Contributing to the engineering curriculum reform through the development of a nano-satellite program

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Introduction

Several engineering schools in Chile are undergoing a process of reviewing their vision of higher engineering education.
The University of Concepcion is implementing a new educational model under which the Department of Mechanical Engineering, responsible for the majors in Mechanical and Aerospace Engineering, is undergoing a curriculum reform process.
Within this context, a program of developing small satellites, specifically CubeSat with focus on applications, technology transfer, and services, is proposed in order to synthesize knowledge and capabilities acquired through the entire educational program as well as interdisciplinary collaboration amongst different majors in the School of Engineering and other relevant fields.

Rationale

University of Concepcion "new" educational model defines a series of knowledge, abilities, values, and attitudes in a professional area that prepares the students to work after graduation.
The main relevant competences are provided below:

1. Conceptualize, design, implement and operate systems, products, and processes related to their specific field to serve needs.
2. Solve complex problems, in their specific field, with applied knowledge of mathematics, science and engineering; considering the technical, economic and other relevant criteria within the context of collaborative work.
3. Practice leadership within interdisciplinary teams

International Context

Organizations such as UNOOSA through the Basic Space Technology Initiative (BSTI) mission:
"The mission of BSTI is to enhance access to space application tools for sustainable development through building capacity in basic space technology"[1].
The International Council on Systems Engineering (INCOSE) has established in the 2017 Annual IEEE International Systems Conference the "*Education Grand Challenge: Reform education systems to address gaps in Systems Skills in individuals*"[2].

Engineering 2030 educational program goal

"The objective is to achieve the educational standards of excellence in engineering, with special emphasis on applied R & D, technology transfer, innovation, and entrepreneurship"[3].

University of Concepcion's School of Engineering Mission

"To train professionals of excellence, according to international standards in the forefront of engineering, based on Research, Development, Innovation, and Technology Transfer, which supports the sustainable development of Biobio, Chile and Latin America, into a knowledge-based global society"[4].

Objectives

Main objective

Provide a framework for the education of future engineers while developing their knowledge, interests. and complementary abilities.

Secondary objectives

1. Provide a student-centered experience, where engineering is taught by performing engineering task under the guidance of staff.
2. Develop leadership, teamwork and relevant complementary skills for the practice of engineering upon graduation.
3. Attain launch capability for a pico-satellite based on the CanSat concept .
4. Design, manufacture and integrate an operational CanSat for launch up to 1 km altitude using a sounding rocket or deployment from a Remotely Piloted Aircraft System (RPAS).

Methodology

Nano-satellites, specially CubeSat, have been established as "being excellent platforms for education and technology demonstrations" [5] together with the best practices and knowledge provided by the systems engineering research community
The use of open source web or cloud-based tools for project work, management, and team communications is encouraged in order to emulate a "realistic" work environment.
Some of the tools used are Trello for work package status and documentation (see Figure 1); Google Calendar for scheduling and planning; Slack for the team and one to one communication.

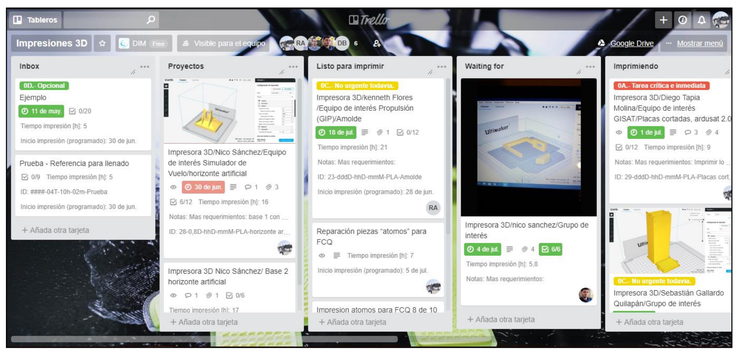


Figure 1. Implemented digital fabrication workflow on Trello.

Results

Preliminary results show a positive reception by the student body and increasing interest in the next phases.

The increase of five times (May to September) with respect to the previous period (March to April) in the output of the digital fabrication team. This is attributed to the implementation of a workflow for Work Orders on Trello (see Figure 1) and assigned responsible student to follow the full life cycle of the work order.

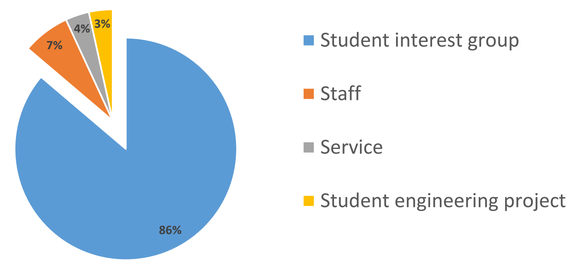


Figure 2. Digital fabrication work (May 29th to September 4th, 2018).

Results from digital fabrication team show over 330 hours and 160 meters of PLA in 3D printed parts and components. Which can be compared to an estimate of about 60 hours in the preceding period. Furthermore, around 30 parts where manufactured, mostly for student projects (see Figure 2), of which ¾ corresponds to 3D printed parts, while the rest were milling.
The digital fabrication capacity has a margin for growth.
During the first half of 2018, no student performed work under a frame that could provide any credits. This has changed in the second half of the year as we have one thesis and one engineering project being performed under the frame of the project.

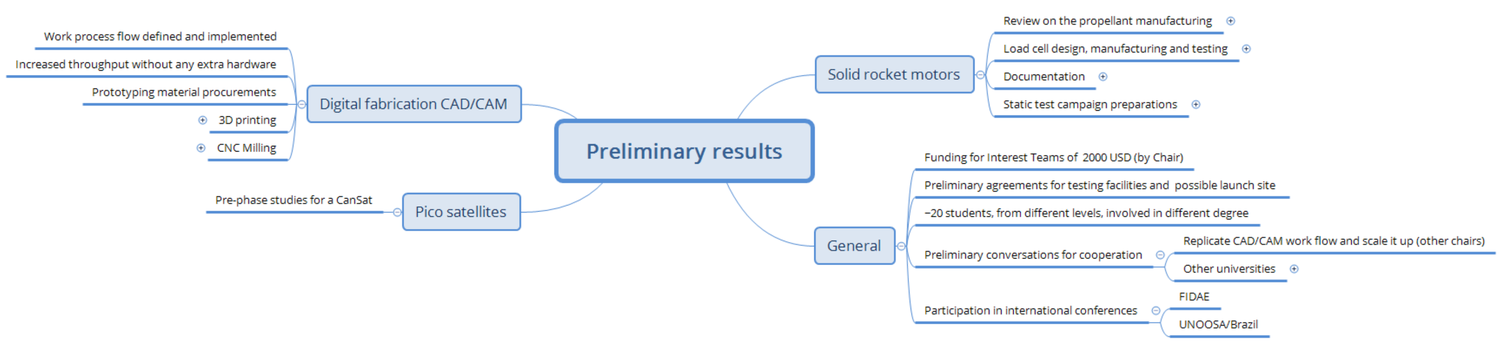
Conclusions & Future Work

Conclusion

Preliminary funding and student interest have been obtained due to sponsorship by the Mechanical Engineering Department. A framework for the development of secondary objectives has been implemented under a pico-satellite and a ballistic launcher development program.
Students have manifested an increased output by adopting the good practices and using software tools proposed in the methodology section.
The program will continue its development in 2018.

Future work

The next steps will focus on the assessment of the requirements and the framework needed for the submission of a funding proposal to pursue the program implementation over the next years. Recruitment of students from other disciplines and in later stages, engineering projects or thesis, in order to increase the manpower available.



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