ABSTRACT

In 2006, The Norwegian Centre for Space-related Education (NAROM), Andøya Rocket Range (ARR) and the Norwegian Space Centre (NSC) decided to initiate a Norwegian student satellite program (ANSAT) as a subsequent program to the NCUBE projects. This includes the development and launch of three to four satellites. Narvik University College is responsible for building the first satellite called HiNCube. The University of Oslo is responsible for building the second satellite called CubeSTAR. This paper will give an introduction to the ANSAT program, including the satellites, the interaction between involved partner - the institutions, industry and the ANSAT management. In addition some of the student activities available for participating students will be presented.

1. INTRODUCTION

In the past, there has been built two student satellites in Norway. Both satellites are of the CubeSat standard format.

The satellites were identical and had an Automatic Identification System (AIS) receiver as the primary payload. NCUBE-1 was launched July 26th 2006, on the launch, known in the CubeSat community as DNEPR-1, where the CubeSat participation was organized by California Polytechnic University in Sal Luis Obispo. The launch was from the Baikanour Cosmodrome, Kazakhstan. Unfortunately the launch vehicle experienced problems shortly into the launch, and shut down, crashing into the desert and not making it into orbit.

NCUBE-2 was launched with two other CubeSats embedded in the SSETI EXPRESS on October 27th 2005. The launch was successful but no contact was made with the satellite.

The NCUBE project ended without having a successful flight of the satellites, however approximately 100 students from four different universities participated in the development and construction of the satellites. Hence in terms of increased knowledge, experience and enthusiasm for further studies the project where a huge success for the students.

In 2006, The Norwegian Centre for Space-related Education (NAROM), Andøya Rocket Range (ARR) and the Norwegian Space Centre (NSC) decided to initiate a Norwegian student satellite program (ANSAT) as a subsequent program to the NCUBE projects running from 2007 - 2011. This includes the development and launch of three to four student satellites.

2. ANSAT

The ANSAT program is organized as a project, with the organizational structure described in the organizational chart in Figure 1.

2.1. Program head

The NSC is the top branch of the program, in charge of keeping the program within the limits drawn up by the terms of the funding.

2.2. Program board and responsible at NAROM

The person in charge locally is the Program Responsible, located at NAROM. This person has a program board at his disposal for advisory function. The program board meets regularly, and is put together with officials from the NSC, ARR and NAROM. The program board advices on everything from how the satellite construction and development is going, to the educational outreach and conferences to sponsor students to go to.

2.3. Project manager and technical coordinator

ANSAT is run by NAROM located at ARR. The program management consists of the project manager, employed by NAROM, and the technical coordinator employed by ARR. The daily administration is done by the project manager by communicating with the institutions, carrying out the terms listed in the contract between the program and the institutions. The technical coordinator is available for the satellite projects to advice on technologies, to introduce them to industrial partners, to aid in technical development, and several other areas upon the satellite teams request. The technical coordinator is also in charge of the operation and maintenance of the amateur satellite ground station located at Andøya. In addition, the location at ARR provides access to educational and technical personnel.
as well as technical resources located at the launch site.

2.4. Expert group

The expert group is put together with members from ARR, Kongsberg Defense and Aerospace (KDA), Norspace and NTNU. The joint experience of the members include but is not limited to scientific and industrial experience with small and large satellites, both full satellite systems and single subsystems. Also test procedures are well known to this group.

The expert group participates at workshops and reviews for the projects, giving advice on both the technical and organizational parts of the satellite building. This advice is greatly appreciated, and it is well known that professional attention to the program is a motivational factor for the students. The expert group attended both the preliminary design and critical design review of HiNCube, giving valuable feedback to the students involved.

2.5. Funding

Funding of this program is mostly provided from the NSC but also from NAROM and ARR. This funding includes testing and launch for the participating institutions. It also includes funding for some of the electronics, travelling and participation for students to workshops and conferences both nationally and internationally. In addition to the funding from NSC, the institutions have to fund their own hardware, which means they have to pay for the equipment and technology they develop themselves. This can be done by for example in getting external funding or internally in their institution.

3. INVOLVED PARTNERS

3.1. Norwegian Space Centre

The Norwegian Space Centre is a Norwegian government agency that promotes the development of Norwegian space activities. These activities are both industrial and educational. More information about NSC can be found in [2].

3.2. Andøya Rocket Range

ARR is the world’s northernmost launch provider for sounding rockets. The range is located on the island of Andøya, at 69 degrees North and 16 degrees East on the Norwegian coastline. The impact area for sounding rockets launched from Andøya stretches between Iceland, Greenland and across the Arctic. A second launch site is also run by the rocket range, located in Ny Ålesund on the island of Svalbard. Rockets from this launch site are launched southward. This way, a wide range of measurements can be done, measuring phenomena as Aurora Borealis during day or night conditions as well as Noctilucent Clouds during the summer. In addition to the launch site, ARR also houses the Arctic Lidar Observatory for Middle Atmosphere Research (ALOMAR) facility. Also, ARR has several other instruments and facilities for ground based geophysical measurements to aid the scientist in launching their rockets into the best possible conditions for their research. More information about ARR can be found in [3]

3.3. NAROM

NAROM - Norwegian Centre for Space Related Education was opened in 2000 by the Minister of Educational Affairs and is partly funded by the Norwegian Government. The Centre was formed to organize space education in Norway and to ensure recruiting, promote appreciation for the benefits of space activities, and to stimulate the interest for science in general. NAROM is a subsidiary company of ARR and is co-located with ARR at Andøya. In addition to hosting the ANSAT program, NAROM host’s courses for pupils, students and teachers from upper primary school to university level within subjects as space technology and space physics. Most known are the European Space Camp and the Teacher Space Camp. They draw participants from all over the world that want to learn about space science and technology. After a week with classes and lab work, the students (or teachers) get to run their own launch campaign, and launch a student rocket with their own instruments to about 10km altitude. NAROM host several different web based resources where SAREPTA.org is the most know, also available in English. NAROM also has the responsibility of running the European Space Education Resource Office in Norway, where the main activity is to provide 25 teacher training courses the next three years for teachers at upper primary school within natural science and geography. In 2008 NAROM arranged 69 activities where over 2500 people attended. More information about NAROM can be found in [4]
3.4. Industry
Both KDA and Norspace have shown interest in hosting qualification testing of the satellites in the program. This will provide a benefit both to the program and to the industry. This will introduce the students to the procedures used in professional testing of the satellites that will go into the space environment. At these locations thermal testing, vacuum testing and thermal cycling in vacuum chambers is possible. Also vibration testing with and without extreme temperatures is possible, along with several other tests that are used on professional space components. In addition KDA and Norspace provide valuable feedback as members of the expert group.

3.5. Others
ANSAT is also working closely together with other partners to exchange information and knowledge within the CubeSat community. More information about the ANSAT program can be found in [4].

4. PARTICIPATING INSTITUTIONS
Currently there are two ongoing student satellite projects. Narvik University College (NUC) is responsible for building the first satellite called HiNCube. The University of Oslo (UiO) is responsible for building the second satellite called CubeSTAR. It is not yet decided which University will be responsible for the third and forth satellite. However the Norwegian University of Science and Technology have been invited to enter the ANSAT program.

All of the satellites are to be designed and built after the CubeSat standard. The student satellite project teams are free to organize as they see fit. This will lead of course to several ways of organizing.

4.1. Narvik University College - HiNCube
The HiNCube team is working as an all student driven project, with the professor stepping in and guiding. The students have dived them self into different group responsible for the different kinds of subsystems. The students them self has also formed a management team who tries to keep control of the other teams, making sure that every team is working with their assign task. The organization of the HiNCube project is shown in Figure 2.

HiNCube has chosen a one unit CubeSat with a maximum weight of 1kg and the dimension of 10x10x10cm$^3$. A 3D model of HiNCube is shown in Figure 3. HiNCubes mission is to build a CubeSat, which will be deployed into low Earth orbit to take pictures of the Earth. The actual payload consists of a Camera and thermal sensors placed around the satellite.

During the spring of 2008, HiNCube was selected as a backup satellite for the CubeSat payload opportunity on ESAs Vega Maiden Voyage.

A Critical Design Review of HiNCube where held at Narvik University College March 27th. More information about HiNCube can be found in [5]

![HiNCube organization chart](image)

4.2. University of Oslo - CubeSTAR
CubeSTAR entered the ANSAT program in December 2008 and is organized differently than HiNCube with employees as a project manager, technical manager and a scientific manager. In addition UiO has several employees supporting the CubeSTAR project. The professors and staff at UiO try to stay ahead of the students and give them support in the design process of the satellite. The students have been divided into different groups where each group is responsible for one or more subsystems. A model of the CubeSTAR satellite is shown in Figure 5.

CubeSTAR is being design as a two unit CubeSat with a maximum weight of 2 kg and 20x10x10cm$^3$. Their mission is to demonstrate a new concept “Space Weather” satellite. In polar regions there are often auroral irregularities, which might disrupt signals from navigation and communication satellites. An illustration of this is shown in Figure 4. Hence we need to
investigate the region that disrupts the signal to know more about this. Therefore the University of Oslo has come up with a new payload consisting of Multiple Needle Langmuir Probes (m-NLP) which are able to achieve meter resolution instead of km resolution of absolute electron density measurements. The concept has been tested on the ICI-2 rocket which where launched in December 2008 from Svalbard, Norway.

Figure 4. Auroral irregularities disrupting signals from communication and navigation satellites

5. GROUND STATIONS

There are two ground stations that are controlled by ANSAT. One station at Svalbard, 78 degree North and the other one at Andøya Rocket Range, 69 degrees North. Both ground stations are built and set up mainly by students. In addition, there is a ground station at NUC that was set up during the NCUBE project, and a newly built ground station at UiO that will be the main ground station for CubeSTAR. These stations are owned and controlled by NUC and UiO respectively.

5.1. Svalbard

The ground station at Svalbard was originally set up as a part of the NCUBE project and where designed to be remotely controlled from the mainland. The station is currently under reconstruction, upgrading and testing. This is done in close cooperation with Svalbard Satellite station (SvalSat division of Kongsberg Satellite Services, KSAT), the owners of the ground station. The upgrading of the station is intended to make it compatible with GENSO, the global educational ground station network that is under development. By using GENSO software and compatible stations, satellites will be able to transmit down data continuously on some passes that overfly Svalbard and the Norwegian mainland. Before GENSO is operational, the station will still be useful in listening to new student satellites because it is able to see all 14 passes a day of a typical student satellite LEO orbit and download data from the satellite.

Figure 5. Model of CubeSTAR

5.2. Andøya

The Ground station at Andøya was built in August 2008 by NAROM together with students from the University of Oslo. As shown in Figure 6, Six students used 1 week in cooperation with the ANSAT technical coordinator and successfully built the station. At the end of the week the station tracked and received beacon signals from the Japanese satellite XI-IV and other satellites. This station will be available for NAROM activities, as well as support for satellites in the ANSAT program and possibly other satellite projects as well.

Figure 6. Students setting up the ground station at Andøya.

6. STUDENT ACTIVITIES

ANSAT will offer the participants possibilities to join in workshops and conferences, both international and national arranged by the program. The aim of the workshops is to give the institutions that are working on these projects a chance to come together
and discuss their ideas on design and solutions and to exchange valued experience. It is also important that we introduce the students to experts from industry that have years of experience on designing and building spacecrafts so that the students can learn and to prepare them for the working life.

It may be useful for students to meet with other students also, both nationally and internationally, to discuss their ideas. Attending conferences and workshops for the students often give them an extra drive to reach their goals and to finish with the project they are doing. For many the chance to give presentation for fellow students or experts is an incentive for hard working students that are most of the time doing these projects in addition to their studies.

Now that the program has entered the second phase with two satellite project being done simultaneously, the aim for the workshops are to have both the projects on common workshops. This will give the "beginners" a chance to learn from the "experts" that are already working on their project and the "experts" a chance to present their work and get it reviewed by another group.

7. REFERENCES
1. The ANSAT, http://www.ansat.no
4. NAROM, http://www.narom.no
5. The HiNCube, http://hincube.hin.no