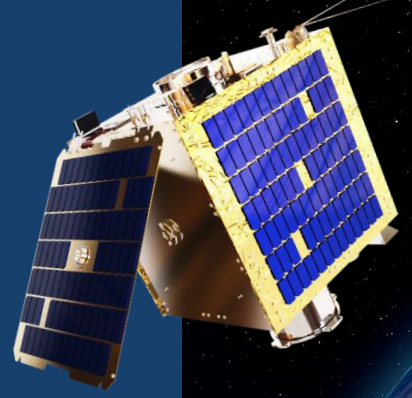
HYBRID ONLINE AND HANDS-ON TRAINING FRAMEWORK FOR SPACE EMERGING NATION: THAILAND CASE STUDY AND FOLLOW UP



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THEOS-2 Project, Geo-informatics and Space Technology Development Agency (GISTDA) Thailand

Outline

Background
GISTDA satellites program
THEOS-2 Satellite

The objective of hands-on training program

Training framework
Selecting Training
Monitoring

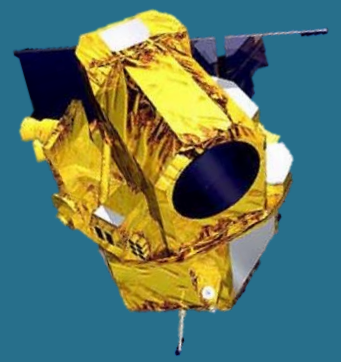
Feedback
Lesson learnt
Follow up
The way forward

GISTDA's SATELLITES

GISTDA THEOS-2

COMING SOON

THEOS (THAICHOTE)



Launch date : Oct 1st 2008

Payload : 2 m resolution panchromatic imager, 15 m resolution Multispectral imager

Mass : ~718 kg

Orbit : ~822 km Sun Synchronous - Low Earth Orbit

THEOS-2

Launch date : 2023

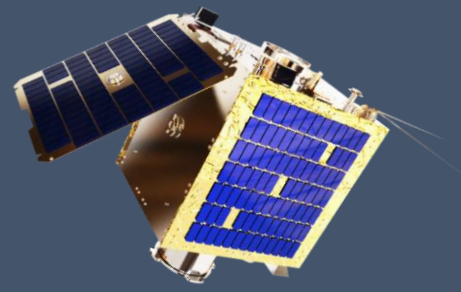
Payload : Optical Instrument (KORSCH Type with 3 SiC mirrors) Diameter 500 mm (Primary Mirror) Focal Length 14.9m

Mass : ~425 kg

Dimensions : 1.4m x 1.2m x 1.8m

Orbit : ~621 km Sun Synchronous - Low Earth Orbit

THEOS-2A



Launch date : 2023

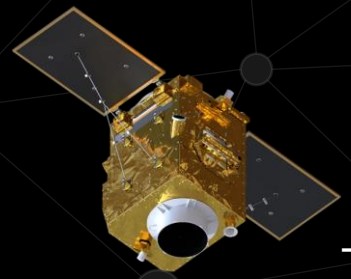
Main Payload : High-res imager with CMOS; 250mm aperture with focal length of 2.1 m

Mass : ~100 kg

Dimensions : 0.62m x 0.72m x 0.95m

Orbit : ~500 km Sun Synchronous - Low Earth Orbit

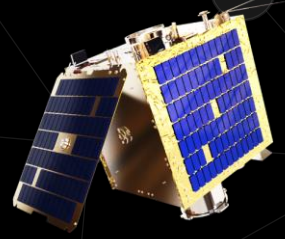
GISTDA THEOS-2



1

THEOS-2

Multi Mission Ground Segment (MMGS)



2

THEOS-2A

National Satellite Assembly, Integration & Test Center (AIT)

Technology Transfer

THEOS-2A isn't just a satellite program but a knowledge, technology transfer how to make a satellite and bring Thailand to satellite industry through 54 engineers.

THEOS-2

Thailand Earth Observation System

3

Capacity Building

Solutions & Applications / Customer Engineer

CE-A = 22

CE-B = 32

4

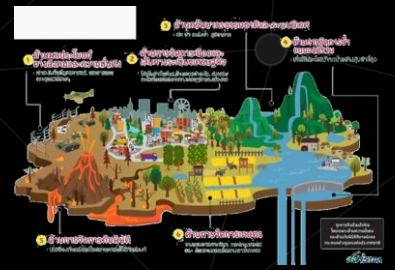
Space Economy

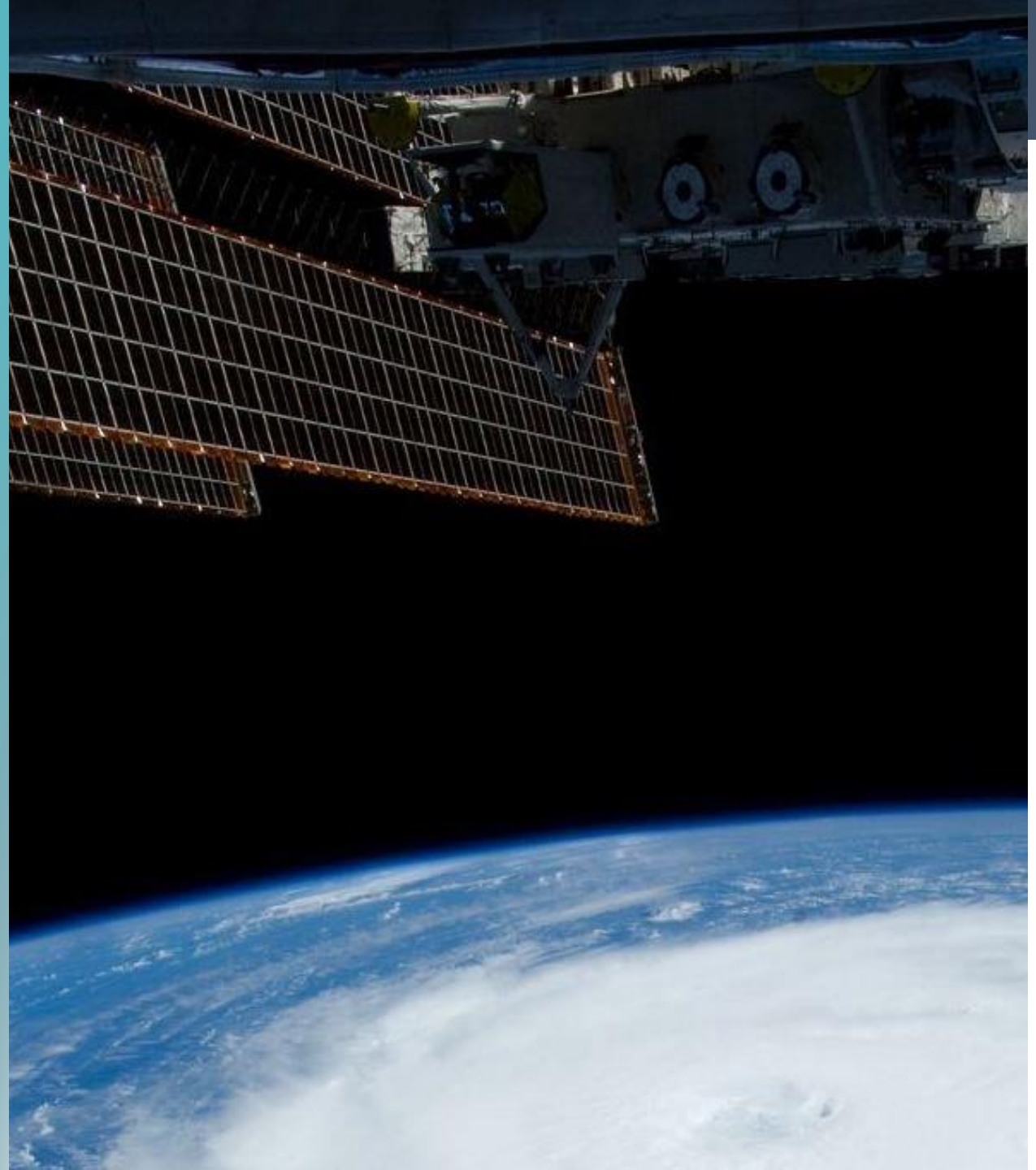
Aerospace Structures and Materials

5

Integrated Solution System & AIP Platform

Action Intelligence Policy



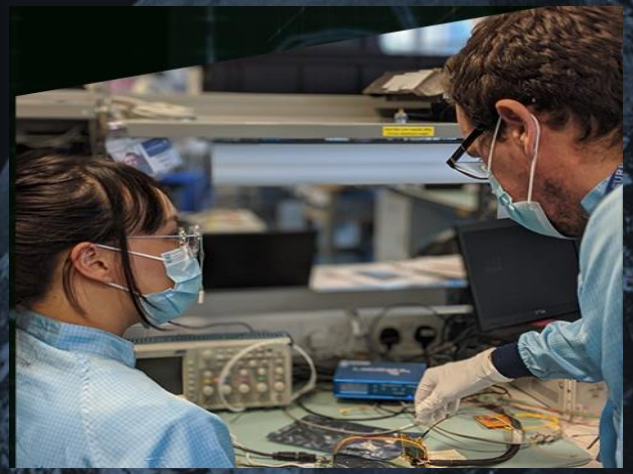


The objective of training program

To further develop the knowledge base in the field of industrial-grade satellite development, to be able to continually **support the growth of the space industry in the future**

To increase the potential of personnel in the country through the transfer of knowledge of industrial-grade satellite development to have the ability to develop advanced technologies

Know How Transfer and Training CE-A Program



Know How Transfer and Training CE-B Program

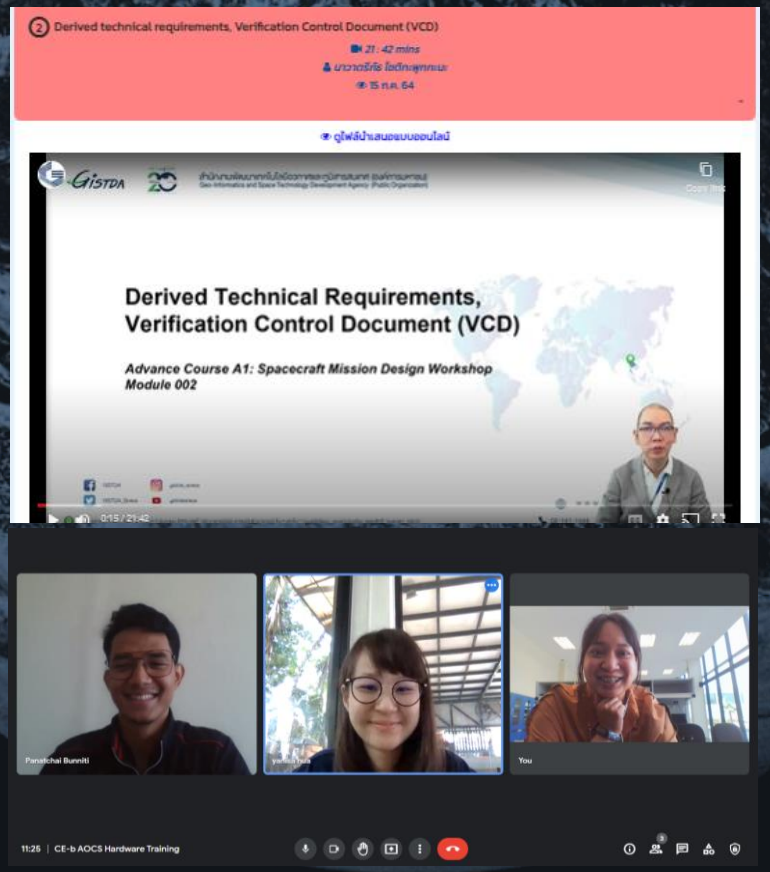
Hybrid Online And Hands-on Training Framework Training program

Online

- 1 Month: Basic course 22 module (~200 participant)

Online

- 1 Month: Advanced course 10 Module (~120 participant)



Hybrid (Online & Onsite)

- 5 months: Hands-on training (32 participant)

Plan of training: The candidates have learnt from the SQM development in parallel with the verification of THEOS-2A which is expected to launch during Quarter 3-4 of 2023

TT Activities On-site

phase	Item	29	2	3	4	5	6	9	10	11	12	13	16
			week14					week15					
MOI test	THEOS-2 SmallSAT MOI test												
	Post MOI -vibes THEOS-2												
TVAC test	SQM TVAC test												
	Post TVAC SQM												
	THEOS-2 SmallSAT TVAC												
EMC test	THEOS-2 SmallSAT EMC test	1											
		me,ee											
	review result		1	1	1	1	1						
			ma,e	ma,e	ma,e	ma,e	ma,ee						
System and ground test	THEOS-2 SmallSAT SEET test												
	review result												
	THEOS-2 SmallSAT ground segment compatibility							1	1	1	1	1	1
								ee	ee	ee	ee	ee	ma
	review result												
	commisioning reharals												
	flight readiness review												

MA: Management, ME: Mechanical, EE: Electrical

Hybrid Online And Hands-on Training Framework Selecting Process

Round 1

Basic course 22 module (~200 participant)

- Selecting by examination (passed ~120)

@https://training.gistda.or.th/courses/theos-2

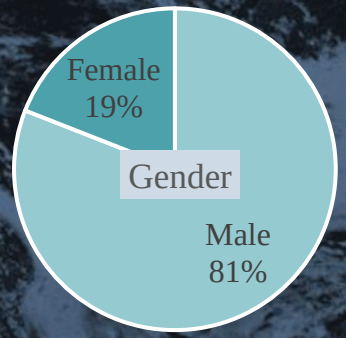
22 basic modules include sub-system overview such as project management, system, payload, attitude control, onboard computer, flight software, structure, operation

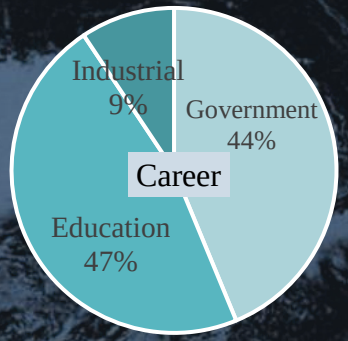
10 advanced course explain overall mission level objective, Concept of Operations, Derived technical requirements, Heritage mission, Spacecraft performance budget calculation

Round 2

Advanced course: 10 Module (~120 participant)

- Working Group (60 participant)
- Selecting by presentation (passed 32) decided by mentor





Total participants is 32 Trainees

- Gender: 27 males and 5 female
- Occupation
  - Government and state enterprises 14 people (11 Gistda employees)
  - A total of 15 educational institutions by 10 students and 5 lecturer
  - Private sector 3 person

Round 3

Hands-on training: (32 participant)

- 5 months (3 groups)

Management group is Project and System

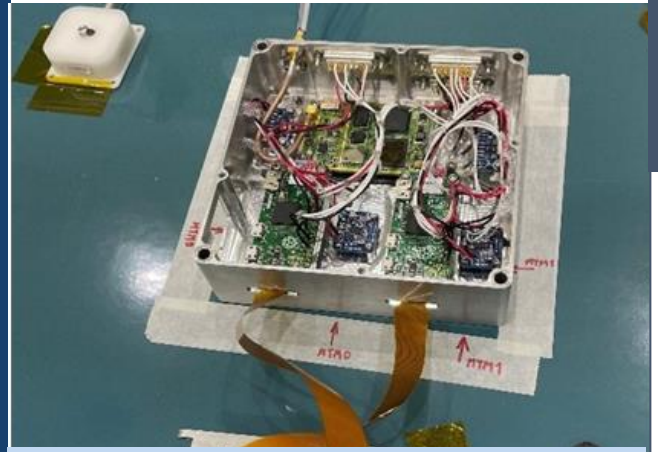
Mechanics group is Thermal, Structure and AIT

Electronics group is FSW, OBC, ADCS, RF, Power and Payload

Keys solution: THEOS-2A Satellite Qualification Model (SQM)

The crucial element of THEOS-2 program is that GISTDA has a license to rebuild a 100-kg class THEOS-2A spacecraft locally.

Satellite Qualification Model uses the same blueprint as flight version. However, SQM components will undergo extensive qualification tests which are more severe than flight acceptance level.



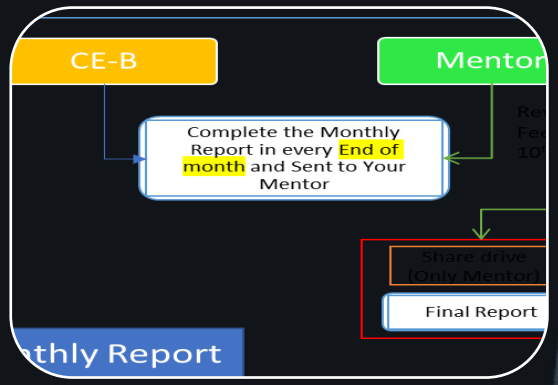
3PL Re-built

3rd Payload SQM has been rebuilt for electrical test for satellite qualification model, for every components are the same as 3rd payload flight model designed at SSTL the difference between the two are SQM is C++ based software.

Primary Structure

Electrical Ground Support Equipment

Hybrid Online And Hands-on Training Framework Monitoring



Review (by reviewer team)

- Training plan
- Monthly Report
- Review Material

Presentation

- Frist presentation
- 2nd (Midterm) catch up -> Interview
- Final Presentation

Mini project -> SchoolSAT

MOOC: Online platform

- ✓ To set and match the objectives between trainees and trainers
- ✓ Review and summarize the training did meet your objective or not?

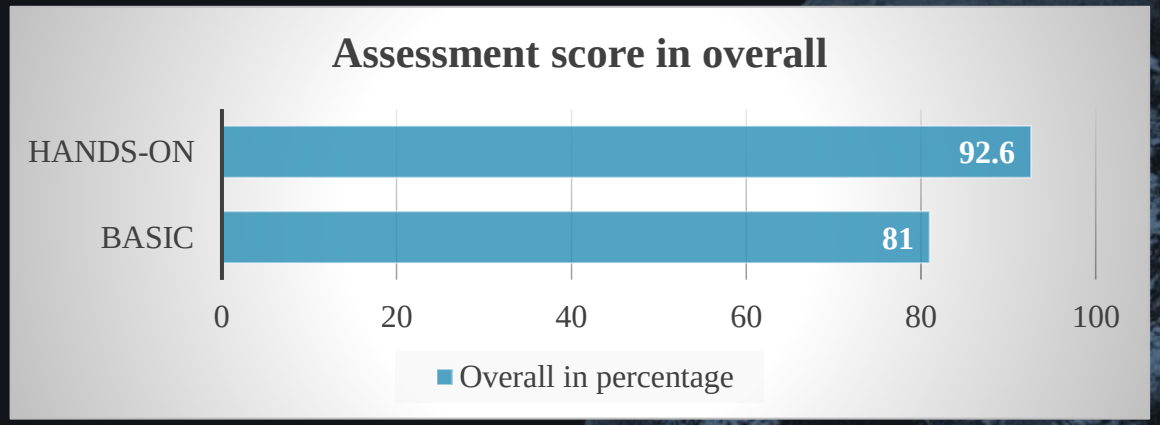
First Presentation (Onsite)

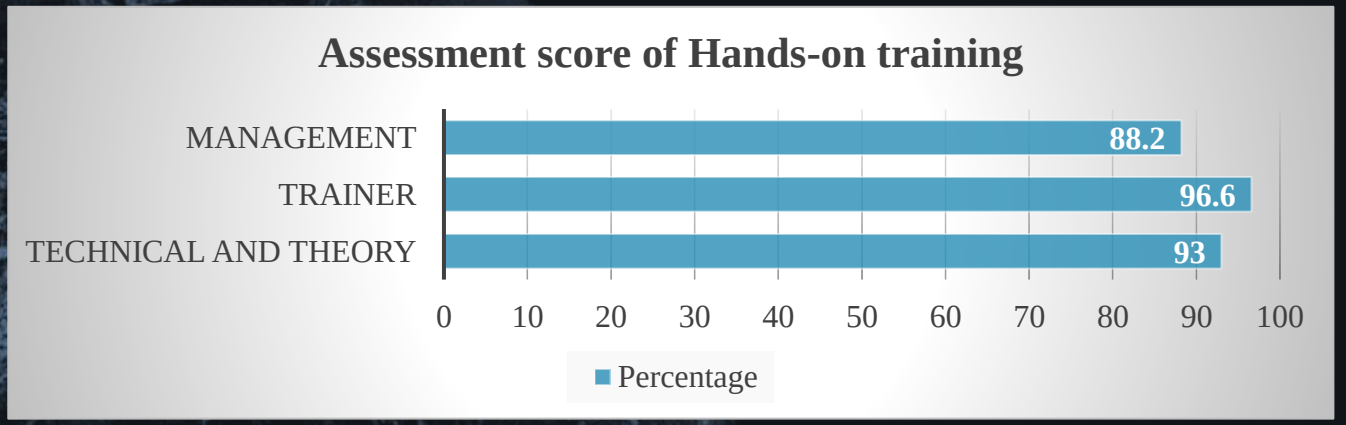
- Introduce your self
- Expectation
- Personal Goal relate to Space
- 5 Minute Presenter
  5 Minute for Q&A

Final Presentation (Online)

- Evaluate the Training plan outcomes meet your expectation
- Summary all task you are done
- Suggestion or recommendation
- 5 Minute Presenter
  5 Minute for Q&A

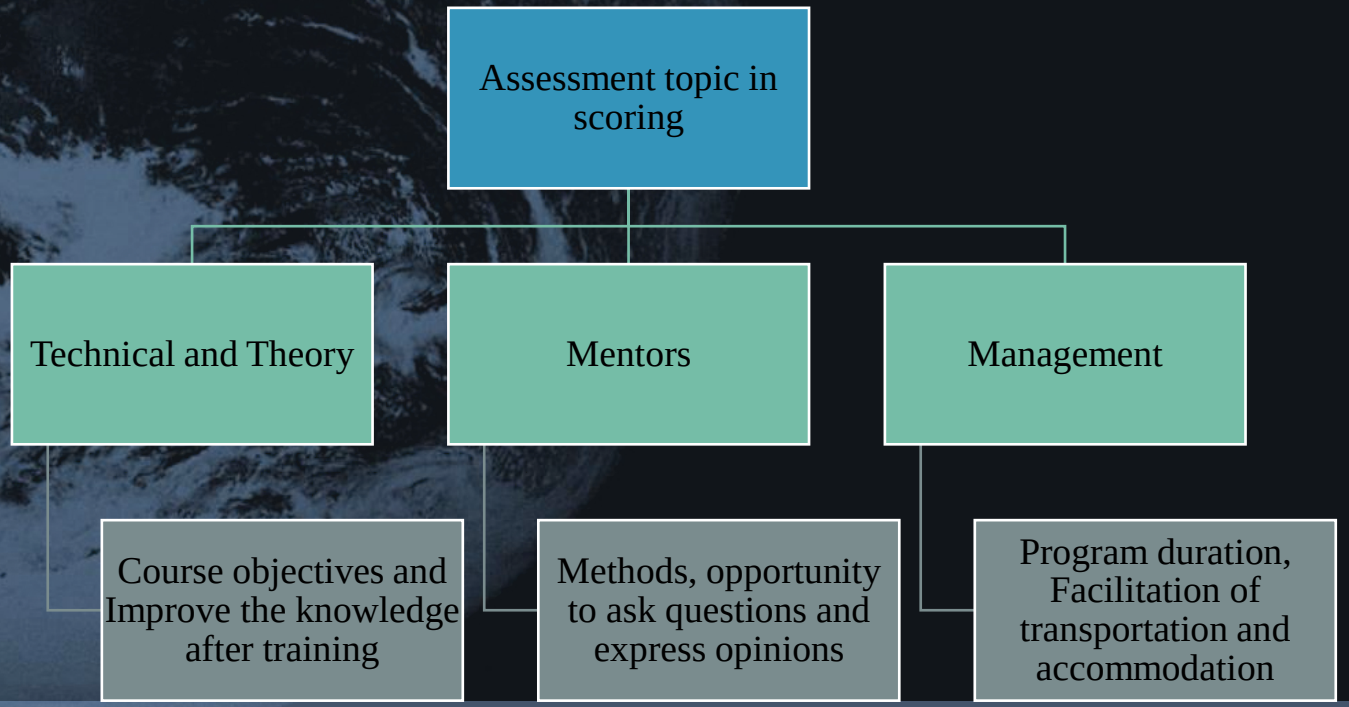
The satisfaction score of the participants in the blind test





The maximum score has 2 topics are the opportunity to ask questions and express opinions and mentor's personality (mentors' topic) = 99%

The minimum score is program duration (management topic) = 77%



What difficulties did you overcome and what recommendations do you have for countries wishing to follow the same path?

Challenge	Effect	Solution
Training course during Covid-19 pandemic	Limit the participant numbers entering work areas e.g., cleanrooms Effecting course operations are not continuous	Training program is divided into 3 phase: online, online and hybrid. ***Hybrid course was separated into 3 sub-groups 1. Onsite according to SQM and satellite testing schedule 2. Online training is used when hands-on satellites are not required including online meetings during the review process
Training course mismatch a plan due to delays from the other activities e.g., the launch schedule, a technical issue	Training plan is delayed	The timetable could be adjusted following a development plan and inform the trainee about this risk early.
Relationship (GAP) between Team Between Trainee Team Between Trainer and Trainee	Miscommunication and did not teamwork Knowledge transfer is incomplete	Understanding cause of gap such as age, culture, personality Mini-project can be making a teamwork Ice breaking > mini party by random seat
Intellectual property is an issue for technology transfer forwarding.	Cannot transfer all technology affect to completeness of the content	Prepare the general information Explaining and clarifying the participant's understanding is a good thing to do before training

The lessons learnt and recommendations?

Suggestion from trainees is our lesson learnt	Recommendations from training program
Technique They are requiring more practice on the job training Request to learn in theoretical Learn another sub system	- SQM does not cover all groups then, we are developing every sub system for everyone. - Theoretical foundation may have to invite professors from universities - Allocation to learn other subsystems to understand and be able to relate
Facility There should be equipment, tools, software, budgets that help support hands-on operations in a more concrete way Request the document library included for each sub-system for the trainees to study.	- The limits of the facility and budget are the main reason - Due to this being the first program we review and pass through the document on request from a mentor, the reviewer must have the time to review any IP. The training program should prepare the document for all participants
Management Request longer period and extent program until the launch Would like more of all Sub-Systems to join Onsite at the same time.	- The launch site is out of the control of the training program however; the training program can add this risk to reserve the budget or mitigation plan - The limits of the facility and budget are the main reason however then we can set the monthly team meeting at a minimum.

The lessons learnt in building education and capacity-building opportunities

Lessons learnt	Effect	Program Improvement
Limitations on facilities such as software license, the workplace of participant.	The limits of software licenses might affect training results The workplace cannot support the whole group	Budgets would be allocated for the main objective e.g., software to design and analysis, then a trial license alleviate this problem • Online meetings alleviate this problem
Transferability • Knowledge transfer personnel have specialized knowledge	The quality of some subsystems did not meet the standards	Experts will be invited to evaluate all modules for compliance including guest lecturer who specialize in that field. (require budgets)
Inadequate cooperation • Manhours less than expectation especially mentee • Quality of report and level of evaluation score in training plan	Knowledge transfer is incomplete	Mentee: Clarify the workload before you begin. Strictly rule being subject to penalties or deprivation of benefits Mentor: Estimate real workload and catch up closely (monthly)

Challenges, Lessons Learnt

Training framework

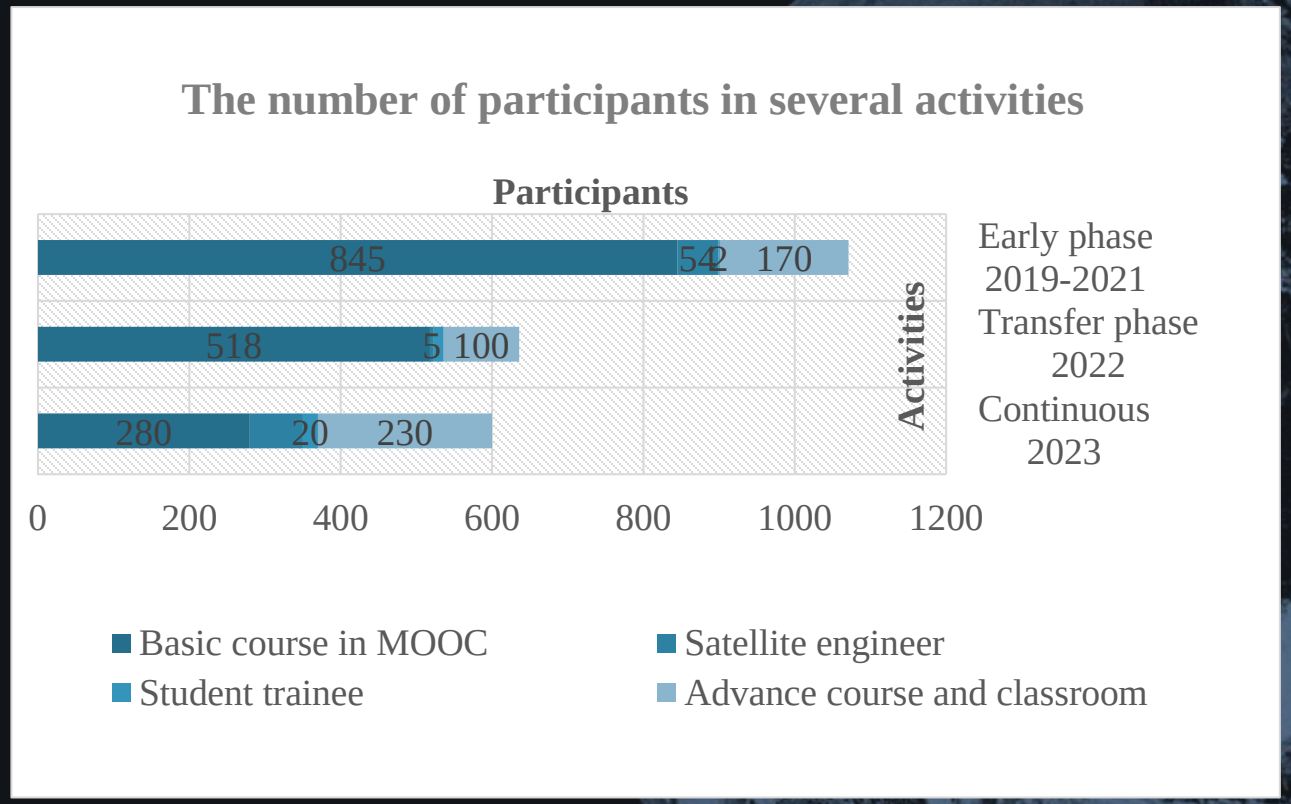
The large number of participants makes it difficult to manage. The recommended number should not exceed **10 persons per group**, which is easy to manage such as facilities.

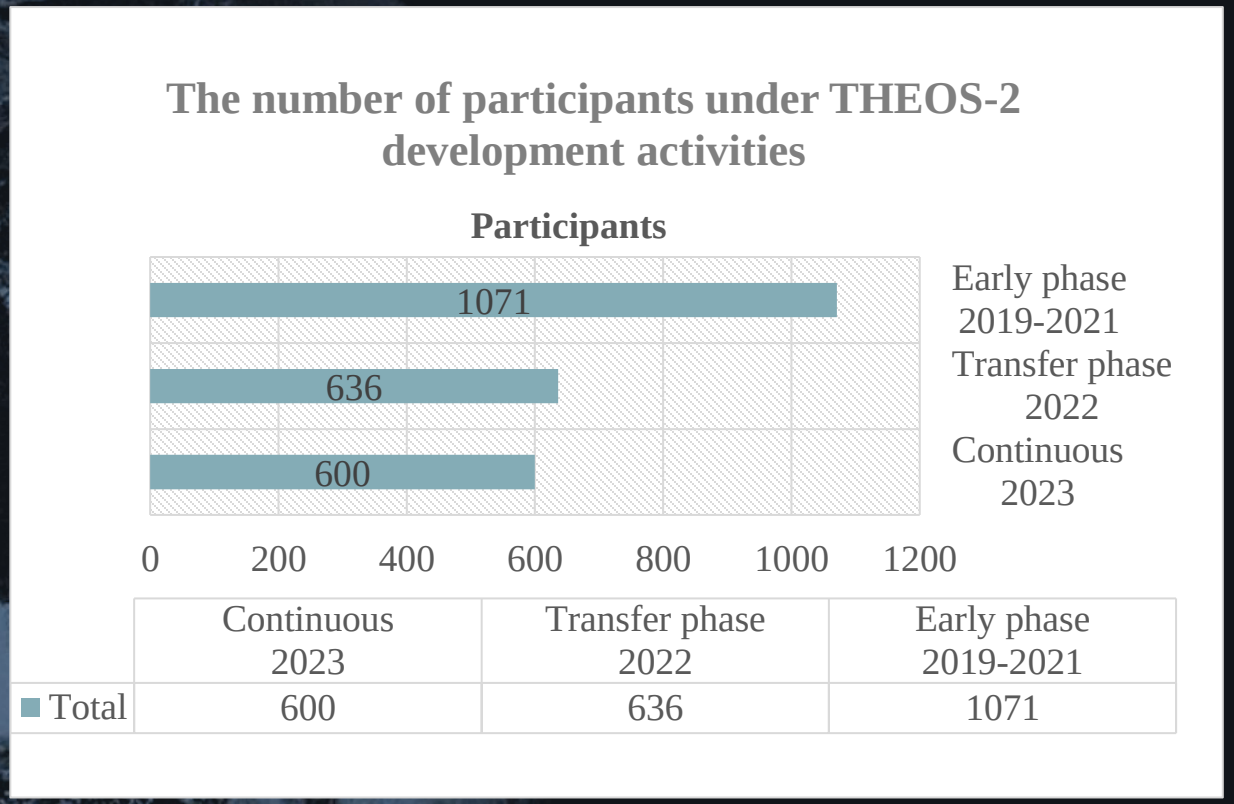
Student trainees gain more knowledge, corresponding to the number of hours participating in activities. Did not have the gap and reduced teamwork problem

Preparing the **general information** to avoid Intellectual property is an issue for technology transfer forwarding. Quality control by external expert evaluation methods.

Hybrid training alleviates the limit of budgets. Reduce the time and budget for travelling and accommodation and can be rerun anytime and anywhere

The number of participants under THEOS-2 development activities





	Continuous 2023	Transfer phase 2022	Early phase 2019-2021
Total	600	636	1071

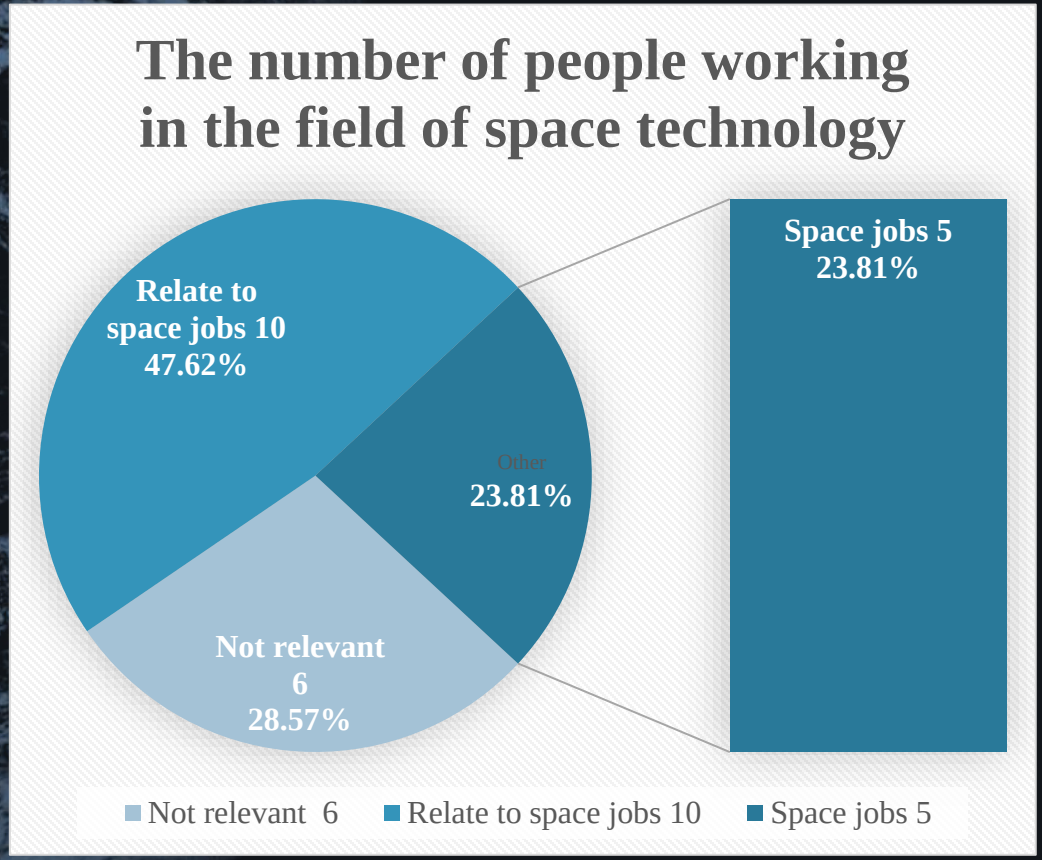
(2019-2021) 1071 + 2022 636 + 2023 600 = Now 2307

Next step (2024 to 2026) >1700

Totally (8 years) ~4000++

Follow up: Space jobs

- **6 months after course is completed: Totally 21 people outside Gistda**
- Attention level to work in space industry after training
  - ***5 = most interested: 17 (81%)***
  - 4 = very interested: 4 (19%)
- Number of job changes after training
  - ***Changed: 6 (29%)***
  - Not changed: 15 (71%)
- The number of people working in the field of space technology
  - 5 person in-space jobs
    - ***2 Engineers (Work at a space company)***
    - ***2 students studying Aerospace engineering*** -> have been trained in an aerospace company
    - 1 job is coordinator
  - 10 person: there are supportive parts such as consultants or research work or others related to this field.
    - Working on a capstone project, then going to work on a space application.
    - Use data for mapping, research about the application



Follow up: Knowledge utilization

Can the knowledge gained from the training be used for self-development or not?

- Hard skill is technical
  - Sub-system knowledge such as space environment, computer programming, finite element analysis, circuit design
  - literature review
- Management skills for space project such as
  - Systematic analytical thinking, review results phases, consider the risks, work is a standard procedure and Analyzing customer requirement
- Soft skills including problem solving, teamwork, presentation skills, project management, resolving conflicts in teams and team meeting management

Have you published or shared knowledge gained from training with others? How?

- Sharing and exchanging their experience with colleagues, lecturers, students, classmates and team member
- Apply knowledge to work in space research One article can be published at the National Mechanical Engineering Conference 2022.
- sharing satellite development process according to ESA standards and the phase review e.g., preliminary design review

What is the way forward for younger generations?

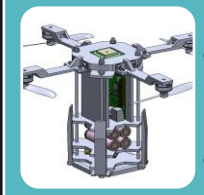
Continue

Education technology platform

- This has been launched -> Domestic (Thai language) https://www.theos2a.com/-> developing into international

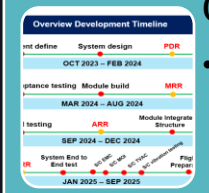
Space science school

- 1st year in Asian has been done (July2023) -> looking for 2nd year



SchoolSAT Project

- This has been started. There are 600 registers (ages 15-22), and the best 100 have been passed to train with satellite engineers.
- The final round of competition will be held in December 2023 -> looking for 2nd year



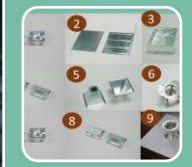
CubeSat Project

- This will be continued the early next year 2024 -> We expected the output of more than 60 younger space engineers can be built 1Flight Model and 6 Engineering Models within 2026

Outreach

Internship framework

- The apprenticeship framework is a key solution that addresses human capacity-building for us today.



Knowledge transfer to Thai entrepreneurs

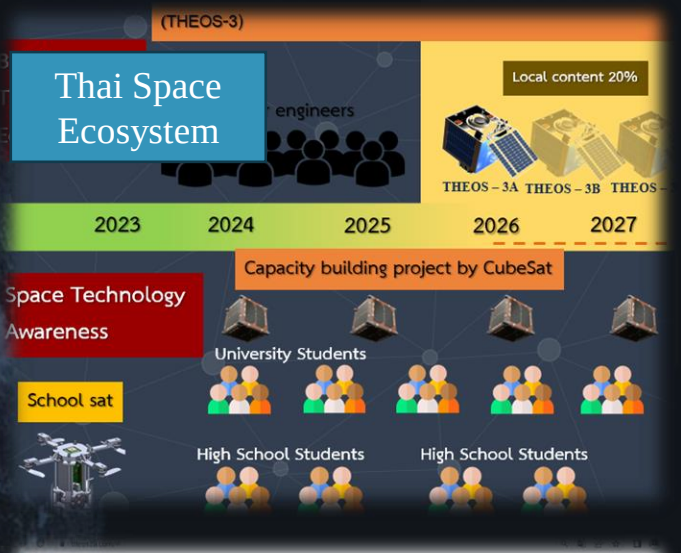
- Who are interested in enhancing the competitiveness of the aerospace industry, such as manufacturing control through ECSS standards, etc.

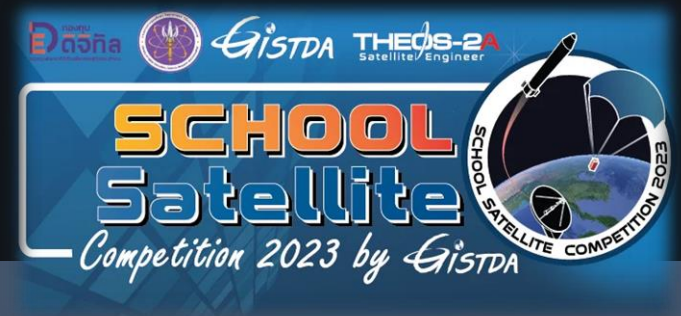
Asia Pacific collaboration

- Starts from AIT facility e.g., vibration testing service

Space science school collaboration with other countries

- Short course space camp





Thank you

Q & A