RV College of Engineering®

(Autonomous Institution under Visvesvaraya Technological University, Belagavi.)

Project Proposal

SOUNDING ROCKET

Submitted by:

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Executive Summary:

RV College of Engineering® (RVCE) established in 1963, is one of the earliest self-financed engineering college in the country. With 12 Bachelor and 21 Master programs along with a host of technical teams, today RVCE is recognized as one of the India's leading technical institution with NBA accreditation. It also boasts to be the top engineering college in the state of Karnataka.

Team Antariksh is a space technology student club whose goal is to understand, disseminate and apply the engineering skills for innovation in the field of aerospace technology. The hundred-member strong team belonging from various engineering backgrounds is involved in designing nanosatellite, payloads for ISRO's PS4 and self-landing rockets. The sounding rocket is a project wherein members develop a sounding rocket with a solid rocket motor which will carry an electronic based scientific payload of atleast 4 kg to an altitude of 10,000 ft. After attaining the said altitude, the rocket and payload will be safely recovered using dual-deployment parachute. This project is aimed at winning the Spaceport America Cup 2020 (Las Cruces, New Mexico, USA), the worlds' largest inter collegiate rocket conference and competition. This competition hosts teams from American and International Colleges and Universities. The technologies developed for the sounding rocket will be extended to realize a self-landing rocket and develop a community of rocketeers in India.

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1. Vision & Mission

1.1. Vision Statement:

- To inspire young minds to take up challenging tasks in aerospace technology through interdisciplinary research and development.

1.2. Mission Statement:

- To design, develop and test a rocket for Spaceport America Cup, New Mexico, USA
- To design, develop and test a self-landing rocket.
- To develop a microbiological payload for ISROs PS4 initiative.
- To increase the participation of the students of RV College of Engineering® in Space Research and Technological development in India.

2. Mission Timeline

SA CUP 2020
Design a COTS based Solid Motor Rocket for **10,000ft.** AGL with dual-deployment recovery

SA CUP 2021
Design a self-researched Liquid Propellant based Rocket Motor for **30,000 ft.** AGL

SA CUP 2022
Design a Hybrid Propellant based Rocket Motor with **Self-landing** mechanism for recovery

3. Deliverables

- **Technical expertise for students**
  Developing the capabilities of team members through training, knowledge tools and knowledge resources.
- **Assets**
  Development of valuable assets such as results of payload experiment, self-landing mechanism, sub-systems for sounding rocket, research papers and infrastructure.
- **Recognition**
  Our partners and RV College of Engineering® will get recognition in the International aerospace community for partnering with a student team for building and launching Self-Landing Rockets.
- **Inspiration**
  The success of team inspires other colleges and space enthusiast students to take up similar projects in future and develop a community of student rocketeers in India.

4. Benefits for Sponsors

- **Publicity**
  Publicity through logos and banners alongside team accessories and apparels. Promotion during all public appearances i.e. outreach events, media etc.
- **Recognition**
  Company logo on all Rockets flown by the team and posts on social media and team website.
- **Acknowledgement**
  Acknowledgement and mentions in our International and national research papers and poster presentations.
- **Tax Benefits**
  The funds will be received in the name of RSST, a non-profit organization and tax incentives for sharing CSR funds.
- **Placement**
  Conducting placement activities in RV College of Engineering® and also granting access to students for internship.
- **Reputation and Compliance**
  Sponsors will gain the opportunity of partnering with a unique team which fabricates a rocket having Self Landing capability and works on a novel idea of microbiological payload.
- **Workshops**
  Conducting workshops in association with Team Antariksh and setting Industry based innovative labs in association with the department of Aerospace Engineering.
- **Availability for team presentation**
  Availability of our team members for giving presentation during any business or outreach program of the company.
- **Campus ambassador**
  Partners can have student representatives from college who can work as campus ambassador to promote brand awareness.
- **Access to Capable Maturity Model of the team**
  Partners will have access to the Organizational Process Assets and regular project status updates of Team's first Sounding Rocket and biological payload.

5. Achievements

Since its launch by **Prof. Udupi Ramachandra Rao** (Former Chairman, ISRO) in September 2015, Team Antariksh has come a long way.

- **25** International Publications
  - 3 at 69th International Astronautical Congress, 2018, Bremen, Germany
  - 10 at 70th International Astronautical Congress, 2019, Washington DC, USA
  - 2 at AIDAA, 2019 International Congress, Rome, Italy
  - 1 at IEEE Aerospace, 2019, Washington DC, USA
  - 3 at 2nd ICMAE, 2018, Indore, India
  - 1 at 4th IEEE-I2CT 2018, Mangalore, India
  - 3 at IJNSTE, 2018, India
  - 1 at IEEE Aerospace, 2020, Big Sky Montana, USA

    - 1 at International Conference on Small Satellites, Hyderabad
- **1** International Poster
    - 1 at ICSS, Hyderabad

- **1** International Competition
    - Winners in International Conference on Small Satellites, Hyderabad
- **3** National Competitions
    - "Runners up" & "Best project" by employees at QuEST Ingenium 2018
    - Winners in "Space Missions" at Founders Day – Indian Institute of Astrophysics
    - All 6 prizes at Space Week, URSC – ISRO
- **4** National publications
    - 2 at Satellite Technology Day 2018, URSC-ISRO, Bengaluru, India
    - 2 at Alchemist 2018, Belagavi.

6. Success Criteria

The success criteria are defined as per the mission phases set by the Spaceport America Cup 2020 and will be considered 100% successful if the rocket is successfully recovered and passes the test criterion set by IREC Officials.

Criteria	Percentage
Prototype Testing	40
Flight Model Ready	60
Successful Lift-off	70
Reaching 10,000 ft. altitude	80
Payload Experiment Successful	90
Successful Recovery	100

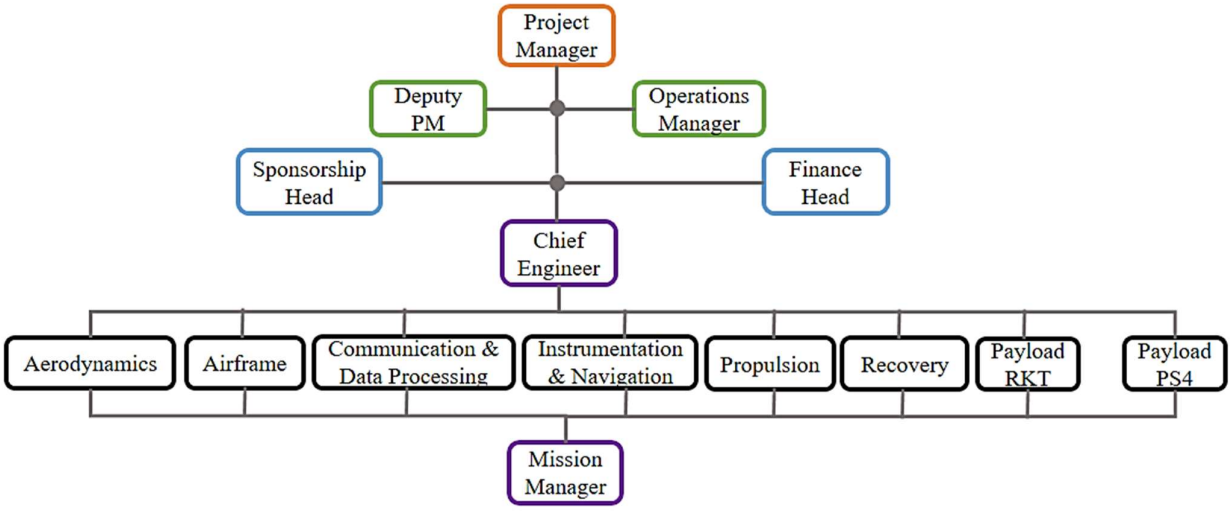
7. Milestones

PHASE I	• START • Rocket payload finalization • Deciding components and materials. • Finalization of mechanisms involved (including basic recovery mechanism) • Model Rocket Launch • Detailed design review meeting	**JUNE 2019 TO SEPTEMBER 2019**
PHASE II	• Entry Application • Failure mode and effect analysis (FMEA). • INAV & CDAP integration, Aerodynamic and structural testing of assembly • Reiterating and finalizing rocket specifications with all Subsystems functional (Partial Payload, Recovery) • Commence Prototyping of sub-components. • Acceptance Announcement	**OCTOBER 2019 TO DECEMBER 2019**
PHASE III	• Submit 1st Progress Update • Reiterating and finalizing rocket specifications with all subsystems functional (Payload, Recovery) • Commence Manufacturing. • Testing on Subsystem level • Integration and testing at system level	**JANUARY 2020 TO FEBRUARY 2020**
PHASE IV	• Final testing • Pre-Shipment Review • Mission Readiness Review • Assembly at launch site • Gather post launch data • Mission Success/failure: 1. Anomaly investigation 2. Mission close out report	**MARCH 2020 TO JUNE 2020**

8. Budget

S N	Subsystem	Budget (INR)
1	Aerodynamics & Airframe	2,50,000.00
2	CDAP	90,000.00
3	INAV	80,000.00
4	Propulsion	1,00,000.00
5	Recovery	80,000.00
6	Payload	1,00,000.00
7	SA Rocket fee + Entry Deposit	80,000.00
8	SA Cup Member Fee	90,000.00
9	Manufacturing Cost	1,00,000.00
10	Shipment Cost	1,20,000.00
11	Misc.	50,000.00
Total		**11,50,000.00**

9. Team Structure



The team has been divided into various subsystems and is managed by effective communication among subsystems. Therefore, it is necessary to define the roles and responsibilities of every position held by an individual in the team.

9.1. Project Manager

The Project Manager provides the direction and guidance for the team and is the central driving force of this project. He/she acts as the bridge between the team and organizations, and delivers the project on time, within the scope and budget. He/she foresees the impact of the results of the project on the project stakeholders. He/she understands the business context and the issues associated with the application of technology.

9.2. Operations Engineer

The Operations engineer works in a wide variety of settings and roles, optimizing the overall efficiency of the project. He/she ensures that progress of an individual is consistent and as per the team's expectations. He/she coordinates with all subsystem heads to fine-tune their operations.

9.3. Chief Engineer

The Chief Engineer is responsible for the supervising the technical developments of the project. He/she coordinates with project management to ensure project completion in an efficient manner. He/she oversees each phase of the project so that the team meets Spaceport America Cup specifications and complies with federal and state regulations.

9.4. Mission Manager

The Mission Manager focuses on System Integration and System level overview of all other subsystems. He/she plans the mission and ascertains that all subsystems fit together at the time of assembly-integration of the Rocket. He/she is able to visualize the bigger picture to ensure a successful project.

10. Subsystems

10.1. Payload Subsystem:

The payload unit works on designing a payload for the Rocket based on the requirements. It will weigh atleast 4 kg and will feature an Electronic based scientific experiment. Currently the unit is researching and will announce the scientific payload soon.

10.2. Airframe Subsystem:

The function of the Airframe subsystem is to design, analyse and optimize the structure of the rocket considering various launch parameters. The designed structure should be feasible and reliable with respect to the mission. The structure should withstand all the launch and aerodynamic loads. A fail safe structure is designed and optimized after conducting various tests. Airframe includes design of Nose Cone, Body Tube, Payload Tube, Engine Mount Tube, Launch Lug Tube, Tail Cones, Avionics bay. Other parts are selected based on the mission requirement.

10.3. Aerodynamics Subsystem:

Aerodynamics subsystem analyses flow of air around the rocket structure and calculates the aerodynamic forces and its effects on stability. The subsystem aims in aerodynamic design such that drag is minimal. The amount of drag depends on the cross sectional area of rocket, velocity and the shape. The best way for reducing drag is by varying the shape of rocket. Fins are used in rockets to provide stability and to control direction. Also, Aerodynamic heating is the most common concern for high speed vehicles and re-entry vehicles like rockets. To avoid this issue Heat shield must be used to protect the rocket from any kind of damage.

10.4. Propulsion Subsystem:

Propulsion subsystem ensures the required amount of thrust necessary to propel the rocket in a particular direction is provided. This thrust is generated by oxidizing certain amount of fuel which may be in solid or liquid state and ejecting the oxidized product at high velocity through a nozzle. Solid rocket propulsion system is selected for the first competition in

accordance with IREC under the Category of 10,000 ft. AGL (Above Ground Level) with COTS (Commercial off-the-shelf) based Motor. Parameters like grain size and grain cross-section affect the thrust generated by the solid rocket motor.

10.5. Communication and Data Processing (CDAP):

The subsystem mainly comprises of the communication system and the on-board data processing system. This is used for establishing a communication link between the on-board systems and the ground-station equipment to send/receive data. Various sensors like thermistor, fuel gauge, current and voltage sensors, flash memory, accelerometer and altimeter are used to monitor the real time data. A communication link is established to transmit the Video link of the on-board systems to the ground station to get the real-time view of the rocket.

10.6. Instrumentation and Navigation (INAV):

. Instrumentation and Navigation subsystem performs the navigation and guidance of the rocket, manages the power distribution within the rocket and provides an interface between the sensors employed and the other subsystems. Navigation and guidance are required to keep the rocket on the required trajectory. Batteries are used for power storage and a centralized architecture is used to distribute the power to all the subsystems.

10.7. Recovery Subsystem:

The Recovery subsystem focuses on retrieving the rocket body and the payload safely from the apogee height. Parachutes will be used as the method of recovery. The recovery of the rocket allows the rocket to be reusable, which is a very important factor to reduce the material and time usage and improve cost effectiveness of a rocket. The recovery is done using two parachutes, a drogue parachute and a main parachute. The drogue parachute is deployed after the apogee is reached, and the main parachute is deployed once the required height and velocity parameter is reached. This is done by using electronic sensors and timer devices like altimeter, air speed sensor etc.