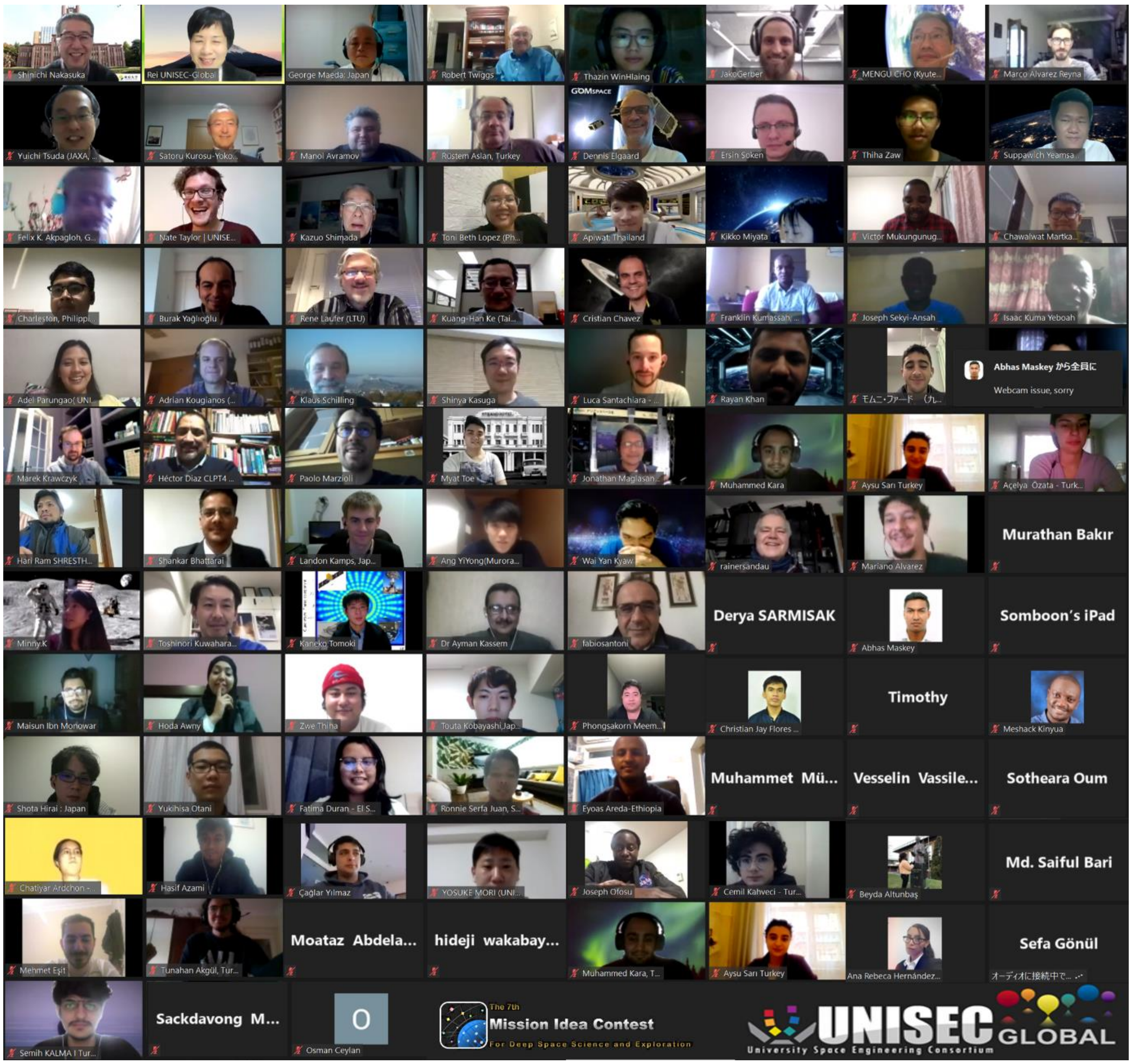
UNISEC-Global The 5th Virtual Meeting

January 16, 2021 22:00-00:00
(Standard Japan time GMT +9)



The following report prepared by UNISEC-Global Secretariat
January 18, 2021.
Japan

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1. Welcome and Opening remarks

Shinichi Nakasuka, the University of Tokyo

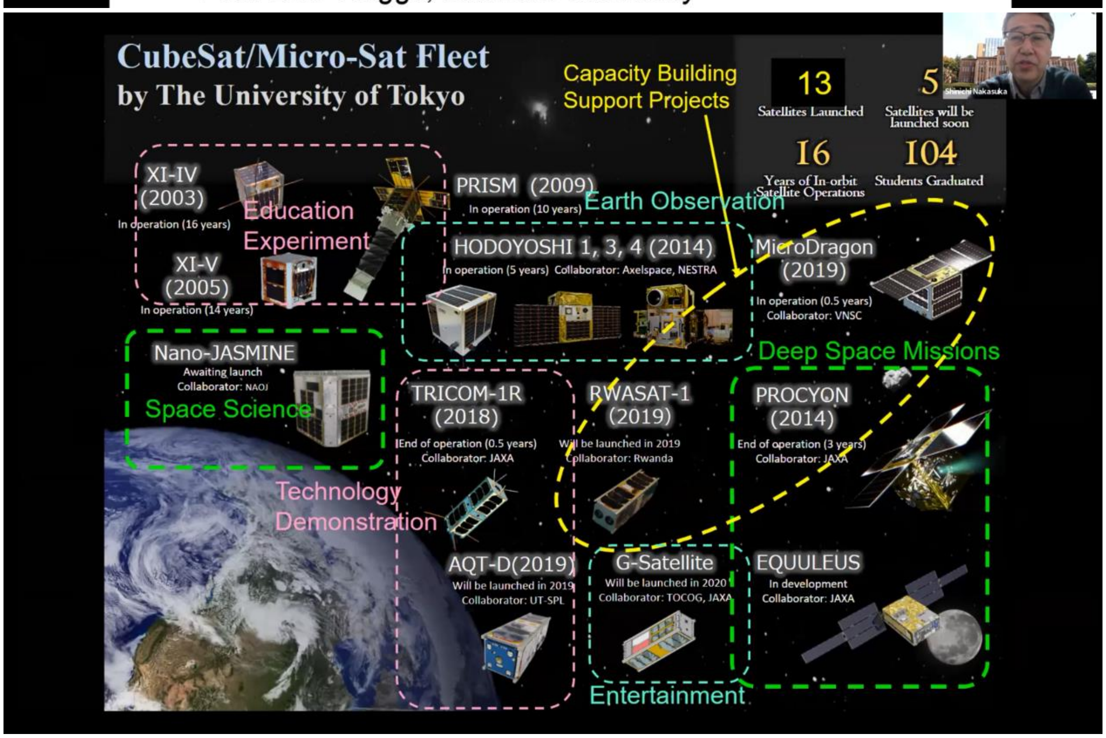
Professor Nakasuka graduated from the Graduate School of Univ. of Tokyo, Doctor Course in 1988, and got Ph.D. in Aeronautics. He joined IBM Research in 1988, joined Univ. of Tokyo in 1990 as a lecturer, and has been an Associate Professor of Dept. of Aeronautics and Astronautics since 1993. His research fields include space systems design and operation, navigation, guidance and control, small satellites, autonomy and intelligence for space systems, space robotics and machine learning.

Pictured: Professor Shinichi Nakasuka, the University of Tokyo.

"千里の道も一歩から– A journey of a thousand miles begins with a single step"

<u>Highlights:</u>

- History of CanSat via Japanese University and introduction to Prof. Twiggs.
- Became the voice of the world's first CubeSat in 2003 launched by Russian rocket into space and introduction to Prof. Tsuda.
- Consider what you can do in the current situation with your available resources.
- Continuation and growth is important. Even if you start small, you can grow it.
- The University of Tokyo has been working to develop a CubeSat/Micro Sat fleet in several areas:
    - Educational experiments.
    - Space Science.
    - Earth observations.
    - Deep Space Missions.
    - Entertainment.
    - Capacity building support for other countries.

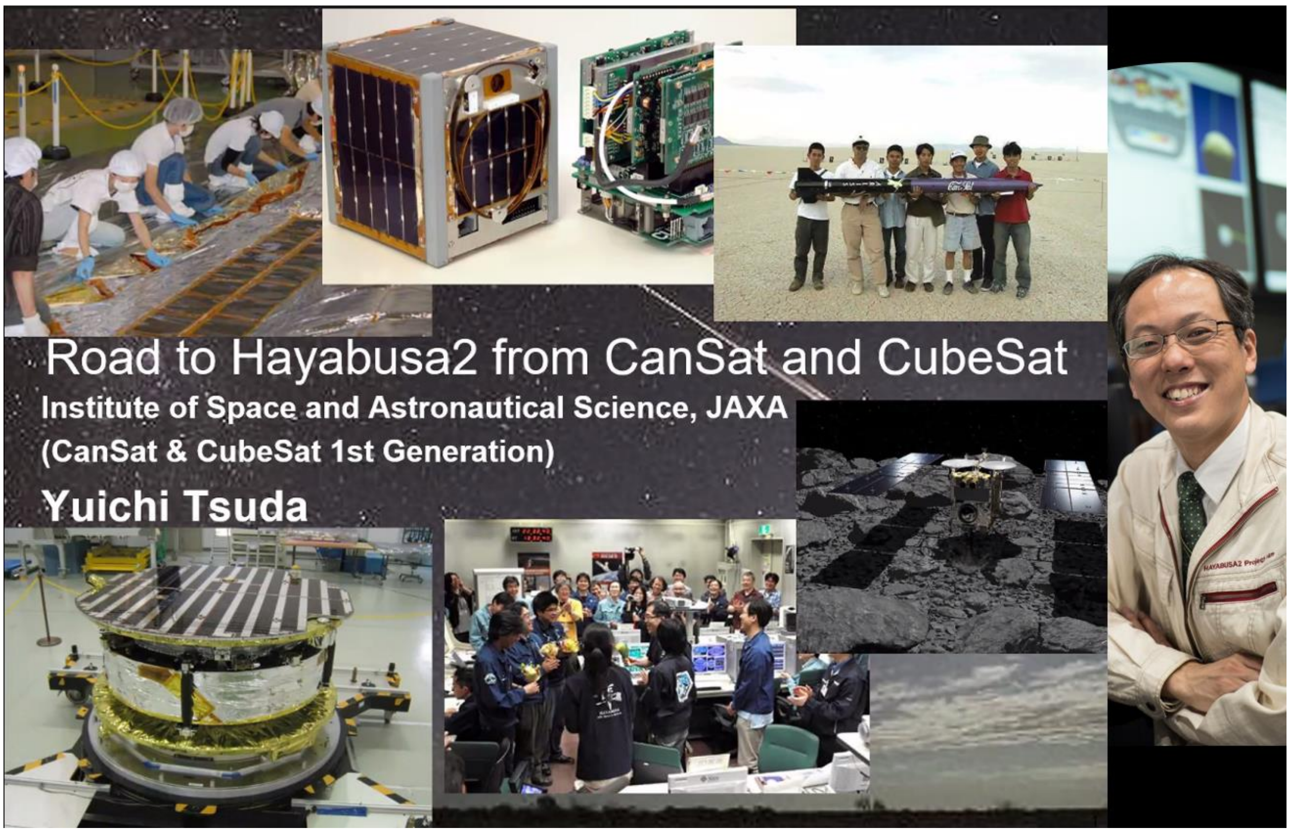


Pictured: Professor Shinichi Nakasuka introduces Professor Robert Twiggs' idea of a CanSat (top) and projects in CubeSat/MicroSat at the University of Tokyo (bottom).

2. Presentation “Road to Hayabusa-2 from CanSat and CubeSat”

Yuichi Tsuda, Project Manager of Hayabusa-2, ISAS/JAXA

Professor Tsuda specializes in space engineering, aerospace dynamics, and solar system exploration. He is the Project Manager of Hayabusa2, an asteroid sample-return mission which successfully completed the round- trip journey recently. He and his students have participated in several space mission projects, such as: the CubeSat development and flight project, solar sail deployment experiments using sounding rocket & high-altitude balloon, the asteroid sample return demonstration mission 'Hayabusa', the solar power sail technology demonstration mission 'IKAROS' and the asteroid explorer 'Hayabusa2'.



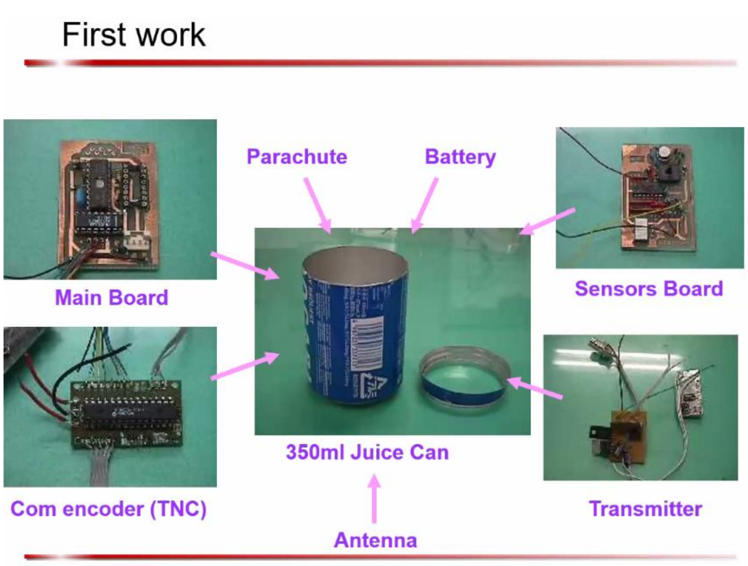
Pictured: Yuichi Tsuda, Project Manager of Hayabusa-2, ISAS/JAXA introduces his presentation about his personal 20-year journey.

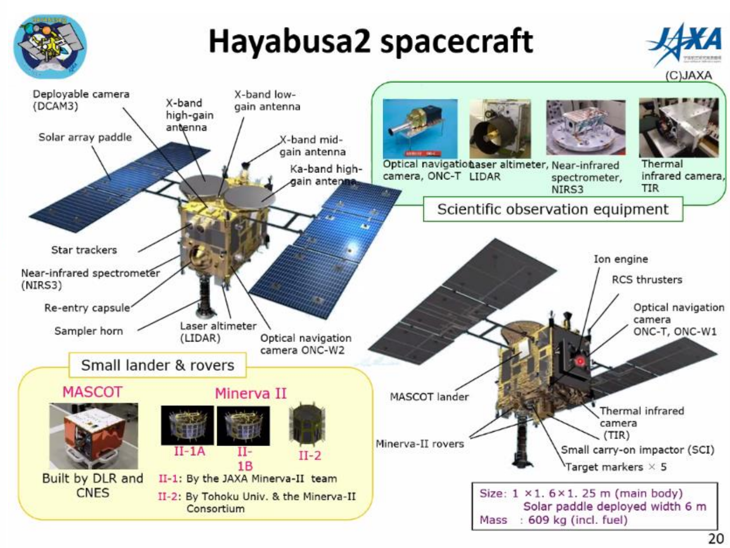
<u>Highlights:</u>

- Currently a Professor at ISAS in innovative spacecraft systems, Solar system exploration, and astrodynamics.
- His career began with CanSat education 1st generation (University Space System Symposium workshop in Hawaii), then CubeSat. He has made many lifelong friends through the projects.
- He did not believe as a student in a small lab that they could design and launch a satellite.
- Lesson 1: Luck is important.
- Bought components from Akihabara and hand-made circuit board along with juice cans for CanSat. Launched CanSat in Black Rock Desert 1999. Tsuda-sensei CanSat failed after changing the

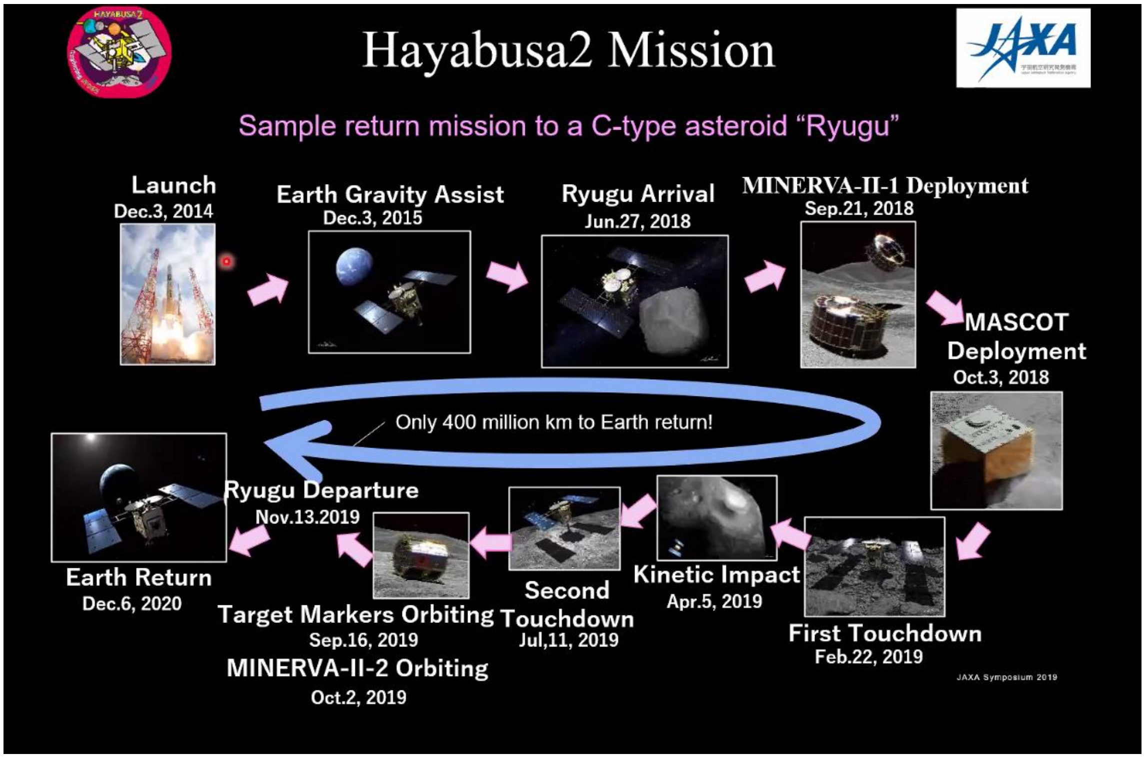
antenna for a better fit to the rocket.
- Lesson 2: Test as you fly, fly as you test.
- Lesson 3: Prepare a backup (memory flight data from failed launch retrieved later).
- CanSat was difficult to produce due to the cylindrical shape, CubeSat was proposed by Prof. Twiggs which led to the Prof. Tsuda developing Pluto explorer concept (equipped with flexible solar cells). The design resulted in a CubeSat without the membrane but solar cells instead.
- Study group on solar cells allowed the development of membranes and production with JAXA IKAROS project (launched May 2010).
- Interest directed more strongly toward deep-space missions after IKAROS and he joined Hayabusa2 team.
- Hayabusa2 (600 kg satellite) sample return mission from C-type (carbon-rich) asteroid "Ryugu" launched on Dec 3rd 2014 and returned sample Dec 6th 2020.
- The mission included rover deployment (4 robots for surface exploration), kinetic impact, and touchdowns (all successful).
- A target marker was dropped so the spacecraft could automatically land at the marked location. Once touch down is detected a projectile is launched and sample is collected (happened 300 million km's away from Earth!).
- CanSat DCAM3 deployed to observe crater forming process from impacts.
- Hayabusa2 has extended mission plans up until 2031.

<u>Participant Questions:</u>
- How long was the communication delay between the Earth and the satellite and how did you cope with this delay in issuing commands to the satellite? (From Zwe Thiha and Charleston)
  - *This depends on when. At longest the distance is 360 million km corresponding to 20 min delay (round-trip 40 min).*
- Will there be Hayabusa-3 planned in the future? 💥 (From Minny K)
  - *This has been given thought from the learnings in engineering and science from Hayabusa2 and they want to make another spacecraft (may not be named Hayabusa3 and not officially approved, yet).*





Pictured: The first work of Professor Tsuda vs. the Hayabusa2 space craft.

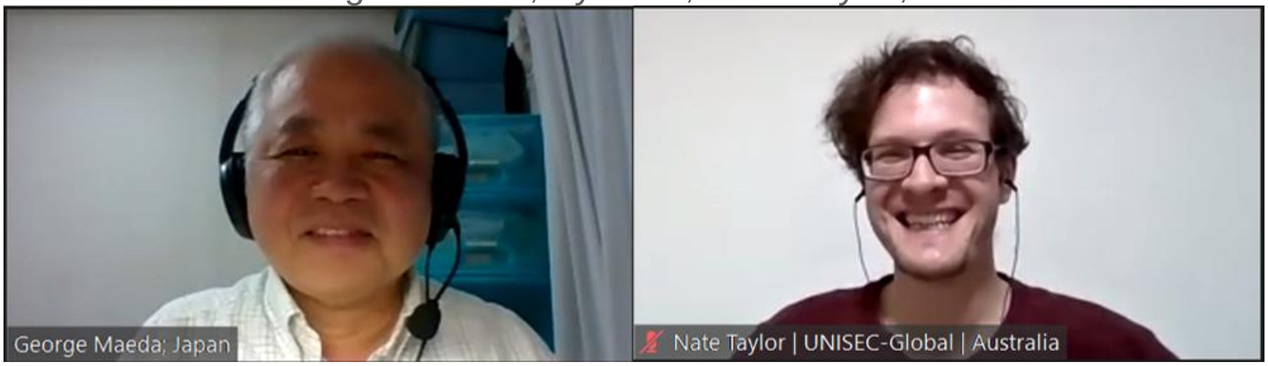


Pictured: The various stages of Hayabusa2 mission up until sample return in Dec 2020.

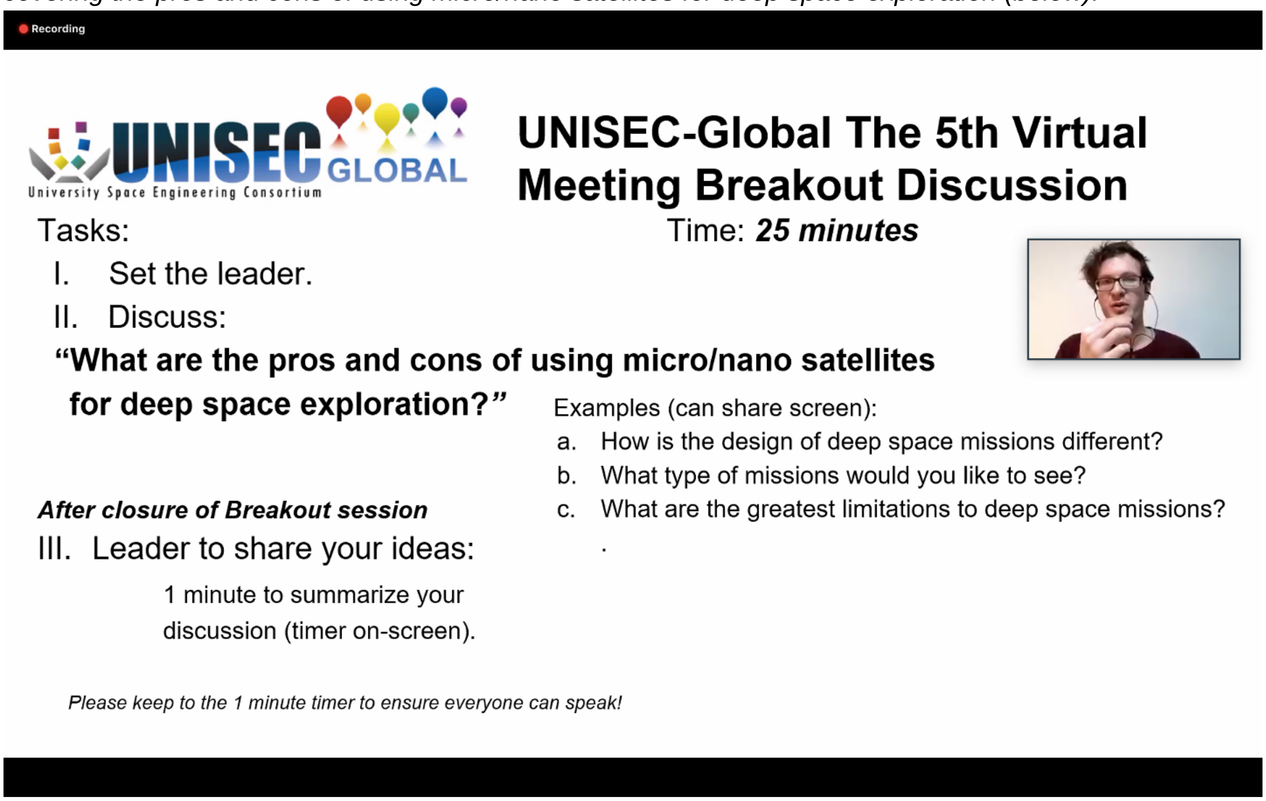
Pictured: Members of the Hayabusa2 mission celebrating the successful first touchdown of the spacecraft on February 22, 2019.

3. Breakout discussion and sharing.

Moderators: George MAEDA, Kyutech; Nate Taylor, UNISEC-Global.



Pictured: MAEDA, George (left) and Nate Taylor (right) moderating the virtual meeting and breakout session covering the pros and cons of using micro/nano satellites for deep space exploration (below).



<u>Highlights:</u>

- Entire meeting is divided into 10 breakout rooms (about 4-5 people in each room).
- Participants discuss the above agenda for 25 minutes.
- Representatives of each room make a 1 min summary to the entire meeting.

Summary of breakout group discussions

<table>
<tr><th>Group</th><th>Speaker</th><th>Pros</th><th>Cons</th></tr>
<tr><td>Room 1</td><td>Chawalwat</td><td>Small size, reduced cost
Transferable technology
Easier to achieve orbit networking
Able to plan multiple missions</td><td>More difficult to achieve autonomy
Requires precise orbit and navigation design / hardware</td></tr>
<tr><td>Room 2</td><td>Prof. Twiggs</td><td>Group interested in lunar exploration, space debris removal, deep-space mission.</td><td>Size and capability are an issue. Must minimize the size of components in payload.</td></tr>
<tr><td>Room 3</td><td>Kuang-Han</td><td>Interest in discovery, breakthrough and resources:
Leads to tech advancement
Increase reliability of components
More missions and lower cost</td><td>Size constraints
10 year + missions and environmental challenges.</td></tr>
<tr><td>Room 4</td><td>Luca</td><td>Differences
Orbit complexity
Radiation damage
More power required
Would like to see
Other planets; Asteroid missions
Technology demonstrations
Public involvement</td><td>Limitations
Budgeting, public support and marketability
International collaboration
Talent attraction</td></tr>
<tr><td>Room 5</td><td>Maisun</td><td>Cheaper and easier for developing countries
Cost-sharing with other nations/parties</td><td>Propulsion systems
Volume and capacity for payload</td></tr>
<tr><td>Room 6</td><td>Toni</td><td>System can perform specific tasks
Cost reduction
Integration of AI</td><td>Thermal controller
Maximize use of solar
Radiation shielding</td></tr>
<tr><td rowspan="2">Room 7</td><td rowspan="2">Charleston</td><td>Cost reduction, increased frequency of missions</td><td>Power, communication, payload and thermal control</td></tr>
<tr><td colspan="2">Want to see fleet relay chains, more autonomy on a smaller frame</td></tr>
<tr><td rowspan="2">Room 8</td><td rowspan="2">Meshack</td><td>Useful for exploring deep space before deploying bigger systems
Study inner planets
Scientific instrumentation demonstration
Companion missions</td><td>Power and distance limitations
Transmission and communications limited in range of bits/sec (not enough)</td></tr>
<tr><td colspan="2">Deep space network necessary
Virtual antenna arrays to compensate for transmission budget
Nuclear power for smaller sats?
Microwaves/laser for transmission?</td></tr>
<tr><td>Room 9</td><td>Adrian</td><td>Interesting missions
Particle measurement
Solar missions
Lunar GNSS</td><td>Steering craft (without gravity assist)
Communication – low power/low signal strength (gain, thermal)</td></tr>
</table>

Room 10	Aysu	• Greater flexibility in mission design • Fleets can be easily positioned	• Higher risk • Little power for communication of vast distances

Pictured: Chawalwatl (top left), Kuang-Han (top right), Luca (bottom left), and Aysu (bottom right) sharing their breakout room discussion with the meeting.

4. Special address

Robert Twiggs, Destination Space -STEM and Twiggs Space Lab

Professor Robert Twiggs has a bachelor's degree in electrical engineering from the University of Idaho and a master's degree in electrical engineering from Stanford University. He has been working with academic small satellites since 1982 and has had six student built small satellites launched into low Earth orbits. He was the co-developer of the CubeSat concept and was responsible for developing the original concepts for the CricketSat, CanSat, and the PocketQub for educational applications for use in space.

Pictured: Professor Robert Twiggs re-enacting the moment he developed the idea for making a satellite out of a coke can. ***"The more you give away, the more you get back!"***

Highlights:

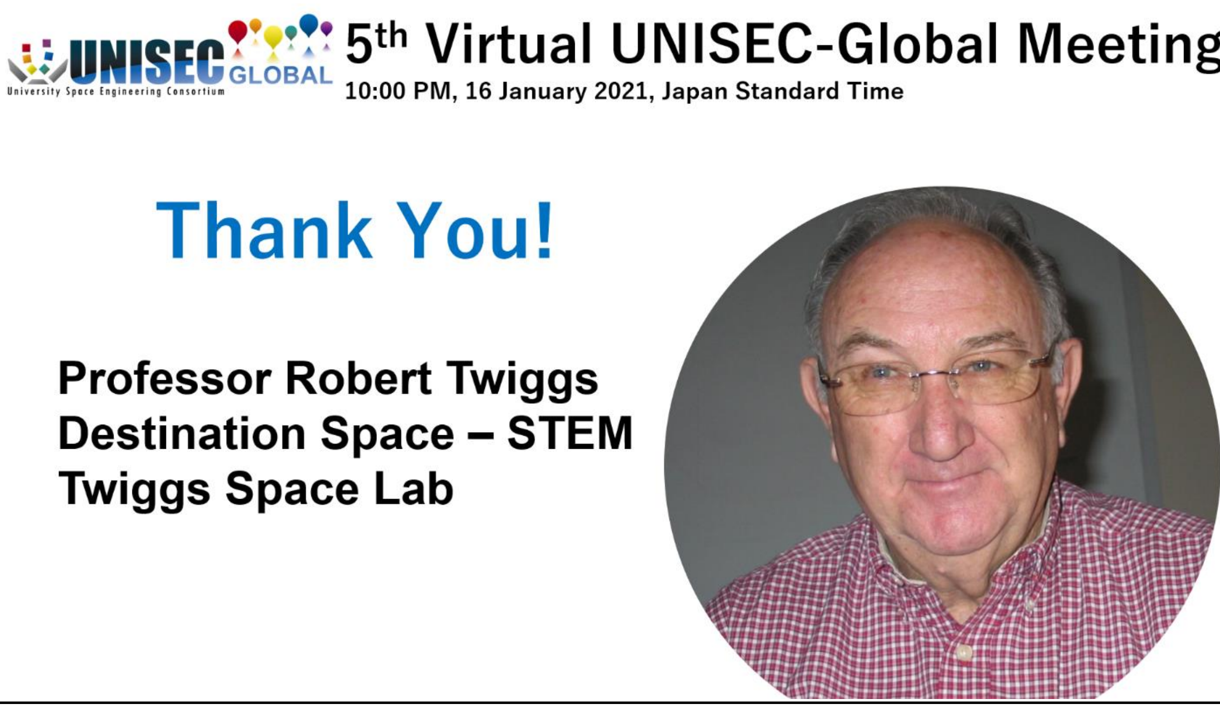
- He challenged the students and a response came back from the Japanese students that overwhelmed him, *"CAN-do!"* they exclaimed.
- The prospect came along to launch via a high-powered rocket in Nevada using CanSats to 15,000 feet (4.5 km).
- Students wanted another challenge to return an object to a flag near the launch-site.
- Students built rovers over 4 years eventually having successful missions. Prior missions had issues tangled in parachute and running out of power.
- We began CubeSats and CanSats for student education providing a platform for failure and learning without criticism.
- What technology is a CanSat and CubeSat using? As long as it does what we need it to, it doesn't matter!
- If the projects we are doing now did not coincide with the miniaturization of electronics, this may not have happened.
- We didn't patent the idea because not doing so pushes technology and give it away instead.
- Think about something you can do for kids in the education system. Build them cheaply so every

student from kindergarten can have a device that gives them science return. Get them excited about science, mathematics and learning.

- Prof. Twiggs on school: "*When I wen to school it was SO boring!*". He was from a farm community and school focused on livestock.

Participant Questions:

- What is the capability of CubeSat to perform a space solar experiment? (From Meshack)
    - *People have done amazing things with CubeSats. Once students asked to put a camera in a CubeSat and Prof. Twiggs was not confident. The students proceeded and now he receives a picture a week from that satellite. Tell students they can't do something and they will make it happen.*
- Can we develop a home-made CanSat? (From Charleston)
    - *Absolutely. YouTube has terrific resources. Arduino and Raspberry Pi components are so cheap; Seeed studio processor. High capability small components. Go get some data any place you can get it. Don't let cost be a limit.*
- Performance is limited but we can combine into formations for innovative missions. Can we inform larger constellations and promote international collaboration? (From Klaus)
    - *It is a wonderful idea to have an international collaborative project like that. The more we can have these programs, the more exciting it is.*

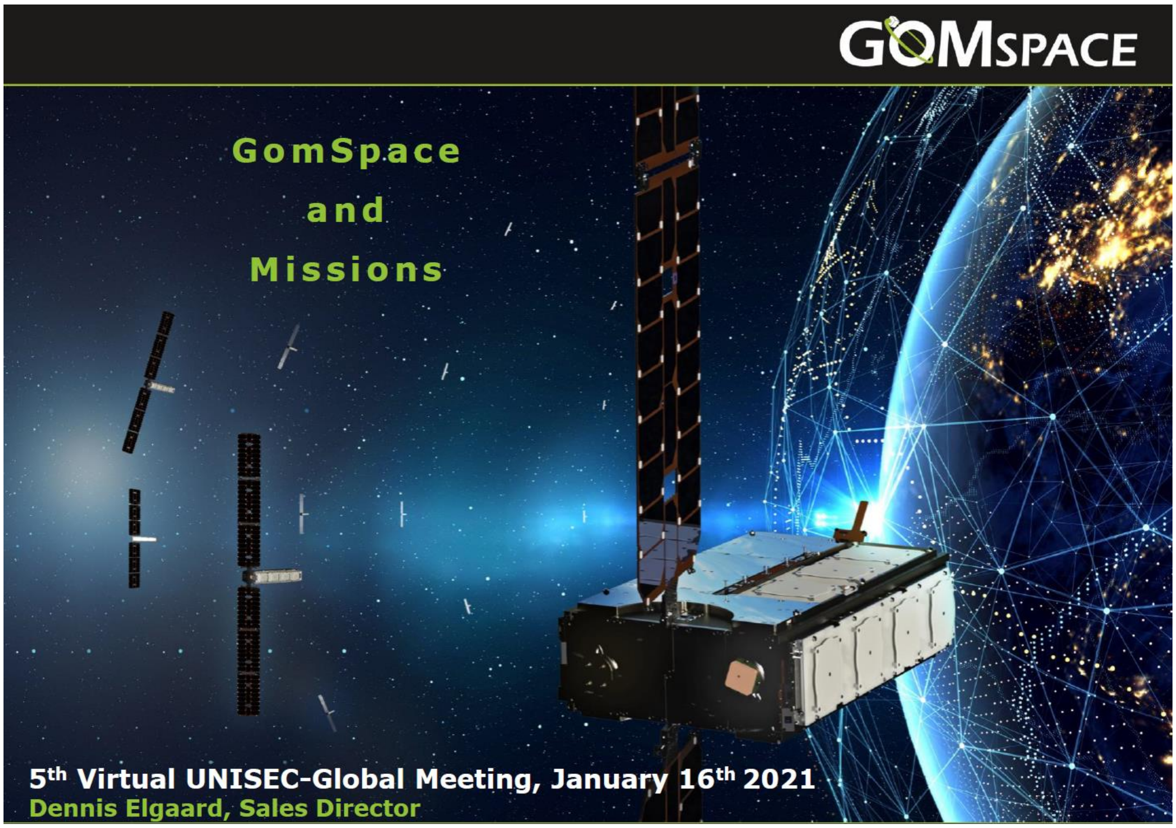


Pictured: An expression of gratitude to Professor Robert Twiggs for his address to the UNISEC-Global meeting.

5. Corporate presentation: GomSpace

Dennis Elgaard, Director of Sales, EMEA & APAC, GomSpace

Dennis Elgaard has a Master degree in Computer Science from Aalborg University in Denmark. For the past 25 years he has been in and out of the space and telecommunications business. He has worked for ESA on the architecture and design of the ESA SCOS-2000, a Satellite Control Operating System. In 2014 Dennis moved to GomSpace to undertake the challenge of CubeSats and is currently acting as Director of Sales, EMEA & APAC at GomSpace.

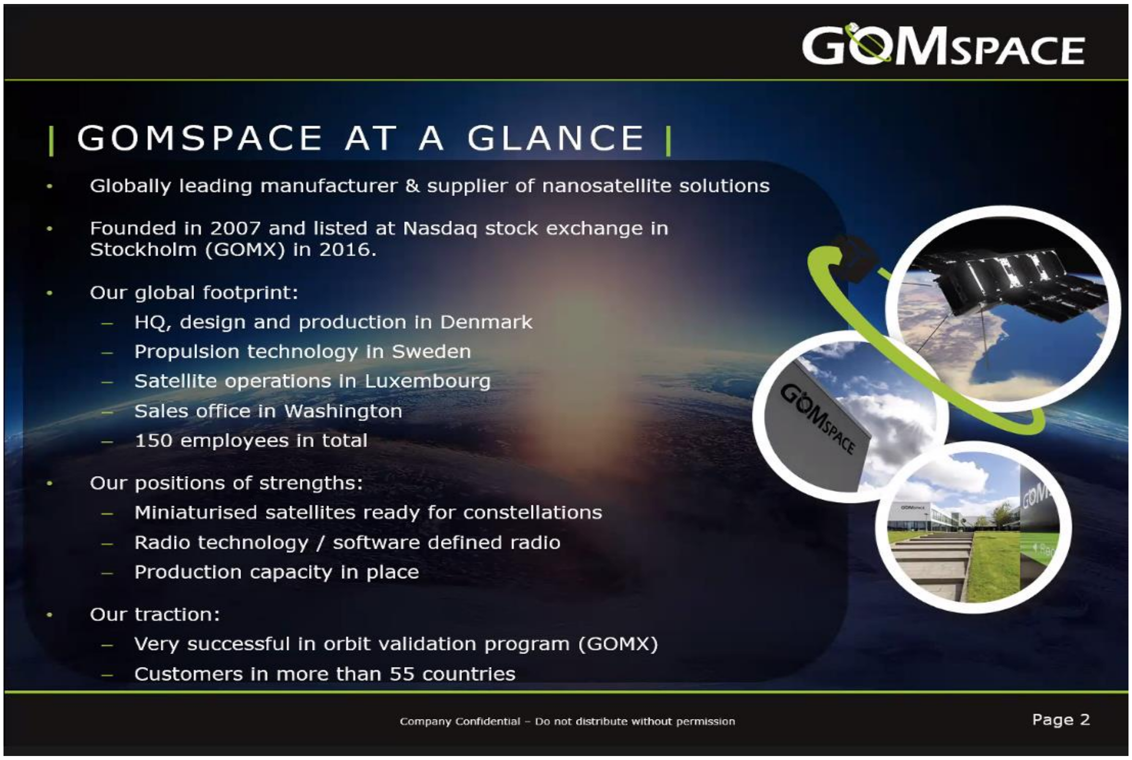


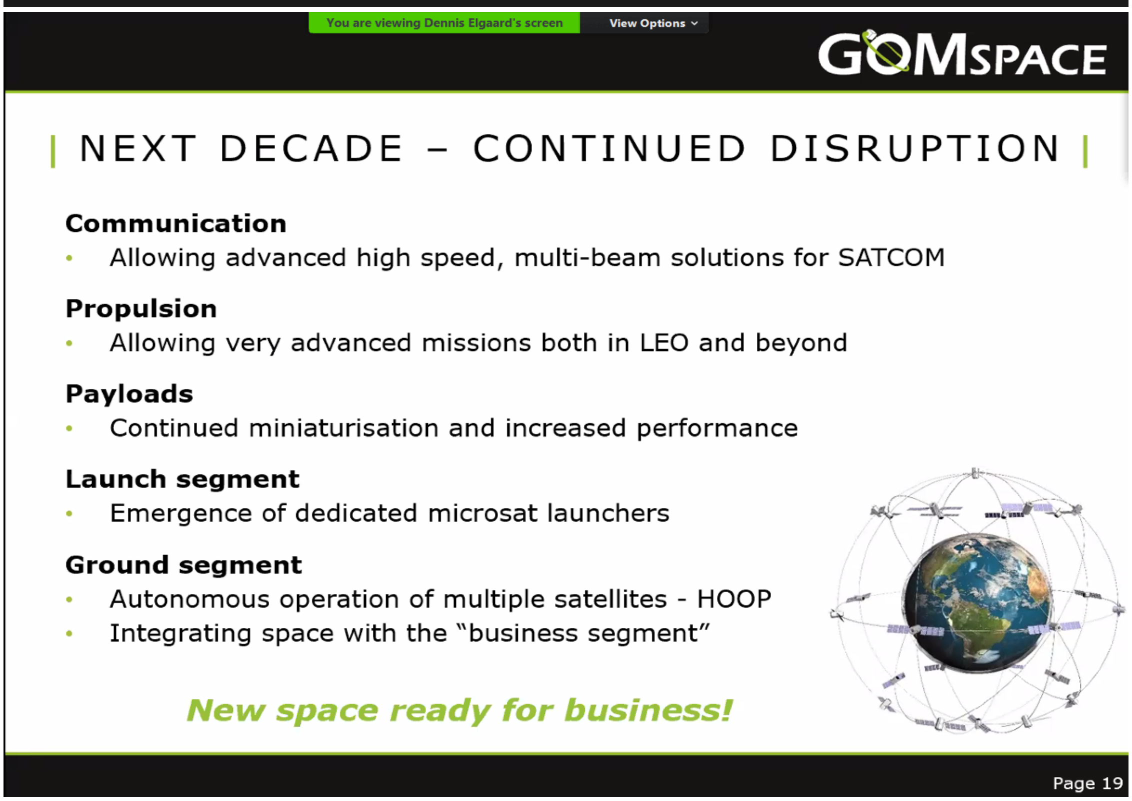
Pictured: An overview of GomSpace given as an introduction to the company by Dennis Elgaard.

"NewSpace is open for business!"

Highlights:

- Commercial company employing 150 people and listed on Nasdaq stock exchange.
- Global company: Propulsion unit in Sweden, Satellite Operations in Luxembourg, Sales in Washington DC.
- "We fly what we sell". Since 2013 we have been flying our own satellites with payloads and experiments.
- In the process of preparing a new larger satellite GOMX-5 to demonstrate orbital transfer maneuvers in LEO; high speed intersatellite linking; hybrid propulsion; GNSS Precise Point Positioning; 8 separate payloads.
- Have a deep space RACE mission investigating six degrees of freedom propulsion (6DOF).
- Looking at going into deep space with the HERA/JUVENTAS mission.
- ESA mission M-ARGO – Miniaturized Asteroid Remote Geophysical Observer.





Pictured: An overview of GomSpace (top) and their focus over the next decade.

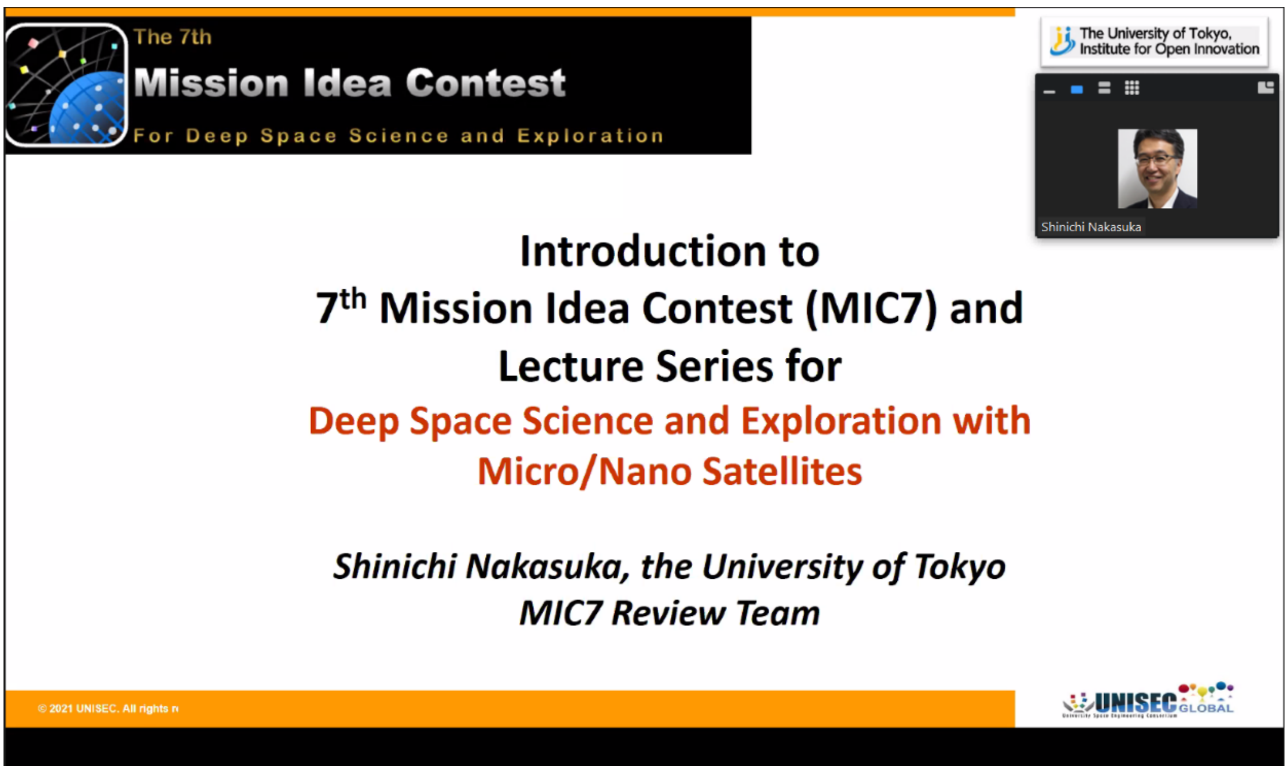
Point of Contact for "GomSpace":
Dennis Elgaard – Director of Sales, EMEA & APAC
Website: https://gomspace.com/
E-mail: dennis@elgaard.dk

6. Introduction to the 7th Mission Idea Contest for Deep Space Science and Exploration with micro/nano satellites

Shinichi Nakasuka, the University of Tokyo

The Mission Idea Contest (MIC) was established in 2010 to provide aerospace engineers, college students, consultants, and anybody interested in space with opportunities to present their creative ideas and gain attention internationally. The primary goal of MICs is to open a door to a new facet of space exploration and exploitation.

Development of micro/nano-satellites started as an educational and research program primarily at university laboratories. As the micro/nano-satellite technology matures, it has spread rapidly across the academics and industry for practical application.



Pictured: An introduction to the 7th Mission Idea Contest (MIC7) to encourage registrations from participants and to feature the free lecture series.

Highlights:

- We are going into deep space with MIC to offer aerospace engineers, scientists, college students, consultants, and anybody interested in deep space science and exploration (www.spacemic.net)
- Key Dates:
    - Abstract submission due: July 7 2021
    - Notification: August 18 2021
    - Full Paper submission due: September 30 2021
    - Final presentation: TBD (around Nov 20, 2021)
- Overview of requirements for an innovative experiment idea which contributes to deep space science and exploration.
    - Spacecraft envelope size is less than 1.0 m x1.0 m x1.0 m size with less than 100 kg in weight (Multiple satellites are acceptable within the envelope area).
    - cis-lunar orbit or deep space trajectory orbit with the relative velocity to the Earth (excess velocity) greater than 0 km/s and the deliverable spacecraft mass is shown in Fig. 1.
    - You can use a transponder onboard of PROCYON.
    - You can assume you can use earth ground stations for deep space missions like DSN (Deep Space Network).
    - You can take continuous 8 hours for spacecraft operation every day.
    - The lifetime is a free parameter. But you should consider the effect of radiation for the proposed lifetime.
    - The proposed launch date should be before 2030.
- Overview of evaluation criteria:

Originality	Novel concept not yet realized or proposed, or a new implementation of an existing capability or service (25).
Impact	Impact on society / Potential to expand scientific knowledge / Strengthen deep space mission motivation (25).
Engineering	Technical description and solutions (20). Operational (protocol, communication and interaction during experiment) (15).
Feasibility	Programmatic (realistic- cost, development schedule, infrastructure requirements) (15).

- Free lecture series with experts:
    - **Mon 02/15/21 – New challenges for Deep Space Exploration with Micro/nano Satellites**
      Prof. Ryu Funase
    - **Thurs 02/18/21 - Science operations of Space missions**
      Prof. Munetaka Ueno
    - **Thurs 02/25/21 – Deep space exploration and micro propulsion**
      Prof. Hiroyuki Koizumi
    - **Mon 03/01/21 – Trajectory Design for Deep Space Exploration Missions**
      Prof. Naoya OZAKI
    - **Thurs 03/04/21 – Communication for Deep Space Mission with micro/nano Satellites**
      Prof. Atsushi TOMIKI

JOIN US!

Join Lecture series: http://www.spacemic.net/lecture.html
Register at: https://tinyurl.com/MIC7-LS

Download the abstract template: http://www.spacemic.net/

Submit your abstract!

Application Submission : Deadline July 7, 2021

Note: Registration to compete in MIC7 will open soon. You can begin working on your abstract now.

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7. New member acknowledgment, Announcements and Closing

Rei Kawashima, UNISEC-Global

Pictured: Kawashima-san introducing the new university member for UNISEC-Nepal and new *corporate member Mitsubishi Electric Corporation.*

Highlights:

- Please contact the UNISEC-Global secretariat (KAWASHIMA Rei) if you wish to establish a new local chapter. Requirements for a new chapter:
    - 2 or more participating universities.
    - Professor and student involvement.
    - Fill out the university application and local chapter application from: http://www.unisec-global.org/localchapters.html
- New chapter member Tribhuvan university's Institute of Engineering (Nepal)
- Next Virtual Meeting will be held on Feb 20th 10 PM (JST) and feature Dr. Tatsuya Arai spacesuit designer and local chapter presentation from UNISEC-Turkey.
- Local chapter presentations are booked for March and April. Please contact Kawashima-san if you would like to present in May.
- KIBO-Cube Academy (Basic space engineering lectures) by UNOOSA and JAXA
  Jan 14, 21, 28, Feb 4, 21:00-23:00 (JST)
- MIC7 Lectures: Deep Space Science and Exploration with nano/micro satellites
  (sponsored by the University of Tokyo)
  Feb 15, 18, 25, March 1, 4, 21:00-22:30 (JST)
  Registration: http://www.spacemic.net/lecture.html
  UNISEC will join planning and organizing the working group of the higher education at APRSAF 2021 (held in Vietnam).
- International Symposium on Space technology and Science to be held in Beppu, Japan February 26 – March 4, 2022.

Pictured: ISS conference details.

Pictured: Follow us on our social media pages and get involved!

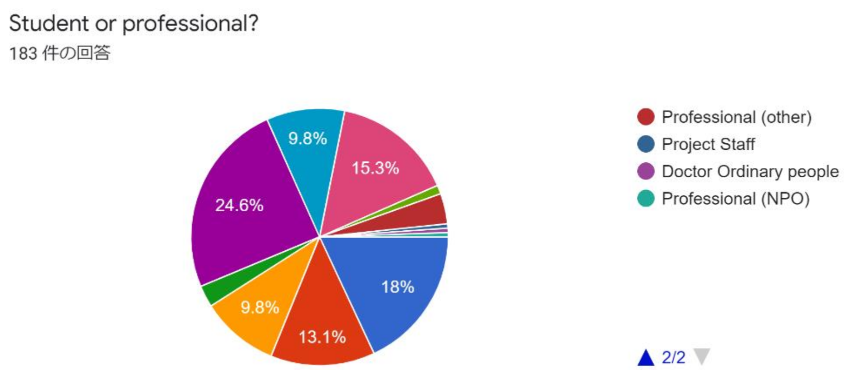
8. Participant Statistics

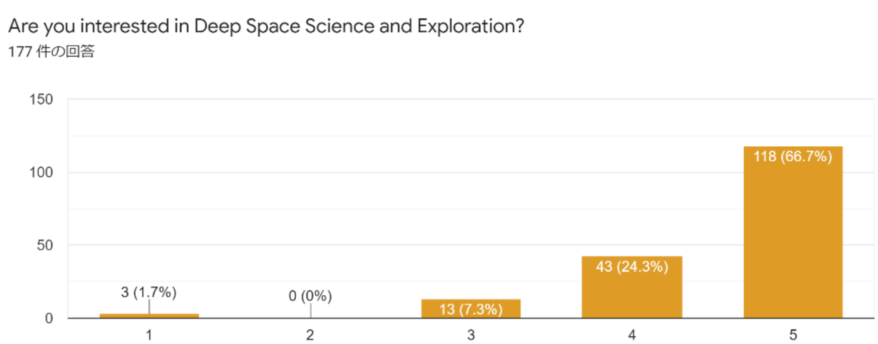
183 registered participants from **47** countries/regions participated in the 5th Virtual UNISEC-Global Meeting.

1	Afghanistan	17	Estonia	33	Pakistan
2	Angola	18	Ethiopia	34	Perú
3	Argentina	19	Germany	35	Philippines
4	Australia	20	Ghana	36	Poland
5	Bangladesh	21	Greater Accra	37	Rwanda
6	Belgium	22	South Korea	38	South Africa
7	Bhutan	23	India	39	Sudan
8	Bulgaria	24	Indonesia	40	Sweden
9	CAMBODIA	25	Italy	41	Switzerland
10	Canada	26	Japan	42	Taiwan
11	Chile	27	Malaysia	43	Thailand
12	China	28	México	44	Tunisia
13	Colombia	29	morocco	45	Turkey
14	Danmark	30	Myanmar	46	UK
15	Egypt	31	Nepal	47	United States
16	El Salvador	32	New Zealand		

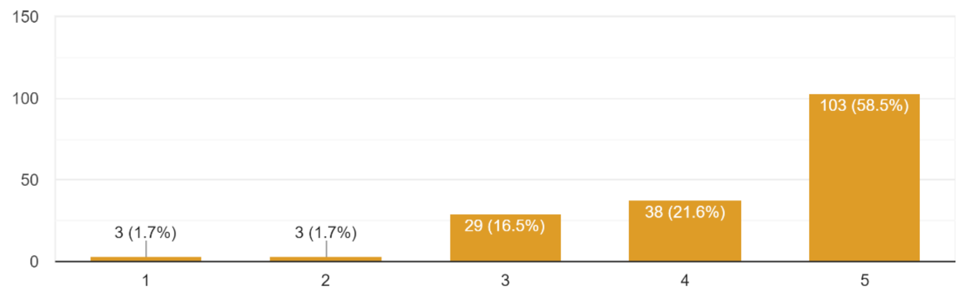
Relationship with UNISEC	Number
Academic or Student	47
CLTP graduate	18
Corporate Member	3
Follower of UNIGLO SNS	12
Interested	3
ISU Alumni/Staff	6
Local Chapter member/staff	57
MIC Associate (Regional Coordinator / Reviewer)	6
Participant (other)	14
UNISEC Alumni/Staff	12
MIC Participant	5

9. Participant Questionnaire

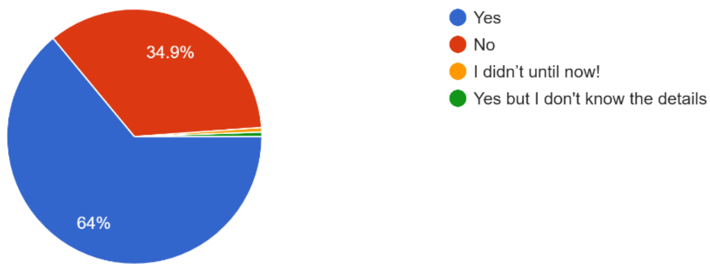




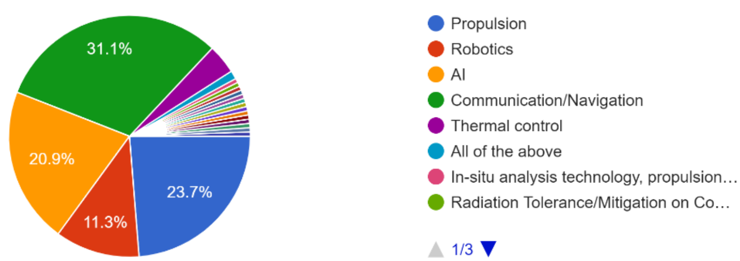
Do you want to study and/or work for the field of Deep Space Science and Exploration?
176 件の回答



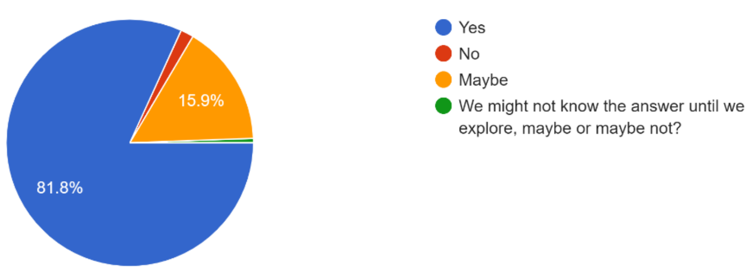
Do you know the theme of the 7th Mission Idea Contest is "deep space science and exploration"? (http://www.spacemic.net/)
175 件の回答



What technology developments (if any) do you think are critical to advance Deep Space Exploration?
177 件の回答



Do you think human beings should explore deep space?
176 件の回答



Some of your answers as to why we should or should not explore deep space:

Deep Space Exploration gives information on the exoplanets and other bodies that might have effects on the earth in the long-term. These studies also give information on possibility of expanding human portfolio for habitable planets

This is the ultimate human nature. Curiosity guides us to the wonder of the unknown.
There are a lot of things that are unknown in the universe. Deep space exploration might give us essential knowledge and understanding which can impact our way of life.

Discovering space is like discovering our own selves. Going into space help us to discover new sciences and approach new technologies.

It is essential that humans establish presence on other planets. Our civilization's expansion in space is inevitable, so the sooner we create a framework how to travel to and settle other planets, the better.

As human species we have the curiosity to explore. Space is interesting. The search for knowledge and a better understanding of our place in the universe is a noble endeavor when approached not as an attempt to escape the problems we face on earth, but to give us a perspective that enables us to handle the problems more effectively. Human beings are instinctively exploring the new world in our history. This will help us to understand the formation of the universe. The more we know about other bodies, the more we know about ourselves.

The future of mankind is in space.

As humans, there is a need for us to explore further to expand our knowledge and understanding of our own existence and to give opportunities and/or solutions for our future generations. Studying deep space would help us answer the mysteries of the universe. We might find something that, when thoroughly studied, will aid humanity's survival. Presently, we are at the mercy of the universe. There are still a lot we do not know about the universe. Once we understand them, we can harness them, just like how we have studied, understood, and harnessed electricity. To learn more about the presence or absence of living forms there and to understand better what is there in deep space for humans. Deep space exploration is an activity that would unite human beings as it is one big challenge for all of human kind.

Human deep space exploration helps to address fundamental questions about our place in the Universe and the history of our solar system. Through addressing the challenges related to human space exploration we expand technology, create new industries, and help to foster a peaceful connection with other nations.

I think that making it clear that we have not known yet leads to new possibilities on not only space engineering but also others.
All of us have one life to live. Therefore, I think it is important to examine why we are the person who is the owner of this life. Moreover, we need to think not only about our daily life stuff but also about the wonderful universe which is waiting for us to solve its mysteries :)
Deep space is important to humans as it contains traces of life. If we're wondering where we came from, we must explore deep space.
In addition, many things that contribute to daily life are discovered while performing the space mission. We have to keep working for everything in space. This will bring us new technologies, new ideas. The more we discover, the faster we will develop.
exploration.

Thank you.