Internship Report on

ENDURANCE-X

At STAR – Space Technology and Aeronautical Rocketry

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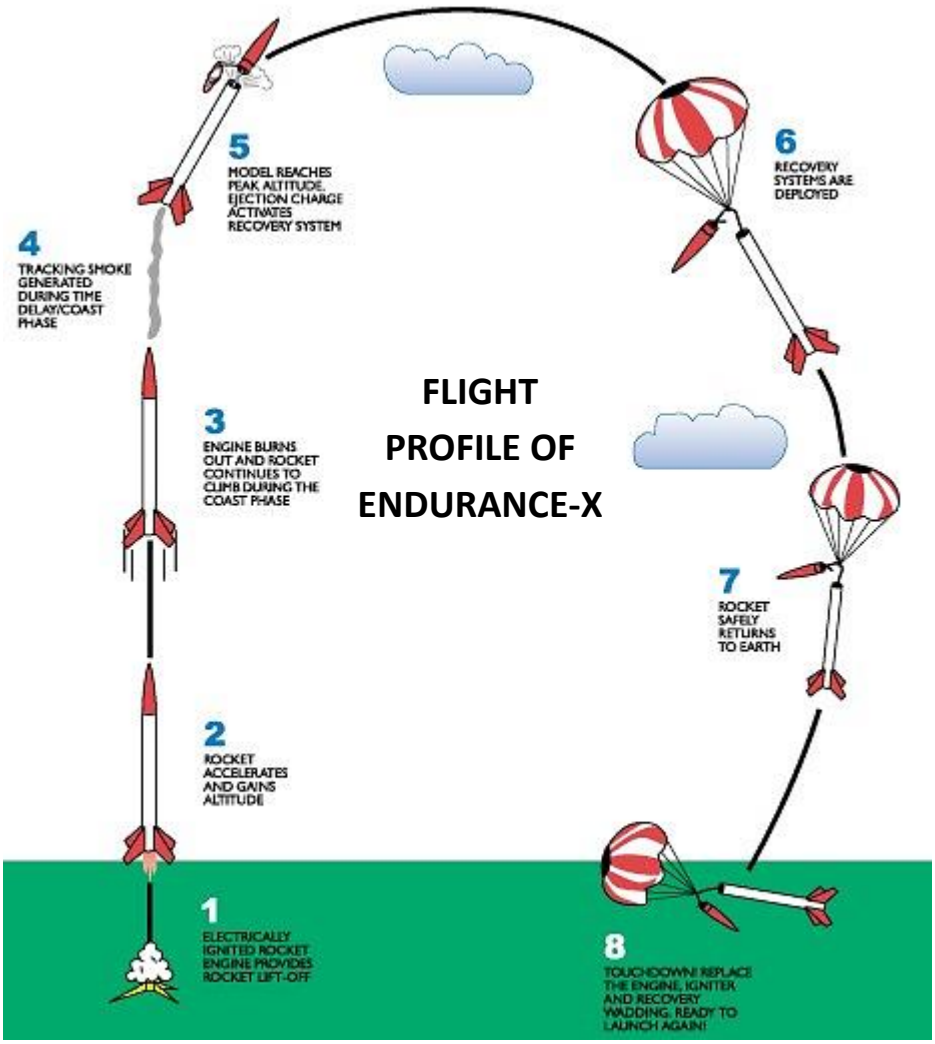
ENDURANCE-X

What is an ENDURANCE-X?

- It is a high-powered rocket with easy to setup components and built in GPS and Wi-Fi controlling feature to easy work. It is highly stable for its size and weight. The ejection system of the rocket is also the best one could see or have in a really low price.

Basic working principle of ENDURANCE-X:

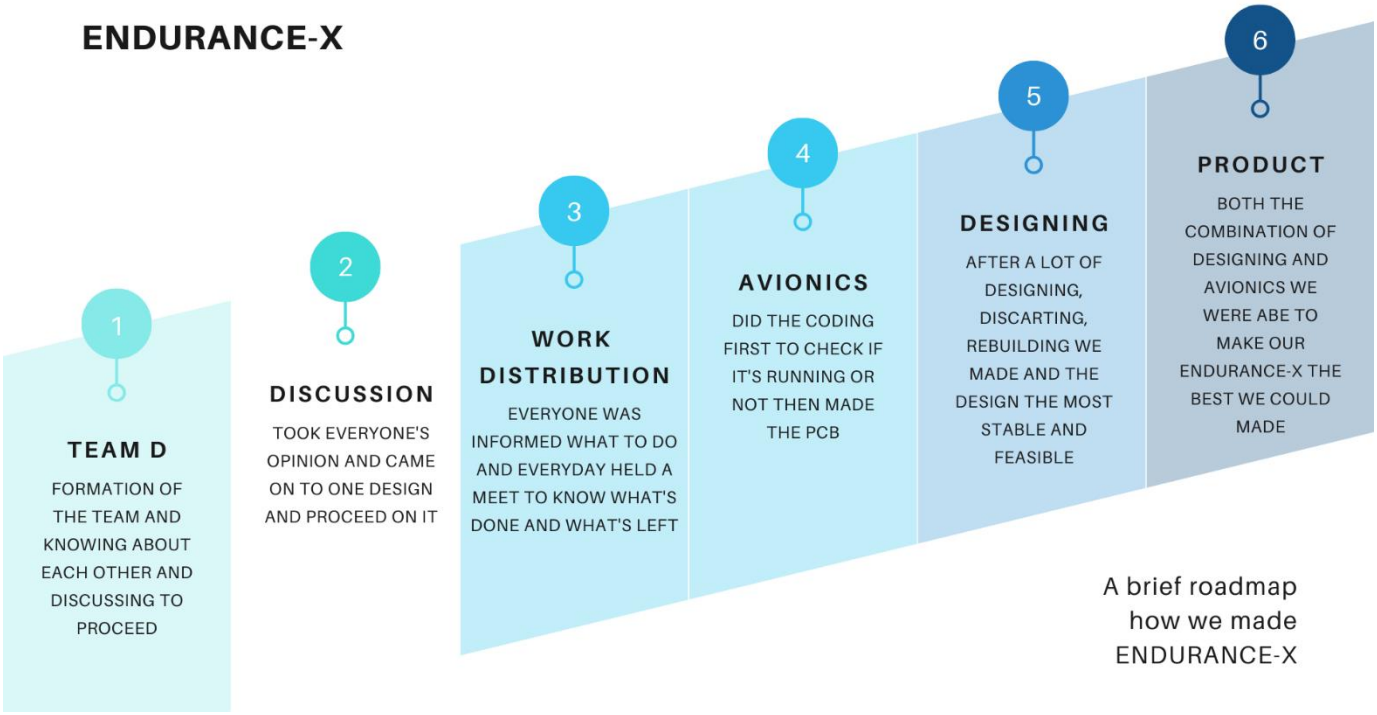
- As for the ignition of the rocket it is controlled wirelessly.
- After ignition and when apogee is achieved through its gyro sensor the rocket would automatically will release the recovery system so that the parts and components are safely landed on the ground.
- For getting the information where the rocket landed there is an in-built GPS to track it down.

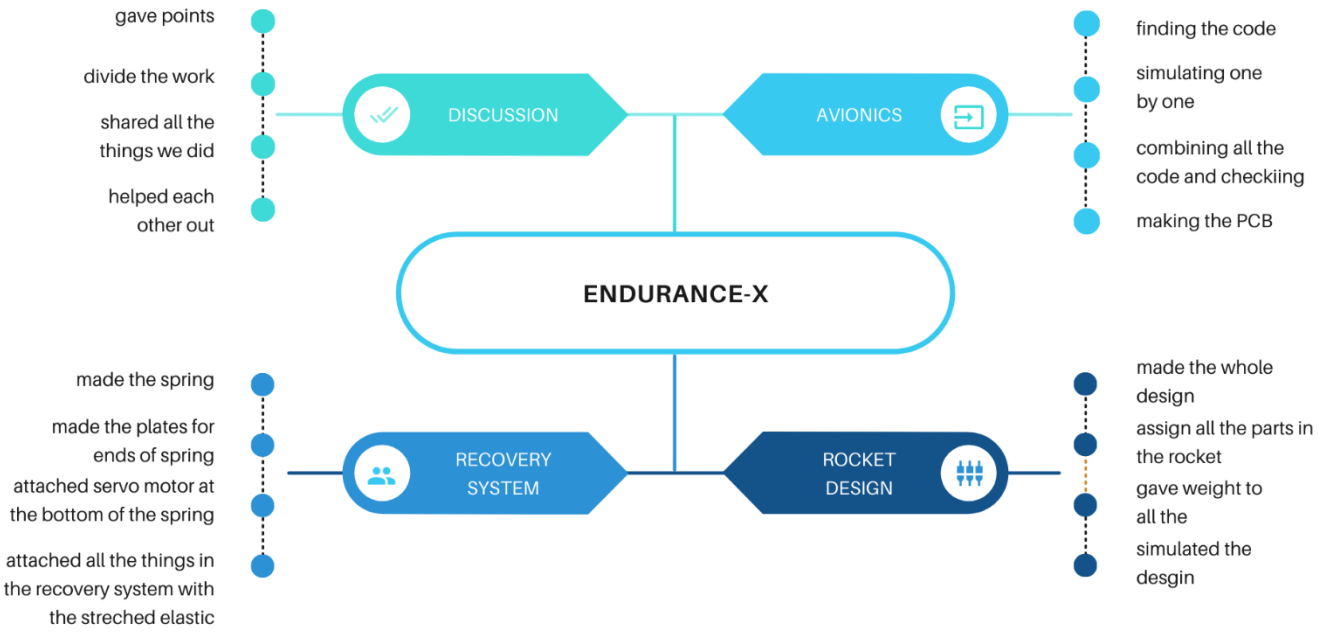


Why to make ENDURANCE-X?

We have seen many high-powered rockets but they either are stable or low priced. So, we build ENDURANCE-X so as to make a rocket which is both stable as well as low priced. The making of the rocket is very simple so as a beginner can also make the high-powered rocket.

How did we proceed?

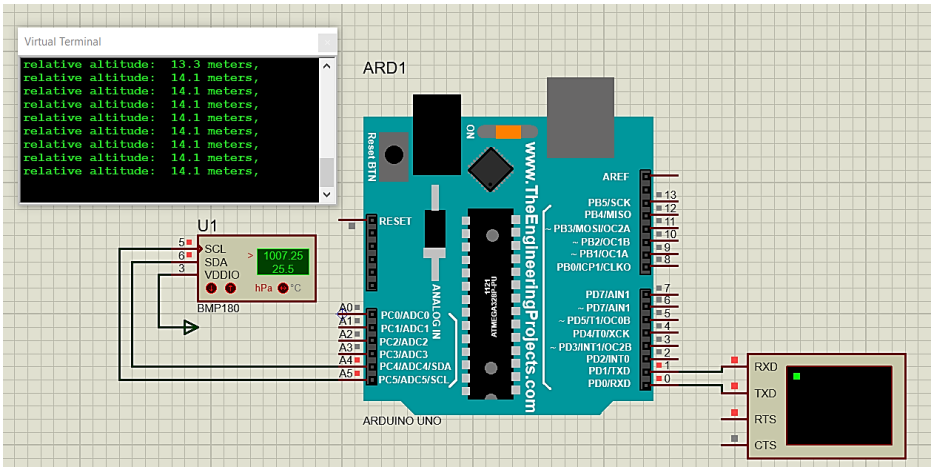




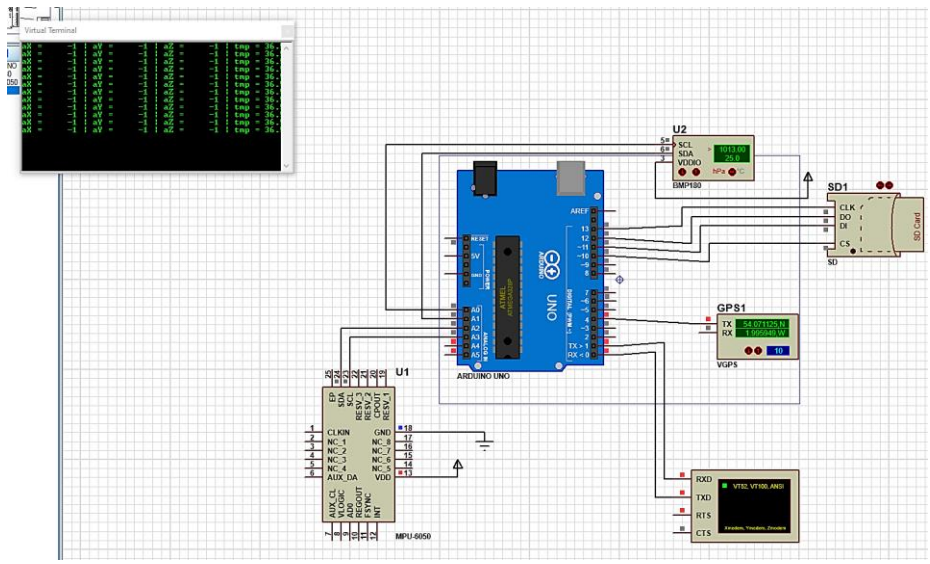
AVIONICS

Architecture:

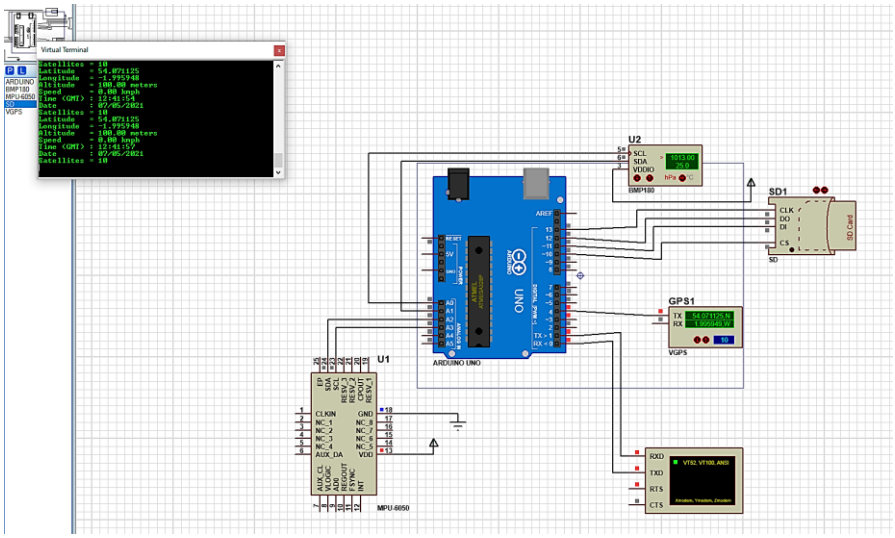
- So firstly, our approach was to find the code of individual sensor and then test it in the proteus one by one after the compilation of the code in Arduino IDE.
- After the compilation of every sensor and required component individually we combined them one by one the keep testing as we were adding the new component in the proteus.
- This is how from one by one compiling the code and running them on proteus.



BMP180 SENSOR

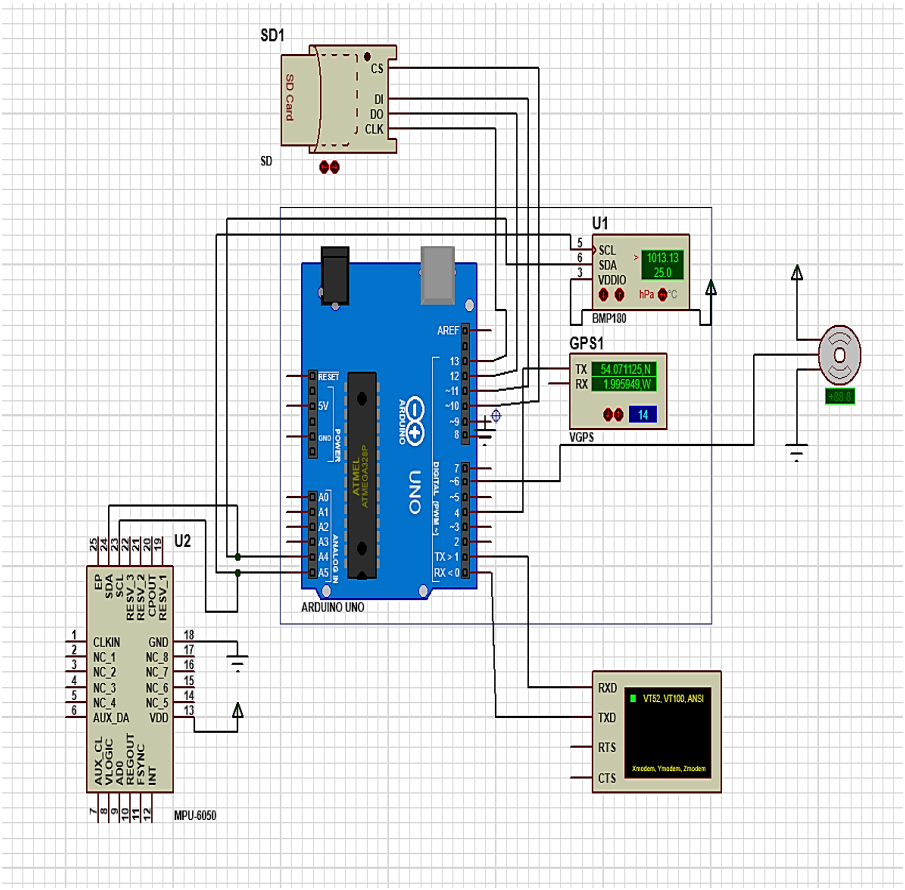


MPU6050



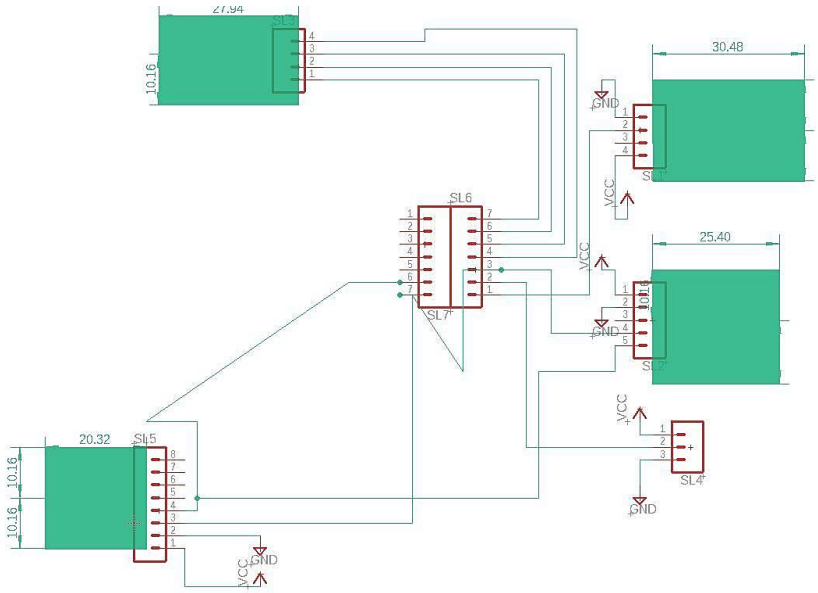
VGPS

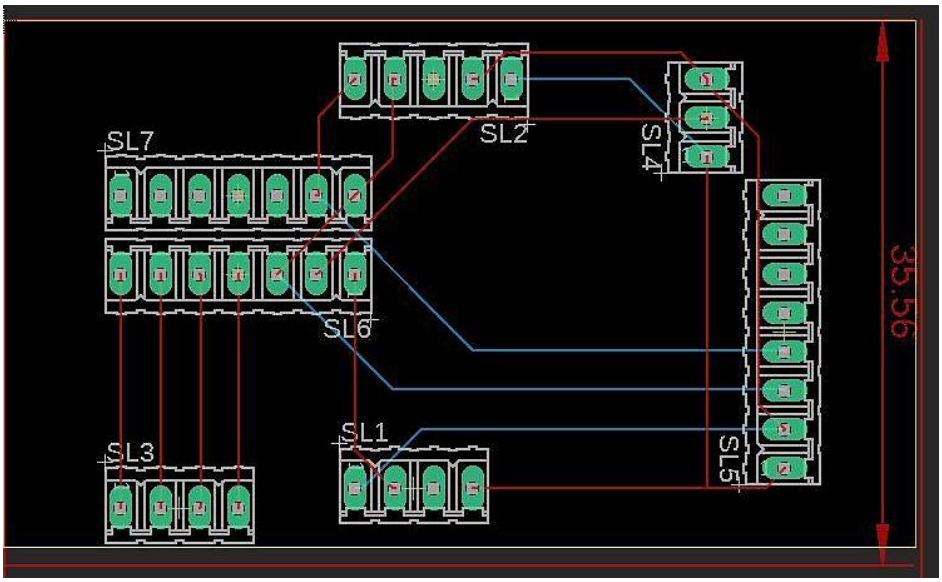
- After this we combined all the circuits in proteus and combined all the codes in Arduino IDE.

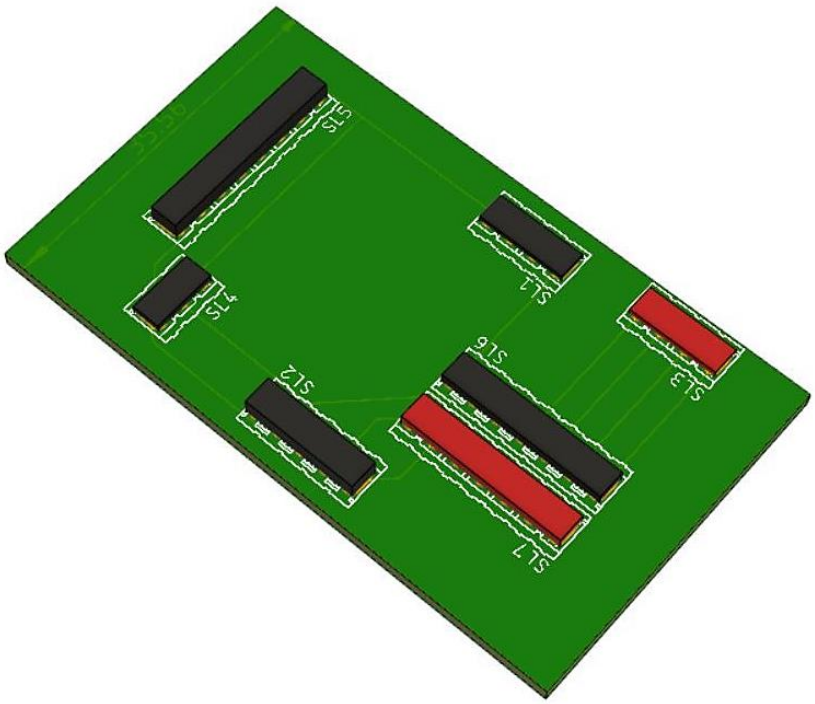


COMBINED CIRCUIT

- After whole completion of the code we then went for the designing the PCB for the avionics bay.


27.94
10.16
30.48
SL6
SL7
25.40
SL5
20.32
SL4
GND
VCC


SL7
SL2
SL4
SL6
SL1
SL3
SL5
35.56


SL5
SL4
SL1
SL2
SL6
SL3
SL7

Basic components, software required to build ENDURANCE-X:

- List of Component
    - Arduino UNO
    - Accelerometer
    - Altitude sensor
    - NRF module
    - GPS module
    - Servo motor
    - SD card
    - Battery

- List of Software
    - Autodesk Eagle EDA
    - Arduino IDE
    - Proteus

Pre-making knowledge to do the coding of ENDURANCE-X:

- Things to know about the components used in avionics bay
    - Arduino UNO – it is microcontroller board used to give all the commands to all the sensors and it is kind of the brain of the PCB which we will build
    - NRF Module – we thought of making the avionics wireless. So, this is to get all the data on our phone and we could ignite the motor wirelessly.
    - SD card – it is going to be a micro SD card to store all the data we get through the tests and through our sensors.
    - Battery – to power up the modules and controllers and to ignite the motor.
    - Gyroscopic sensor – to check the angular velocity during the test.
    - GPS Module – to track the rocket after it's landing.
    - Servo motor – to release the recovery system.
    - Accelerometer – to check the vertical acceleration of the rocket.
    - Altitude sensor – to measure the height of the rocket at which it is going till.

- As knowing the components and it's uses then it's just about the coding and connection to the right ports of one sensor to the controller/other sensor.
- While designing the PCB it's very typical to connect but we got through.
- Attaching the avionics bay below the recovery system with bulkhead as a separation between the two.

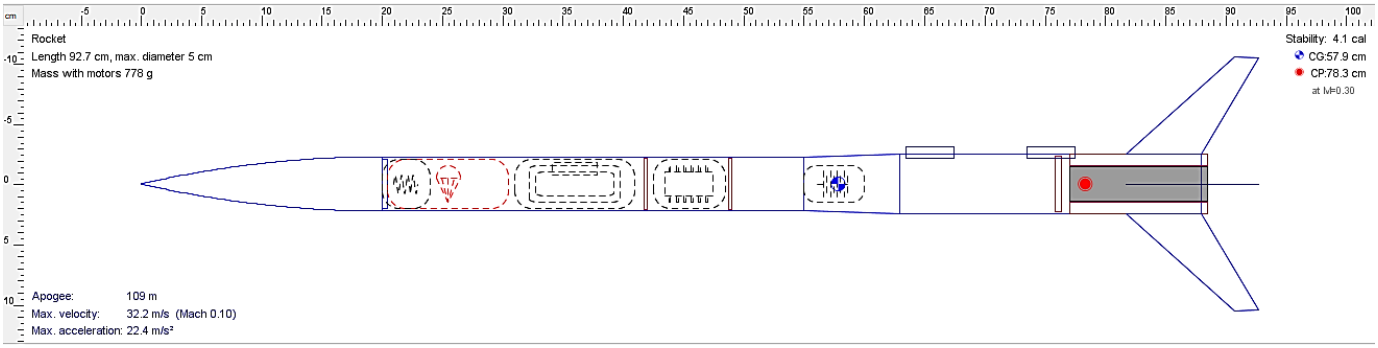
Procedure to build avionics bay of ENDURANCE-X:

- So now the procedure of making avionics and coding for ENDURANCE-X is very simple.
- Firstly, for avionics check all the codes of every components you are taking and combine them with the components itself using proteus.
- After checking of all the code combine all the codes and all the components in the proteus and then check.
- Then after the combine code is running properly make the PCB using Autodesk Eagle EDA.
- Then after the completion of making the PCB export it to Fusion 360.

DESIGNING

Architecture:

- We started with both the designing of the rocket.
- Held with some problems in the beginning we then overcame our problems and made a simple yet a most stable design of a high-powered rocket.
- Made a high-powered rocket with less than 8oo grams and less than 1 meter.



- Then we went for the designing of the recovery system which will shoot the parachute.
- First it was difficult to come up for a design and working of a recovery system.
- But then we build the recovery system with a spring and elastic system to push out nose cone.
- Then there would be a shoot for safe landing of the rocket.

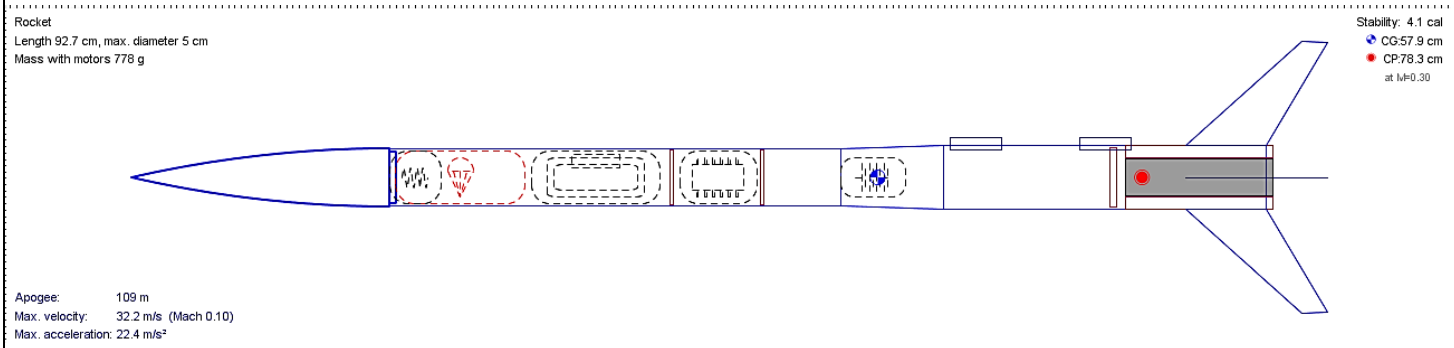
Basic components, software required to build ENDURANCE-X:

- List of Component
  - Card board
  - PLA
  - Steel
  - Nuts and bolts
  - Parachute
  - Shock cord
  - Elastic
  - F-15 motor

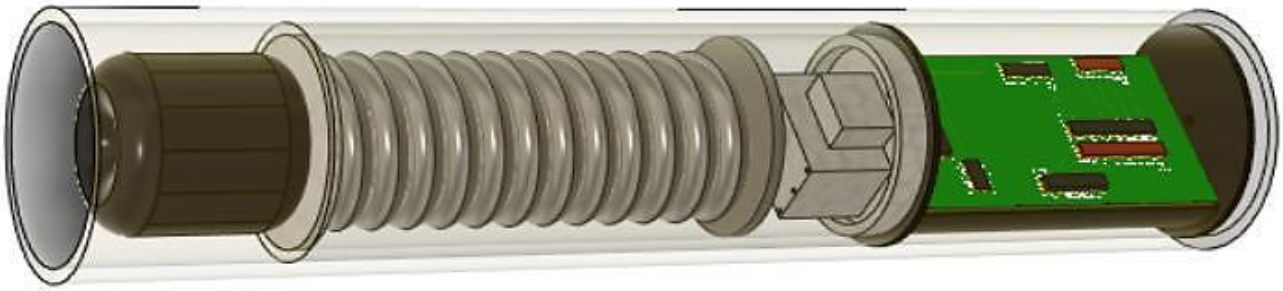
- List of Software
  - Autodesk Fusion 360
  - Open rocket
  - Paint

Pre-making knowledge to build ENDURANCE-X:

- For designing the rocket use open rocket
  - First start designing the rocket with nose cone and then go to the engine.
  - Just keep in constrain as given.
  - For minimising the ground hit velocity increase parachute diameter.
  - For increasing apogee change nose one shape.
  - For increase stability use right type of fins.
  - If CP is in front and CG at back then increase the weight in the upper side of the rocket and decrease weight in lower side.
  - It is important to choose right time of weather and right type of motor.
  - Remember to put launch lug in the design.
  - Try to keep recovery system and avionics bay as small as possible.

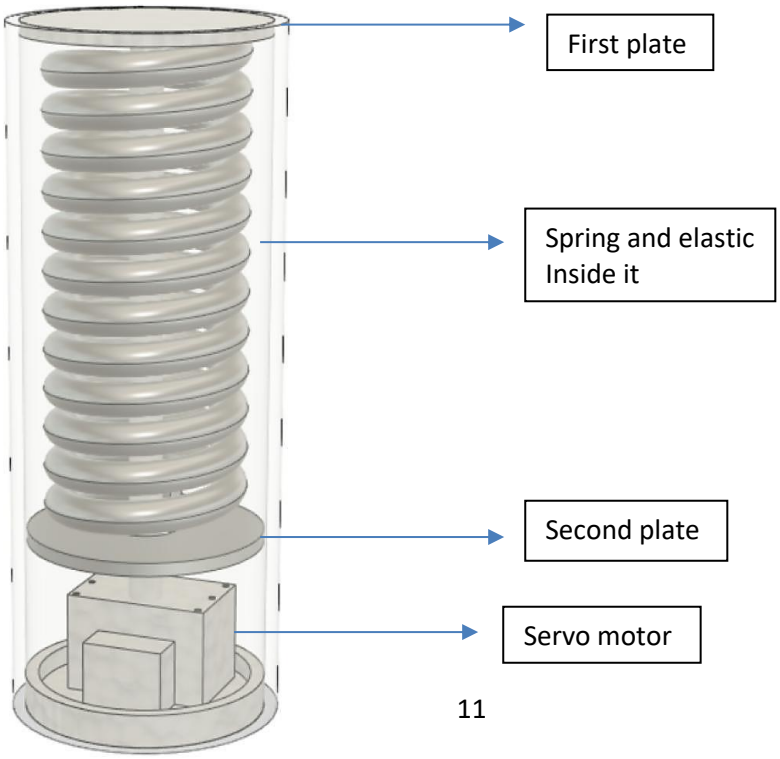


- For designing the recovery system use Fusion 360.
    - Use steel for making spring.
    - Try to keep the spring in compressed form only so to avoid future problems.
    - Keep at least 10 rounds in the spring as it has to push nose cone.
    - Keeping it in a tube and then attach both of its ends with a plate as one plate will put pressure on the nose cone's shoulder.
    - To compress put a stretched elastic band so as to the spring keeps compresses.
    - And try to keep every joint fully intact so as to minimise the failure of it.

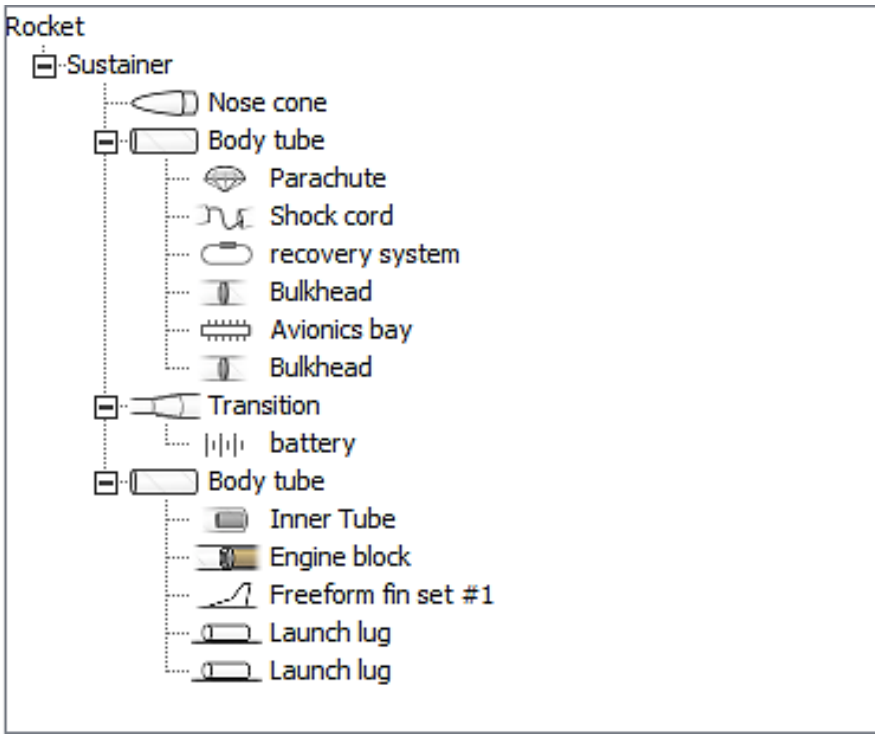


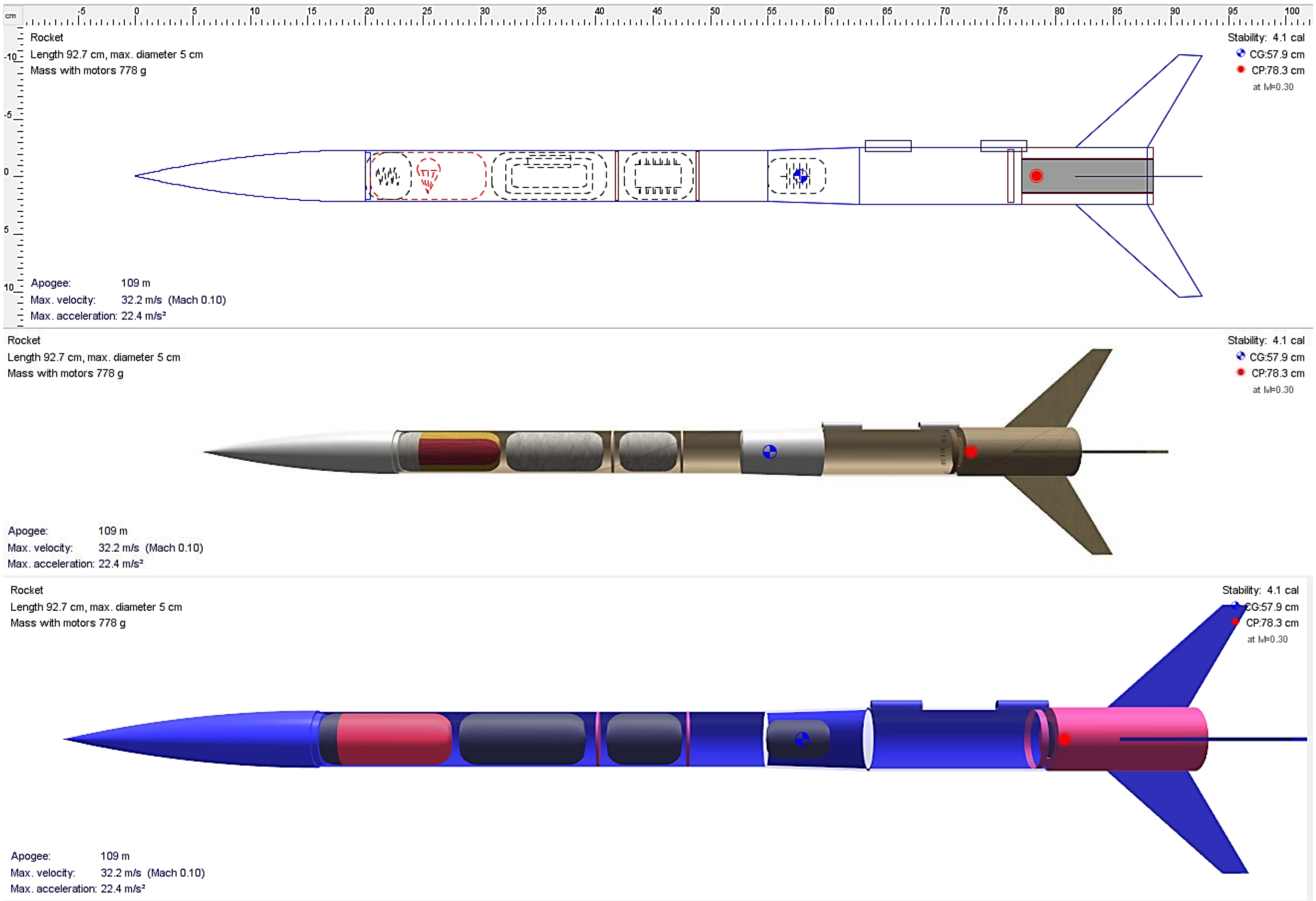
Procedure to design ENDURANCE-X:

- For the recovery system
    - First make the spring and join the to plates at both end with holes.
    - Put the servo motor at the end of the spring.
    - Put the elastic (fully stretched) between the spring and attach the first end with the upper end of the end with plate.
    - And then attach the other end of the elastic to the servo motor as it releases the elastic so as the spring can apply the force on the nose cone shoulder.



- For designing rocket
  - Design it in the open rocket as it will help in the simulations.
  - Start from the nose to the fins and engine.
  - Pre- plan the design on a paper first.
  - Then start adding the components
    - Nose cone
    - Body tube
      - Shock cord
      - Parachute
      - Bulkhead
      - Recovery system
      - Bulkhead
      - Avionics bay
    - Transition
      - Battery
    - Body tube
      - Engine block
      - Inner tube
      - Engine
      - Fines
      - Launch lugs





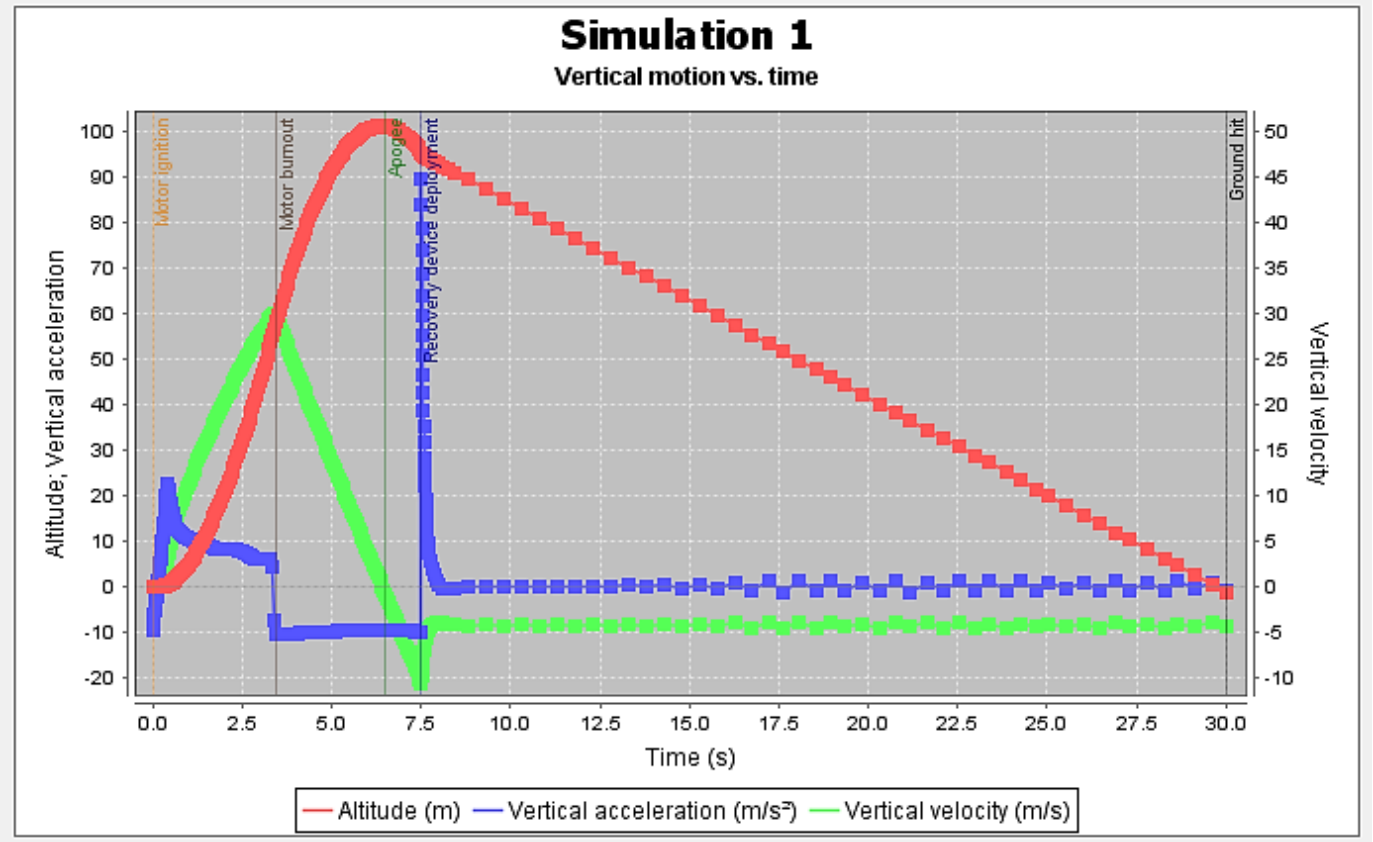
Observation:

- Increasing the weight decreases the apogee.
- Increasing weight in upper side increases the stability whereas decreases if we add weight in the lower side of the rocket.
- Shape of the nose cone plays an important role in stability and apogee.
- Fins with right shape can change the stability a lot.
- Recovery system can produce a lot of un-stability if not properly placed.

Results:

- Length of the rocket = 92.7cm
- Weight of the rocket = 778g
- Max diameter of body tube = 5cm
- Stability = 4.1
- CG = 57.9cm
- CP = 78.3cm
- Apogee = 101m (in simulation)
- Max velocity = 32.2m/s; max acceleration = 22.4m/s^2

Name	Configuration	Velocity off rod	Apogee	Velocity at depl...	Optimum delay	Max. velocity	Max. acceleration	Time to apogee	Flight time	Ground hit velocity
Simulation 1	[F15-0]	6.13 m/s	101 m	16.1 m/s	3.05 s	32.8 m/s	22.6 m/s²	6.41 s	30 s	4.01 m/s



Cost Analysis:

S.NO	NAME	QUANTITY	PRICE(INR)
1	ARDUINO UNO	1	370/-
2	NEO 6M	1	700/-
3	BMP180	1	60/-
4	SD CAR MODULE	1	150/-
5	SERVO MOTOR	1	300/-
6	GYRO/ACCELEROMETER (MPU6050)	1	220/-
7	BATTERY 12V	1	50/-
8	F-15 MOTOR	1	1800/-
9	NUTS AND BOLTS	---	58/KG
10	SHOCK CORD/ELASTIC BAND	2	900/-
11	PARACHUTE	1	1400/-

12	PLA	---	80/KG
13	CARD BORAD	---	30/KG
14	STAINLESS STEEL	---	195/KG
TOTAL COST			**6,200/-**

Conclusion:

So, I conclude that ENDURANCE-X is highly stable for its weight and the length and the components it is carrying. It is also very cheap just 6,200 rupees for a high-powered rocket with in-built Wi-Fi and GPS tracking system. The recovery system is fully reliable with it's spring and elastic mechanism the rocket landing would be really soft on the ground.

Precautions:

- While making the PCB make sure you have taken all the components.
- Check code before executing.
- Make the rocket design after creating the recovery system.
- Recovery system should be a fast yet strong and powerful mechanism.
- Always keep in mind the weight and stability of the rocket while designing it.