I felt horrible about and that was the part where our rocket broke itself apart in flight. IT was sad that we didn't have a perfect flight but overall I had a lot of fun, got to see a lot of cool things and can't wait to build another rocket and get ready for next year.

I don't think we could have been better because we as a team had tried to prepare ourselves the best we can, so in a whole we did all we could to prepare us for this competition.

Educational Engagement Summary

Date	Location	PreK-4	5-8	9-12	12+	Total
11/08/10	NWIC				40	40
02/05/11	NWIC			9	4	13
02/10/11	Lummi Nations School		6	12	3	21
02/24/11	NWIC Launch Complex			8	8	16
03/12/11	NAR Convention, Seattle, WA		2	3	12	17
04/25/11	Lummi Tribal HeadStart	18			2	20
05/03/11	NWIC Career Fair				28	28
						155

We will be continuing to conduct outreach activities throughout the existence of the Northwest Indian College Space Center. We have become an example of what young people can do with their dreams. We are continuously being asked to talk about and provide demonstration of what we have been doing. And, we, of course, agree to take advantage of the opportunities.

Budget Summary

We are within our budget and will have a bit of seed money for next year. Our planning process for next year is to generate more income and not have to rely so much on grants that we may or may not obtain. This may result in a much smaller team. Travelling costs may be a restricting element.

Budget Summary	
Scale Rocket	$184.99
Competition Rocket	$229.79
Propulsion	$765.93
Construction Supplies	$250.00
Recovery	$697.10
Electronics & Payload	$1,764.75
	$3,892.56

Travel & Lodging	$15,150.00

Project Total $19,042.56

Project Income	
	$22,500.00

Balance - May 5, 2011 **$3,457.44**

Travel is the most expensive portion of this project. We were fortunate this year in collecting sufficient funds to cover the travel. We hope our luck holds.