CanSat Leader Training Program (CLTP) Report

Hironori SAHARA[1)] Emiko ANDO[2)]
[1)] *Department of Aerospace Engineering, Tokyo Metropolitan University, Tokyo, Japan*
[2)] *UNIversity Space Engineering Consortium (UNISEC), Tokyo, Japan*
Cltp-office@unisec.jp

Abstract

CanSat Leader Training Program (CLTP), established in 2010 as part of the Japanese national program of New Paradigm of Space Development and Utilization Opened by Micro/Nano-satellites with Reasonably Reliable Systems 'Hodoyoshi' Concept led by Prof. Shinichi Nakasuka in the university of Tokyo, is sponsored by UNISEC to provide a training course for researchers and educators as one of the capacity buildings in space technology, and contains whole cycle of CanSat development involving design, fabrication, and launch by a model rocket or a captive balloon, lectures on space engineering and nano-satellite development, and tours of Japanese space institute, so that the participants are expected to learn the hands-on space engineering education methods using CanSat and to be leaders of space technology development in their home countries. The 3rd CLTP is co-hosted by Tokyo Metropolitan University and UNISEC from July 17 to August 20. In this paper, the result of the 3rd CLTP is reported.

Key Words: CanSat, Training Program, Space Engineering Education

1. Introduction

CanSat is a small satellite analog, which has been used for introduction of practical space engineering for more than ten years. All of the components, such as sensors, actuators, and GPS, are housed inside a 350-ml Soda-can. CanSat provides an affordable opportunity for educators and students to acquire basic knowledge of space engineering and to experience engineering challenges in building a satellite. In addition, they can learn basics of system engineering, project management, teamwork through CanSat activities.

The low cost of implementation, short preparation time and simplicity of design compared to other space projects make of this concept an excellent practical opportunity for students to take their first steps in space.

Fig. 1. CanSat developed in CLTP3

When it comes to developing small satellite, time and cost are required; thus even if students somehow get chance to be involved in small satellite project, they can hardly learn whole developing process of satellite but work on a specific part in limited time.

In Japan, CanSat activity has been developing for more than ten years since Robert Twiggs introduced it in Stanford University. ARLISS, A Rocket Launch for International Student Satellites, is held in Black Rock Desert, Nevada, the U.S. And students from Japan and some other countries have been attending ARLISS since 1999[1]. Driven by these activities, UNISEC, University Space Engineering Consortium, was founded in 2002[2] and became NPO in 2003 to train students for innovative space activity and to collaborate among universities throughout Japan. UNISEC is consisted of more than 640 students from 40 universities and more than 220 individuals and 10 supporting members. Not only CanSat, but also activities such as Micro/Nano/Pico satellite project, Hybrid rocket project and many other types of space activities are supported and cooperated.

Now, we decided to launch this knowledge and experience to all over the world.

Rei Kawashima, Chair of International Committee, UNISEC, declared, "We will make the world that space activity is not something special. That is such a world that more than a half of numbers of countries on the earth has ability to develop satellite/spacecraft. Then it will be natural for human activity to go out of gravity of the earth." This is the core motivation of why CLTP was held in Japan.

The 1st CLTP (CLTP1) was held in Wakayama University from February 14 to March 20 in 2012 with 12 participants from 10 countries of Algeria, Australia, Egypt, Guatemala, Mexico, Nigeria, Peru, Sri Lanka, Turkey, and Vietnam. [3]

Fig. 2. CLTP1

The 2nd CLTP (CLTP2) was held in Nihon University from November 14 to December 14 in 2011 with 10 participants from 10 countries of Ghana, Indonesia, Malaysia, Mongolia,

Nigeria, Peru, Singapore, Thailand, Turkey, and Vietnam. [4]

Fig. 3. CLTP2

In CLTP3, we aimed to have a chance not only to teach the significance and values of the basis of satellite subsystems but also to let the participants work so-called project management out on their own CanSat development, i.e. the importance of interface among not only subsystems but also human resources. We are going to open the new report of CLTP3 held in Tokyo Metropolitan University from July 17 to August 20 in 2012 with 10 participants from 9 countries of Brazil, Egypt, Israel, Lithuania, Mongolia, Namibia, Nigeria, Philippines, and Turkey, in the symposium.

Fig. 4. CLTP3 participants and TMU mentors

2. CLTP3 Program Contents

2.1 Lesson 0

Before the start of CLTP3, we introduced the outline of CanSat, its development environment, basic electronics, and tools for CanSat development as Lesson 0. We recommended the CLTP3 participants to read and understand them by the time of their arrival in Japan. As for the versatile products, they could find their information in detail on the corresponding websites. In addition, we informed them as follows:

- Participants in CLTP3 divide into 3 teams; each team consisted of 3 or 4 members and had one chance to launch a representative CanSat with a model rocket in Noshiro Space Event (NSE). Before NSE, each participant had 1 or 2 chances of his/her own flight test by using a balloon in Tokyo Metropolitan University (TMU).
- CanSat developed by the participant in CLTP3 was basically defined as a basic combination consisting of on-board computer (OBC), GPS, transmitter (XMTR), memory (EEPROM), camera (CAM in MISN) and ground station (GS), and we called it the Basic System. Indeed the number of components in the Basic System was a few, but their perfectly-harmonized operation was very difficult, and the participants are expected to aim the perfect operation as first priority.
- We noted that the members in a team developed a commonly-designed team CanSat in cooperation with each other; typically each member had charge of a subsystem of the team CanSat and all of them were integrated to the team CanSat as a whole system. This style is in common with actual satellite development or project management.
- If the participants had surplus time, we allowed that they installed their team's own mission (Optional MISN) into the team's CanSat, as shown in Fig. 5. Once again, the participant's first priority was to complete the perfectly-harmonized operation of Basic System.

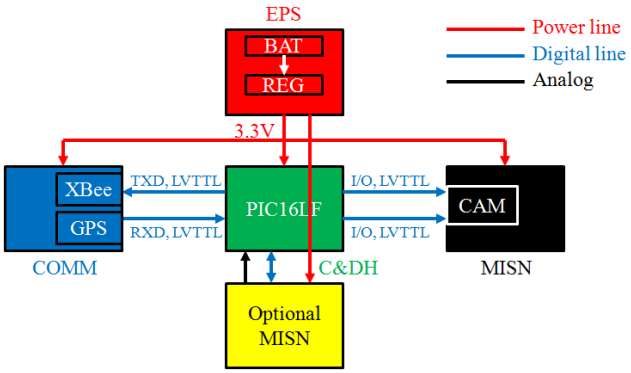


Fig. 5. Basic System, plus Optinal MISN in CLTP3 CanSat

2.2 Schedule

CLTP3 was progressed according to the following schedule.

Table 1. CLTP3 Schedule

1st week	Inauguration Ceremony CLTP Basic Course - Lecture Series #1-5
2nd week	CLTP Basic Course - Lecture Series #6-10 CanSat Fabrication
3rd week	CanSat Fabrication
4th week	Field Test by Balloon
5th week	Field Test by Model Rocket on the occasion of 8th Noshiro Space Event held in Akita, Japan

2.3 Lecture Series

One of the purposes of the CanSat Leader Training Program (CLTP) is to learn, through a miniaturized satellite, significance and values of the following basic systems:

1) Command and Data Handling (C&DH),
2) Communications,
3) Electric Power Supply,
4) Sensor,
5) Actuator,
6) Structural System,
7) Parachute,
8) Accessory Device,
9) Mission,
10) Ground-Based Station.

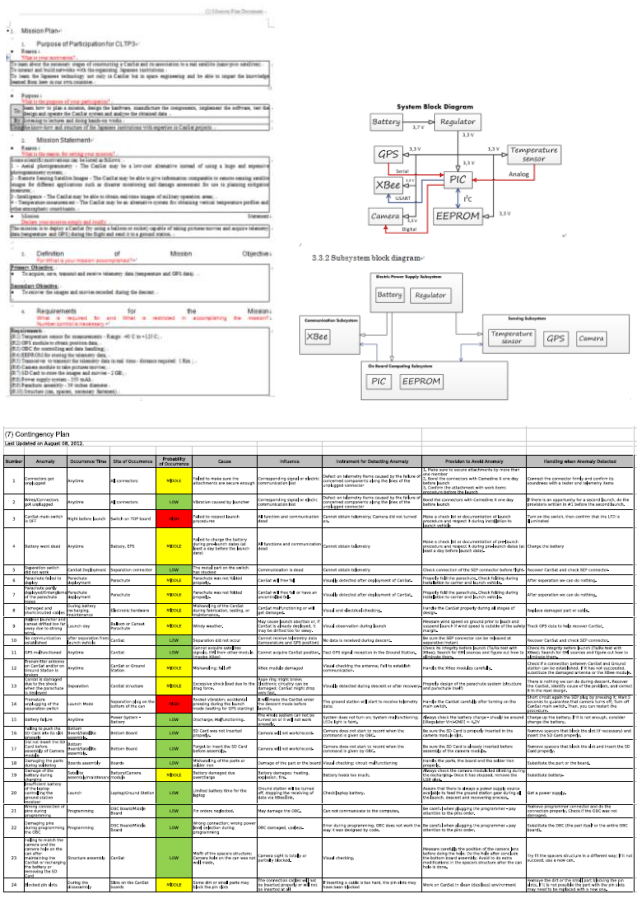
It is also to study how to combine element technologies of these systems for satellite operation, which is called the assembly, integration and test (AI & T) in a broader sense. In addition, the CLTP has an important mission to develop human resources capable of teaching space engineering education, using CanSat in particular, after its completion. The following lectures have been given as the CLTP basic course by UNISEC teachers.

1. **Introduction to and Overview of CanSat** by Shinichi Nakasuka, The University of Tokyo
2. **CanSat System and Subsystem and Preparation before CanSat Development** by Shinichi Nakasuka, The University of Tokyo
3. **Mission Subsystem** by Hironori Sahara, Tokyo Metropolitan University
4. **Structure and Accessary Devices** by Hiraku Sakamoto, Tokyo Institute of Technology
5. **How to Organize the Project and Design Reviews** by Seiko Shirasaka, Keio University
6. **RF Communication Subsystem and Ground Station System** by Seiji Kuroki, Professor Emeritus, Soka University
7. **Sensors and Actuators** by Masahiko Yamazaki, Nihon University
8. **Command and Data Handling (C&DH) subsystem and Power System** by Shinichi Kimura, Tokyo University of Science
9. **Ground Test and How to Feedback** by Yasuyuki Miyazaki, Nihon University
10. **Ground-Field Test and Safety Standards** by Hiroshi Hirayama, Kyushu University

2.4 Documents

The duration for CanSat development at CLTP3 was short as a month, so that we relieved the task of documentations. However, we requested the CLTP3 participants as team by team to document the followings in oder to share an awareness of the development of a system and confirm soundness of the system, as shown in Figs. 6:

- Mission Plan Document
  cleared up the purpose of participants for CLTP3, declared their mission statement, defined mission objective requirements for the mission, success criteria, and criteria for judgment of success and failure.
- System Specification Document
  made the requirements correspond to respective specifications, classify the specifications to subsystems, and configured a system to show its system block diagram.
- Contingency Plan
  was always updated by teams for their confirmation and procedure before flight.



Figs. 6. Documents created by the CLTP3 participants

2.5 Field Tests

The CLTP3 participants completed their CanSat development by Aug. 8, made a whole check on Aug. 9, and conducted a flight test with a balloon in TMU, as shown in Figs. 7. The purpose of the test was to confirm soundness of their integrated CanSat of the Basic System related to the above, and to experience their demonstration as one of the milestones and learn the flight test in order to hold the similar experiment in their country after CLTP3. As the result, they achieved confirmation of their CanSat and extracted problem points from the final flight in NSE.

Figs. 7. Conducted a flight test with a balloon in TMU

Figs. 8. Teams in CLTP3, just before their launch

The CLTP3 participants improved and more developed their CanSat until Aug. 14, the day before departure for Noshiro. At the end of works on Aug. 14, we, the CLTP3 participants and TMU members, cleaned up the workroom we used for a month; all members took well awareness that '*Clean up the place before when you leave*' was a part of project management and its importance.

We all left for Noshiro on Aug. 15, and set up a site of NSE and made a final confirmation on Aug. 16. On Aug. 17, we succeeded in launching 10 CanSats of all the CLTP3 participants, as shown in Figs. 8, thanks to Prof. Akiyama and the other collaborators.

The participants obtained their respective results; 8 CanSats were of success to achieve the mission of the Basic System and shot very nice movies from the sky. Fig. 9 is one scene from the movies, and some of them caught the other CanSats in flight shown in Figs. 10.

Fig. 9. One scene from the CanSat in flight

Fig. 10. A CanSat in flight taken by another CanSat

3. Result and Future Plan

CLTP3 ended successfully as they all experienced the primary purposes of this program. Instruction material of space education focused on CanSat is now in progress, and it is going to be tailored and translated into the version of respective countries.

4. Conclusion

We will be watching how this project will be followed up in the participating countries as Post CLTP activities.

Once again, CanSat is very useful to encourage young students into science and engineering careers. These activities have been carried out with a relatively low cost, where the materials are reusable and recoverable. By this practical training in the development of CanSat, students are able to: conceptualize the mission, plan and design, as well as to manufacture and test their prototypes on the ground, change and improve iteratively their CanSat prototypes. It educates students on key basic concepts of project management with a personal experience in the following areas: "project integration, scope, time, cost, quality, human resources, communication, risk and procurement management". The importance of teamwork made them perform technical discussion, documentation, and learning from failures and conflict resolution, carried out the tests that enable them to continually improve.

In addition, CLTP activities allow not only CLTP participants but also Japanese students of the host university to establish international collaborative network of contacts in the international space education. These activities will help form International CanSat student groups who will be able to participate in international CanSat competitions in the near future.

Continuing improvements can be applied for future CLTP, and succeeding efforts are indispensable.

Acknowledgments

First of all, we'd like to take this opportunity to express our gratitude to the Cabinet Office, Government of Japan for funding support on this program. In addition, we received generous support from Noshiro Space Council concerning the CanSat Launch Test on the occasion of the 8th Noshiro Space Event held in Akita, Japan from August 17-19, and Sahara Laboratory member staffs of Tokyo Metropolitan University, staffs of Wakayama University and UNISEC worked very hard behind the scenes.

We owe our deepest gratitude to lecturers, including Prof. Nakasuka, Prof. Kuroki, Prof. Miyazaki, Prof. Kimura, Associate Prof. Shirasaka, Dr. Hirayama, Dr. Sakamoto and Dr. Yamazaki.

Last of all, it was an honor for us to work together with CLTP3 participants.

References

1. University of Tokyo CanSat Website, "CanSat Main Page", http://www.space.t.u-tokyo.ac.jp/cansat/r_index.html (August 2012)
2. UNISEC Website, "About UNISEC", http://www.unisec.jp/about/indexe.html (August 2012)
3. Yamaura, S., Akiyama, H, Kawashima, R." Report of CanSat Leader Training Program", 5th International Conference on Recent Advances in Space Technologies (RAST), 2011, 9-11 June 2011, pp. 856 – 860, Istanbul.
4 Kamemura, H., Fujii, D., Inoue, S., Yamazaki, M., Ainoura, K., Okumiya, T., Saito, M., Matoba, K., Araki, Y., Miyazaki, Y., Ando, E., Akiyama, H., "Report on Cansat Training Program CLTP2 (PDF in Japanese, 1,313KB)", The 20th Space Engineering Conference(SEC' 11), Sendai, Japan-January 26, 2012