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
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

GISTDA’s SATELLITES

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
THEOS-2 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.
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
Hybrid Online And Hands-on Training Framework

Training program

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.

**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)
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

Round 2
- Advanced course: 10 Module (~120 participant)
  - Working Group (60 participant)
  - Selecting by presentation (passed 32) decided by mentor

Hands-on training: (32 participant)
- 5 months (3 groups)

Gender
- Male 81%
- Female 19%

Career
- Government 44%
- Education 47%
- Industrial 9%

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

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.
Hybrid Online And Hands-on Training Framework

Monitoring

- 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

Mini project -> SchoolSAT
MOOC: Online platform

Review (by reviewer team)
- Training plan
- Monthly Report
- Review Material

Complete the Monthly Report in every end of month and send to Your Mentor

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

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The satisfaction score of the participants in the blind test

Assessment score in overall
- HANDS-ON: 92.6%
- BASIC: 81%

Assessment score of Hands-on training
- MANAGEMENT: 88.2%
- TRAINER: 96.6%
- TECHNICAL AND THEORY: 93%

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%

Assessment topic in scoring
- Technical and Theory
  - Course objectives and Improve the knowledge after training
- Mentors
  - Methods, opportunity to ask questions and express opinions
- Management
  - Program duration, Facilitation of transportation and accommodation
What difficulties did you overcome and what recommendations do you have for countries wishing to follow the same path?

### Challenge: Training course during Covid-19 pandemic
- Limit the participant numbers entering work areas e.g., cleanrooms
- Effecting course operations are not continuous
- Training plan is delayed
- Training program is divided into 3 phase: online, online and hybrid.
- Hybrid course was separated into 3 subgroups:
  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

### Solution:
The timetable could be adjusted following a development plan and inform the trainee about this risk early.

### Challenge: 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 programme could be adjusted following a development plan and inform the trainee about this risk early.

### Challenge: Relationship (GAP) between Team
- 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

### Challenge: 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

**Technique**
- They are requiring more practice on the job training
- Request to learn in theoretical
- Learn another sub-system

**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.

**Management**
- Request longer period and extent program until the launch
- Would like more of all Sub-Systems to join Onsite at the same time.

### Recommendations from training program

**Technique**
- 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**
- 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
- 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

<table>
<thead>
<tr>
<th>Lessons learnt</th>
<th>Effect</th>
<th>Program Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limitations on facilities such as software license, the workplace of participant.</td>
<td>The limits of software licenses might affect training results</td>
<td>Budgets would be allocated for the main objective e.g., software to design and analysis, then a trial license alleviate this problem</td>
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<tr>
<td></td>
<td>The workplace cannot support the whole group</td>
<td>• Online meetings alleviate this problem</td>
</tr>
<tr>
<td>Transferability</td>
<td>The quality of some subsystems did not meet the standards</td>
<td>Experts will be invited to evaluate all modules for compliance including guest lecturer who specialize in that field. (require budgets)</td>
</tr>
<tr>
<td>• Knowledge transfer personnel have specialized knowledge</td>
<td>Knowledge transfer is incomplete</td>
<td>Mentee: Clarify the workload before you begin. Strictly rule being subject to penalties or deprivation of benefits</td>
</tr>
<tr>
<td>• Manhours less than expectation especially mentee</td>
<td></td>
<td>Mentor: Estimate real workload and catch up closely (monthly)</td>
</tr>
<tr>
<td>• Quality of report and level of evaluation score in training plan</td>
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<tr>
<td>Inadequate cooperation</td>
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<tr>
<td>The large number of participants makes it difficult to manage. The recommended number should not exceed <strong>10 persons per group</strong>, which is easy to manage such as facilities.</td>
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Student trainees gain more knowledge, corresponding to the number of hours participating in activities. Did not have the gap and reduced teamwork problem

**Training framework**

- 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

The number of participants in several activities

<table>
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<tr>
<th>Activities</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early phase 2019-2021</td>
<td>845</td>
</tr>
<tr>
<td>Transfer phase 2022</td>
<td>518</td>
</tr>
<tr>
<td>Continuous 2023</td>
<td>280</td>
</tr>
</tbody>
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The number of participants under THEOS-2 development activities

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<tr>
<td>Early phase 2019-2021</td>
<td>1071</td>
</tr>
<tr>
<td>Transfer phase 2022</td>
<td>636</td>
</tr>
<tr>
<td>Continuous 2023</td>
<td>600</td>
</tr>
</tbody>
</table>

(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

**The number of people working in the field of space technology**

- Relate to space jobs: 10 (47.62%)
- Space jobs: 5 (23.81%)
- Not relevant: 6 (28.57%)

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**Legend**
- Space jobs 5 (23.81%)
- Relate to space jobs 10 (47.62%)
- Not relevant 6 (28.57%)
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 (July 2023) -
  - 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 1 Flight 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