A MULTIDISCIPLINARY AND PRACTICAL VIEW IN AERONAUTICAL ENGINEERING EDUCATION

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ABSTRACT

Aeronautical engineering results from integration of many technologies. Unfortunately, this is poorly practiced during the undergraduate courses, mainly at the sophomore year when students take general science courses. This work proposes a multidisciplinary and practical activity that integrates metrology, technical drawing and many concepts of aeronautical engineering that are detailed in the following years as structures, aerodynamics, stability and control. Besides offering an experience closer to the professional activity, the aim of this innovative teaching-learning process is to provide better understanding of the involved subjects and how they connect each other, to increase motivation, to develop soft-skills, among others described along this text. The authors implemented the proposed course during the second semester of 2014 and the positive results encouraged keeping it on the curriculum.

1 INTRODUCTION

The traditional teaching process on engineering is based on cognitive orientation, where the knowledge acquisition is driven by teacher in the role of principal active agent which tends to make students a passive agent in the teaching-learning process. In this model, there is no incentive, motivation nor formal space to develop self-learning. Moreover, the traditional teaching brings to student a compartmentalized knowledge (no connected to other scientific areas) without practical application. This view from engineering education brings to the future engineers often perceptions that a certain specific knowledge will not be useful for their education and professional development. This educational approach do not satisfy a post-modern world where the human being is inserted in a dynamic environment that knowledge is available easily in an interdisciplinary way. Thus, the limitations of the traditional education proposal face a new world boosted the university to research alternative teaching-learning processes able to form engineers with holistic view, integrating theory and practice, through active learning based on skills and competencies. New educational models based on learning by doing to use elaboration of design even if it is simple but it brings to students perceptions that success on learning depends on them in realize a design by active way. The Technological Institute of Aeronautics (ITA) still follows a traditional teaching model in engineering where the first two years at Institute, students attend only basic sciences courses (Mathematics, Physics, Chemistry, Drawing, Computer). After the first two years, students will start their engineering field. This curriculum is not well adapted to a new learning scenario motivating the multidisciplinarity and practice. In this sense, the ITA introduced changes in two disciplines for beginner students (first year). Before 2014, the courses of metrology and technical drawing were given in a traditional way no correlating both courses and without a practical view about the relevance of these courses for future engineers. In 2014 , it was thought in the Physics department at ITA a new teaching-learning process which the responsibility for learning will be attributed to student during active attitude in accomplishing a design that connects several interdisciplinary knowledge through a practical view. To reach an innovated teaching-learning process the metrology and technical drawing courses were pedagogically rethought by interdisciplinary knowledge package with a practical insight. The key to this strategy has succeed was to assembly an airmodel (figure 1), since the great interest of students in aeronautical design. Students built an airmodel using the knowledge from courses as well as the interdisciplinarity between them.

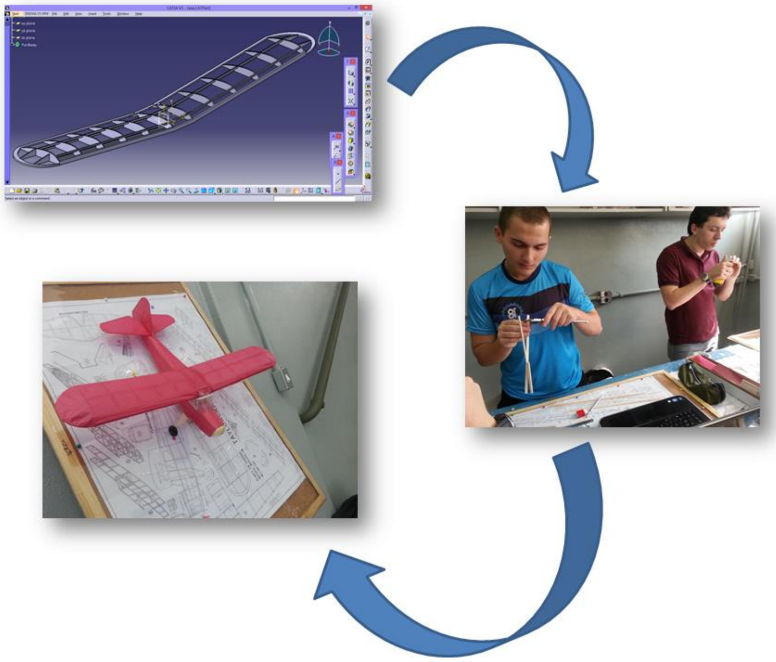

Figure 1: Interdisciplinarity on engineering education (metrology, technical drawing and aeronautics).

The interdisciplinary knowledge package proposes by building the airmodel aims to consolidate the following items:

- Consolidate knowledge on specific course
- Consolidate knowledge on multidisciplinary view
- Increase motivation
- Stimulate creativity
- Experiment a practical view of the knowledge
- Encourage critical thinking
- Promote capabilities of analysis and decision
- Develop skills and competencies to work in groups and to management stress

For pedagogical goals are achieved in terms of competencies and skills in metrology the air-model build process works as a real production process where the production tolerances are obtained by measuring of the air-model parts as spars, ribs and stiffeners comparing among different groups. Furthermore, the error propagation concept could be realized by measurement of the air-model weight. About competencies and skills in technical drawing students draw the air-model three views to realize specification needs during the build process. The airmodel assembly was made in the small aircraft laboratory at ITA where students had the first contact at institute with materials, structures and tools that involves the aeronautical design. The airmodel performs its flight in a unique trim condition showing the concept of equilibrium in flight dynamics. In addition, materials are added as extension on airmodel to increase aspect ratio and stabilizing surfaces in order to present geometric variation effects on aerodynamic design. All details of the implementation of this interdisciplinary knowledge package will be shown in the next section.

2 METHODOLOGIES

These educational project lasted four months, a semester, involving 180 students from the first grade of elementary Engineering Course where four classes were split into 56 groups (3-4 students). In addition, the project had the direct involvement of teachers of the disciplines, laboratory technicians and monitors. Initially groups received a set of parts (kit) for assembly of a small airplane, airmodel EE-206 (manufactured by CASA AEROBRAS). During the semester students had development of activities that took place in the context of interdisciplinary, involving disciplines of metrology, technical drawing and aeronautical concepts in order to give support for the project. These groups received a general instruction, given by Professor of Aeronautics about assembly and some warnings related to the components of this set of pieces. So, each group started assembling its airmodel.

Figure 2: First instructions for students on the Laboratory.

When they receive their mounting kit, each group began the process of building its airmodel, always with support of a teacher, technical or monitor. The Small Airplane Laboratory of the Aeronautical Engineering at ITA was used once a week by students to construct the airmodel. In the Physics Laboratory, the metrology of the airmodel parts was performed, i.e., all the measurement of the airmodel parts (length, diameter, thickness, volume, area, among others). In all activities in the physics lab, students used the software Mathematica, already known by students since the previous semester.

Figure 3: Beginning of the airmodel assembly by groups.

The construction and measurement process of the airmodel parts was split into six phases so that each of which is supported by a theoretical explanation:

First phase:

Explanation of structural and aerodynamic concepts of the wing and its components such as ribs, stringers, leading edge and trailing edge. Measurement and assembly of the wing components.

Second phase:

Explanation of the structural, aerodynamic and stability and control concepts of the horizontal and vertical stabilizers and their components. Measurement and assembly of the components of the stabilizers.

Third phase:

Explanation of structural and aerodynamic concepts of the fuselage and its components such as trusses, main landing gear, nose wheel, propeller. Measurement and assembly of fuselage components.

Fourth phase:

Explanation of the resin and fabric application on airmodel followed by its execution.

Fifth phase:

Explanation of trim, static stability and center of gravity position (CG) concepts. Integration of parts (wing, fuselage and stabilizers), airmodel C.G calculation and the compensation of gliding flight for airmodel.

Sixth phase:

Analysis of measurement data of the airmodel parts, obtaining the respective standard deviations of each component characterizing the deviations in the production process (figure 4).

Figure 4: Measurement of each airmodel part to calculate uncertainties of the productive process.

Although the students received the assembly drawing (figure 5) in the beginning of activities to drive the construction of airmodels, during process they developed drawing activities to represent the air model in a virtual environment, and realize the relationship between drawing and execution.

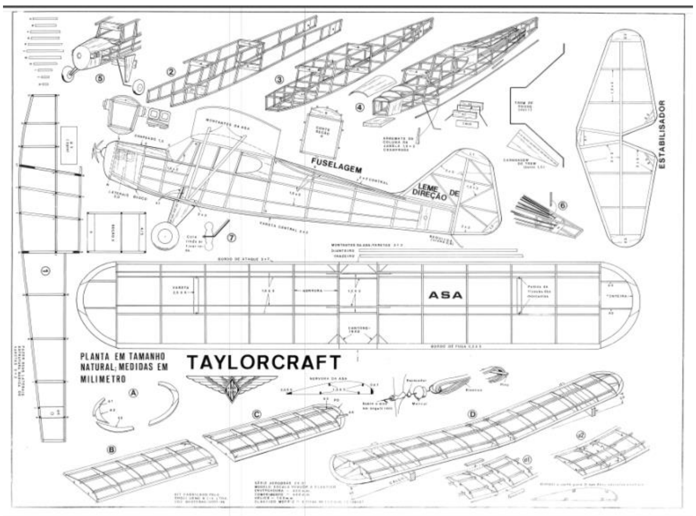

Figure 5: Airmodel planview from manufacturer.

The discipline of Computer Aided Design (CAD) was responsible for the virtual construction of all the parts that composed the airmodel. Thus, the students had contact in Aeronautical Laboratory, with the actual construction of model aircraft, in Physics Laboratory, in all parts of metrology and CAD discipline, built virtually the same model aircraft.

Figure 6: Result of one of the groups. At the left side the real airmodel and at right Side the virtual airmodel developed in the course of CAD.

3 CONCLUSIONS

According to the points discussed in this work, studies and research on interdisciplinarity can contribute strongly encouraging proposals and methodologies that facilitate meaningful learning in the university context. The authors emphasize the importance of teaching engineering with interdisciplinary actions that establish relations between different disciplines, what is appropriated in the aeronautical engineering context.

The interdisciplinarity composed by disciplines of Aeronautics, CAD and Physical gained particular significance within the course encouraging students to practice new skills and attitudes that permeate the engineering professional. In addition, the practice and theory combined establish clearly the knowledge. For instance, It was noticed that while students measured the parts of the airmodel they still had some doubts on using the tools (caliper rule and micrometer), which they had learned at the traditional metrology classes. In this sense, it is clear that the proposed methodology was indispensable to consolidate those concepts.

The learning based on project applied in this work during a semester gave to student opportunity to develop some skills that is not practice in the traditional education. For this work, teachers and students could realize a gain in skills such as creativity to solve problems, a critical thinking in take decisions, deal with people and project schedule. However, for beginner students of engineering the motivation to design a machine that flies drove the project.

It is understood that such practices need to be encouraged and exploited in engineering courses, where teachers, technicians and students work together to form a competent and prepared for the challenges of the future engineers.