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THE FRENCH NATIONAL ROCKETS LAUNCHING CAMPAIGN AND THE DAWN OF ITS COLLABORATION WITH JAPANESE AMATEUR SPACE CLUBS

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ABSTRACT

Since 1962, the French space amateurs have been engaged in launching rocket projects under the control of CNES and the assistance of Planète Sciences. These groups gather at the yearly summer launching campaign organised in France. Considering design constraints dealing with safety and technical matters, space clubs are designing and building experimental rockets which are given flight authorization once they have passed a strict list of controls.
This unique event supported by CNES attracts foreign clubs, especially from Japan where three clubs have now become regular participants in the campaign. These clubs enjoy the technical support provided throughout the year, together with the pedagogical and scientific approach promoted by Planète Sciences. It enables students from as young as 16 to achieve a complete space technical project with safety guarantees. The collaboration with French clubs reached its first milestone in 2007 with a French quasi-satellite onboard a Japanese rocket in France. Collaboration will grow among the clubs together with the motivation to develop international relations within common passion and interests for space usage.

1-INTRODUCTION

1.1 CNES, the French space agency established in 1961, is a public organization in charge of the development and management of the French space programmes. Its mission is to guarantee access to space capability and its use for all national and European needs. This includes support to space amateurs. Under the control of CNES, Planète Sciences, a non-profit organisation, was formed in 1962 to provide assistance to space clubs for the design, manufacturing and launching of the experimental space projects rockets.

1.2 Planète Sciences is a network of regional associations who promote sciences and technology through practical activities and experimentation to youth from elementary school to university levels [1]. The spectrum of thematics has broadened over the years and now includes, space activities, astronomy, robotics, environment, meteorology, energy and archaeology.
Further to nation wide programs and trainings, Planète Sciences organises events or contests such as Eurobot and Eurobot Junior [2], First Lego League, La nuit des étoiles (the night of the stars), the national launching campaign.

1.3 Support to amateurs

It originally started with space activities at a time when the space conquest was leading passionate people to build amateur rockets. Several of them lost their lives while tuning rocket engines made of World War II military ammunition collected from battlefields or by using approximate chemistry formulae.

To prevent further accidents, the French government prohibited any non-professional astronautic activities and assigned CNES to provide assistance to amateurs. The necessity to set specific programs for the youth emerged from the fear that a total prohibition would not eliminate the risk of accidents but on the contrary would promote clandestine usage. CNES, for practical reasons, could not have formal relations with individuals and therefore invited them to gather in clubs thus contributing to the establishment of an association named "Association Nationale des Clubs Spatiaux" (ANCS), now Planète Sciences (Fig. 1).

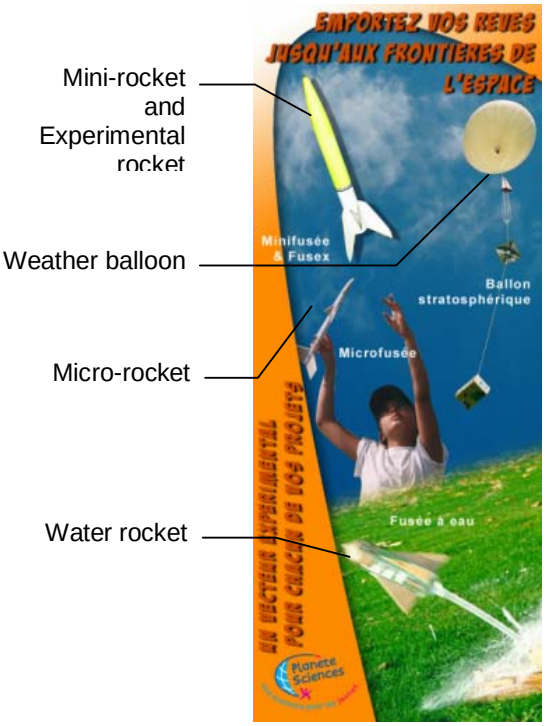

Fig.1: Space activities at Planète Sciences

Influenced by the professional background of its creators, who were members of the industrial world, the association developed avant-garde pedagogical methods that are based on concepts such as:

- To introduce youth to science and techniques through practical activities,
- To develop these practices as leisure activities,
- To promote teamwork,
- To offer youth the opportunity to engage in exciting projects such as rockets, where the tuning complexity naturally justifies the necessity to learn,
- To introduce youth to project management and experimental process since, in order to be successful, the capacity to manage a project is as important as the technical knowledge itself.

When a team is willing to start a rocket project its first step is to make contact with CNES through Planète Sciences. The three parties are bound by a moral contract which may be summarized as follows:

the tuning of a rocket engine is very dangerous for novices and CNES prohibits this practice; alternatively, clubs are invited to design and build a rocket for which CNES provides with both a professional quality powder engine and the launching facilities. From its side, Planète Sciences organises technical assistance, the launching campaign itself and ensures that the activities fall within the European regulations.

The efforts of the clubs are thus focused on their mission which is the experimental content of the payload and the mechanical structure of the rocket. The set up of the propeller and the rocket launch are the responsibility if a professional pyrotechnician from CNES.

A typical experimental rocket is 2 meters long, weighs about 10kg and reaches heights of about 1500 meters as shown in Fig. 2. About twenty rockets of that type are built and launched every year by club members from ages 14 to 25, who come from regions across France, and also from Japan.

Fig.2 Rocket launching by
the French club CLES-FACIL

2- H-10 months

A club willing to turn their dreams to reality can register their rocket project from early October of each year. The club members are required to prepare the definition of the mission and the experiments it would require, For that purpose, a set of online resources are provided by Planète Sciences, which will help the clubs in the development of their project:

A project definition and summary spreadsheet which gathers the main technical and safety data is first generated. It serves to define the main milestones and organise the clubs activities in the evolution of the project with regular reports and updating to Planète Sciences and CNES;

- The design constraints: a wide set of rules focusing on safety and pedagogy. It includes mechanical constraints (stability margins, dimensions, resistance to stress), experimental requirements, recovery systems, ground localization, telemetry systems and compliance with regulations and standards (frequency spectrum, modulation schemes), rocket implementation and results interpretation [3];
- A dedicated stability calculation tool;
- Technical documentation about the engines provided by CNES [4];
- A technical manual about the KIWI telemetry system developed by CNES for the purpose of such projects led by clubs [5];
- Technical tutorials dealing with electronics, sensors, parachutes as well as team and project organisation;
- Previous years projects reports.

All of these resources are prepared, updated and translated into English by the volunteers of Planète Sciences.

Technical assistance is also provided by the volunteers in the following manner:

- On the phone every Wednesday evening while they gather at Planète Sciences' premises,
- Online through a web-based forum,
- Live, once a quarter during meetings with the clubs.

Foreign clubs, mainly from Japan, receive special attention due to the distance. Regular contacts are made through emails and a yearly visit is organised to evaluate the projects compatibility with the design constraints. The evaluation (or pre-qualification) is indeed mandatory for any club before they organise the trip to the launching campaign site. In cases where the project is evaluated to be running behind schedule, or if it shows too much variation within the constraints, the club is advised to consider launching the rocket the following year.

Moreover, one month prior to the launching campaign, CNES and Planète Sciences hold a meeting to review all the projects planned for launch and send recommendations to the clubs.

3- THE LAUNCHING CAMPAIGN

Mourmelon, Bourges, Millau, Sissones, La Courtine (Fig. 3): the launching campaign provides a unique opportunity to visit the French countryside and its military camps. Indeed, the French army hosts the launching campaigns on restricted areas, for obvious safety reasons. Planète Sciences sets up the facilities in the heat of summer under the supervision of CNES and the assistance of the army.

Fig. 3 La Courtine military camp

From the launching pad to the details of accommodation, everything is arranged to host about 30 mini or experimental rockets and more than 300 young amateurs, either club members or volunteers in charge of the organization.

3.1 A space port in French metropole

Like Kourou in Guyana, the launching campaign organised for rocket amateurs includes several distinct facilities, but with a single difference: whereas concrete buildings are available in Kourou mostly tents are available in the temporary launching site.

The launching campaign lasts for a week, organised in two phases: preparation and launch (Fig. 4)

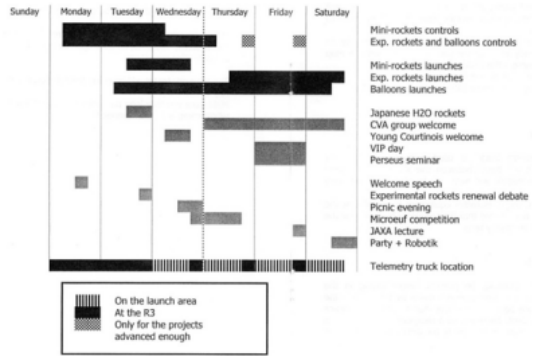

Fig. 4 Campaign schedule

H-7 days: at first the clubs activities take place in the 'R3' workshop, which could be compared to the building for final integration and controls of a space launcher. Team members perform the final adjustments before the controls are started. Controls are not just pre-flight checks: they consist of checking the compliance of the complete rocket with the design constraints as well as the flight mission/experiments defined by the club. Step by step, the mechanical performances, the onboard electronics and experiments, the recovery system, the telemetry system and finally the overall rocket are checked. If a rocket fails to pass a particular control, the club may spend hours and even nights fixing the problem with the help of the volunteers (Fig 5). Once all the checks are "OK", it still takes three successful "simulated flights" (i.e. rehearsal of the rocket launch without engine, with triggering of the recovery system) to get the passport or approval for the launch pad stage.

Fig.5 Volunteers assisting clubs

The second part of the launching campaign is dedicated to the launchings, which take place over two to three days depending on the number of rockets. All the volunteers get involved in what becomes the climax of a year of preparation.
The volunteer DDO and CNES responsable sauvegarde (Director of Operations / ground safety manager) are responsible also for collecting and collating qualification progress reports from which they organise the launching order. Located in the Jupiter tent (Fig. 6), equivalent to Jupiter Center in Kourou, they supervise the set up of the rocket launch.

Fig.6 Jupiter tent

H-1.5 hour, club members are invited to leave the public area to enter the "club tent" where they perform the very last adjustments in the rocket: fully charged batteries are installed, telemetry tests are performed, data memories are reset, recovery system is checked and triggered. Nearby, the telemetry expert, sitting in the telemetry truck (Fig. 7), is adjusting the aerials to the direction of the launch to get the best level of reception.

Fig. 7 Telemetry truck and its equipment

From the Jupiter tent, the groups are given the permission to move to the next phase at launch pad zone. Safety distances (the main one is 450 m) have been calculated in order to reduce the chances of human damages caused by the impact the rocket. These calculations are based both statistics and 45 years of experience.
H-1 hour, meteorological observers report the wind direction to Jupiter. The rocket is slotted into the launch pad for a final mechanical compatibility check. Two pyrotechnicians accredited by CNES take the control of the operations together with Jupiter. The engine is brought from the storage truck located at a regular safety distance. At this stage only five people remain in the area for the final operations.
H-30 minutes (Fig 8), the engine is installed in the rocket by the pyrotechnician. The rocket is laid in the pad before the launch. The igniter is installed by a pyrotechnician, and the launching pad is raised to 80 degrees. Onboard electronics are switched on by a member of the club.

Fig. 8 Launch operations

H-2 minutes, the launching zone evacuation order is given by Jupiter, the five remaining people walk to the "pyrotechnic tent" where the triggering box stands.
Near Jupiter, several binoculars are pointed to the rocket, waiting for the

countdown: the localisation team is ready to track the flight of the rocket and triangulate the location where it will fall.
H-30 seconds, the public is given the final recommendations: track the rocket and remain silent throughout the flight.
H-10 seconds, final countdown is pronounced by the DDO. At this stage, stress reaches its peak among the club members.
Lift-off: the rocket is propelled in the air, the thrust phase is over, the rocket continues its ascent, goes through the clouds, slows down, Will the parachute be extracted as planned?
Intense elation is experienced at the moment when a coloured parachute is spotted with a rocket hanging below. Once the flight is completed, DDO is announcing the result (Nominal, Tangled or Ballistic flight). The rocket recovery phase can take place before the analysis of flight records.

3.2 Volunteers and professionals

The launching campaign is possible thanks to the involvement of the large number of volunteers (more than 40) and the trust of CNES authorities. Professional pyrotechnicians and ground safety managers from CNES assist the volunteers. CNES funds the launching campaign and supports the development of student space research programmes, such as Perseus for nano-satellite launchers.

4-THE JAPANESE EXPERIENCE

Japanese space clubs have been regularly participating in the French rocket launching campaign organized Planète Sciences since 2005. There are several reasons why they come to France to launch rocket.

4.1 Amateur rocket launch in Japan

There is an association similar to Planète Sciences in Japan, called Japan Association of Rocketry (JAR) [5]. This association was established in February 1992 to familiarize so called “model rocket” to Japanese youth. Every year, together with clubs themselves, who own a license from JAR, they provide rocket launch competitions for the youth like elementary school pupils or high school students. The main structure of the model rocket is limited to the use of paper or plastics; the maximum performance of the solid rocket motor allowed for amateurs use in Japan is limited to a 1,280Ns total impulse and to 200 to 400N for thrust. Therefore there are little rooms for the advanced amateurs like university students who are eager to realize their new ideas of experimental rocket.
Another big obstacle to launch amateur experimental rocket in Japan is the launch site. It is hundred percent not negotiable to use any camp that belongs to Japanese Ministry of Defence. This restricts a lot the possibilities to launch amateur rockets.

4.2 Why in France?

In addition to the above mentioned restrictions, one the main reasons why the Japanese clubs are willing to come to France to launch experimental rockets is of course the campaign system itself. Planète Sciences’ volunteers and CNES achieve a high quality organization and accept any club, French or foreign. They are open to all the youth, who have the motivation to develop their own rocket. Since they spend their labours to translate all the important documents in English, the Japanese clubs have little difficulty to learn about the design and safety regulations in advance.
But what is most important thing for this kind of event is the “Let’s do it together” spirit. This atmosphere, far from a contest –what the campaign is not- and the kind hospitality to the guests coming from far allow the young students, who are generally very shy to communicate with foreign people, to keep good

friendship with French students even with low a English level.
From an education standpoint, all the technical documents dealing with safety regulations, propulsion, telemetry system, etc… are helpful for the university students to start the project by themselves. They can first discuss with each other how to realize their own rocket within the restrictions of safety. What most distinctive and worth to mention are the qualification design reviews held in Japan by an advisor from Planète Sciences coming from France, and the ground tests conducted at the place of the rocket launching for the final qualification and the approval of launching. The students experience by themselves that a clear design philosophy is necessary even at the beginning of their project and that the project does not proceed in ease as they have planned. The immaturity in engineering, inexperience at scheduling, and budget management, etc… are the subjects they have to come over once they have decided to start. They finally and really understand that it takes twice more the time that is spent for manufacturing in order to make the rocket work complete as according to the design; important decision is not only made by engineering but also time, and money. This complete set for project management can be hardly taught during the regular university curriculum, due to the academic system.

4.3 Japanese clubs

Three Japanese clubs take part in the French launching campaign.
Space Club Kansai has been organized and led by one of the authors for the purpose of space engineering education and providing young engineers, university students and senior high school pupils with chances to launch experimental rocket (Fig. 9). Their rocket is a single stage system which deploys several “quasi-satellites” during the ascent phase. The industry engineers and university students are responsible for the design and manufacturing of the rocket, while the senior high school pupils are responsible for the quasi-satellites.

Fig. 8 Space Club Kansai

Space Club Gifu, now led by one of the authors, is the first club founded in Japan to participate to the rocket launching campaign in France (Fig. 10). This club is a collaboration team between a young engineer, who is a pure rocket fan, and Gifu University students of engineering. The rocket they have developed is a two stage system, the second stage deploys a quasi-satellite. The fundamental design is mainly made by the young engineer and the students develop and manufacture it to a flyable system.

Fig. 10 Space Club Gifu

The KIT (Kyushu Institute of Technology) Space Club is a pure university club led by one of the authors. The club's students belong to the Department of Mechanical and Control Engineering. They design and manufacture their own unique rocket, most of the body structures of which are made of CFRT (Carbon Fiber Reinforced Plastic) (Fig 10). When the single stage rocket reaches the apogee, it deploys a parafoil to establish a steady gliding flight with guidance by onboard control system toward an aiming point.

Fig. 11 KIT Space Club

5- DAWN OF COLLABORATION

It does not take so much time to grow collaboration between French and Japanese teams.

The club from Lycée Pierre Poivre in La Reunion joined Kansai Space Club to provide the rocket called UCK-06A with their quasi satellite "Reunion-Sat" for the rocket launching campaign of 2007. The satellite successfully deployed from the rocket, landed safely and was recovered intact.

KIT Space Club has informed technology data of Japanese CanSat (can sized satellite), which is very popular in Japan, to CLES-FACIL, the club from INSA-Lyon. CLES-FACIL provided detailed engineering data about French telemetry system KIWI [3] in return. Finally a member of CLES-FACIL has been invited to Japan to conduct the functional tests (Fig. 12).

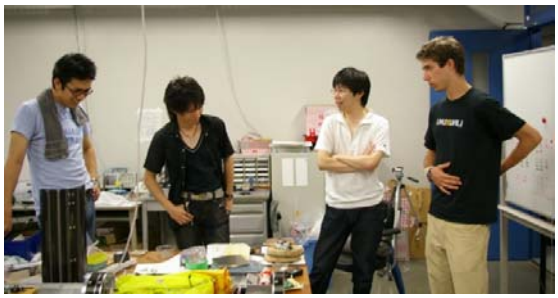

Fig. 12 Collaboration between KIT and INSA-Lyon

Contacts have been strengthened during the 2007 campaign and ideas have emerged for more exchanges and a growing collaboration for the next years.

6-CONCLUSION

Planète Sciences is a non-profit organisation whose ambition is to contribute to the development of scientific and technical cultures among youth using pedagogical methods based on experimental methods and introduction to project management. Together with CNES, it brings rocket projects to reality by proposing a safe and structured organisation to design build and launch rockets.

Japanese clubs have widely taken advantage of the launching campaign and the technical assistance from Planète Sciences and CNES. They also have made the dawn of collaboration in the field of amateur space activities. They, in return, wish to contribute something "give" in engineering that French clubs might think beneficial. The demonstration of giant water rocket launch of last year, or the information exchange of Japanese CanSat in this year might be some "give" they have started. They also hope that this kind of collaboration will encourage nation wide relation of space development activities between France and Japan in future.

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