Sri Venkateswara College of Engineering

(An Autonomous Institution)

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SOCIETY OF MECHANICAL ENGINEERS (SME)

TECHNICAL REPORT ON ALUMNI INTERACTION

AY 2024 – 2025

Start-Up Activities in Space Research

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Venue: QMC Hall

Time: 10:00 AM to 11:30 AM

Prof. Dr. Prathap C, a prominent figure from the Indian Institute of Space Technology, Thiruvananthapuram, Kerala, delivered a talk to interact with students. He threw insights for a better understanding of how Start-Up can have a breakthrough in Space Technology.

1. INNOVATIONS IN SPACE TECHNOLOGY

1.1 Low-Cost Aviation Programs

The development of low-cost aviation initiatives is critical for expanding access to space. A significant model is SpaceX, which has successfully pioneered the reusable launch vehicle concept. This approach drastically reduces costs associated with launching and reusing vehicles, making space exploration more financially viable.

1.2 3D Printing (Additive Manufacturing)

3D printing is revolutionizing the manufacturing of rocket components. This technology offers multiple advantages, including:

A. Cost Reduction: Minimizing material waste and production costs.
B. Speed: Shortening the time from design to production.
C. Complex Design Capability: Enabling the creation of intricate components that traditional methods cannot achieve, enhances overall efficiency in rocket design.

1.3 Materials Innovations

The search for alternative materials to replace expensive titanium is ongoing. Key areas of exploration include:

A. Heat-Resistant Alloys: Essential for maintaining structural integrity under extreme conditions.
B. Carbon Composites: Lightweight yet strong, these materials offer promising alternatives for various components.

2. ROCKET PROPULSION FUNDAMENTALS

2.1 Thrust Generation

Understanding the mechanics of thrust generation is crucial for rocket propulsion. The process involves:

A. Chemical to Thermal Energy Conversion: Fuel combustion transforms chemical energy into heat.
B. Kinetic Energy Conversion: This thermal energy is then converted into kinetic energy through the expansion of gases, which produces thrust.

2.2 Combustion and Efficiency

The efficiency of rocket engines heavily relies on the types of fuel used:

A. Cryogenic Fuels: Hydrogen, stored at temperatures between 60K to 80K, is favored for its high energy density.
B. Solid Fuels: These fuels are critical for initial ignition and provide a reliable source of thrust.

2.3 Operating Conditions

Rocket engines operate under extreme conditions:

A. Temperature: Typically around 3000K during combustion, requiring materials that can withstand such heat.
B. Pressure: Operating pressures range from 250 to 300 bar, necessitating robust engineering solutions.

3. START-UP ECOSYSTEM AND CHALLENGES

3.1 Understanding Market Needs

For start-ups in the space sector, recognizing and addressing market demands is vital. Key challenges include:

A. Financial Barriers: High costs associated with research, development, and operational aspects.
B. Innovation Requirement: Start-ups must continuously innovate to stay competitive and relevant.

3.2 Data Management

Efficient data management is essential for mission success. This includes:

A. Collection and Storage: Handling vast amounts of data from satellite missions effectively.
B. Transmission: Ensuring reliable communication between spacecraft and ground stations.

3.3 Regulatory and Educational Framework

Institutions like the Indian Institute of Space Science and Technology (IIST) play a crucial role by:

A. Providing Structured Pathways: Offering programs that prepare students for careers in the space sector.
B. Setting Admission Standards: Rigorous criteria ensure that only the most qualified candidates enter the field.

4. APPLICATIONS AND OPPORTUNITIES

4.1 Payload Management

Understanding the payload capacity of launch vehicles is essential. Effective management of payloads can significantly impact mission outcomes, including cost efficiency and mission success rates.

4.2 Indigenous Product Development

The focus on developing indigenous solutions for electronics and propulsion systems reduces dependency on imports. This fosters innovation and boosts the local economy.

4.3 Solar Satellites

The concept of solar satellites presents a transformative opportunity for energy generation. Key benefits include:

A. Continuous Energy Supply: Harnessing solar energy in space, free from atmospheric interference.
B. Challenges: High initial costs and efficient energy transmission need to be addressed.

5. TECHNOLOGICAL ADVANCEMENTS

5.1 Shape Memory Alloys (SMAs)

SMAs are increasingly used in deployable structures, providing Reliability. They return to their original shape when exposed to specific temperatures, enhancing deployment mechanisms in space.

5.2 Injectors

Fuel injectors are crucial for rocket performance, ensuring Optimal Combustion by precisely mixing fuel and oxidizer, injectors enable controlled combustion, maximizing thrust efficiency.

6. EDUCATIONAL AND PROFESSIONAL PATHWAYS

6.1 Admission to IIST

The IIST provides structured educational programs:

A. Undergraduate and Graduate Options: B.Tech, M.Tech, and PhD programs are available, often requiring entrance exams like JEE Advanced.

B. Career Opportunities: Graduates have the flexibility to either work with ISRO or explore entrepreneurial ventures in the growing space sector.

CONCLUSION

The integration of innovative technologies, effective resource management, and strong educational frameworks is essential for advancing the space industry. By addressing existing challenges and leveraging new ideas, the future of space exploration can become more accessible, efficient, and sustainable, paving the way for significant advancements in both technology and knowledge.