ICARE: a CanSat using renewable energies for better performances

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Abstract– **ICARE is the CanSat engineered by eight French students of Telecom SudParis in order to take part in the C'Space 2013 contest. The development falls into the category of a teaching unit specific to the school and called GATE, which stands for Gestion et Apprentissage du Travail en Equipe. ICARE fits in the international category (weight < 350g; volume < 33cl). Their club T'Space has been joining in the competition for three years. During the very last months, they have focused on alternative ways to power the CanSat. The solution that was developed consists in using a propeller as a power generator using relative wind. Therefore, a very specific mechanism and architecture were designed. The system will be tested in real conditions at the time of the flight, and then, it will tell to what extent it might replace the standard battery powering the CanSat. The success of the mission would mean a significant gain of weight by getting rid of the 9V batteries. Another trail explored by T'Space would be the use of small solar panels. A combination of both systems could be considered in the future, depending on the results of the wind-powered mission.**

I. Introduction

INNOVATION was a key concept when we decided to develop our CanSat. We did not want to make just another student CanSat, but we were having troubles finding ideas to make ours different. Then, we realized that very little has been done towards renewable energies. Our initial goal was to make a self-sufficient CanSat. Being IT-Students, we had only little knowledge about how this could be achieved, thus we decided to go step-by-step. For this year, our goal is to demonstrate the capacity of generating energy using a tiny wind generator, measure the quantity of energy that could be supplied by such a system in order to know whether it is possible or not to use it in operational conditions. Our CanSat was built from scratch in order to make it possible for us to explore this new mission.

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II. Context of Development

A. Club

The ICARE team is new, from September, 2012. Although the T'Space club has existed for three years, the previous members did not choose to continue supporting the club and thus we had to take a new start, from basic documentation to the final steps of the development.

Telecom SudParis is an engineering school in the field of Information and Communication Technologies. One of our school units is GATE, Gestion et Apprentissage du Travail en Equipe, in which we must work on a group project. We choosed to work together with T'SPACE, a club that was created four years earlier by Joséphine KOHLENBERG promoting the CanSat competition and space-related activities in our school. T'SPACE is a club that financially depends on MiNeT, one of the campus' associations.

Our team members must work on both technical and organizational aspects of the project. The technical work can be split between three teams: the "Mechanics" team, that must imagine and produce the CanSat's structure, the "Electronics" team, about the different embedded-systems contained in our CanSat, and the "Code" team, that is handling algorithms and programming of the different chips being used.

On the other side, the project organization is tied to the GATE framework, thus we had to share different roles: a team leader, a chief of public relations, and a treasurer. In the end, our team follows this diagram:

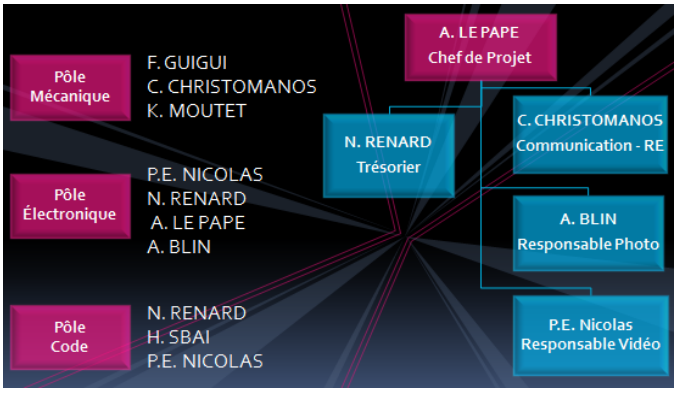


Fig. 1. Organizational diagram.

Fig. 2. Picture of the ICARE team.

B. Work plan

We defined different steps and milestones in our project, using a Gantt diagram. The provisional Gantt diagram, the list of milestones and our effective progress can be found in Appendix I, II and III.

We now realize our schedule was way too optimistic, as the time frames were very tight. We underestimated the influence of unexpected incidents. Two major reasons explain why we could not keep the project up-to-date.

First, we expected help from the senior members of T'SPACE which was not the case. Thus, we had to discover some technical aspects by ourselves, like 3D modeling with SolidWorks, using Arduino for electronics, or Eagle for the design of Printed Circuit Boards. The project had to be done from scratch, where a lot of teams could base their project upon past experience of senior students.

A second reason is that a lot of ICARE team members were also participating in a campaign for the election of the student union. Thus, our progress was frozen during January and February.

III. Definition of the Missions

A. Scientific Mission

The scientific mission performed by our CanSat consists in measuring the ambient air temperature, pressure and humidity and transmitting these data in real-time with the use of radio communications. We will as well store these data using a SD-Card.

B. Free Mission

Our free mission consists in generating electrical energy using a wind generator. The original goal of this mission was to use renewable energies in general, thus miniature solar panels were being considered as an energy source. But we wanted to be sure to achieve this goal and thus decided to keep the solar panel option for a further mission. We also considered doing a "back-to-base" mission, using a GPS and an inertial navigation system to achieve a precision landing. But such a mission is to be kept if enough time is left at the end of the project, considering our tight schedule.

C. Launch during FuSeX contest

Our CanSat will as well be launched with an experimental rocket created by OCTAVE, a student association from Evry, France, during the FuSeX contest.

IV. CanSat Architecture

A. Electrical architecture

Our CanSat uses a 9V Li-Po battery as a power supply. Voltage regulators are used to supply the different components with the needed 3.3V and 5V. The battery choice is crucial as this component weights a lot, considering the 350g weight limit.

Two sensors are used to achieve the scientific mission: the BMP085 for barometric measures and the HIH-4030 for humidity measures. Both are powered using 3.3 and 5V and the data are transmitted to the chip using an I2C channel.

The wind generator system consists in a computer case fan, equipped with a DC brushless motor. We use it as a generator instead of a motor – an AC voltage is generated. A full wave ridge rectifier is used to transform this AC voltage in usable DC voltage.

B. *Mechanical parts*

The CanSat structure consists in four parts: the upper cover, the CanSat body, the down cover and an inlet for the wind generator. All parts have been 3D printed in ABS plastic. Although this material was very light, we decided to use aluminum for the upper and down covers, thanks to our sponsorship with a CNC-machining company. The body will then be molded using Epoxy resin. As the air inlet does not need mechanical strength, the ABS part will be kept for the final product.

Plans can be found in Appendix IV.

C. *Telemetry*

For the radio communication, we use X-Bee Pro transmitters that can be found in electronics stores. Frequencies used are 2.4GHz at 10 mW emitting power. Since these radio frequencies are already used during the FuSeX contest, our radio transmitting device will not be used during this contest but only during the CanSat contest.

V. CONCLUSION

None of us regret the choice of participating in such a great adventure. This experience is unique in a student's life and will be so during its highest point, the C'SPACE 2013 competition.

As we write this article today, we still have to work on some parts of the electronics that will be completed during June and July, regarding GPS localization. We are also looking at implementing a precision landing mission if time is left. Anyway, we are pretty confident that our CanSat will be ready for the competition in the end of August, 2013.

ACKNOWLEDGMENT

We would like to thank:

- Telecom SudParis, our engineering school, and MiNeT, for supporting our project
- M. SIMATIC, our tutor during this project.
- J. KOHLENBERG, researcher in Telecom SudParis
- OCTAVE for supporting our project with electronics and the 3D printing of our CanSat's structure
- PROTOLABS, for supporting our project with the high-precision machining of our aluminum parts.

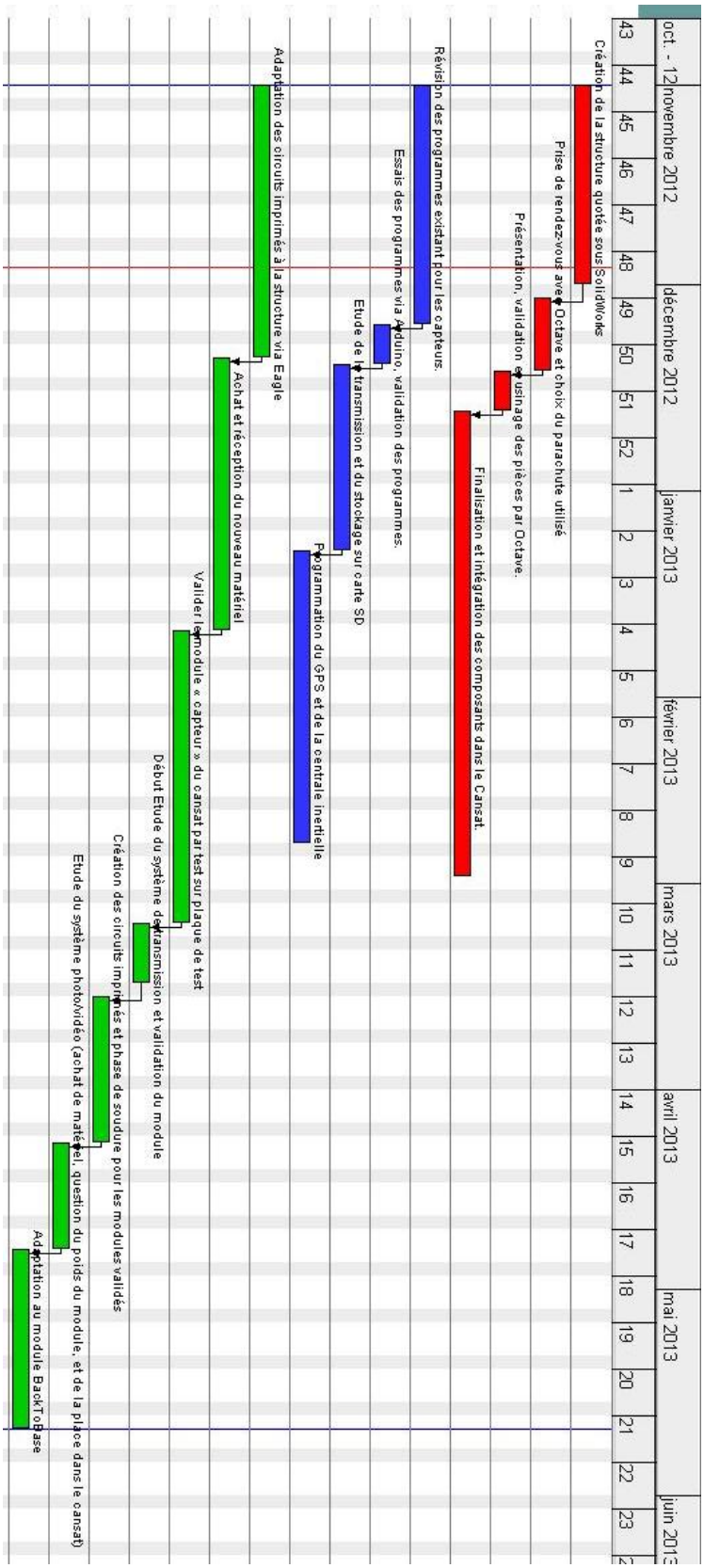
APPENDIX I

List of milestones used in our project.

Création de la structure quotée sous SolidWorks
Prise de rendez-vous avec Octave et choix du parachute utilisé
Présentation, validation et usinage des pièces par Octave.
Finalisation et intégration des composants dans le Cansat.
Révision des programmes existant pour les capteurs.
Essais des programmes via Arduino, validation des programmes.
Etude de la transmission et du stockage sur carte SD
Programmation du GPS et de la centrale inertielle
Adaptation des circuits imprimés à la structure via Eagle
Achat et réception du nouveau matériel
Valider le module « capteur » du cansat par test sur plaque de test
Début Etude du système de transmission et validation du module
Création des circuits imprimés et phase de soudure pour les modules validés
Etude du système photo/vidéo (achat de matériel, question du poids du module, et de la place dans le cansat)
Adaptation au module BackToBase

APPENDIX II

Gantt diagram for the project organization



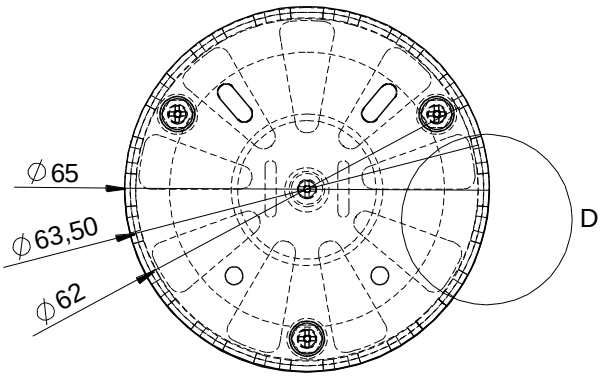
APPENDIX III

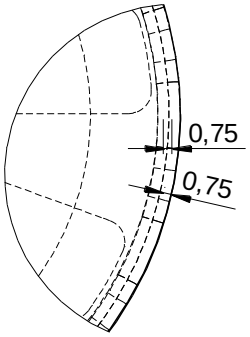
Effective progress of ICARE Project

Octobre - Novembre - Décembre 2012	Découverte du projet et du C'space. Rencontre du client et du tuteur. Définition d'un premier cahier des charges. Phase de recherche et de documentation. Formation à Eagle et Arduino par tutoriel. Premier achat de composants mécaniques et électroniques
Janvier – Février 2013	Campagne BDE Projet bloqué
Mars – Avril 2013	(re)Définition de nos missions. Phase de réalisation. Création des montages et des schémas électroniques. Test des codes capteurs via Arduino.
Mai 2013	Débordement de la phase de réalisation. Construction de la structure externe du cansat. Construction des circuits imprimés Réévaluation de la mission « atterrissage de précision »
Juin 2013	Phase de test finale. Intégration électromécanique.
Aout 2013	Participation au C'Space 2013.

APPENDIX IV

General overview of mechanical parts
(SCALE IS INCORRECT IN THIS DOCUMENT)





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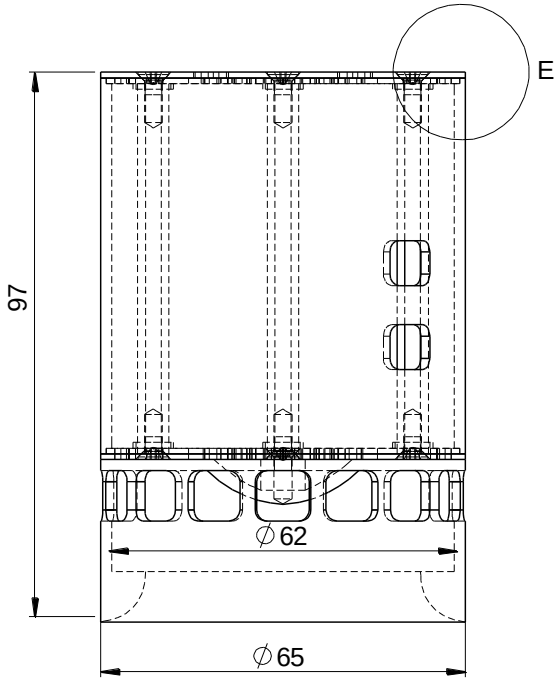
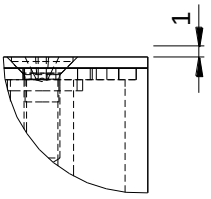


ECHELLE 1:1



DÉTAIL E
ECHELLE 2 : 1

SAUF INDICATION CONTRAIRE: LES COTES SONT EN MILLIMETRES ETAT DE SURFACE: TOLERANCES: LINEAIRES: ANGULAIRES:	FINITION:				CASSER LES ANGLES VIFS	NE PAS CHANGER L'ECHELLE	REVISION
	NOM	SIGNATURE	DATE			TITRE:	
AUTEU	CHRISTOMANOS		05/03/13			CanSat Rassemblé (Coque et couvercles)	
VERIF.							
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