

# UNISEC's Activity for Micro and Nano-Satellites Mission Assurance

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1. Background
  1. Introduction of UNISEC
  2. UNISEC Space Engineering Education Activities
2. Lessons & Learned for Mission Success of Microsatellites
3. Taskforce for Mission Assurance Handbook Publication
4. Enhancement of Relationship with JAXA's Activity
  1. Preparation for Mission Assurance Structure Construction
  2. Practical Space Development Activities
5. Summary

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# Background: Introduction of UNISEC

## What's UNISEC ?



- UNISEC: University Space Engineering Consortium
- A non-profitable organization (NPO) to **support practical space development activities** in universities and colleges, such as small satellite and hybrid rockets. (Since 2002 @ Japan)
- **Three main subjects**
  - Human Resource Development
  - Technological Development
  - Outreach



# Background: Introduction of UNISEC

## UNISEC-Japan



- **UNISEC-Japan** members maintain cooperative relationships in conducting practical space development and utilization
  - Consist of
    - **36 Universities/Research Institutions, 49 organizations**
    - Over 600 student + 200 individual + 19 cooperate members + alumni members (based on Apr. 13, 2021)
- **Vision**

Enhance our world for all humankind through the creation of thriving networks, engaging programs, accessible assets, and fundamental capabilities such that **anyone around the globe can utilize space science and technology**
- **Mission**

Create an environment that will promote the **free exchange of ideas, information, and capabilities** relating to space engineering and its applications, especially for young people, including those in developing countries and emerging economies

# Background: Introduction of UNISEC

## UNISEC-Global



- **UNISEC-Global** : established in 2013
  - An international nonprofit, non-governmental organization, consisting of local-chapters across the world
  - **21 Local Chapters with 55 POC**
  - Create a world where space science and technology is used by individuals and institutions in every country and offers opportunities across the whole structure of society for peaceful purposes and for the benefit of humankind
- **UNCOPUOS permanent observer 2017~**  
(The United Nations committee on the Peaceful Uses of Outer Space)
- **Vision 2030-All**  
"By the end of 2030, let's create a world where university students can participate in practical space projects in all countries."



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# Background: UNISEC Space Engineering Education Activities



## Practical Implementation

- CanSat Working Group
- Rocket Working Group
- **Satellite Working Group**
  - Safety Assurance Support
  - Frequency Allocation Support

## Hands-on Training

- CanSat
- CLTP: CANSAT Leader Training Program
  - Lecture series for professors/instructors
- ARLISS: A Rocket Launch for International Student Satellites
- HEPTA-Sat Training
  - Lecture series with classroom CubeSat
  - 9 host countries, 53 participating countries, 400+ trainees
- Hybrid Rocket

Satellites Born From UNISEC Activities



## Academic Research Advancement

- UNISEC Academy
  - Space Engineering Lecture Series
- UNISEC Space Takumi Conference
- Journal
- **Micro and Nano-satellite Lessons Learned Research Group**
- Publications
- Contest
- Diverse Event



# Background: UNISEC Space Engineering Education Activities



## Changes in purposes of small spacecraft

**Primary education, Demonstration**



**Practical implementation, Innovative space development**  
Rapid space development, utilization, and exploration

Space exploration  
beyond the Earth orbit

NewSpace Companies  
from UNISEC Community

Best engineering missions provides  
best educations to young engineers

**Mission Assurance  
for small space systems  
is critical challenge**

### **UNISEC-Japan's Engineering Road Map**

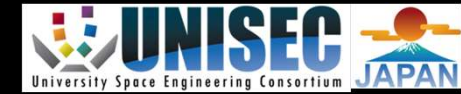
1. Setting new frontier development goals and further promoting the practical development, utilization, and exploration of space. This includes Moon, planet, and deep space exploration.
2. Enhancing cooperation between space engineering R&D groups in different research fields, such as satellite system, rocket motors, electric propulsions, planetary rovers, space architectures, etc.
3. Assuring the **safety mission assurance technology level** of space systems. Improve the success rate of academic space missions. Enhance NewSpace businesses.

## How to ensure Mission Assurance for small space systems ?

1. Understanding the status
    1. Lessons & learned research group activity (FY 2020)
  2. Analyzing the status
    1. Primary analysis of the shared info. (FY 2020)
    2. Additional information gathering (on going -)
    3. Detailed analysis (on going -)
  3. Taking measures
    1. Discussing the methods to improve the status (on going -)
    2. Summarizing the recommendation (on going -)
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# Lessons & Learned for Mission Success of Microsatellites



## Micro and nano-satellite Lessons Learned research group's activity

Over 20 univ. & research institute

Weekly online-mtg sharing the lessons learned, seminar bases

@2020



Spacecraft development, Ground verification, On-orbit operation, Safety design, Review process, Project management... etc

## Survey on the lessons learned of mission assurance (contract from JAXA)

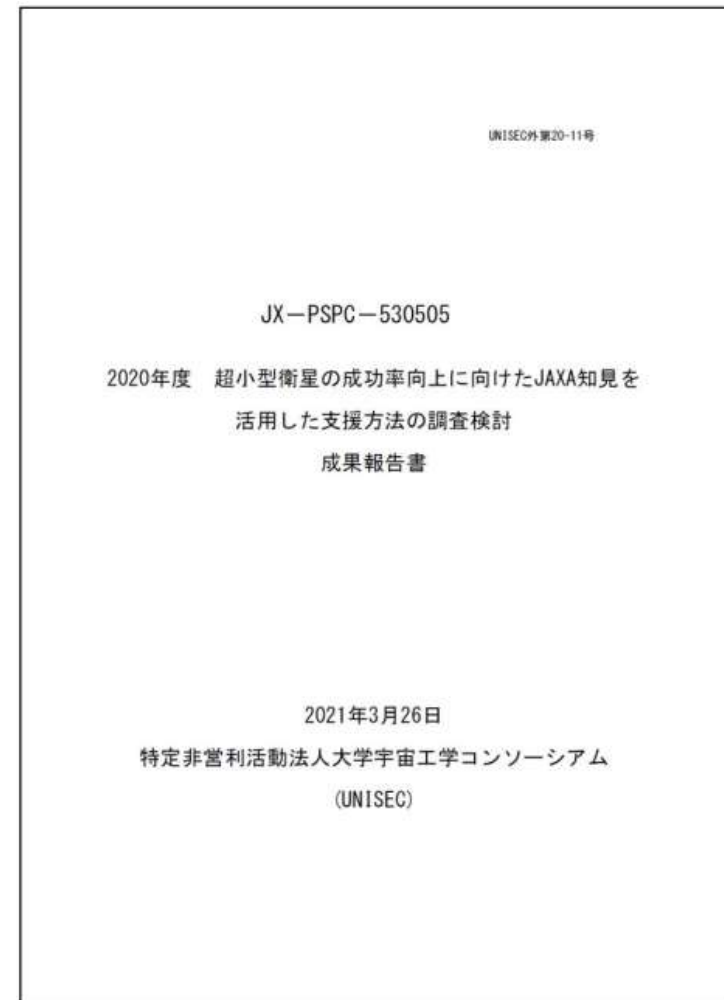
Distill the best practices to ensure the mission success

- 15 researchers of 10 institutions
  - 32 satellites, 36 projects, **208 individual success and failure cases**
- 439 pages report (in Japanese) → submitted to JAXA on March 26th, 2021

# Lessons & Learned for Mission Success of Microsatellites



- **Success and failure cases analysis** of domestic satellite projects and their causes
  - Success and failure cases
    - Analyses and classification
- **Penetration level of the JAXA common technical documents** to our community
- Small spacecraft system's **management method**
- **Cost for the improvement of system reliability for mission success**
- Lessons learned through successes and failures of projects
- Extraction of requirements for mission assurance of micro and nanosatellite



# Lessons & Learned for Mission Success of Microsatellites



## Summary

- Recommendation remarks about the best practices for the safety and mission assurance of micro and nano-satellite in the following four categories

### **Project Management**

Series of satellite projects as a program, project team building, early and proper initiation of frequency allocation process, keeping motivation of student members, evaluation of capabilities of the team and adequate mission planning, recognition of the limit of the capability of the team, effective communication, risk management, documentation, etc.

### **Satellite System Design**

Making the satellite die-hard, reflection of the experience of operation to the design, consistency of mission requirement and system design, risk of normalcy bias, etc

### **Verification Test**

Importance of long term end-to-end system test on ground, RF communication test, end-to-end mission component verification, deployment test, Test-as-you-fly, proper preparation of ground test, correct evaluation of test results, etc

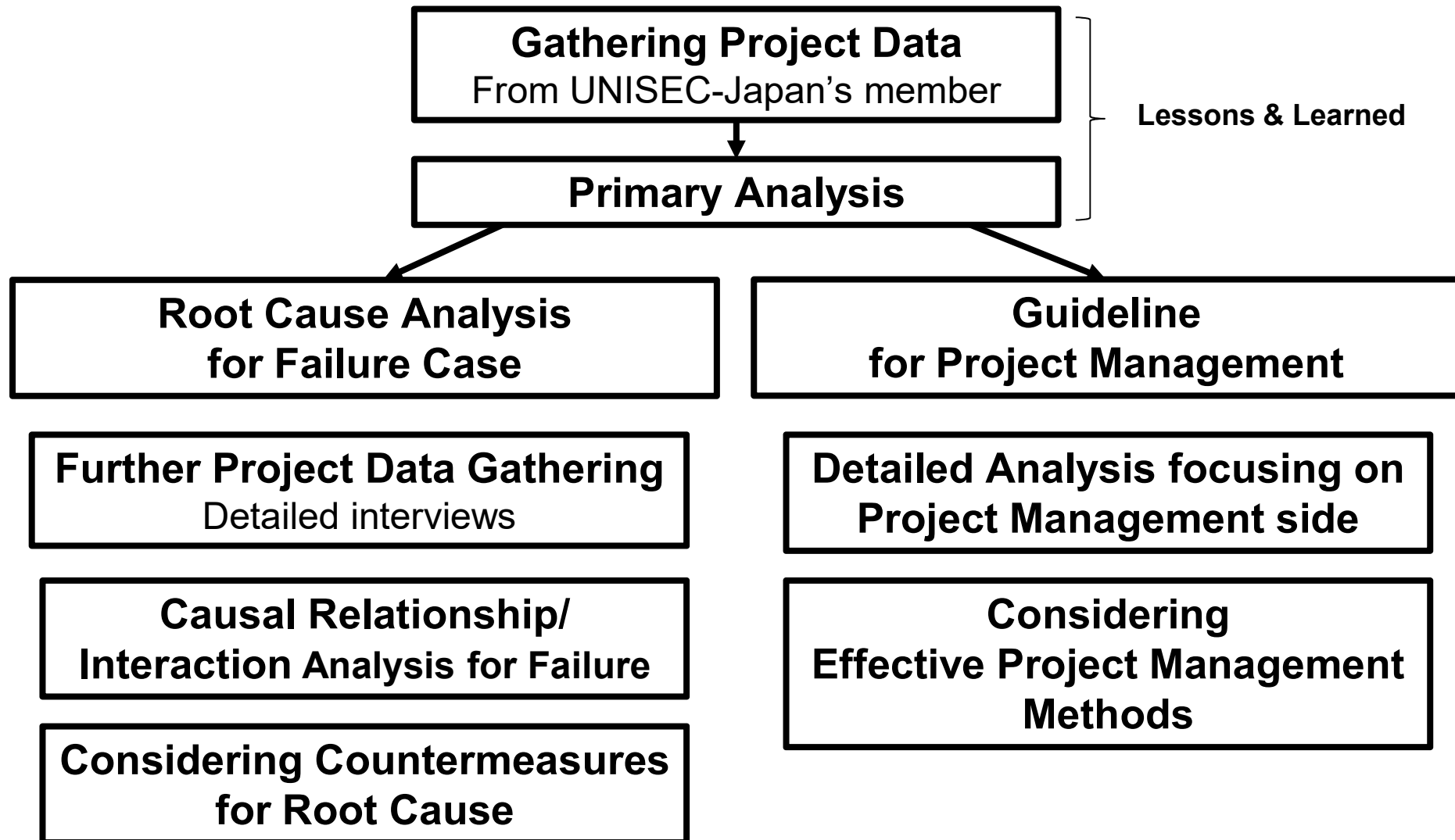
### **Future Tasks**

Sharing of data, know-how, software with community, independency of personal skills of limited members, **relationship between JAXA and micro and nano-satellite community**, project management, sustainable microsatellite program, **root cause identification of mission failure**

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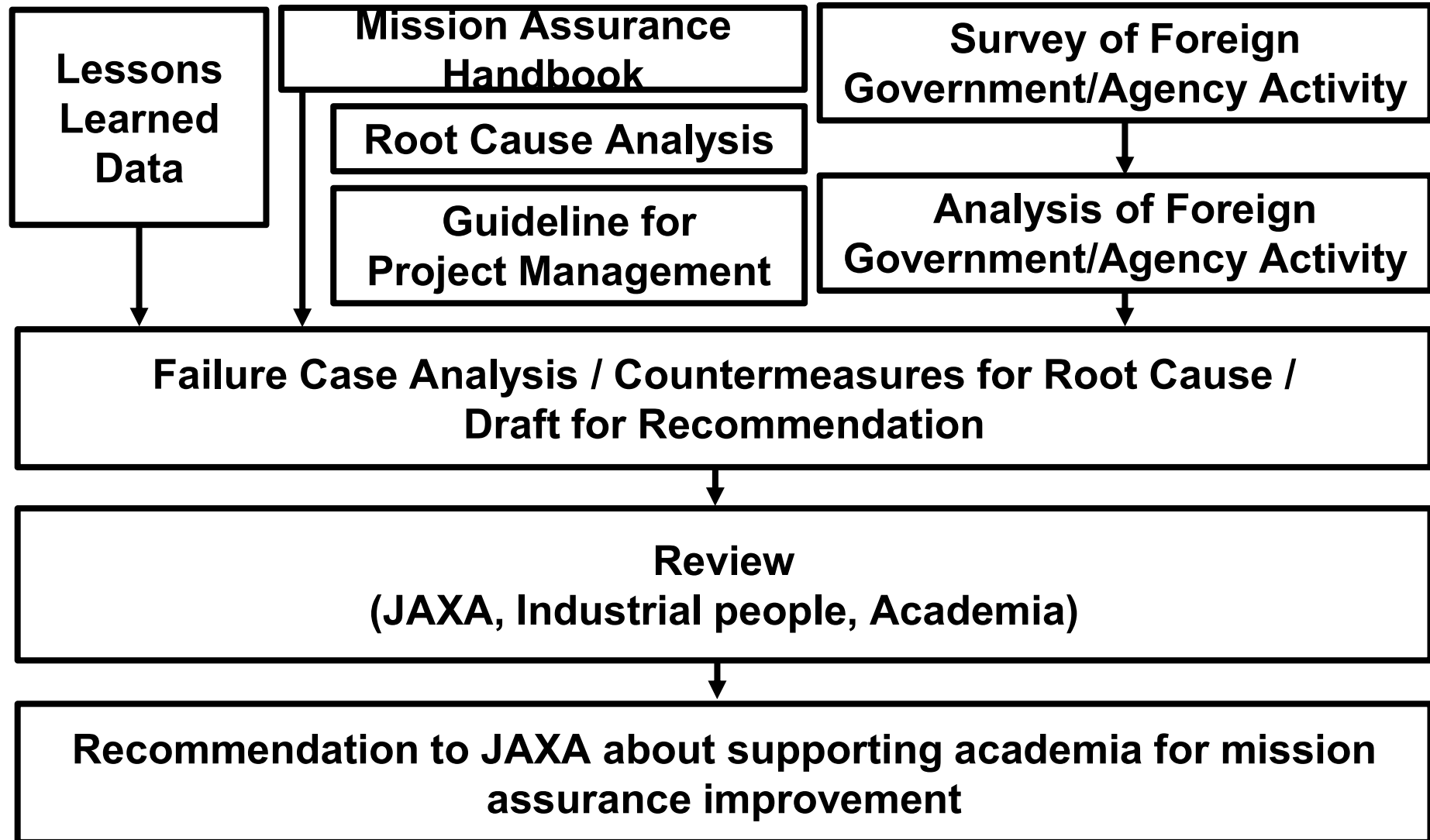
# Taskforce for mission assurance handbook publication



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# Enhancement of relationship with JAXA's activity

## Preparation for Mission Assurance Structure Construction



# Enhancement of relationship with JAXA's activity

## Practical Space Development Activities



### Support for practical space development opportunities

- JAXA-UNISEC Partnership for CubeSat Release from the ISS-Kibo  
UNISEC-Japan -- JAXA MOU (April 1, 2021)  
Comprehensive collaboration agreement on CubeSat release from ISS-Kibo for academic research and capacity building

**J-CUBE** <http://unisek.jp/serviceen/j-cube>

- **Sustainable and evolutionary international collaboration**

Unique fee launch opportunity open for UNISEC-Japan's academic organization

- Up to 12 U/year (or 6 satellites per year) for 1-3U CubeSats
- 2 categories
  - International collaboration proposal
    - **Construction of international collaborative relationships**
  - Innovative mission proposal
    - **Building domestic capacity**
    - Strengthen the domestic human resources and capacity building capabilities,
    - Improve the technology level of involved UNISEC member

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- UNISEC-Japan poses new goals of space technology development
  - focusing on **ensuring the technology level of mission assurance for small space systems**
  - to promote practical and rapid space development, utilization, and exploration
- To ensure the technology level of mission assurance
  - **Surveying lessons learned** of domestic satellites
  - **Distilling the best practices**
  - Analyzing the surveys to **identify the root cause of failures**
- **Discussions on effective government/agency support method for mission assurance is on-going**
  - **Lessons learned info** → analysis
  - **Foreign government/agency activity survey** → analysis