

Colorado Space Grant Consortium

DEMOSAT Final Report from  
Community College of Denver

Team: M.O.S.T.

Monkeys Observing Space Temporarily



Written By:

Zophie Prystalski

Dylan Davis

Kira Blaus-Plissner

Jeffrey Kearns

Addiel Orozco

Daisy Adriana Solano

Judith Mendoza

Margaret Hoban

Joseph Tatum

George Alvarez

Sponsors: Dr. Joel S. Thompson and Steffanie Peterson

December 3, 2014

## 1. Mission Overview.

Team M.O.S.T. planned on collecting data from different sensors located inside, and outside of the DemoSat payload box. In addition to collecting an air sample at ~3psi of atmosphere, and having a camera to record images of ascent and descent of the payload. Our secondary goal, involved learning how to solder properly, how to program an Arduino board. Additionally, a goal of this project was to ensure all sensors would work properly during the flight, and to create a payload with sufficient integrity to survive both testing and the actual flight.

Team M.O.S.T.'s air sample was of particular interest in our project, as similar models had been used in previous DemoSATs from the Community College of Denver, but had not yet been successful. It became a primary objective for Team M.O.S.T. to take the past experiences from past projects and create a method for obtaining an air sample that would work properly.

## 2. Requirement Flowdown.

- Our payload was expected to withstand the extremely cold temperatures of the stratosphere, as well as maintaining its structure after freefall while keeping all electrical components secure and fastened as required.
- Mass was not to exceed 1.5 kilograms
- Computer was to record data from three different sensors.
- Camera would watch the inlet port for air sample as well as document launch, flight, and descent.

## 3. Design.

### 3.1 Data Collection

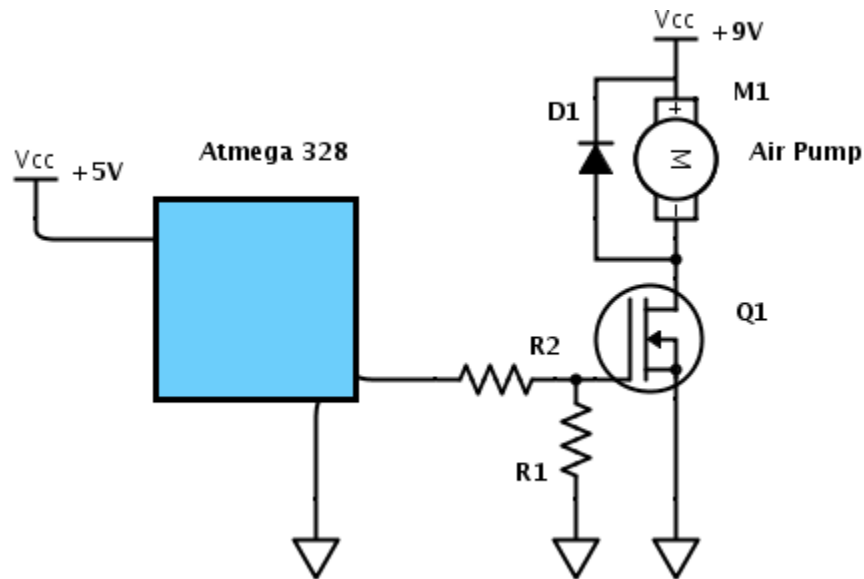
Data was collected on the arduino and then downloaded post mission, through a USB connection to the arduino. The camera was set up to download onto an SD card to save time and RAM on the arduino during flight. This piece of equipment worked during pre-flight testing but failed during the actual flight. It's hypothesized that a jolt during parachute deployment or during landing caused the SD card to realign and short out. This was evidenced by cracks seen in the SD card during post-flight analysis.

### 3.2 Air Sample:

The collection of an air sample was part of the primary objectives of this project. During past payloads the collection of an air sample was not obtained due to different complications from different components at those times. After reviewing some of the components and the system from the past payload, some new proposals were taken into consideration. The past air sample collection system was using electrical relays to control the electrical flow to the air pump and an electrical solenoid that prevented backflow of air from the air sample in the collection bag. Since the electrical power required to operate the air pump needed to be at a minimum of 9 volts and the Arduino board can only supply a maximum of 5 volts, this constituted one the reasons why past teams opted to use a relay as means of control of the electrical power for the air pump. However, electrical relays have moving parts that could be affected by changes in altitude and temperature. Due to this consideration, it was opted to use a solid state transistor as means to control the flow of electricity to

power the air pump. The past trials for an air sample had a solenoid to prevent the air collected from escaping the air collection bag. At first this solution seems to be a good option, but it does has some drawbacks. The particular solenoid used in the past payload was substantial in mass and weight. In addition, in order to operate the solenoid it needed a separated source of electrical power and an additional relay to be controlled. Furthermore, in order to prevent the backflow of air from the collection bag, a simple check valve was used in place of the solenoid. This also eliminated the need for an extra power supply and the weight associated with the solenoids and batteries.

Sensor Schematic:



Air Sample Circuit

### 3.3 Payload Shell

The Payload design was a truncated Octahedron. This shape is similar to a soccer ball and has a more even weight distribution so the payload would roll on impact and be less likely to burst at its joints. The payload was designed with foam core.

### 3.4 Parts List

Part	Manufacturer	Model
Arduino	Smart Projects	Arduino Uno (ATmega328)

Air Sample Collection Container	Cel Scientific Corp.	Tedlar Bag 0.5 liters
Air Pump	Honeywell	N/A
Batteries	Sparkfun	Po-Li 2000mAh
HackHD Camera	HackHD	1080p HackHD
Humidity Sensor	Sparkfun	HIH-4030
Temperature Sensor	Sparkfun	DS18S20
Methane Sensor	Sparkfun	MQ-4
SD-Card Shield	Sparkfun	SparkFun microSD Shield

#### 4. Management

Our team changed members several times during the initial phase of the project, however our final team worked together in order to put together our project under the time constraints and suiting the requirements. While the people listed were the primary handlers of each part of the project, there was overlap from all members as the project developed.

Scheduling and Presentation: Margaret Hoban, Zophie Prystalski, Kira Blaus-Plissner

Box Design: Kira Blaus-Plissner, Zophie Prystalski, Judith Mendoza, Daisy Adriana Solano

Software: Addiel Orozco, Dylan Davis & Joe Tatum

Hardware: Addiel Orozco, Dylan Davis & Joe Tatum

Assembly: Everyone

Testing: Everyone

## 5. Budget

Following is a budget split into 3 sections. Section 1 breaks down the cost for going to the balloon launch and ensuing chase/recovery. Section 2 outlines the stipends set up for students for fall of 2014. Section 3 details the price for constructing our platform.

Budget for Demo Sat Fall 2014 Community College of Denver						
				items	\$ per item	
Demo Sat Launch and Recovery Cost						
2 x SUV rentals				2	\$ 89.00	\$ 178.00
gas veh 1				1	\$ 85.02	\$ 85.02
gas veh 2				1	\$ 50.00	\$ 50.00
						Sub
						\$ 313.02
Student Cost						
Stipends				10	\$ 150.00	\$ 1,500.00
						Sub
						\$ 1,500.00
Parts for Platform						
solder				1	\$ 7.95	\$ 7.95
hot glue sticks				1	\$ 5.95	\$ 5.95
wire				1	\$ 10.00	\$ 10.00
circuit boards				2	\$ 5.00	\$ 10.00
2" high temp Al tape				2	\$ 19.53	\$ 39.06
0.5 cm foam board support				1	\$ 3.00	\$ 3.00
1.0 cm insulation foam				1	\$ 14.00	\$ 14.00
heater strips				3	3.95	\$ 11.85
Ardino Uno				1	\$ 19.95	\$ 19.95
SD shield				1	\$ 14.95	\$ 14.95
16 GB SD card				1	\$ 9.75	\$ 9.75
Methane sensor				1	\$ 4.95	\$ 4.95
Temp sensor				1	\$ 5.95	\$ 5.95
Humidity sensor				1	\$ 16.95	\$ 16.95
Camera				1	\$ 159.95	\$ 159.95
LiPD 2000 mHA				3	\$ 12.95	\$ 38.85
LIPD 1000 mHA				1	\$ 8.95	\$ 8.95
						Sub
						\$ 382.06
						TOTAL
						\$ 2,195.08

## 6. Test Plan & Results

### 6.1 Drop Test.

The drop test was performed at the Confluence Building at CCD. During this test the payload box containing the board and electrical components descended in freefall for the distance of approximately 130 ft. off of the Confluence building. The landing surface for the drop test was concrete. After examination following the test minimal structural damage was found, and the whole board and components responded appropriately to the software testing. There were no reportable incidents before, during, or after this test.

## 6.2 Stairs Test.

The “stair test” was performed at the CCD Cherry Creek building. During this test the payload box was dropped down three flights of concrete stairs. The payload box did contain the Arduino board, air sample components. After the conclusion of the stair drop it was noticed that the two cables that were providing the power supply for the air pump were severed. However, after examination it was concluded that the reason for failure was faulty terminal end of the cables. Nonetheless, after the integration of better quality cable terminals and one reinforcement anchor the issue was resolved. During additional testing this particular problem was not presented again.

## 6.3 Pressure Testing.

The pressure test was performed at CU Boulder. During this test the components and Arduino were subject to pressure conditions similar to those experienced at 100, 000 feet for 10 minutes. After the conclusion of this test a visual examination of the components and solder joints did not yield any signs of structural failure. In addition, all the sensors were examined by running the software and comparing readings against a calibrated source. No reportable incidents occurred during or after this test.

## 6.4 Temperature Testing.

For the temperature testing the initial plan was to place the board and components with dry ice. However, due to time constraints obtaining dry ice was not possible. Nevertheless, the performed cold test of the arduino and components did bring the temperature down to -50 degrees celsius and maintained the negative temperature for a significant period of time. During this time the board and components did not show any indication of malfunction or any signs of structural test. In addition, it is important to point out that during some period of time when the board and components where exposed to room temperature after the cold test, thin but significant sheet of ice was created and covered most parts of the board and components. However, this did not affect the function of any of the sensors or the board.

## 6.5 Results.

All parts were tested and ensured to be working before our launch date, November 15, 2014.

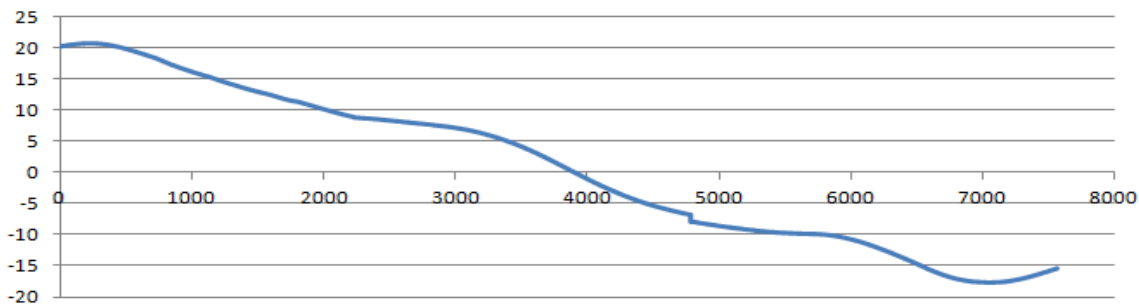
## 7.Launch & Recovery: Successful

Before the flight the payloads were arranged horizontally on a table. Consequently they were attached to a string, which connected the payloads in the following order: parachute, beacon and the cord holding the payloads. On top of the parachute, there was an area in where the balloon was going to be connected prior to launch. When everything was set for take-off, it was moved to an empty field in where the balloon was filled with hydrogen and connected on top of the parachute. Our payload was on flight #201 which took place on Saturday November 15, in Windsor Co, at 7:00 am. The balloon ascended right away; contrary of what we expected, which was that it would take a while to ascend and gather speed. When the balloon reached approximately 98,000 feet in altitude, due to the change of atmospheric pressure the balloon when kaput. The payloads were in freefall for about 30 min, afterwards the parachute deployed, allowing a more controlled descent. It also made it more difficult for us to predict where our payload would land, because any slight change on the wind current, would take it in a different direction. After driving an hour and a half in pursue of our payload, it finally touched ground. We were able to retrieve our contents at 9:24 am, at coordinates 40.23 N and 103.85 W. The first thing we did after recovery was an initial examination to assure that our payload did not present any external damages and we secured the bag containing the air example. The SD card that contained the flight data was extracted and the files were immediately uploaded to a computer. We proceeded to check the

second SD card that contained the video files taken from the flight. To our misfortune the SD card was damaged from the impact of the landing which broke the SD in half. That event made it impossible for us to obtain the information. As expected the internal heater worked perfectly fine, without interrupting our temperature measurements.

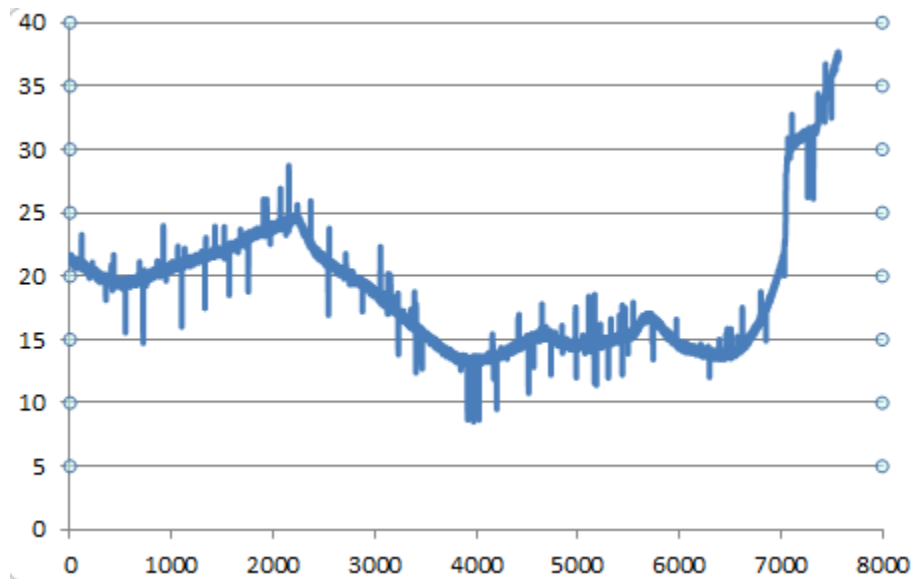
## 8. Post Flight Results, Analysis & Conclusions

### 8.1 Temperature



The temperature sensor was a must have in order to establish a baseline to which future payloads can use and manipulate different sensors. This allowed our team to develop and test successfully a payload that has the potential to be used in future experiments and this was a great achievement for ourselves and for future teams.

### 8.2 Humidity Sensor:



#### 8.4 Methane Sensor.

An error in our code caused the data from the humidity and methane sensor to be retrieved through the same command, and therefore the results for the methane sample were not obtained.

#### 9.0 Conclusion

Our platform was weighed in under 1.5 kg and performed well during the flight. The highlight was a successful air sampling. In addition, we were able to successfully track temperature and humidity. This was a success for a "rookie" team and were excited to build upon our experience for next semester's launch.