24th, MIYAZAKI
ISTS

ISTS 2004-u-05

Education Program in Kakamigahara Chapter of Young Astronauts Club-Japan

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24th International Symposium on
Space Technology and Science
Miyazaki, Japan
May 30-June 6, 2004

24th International Symposium on Space Technology and Science
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Abstract

The Kakamigahara Chapter of Young Astronauts Club-Japan(YAC-J) has been working on the education program related to rocket launchers. In 1992, they sent a team to participate in the World Wide Launching Campaign held at Moumelon le-petit near Reims in France. They brought a small experiment rocket called YAC- γ -92. This Program was supported by the Headquarter of YAC-J, the Kakamigahara Aerospace Museum, the city of Kakamigahara and various private companies. Since then, the chapter created the various educational programs related to rocket launchers.

This paper reviews these education programs and discusses some of the future plans.

1. Brief History of the Kakamigahara Chapter

The chapter was established in 1989, with the support from YAC-J Headquarter, the Kakamigahara Aerospace Museum, the city of Kakamigahara and various private companies. Some young engineers of Kawasaki group led the activities of the chapter.

After some monthly activities, they had the chance to build a small experiment rocket and joined the World Wide Launching Campaign in France in 1992. The team of 10 young people launched 2 small rockets(Red and Blue). One of them was the complete success.

In 1997, they sent 2nd experiment rocket to Bourges in France. It was a two-staged rocket called KHR-96.

In 1999, they organized the Annual All-Japan Water Rocket Festival in Kakamigahara. It was the beginning of creating consistent education program concerning launchers.

Based on these experiences, they developed 2 major areas of activities; namely

- ◆Invented High-Tech. Water Rockets in 2001
- ◆Started Continuing International Exchange Program with 'Ile de La Reunion' of France in 2002, and welcomed the mission from La Reunion in 2003.

2. Intent of the Education Programs

These programs were to stimulate young leaders for the long lasting activities of the chapter. They have potentials over wide areas such as;

- ◆Familiarize young people with space related technologies
- ◆Familiarize them with basics of rocket propulsion
- ◆Get them create their own missions
- ◆Get them manage a small system on their own
- ◆Familiarize them with micro-computers & sensors
- ◆Get them communicate with people from the different part of the world

3. Brief Overview of Rocket Education Program

The chapter started with the elementary level water rockets. These are the simple plastic bottles with small fins, within which the water was pressurized with air.

In the second step, water rockets are equipped with micro-computers & sensors. These rockets incorporate fairly modern technologies and may trigger the imagination of senior high school

students.

The highest level of these programs is to build small experiment rockets. These rockets may have some payload capability and will be a good exercise for young college students and engineers.

These steps and descriptions are summarized on Table 1.

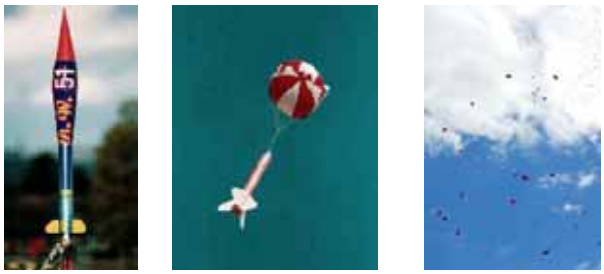
Table 1. Brief Overview of Rocket Education Programs

Steps	Descriptions	Remarks
First Step (Initial Level)	・Elementary Level Water Rockets ・With Pressurized Water Propellant ・With Various Configurations ・Flight Altitude less than 100 meters ・Launched Easily and Frequently ・Safe	・For Elementary School Kids ・Idea Water Rocket Contest at Kakamigahara Aerospace Museum ・Various Types Available
Second Step (Middle Level)	・Higher Level Water Rockets (Hi-Tech Water Rockets) ・With Pressurized Water Propellant ・With Micro-Computers and Various Sensors ・Flight Altitude up to 100 meters ・Launched Frequently ・Safe	・For Senior High School Students ・Under Development in Kakamigahara Chapter of YAC-J
Third Step (High Level)	・Creative Missions for Small Experiment Rockets ・With Solid Rocket Motors and Micro-Computers ・Flight Altitude up to 1 Km	・For College Students and Young Engineers ・Launching Campaign, hosted by CNES & ANSTJ in France

3.1 Elementary Level Water Rockets

In this step, various types of water rockets have been invented. Basically they are the plastic bottles filled with pressurized water. They are easy to make and safe to operate. The chapter organized the Annual All-Japan Idea Water Rocket Festival at the Kakamigahara Aerospace Museum. This Festival has been supported by YAC-J and the Aerospace Museum of Kakamigahara.

Some of these water rockets are shown in Fig.1.



(Balloon Type) (With Parachute) (Flight Demo.)

Fig.1 Various Types of Elementary Water Rockets

These rockets are propelled by the pressurized water inside the plastic bottle, and the thrust would be 90 to 70N with the pressure of 7 atm inside the bottle. The thrust would quickly decrease after its launch. However, the weight of the rocket would also decrease since the major portion of its system weight is for the propelling water. Although the thrust is smaller compared with ordinary rockets, still they can take some payloads. These payload capabilities lead to the concept of High-Tech. Water Rockets.

3.2 High-Tech. Water Rockets

The high-tech. water rockets in the second step are the rockets with micro-computers & sensors. Micro-computers handle the operation sequence and gather the data from sensors. In these days, computers and sensors are readily available from commercial fields. They have highly sophisticated performances with compact and light weighted.

As to the computers, the chapter uses PIC16. This computer has some A/D converters and DI/DO ports. These I/O ports can be used to control the sequence of the rockets, and to gather the data from sensors, such as speed meters and GPS receivers. The program for this computer is easy to develop using C computer languages.

One example of this type of water rockets is shown in Fig.2. In this case, pressure sensors to measure the speed of the rocket were on board. It flew only up to 30 meters high, yet it was enough to confirm the function of the sensors. Moreover, it is easy to repeat the flight in case the payload has malfunctions.

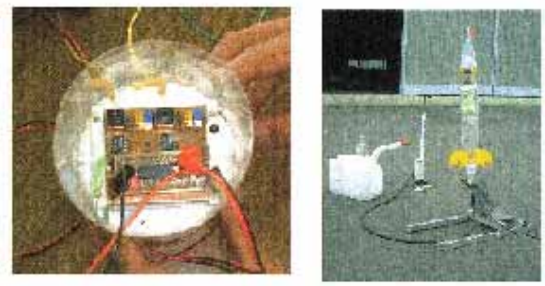


Fig.2 High-Tech Water Rockets

These high-tech water rockets have been used to develop the necessary sensors for small experiment rockets in the chapter.

3.3 Small Experiment Rockets

The final step for the chapter has been the small experiment rockets. Two rockets have been already assembled and tested in France. Unfortunately the environment for the launch of this type of rockets is

not prepared in Japan for the time being.

The first try was made in 1992. It was the year of the International Space Year (ISY'92), and YAC-J received the invitation to join the World Wide Launching Campaign from ANSTJ of France (French national association of engineering for the young). The Kakamigahara chapter decided to submit the proposal to join the campaign with a single stage small rocket called YAC- γ -92. It had a computer (Z80-8bit micro-computer) on board, and the operation sequence was controlled by this computer. Namely the timing of the opening of parachute door has been controlled by the computer as scheduled. Also the data from the sensors, such as an accelerometer and pressure sensors, are gathered through the A/D converters. It also had a telemetry system to send the sensor data to the ground.

The chapter brought two identical rockets (Red and Blue). Red went well and recovered successfully after the flight. However, the telemetry was not working properly and all the expected data were recovered from the computer memory. From these data, the flight trajectory was confirmed. Blue had some troubles with its computer from the beginning. However, the team decided to give it a go. It was a complete failure. The computer did not work to open the parachute door, and the rocket crushed on the ground after its ballistic flight. The launch of this rocket (Red) is shown in Fig.3.

Fig.3 Launching of YAC- γ -92 Rocket (Red) in 1992, France

This rocket had the length of 1.3 meters and the dimension of the main body was 0.1 meters φ, and the weight approx. 5.7 Kg. It was propelled by the solid rocket motor with the thrust of 600 N. It reached approx. 1.3 Km high. Before the launch, the system, structure, electronics, sequence and other devices were inspected by the Campaign teams of engineers. The rocket motor was supplied by the Campaign organization.

The second try was made in 1997. The chapter put the larger 1st stage on YAC- γ -92, and it became a two stage rocket. The new rocket was called as KHR-96 Rocket. On the first stage, it had a Video camera to see the forward and the aft through bi-directional mirror (a beam splitter), and a compact film camera on the second stage. On each stage there was a H-8 micro-computer to control the operation sequence and to gather the data. The system inspection and the rocket on the launcher are shown in Fig.4. The overall length of the rocket was 2.5 meters, and it weighted 15.4 Kg. The thrust of the 1st stage was 900 N. A motor for the second stage was not supplied because the second stage might go out of the safety zone for the launch. However, the stage separation mechanism was installed, and the separation was controlled by the on-board computer.

(System Inspection)

(On the Launcher)

Fig.4 Launching of KHR-96 Rocket in 1997, France

The launch of this rocket was successful, and the stage separation worked properly. However, the deployment of the 1st stage parachute was engaged while the speed of the rocket was not low enough, and hence the sling of the parachute was torn off.

The 1st stage and its equipment, all crushed after the ballistic flight. It was because the timing sequence was somehow to be changed on site. The second stage was jettisoned and recovered safely and took some pictures of the launching ground.

4. International Exchange Program

In 1992 and 1997, the Kakamigahara chapter sent the mission to France to launch small experiment rockets. It was the beginning of the long lasting relationship with France. In the summer of 2003, the chapter welcomed the mission from 'Ile de La Reunion', which is a French island in the east of Madagascar, to discuss the exchange program between La Reunion & Gifu area. This is a multi-lateral relationship between universities, provincial governments, museums and space clubs, in which Gifu University, Gifu Prefecture, the city of Kakamigahara, the Kakamigahara Aerospcae Museum, VR Techno Center and the Kakamigahara chapter of YAC-J are involved. This relation was triggered by the activities related to space technologies. In the year of 2004, the Science Sainte Rose of La Reunion is planning to have the International Water Rocket Festival, and invited groups from many countries on the rim of the Indian Ocean. The chapter is preparing to send some people to join the Festival.

In the process of this international exchange program, Gifu University has already welcomed the president of University of La Reunion this year, and discussed future collaboration in several areas of research.

The chapter itself has been planning to have the continuing relation with this island, firrst by visiting each area to know better each other. Then the chapter is hoping to have the exchange on the technologies such as water rockets and small satellites..

5. Future Scope

The Kakamigahra chapter is now working on the third Small Experiment Rocket (KHR-05 Rocket). This small rocket may have a small quasi-satellite system on board. The concept of this rocket is shown in Fig.5.

This program is the continuation of the previous launching programs, and the performances of its payloads will be ever better as technologies in the commercial fields advances.

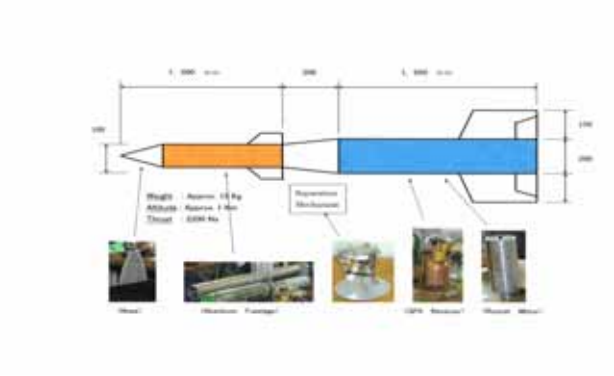


Fig.5 Concept of KHR-05 Rocket

In the process of creating KHR-05 Rocket, 'Space Club of Gifu' is organized. It is the group of young students, engineers & small private firms, who are interested in space technologies. This 'Space Club' is the new concept in which some people gathers from the different sectors of the society. There is a hope for the group in which they may create new ideas and concepts to utilize future space systems.

International Exchange will continue with 'Ile de La Reunion' not only in space related education but also in other cultural fields. The future scope of these activities will come from the imagination of all the participants at present & in the future.

Aknowledgement

The authors would like to express their sincere gratitude to all the participants in Gifu area, and especially to Dr. Guy Pignolet of the Science Sainte Rose and Ms. Akiha of YAC-J who encouraged us in every aspect of this endeavor from the beginning. Without their interest & support, these programs had not been created.