

INTRODUCTION OF THE CDIO FRAMEWORK AT THE MILITARY INSTITUTE OF ENGINEERING IN BRAZIL

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ABSTRACT

This paper describes the motivation, the current state and the further actions of an improvement process of the engineering education at the Military Institute of Engineering (IME) in Brazil. Based on the reasons for why and how to change, the CDIO framework has been chosen as the kernel of this improvement process. The activities realized the plan of the further actions and the open questions are presented in this paper. The paper is a condensed presentation of the report (Cerqueira et. al., 2016), where a thorough background and more details can be found.

KEYWORDS

CDIO Initiative, Implementation, CDIO Syllabus, CDIO Standards: 1 - 12

INTRODUCTION

The Military Institute of Engineering (IME) is a Brazilian Army higher education institution. IME has a history of pioneering in Brazilian engineering education and participated in some of the most important national engineering projects. The institute has ten undergraduate engineering programs and admits about one hundred students per year. Since 2012, a project to transform the Brazilian Army's Science and Technology System has been running. This process created an opportunity for IME to initiate a reflection about how to improve and adapt the formation of the engineer to the new scientific and technological system. In parallel to that, during the last years, there has been an increase in student dissatisfaction. This dissatisfaction is mainly related to the great number of theoretical activities in IME. In 2010, a new activity was included in the IME programs, which increased this demand. The students of IME in the fourth year started to participate in international exchanges. These exchanges allowed students from IME to attend six months of courses at some renowned international engineering institutions. This activity, in addition to provide an excellent learning experience, produced one modification in the perception of the IME student. The students now have the perception that the learning and teaching process could change and could be improved at IME. Based on why and how to change, and after visit some universities and analyze some possibilities, the introduction of CDIO framework in the programs of IME was chosen as the kernel of this improvement process.

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IME is, at the same time, an engineering college and a military academy. As a college, it must comply with, like all engineering bachelor's degree programs in Brazil, the rules established by the Brazilian government. In a few words, all engineering undergraduate programs must have at least 3600 hours of academic activities and five years to be graduated (Brazilian Government, 2007). At IME, the engineering curriculum structure has ten semesters. The four initial semesters, called the basics years, are the same for all the ten programs. Only after the fourth semester the student choose the respective engineering program. The programs have between 3.800 and 4.000 hours of activities in engineering education. Despite this number, the main part of the curriculum consists of theoretical activities. Beyond the education in engineering, as a military academy, the military student has more than about 1.700 hours of activities related to military education. The Figure 1 shows the curriculum's structure of IME.

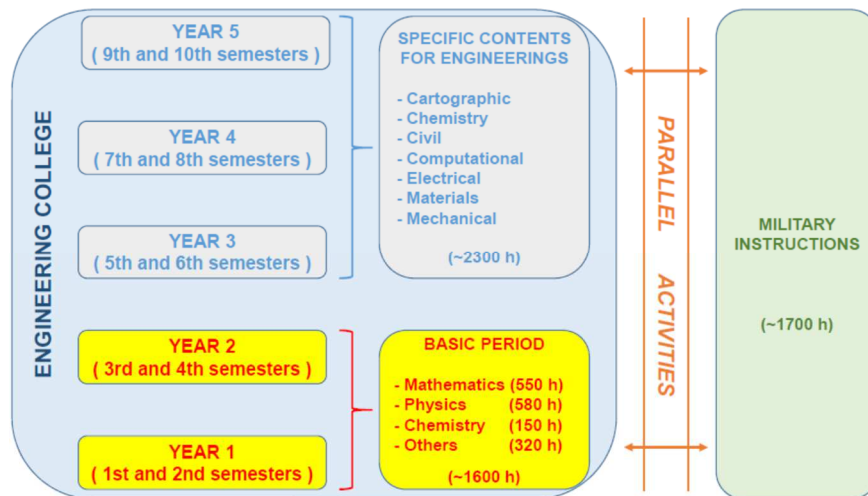


Figure 1. Curriculum structure at the Military Institute of Engineering.

WHY AND HOW TO IMPROVE IME'S EDUCATION PROCESS

The first question that emerged was why an institution that obtains excellent results in the national evaluations and is recognized as one of the best engineering colleges in Brazil should change. The reasons were directly connected to the students' motivation and the change in the manner of performing R & D in the Brazilian Army. Due to this scenario, in 2014, a program was started with the objective to improve the engineering education process within IME, and the CDIO framework was chosen as a way to achieve the program's objectives. This choice was based on the alignment between the intended IME changes and the CDIO framework. As example of this alignment could be cited the creation of new opportunities for students to perform more engineering practice in the academic activities (CDIO Standard 4, 5 and 8); implementation of teacher training and improvement in new teaching methodologies (CDIO Standard 8, 9 and 10); inclusion of integrated learning (CDIO Standard 3) and implementation of the constructive alignment concept as a model for courses design, as also executing a revision of the intended learning outcomes and the curriculum of the programs (CDIO Syllabus, CDIO Standard 2,3 and 12). Another important point is that the educational improvement process has some challenges: How does IME change without losing the excellence already achieved? How does IME change and, in the same time, complies with the rules of Brazilian Government and Army? The answers to these questions are found in CDIO framework to. The CDIO framework is a reference model and not a rigid standard (Crawley et al., 2014). Thus,

the CDIO framework can be adapted to the Brazilian higher education law and to the specific rules.

PROCESS OF INTRODUCTION OF THE CDIO FRAMEWORK

Some steps have been taken in accordance with the suggestion of CDIO Initiative (Crawley et. al., 2014) and related to specificities of IME. See (Cerqueira et. al., 2016) for a detailed description. In November 2014, the high direction of IME, including the Commander of IME visited two Swedish universities, Linköping University (LiU) and Royal Institute of Technology (KTH), to have a first vision about the CDIO framework and its implementation. In 2015, Professor Svante Gunnarsson from Linköping University gave a CDIO workshop at IME to present the CDIO framework to a group of teachers and students. An exchange of two IME professors for six months at Swedish universities occurred from September 2015 to March 2016. The activities during the visit were related to the CDIO framework and the implementation within different programs at LiU and included a course in Teaching and Learning in Higher Education at KTH. In October 2015, the high direction of IME made a visit, similar to Sweden in 2014, to the Massachusetts Institute of Technology (MIT) to see additional implementations of CDIO. In parallel, IME sent professors to attend the “CISB Executive Innovation Management Course (EIMC)” (CISB, 2016). Even though this course isn't directly connected to CDIO, it is useful to make connections between the CDIO implementation and the innovation concept. Finally, it was organized in 2015 the “1st Integration Seminar between IME and Brazilian Defense Industry”, where some themes for Undergraduate Final Projects were defined that could fit the industry interests.

ACTION PLAN

The first action will be the formation of a “task force”, which will coordinate the implementation of the CDIO framework within IME. This task force will plan the further actions, create a vision of change and support all the staff that will work with the CDIO framework. In order to create a favorable environment for changes, a sense of commitment among the IME members, and to communicate the vision of change (CDIO Standard 1) seminars will be held. Another action will be the faculty development (CDIO Standards 9 and 10), and this action will start with workshops to show new methodologies and concepts in education. In this way, there is an intention to create a department of engineering education to support the faculty. It is also planned to introduce of a first-year engineering course (CDIO Standard 4), that will affect all the programs.

The implementation of CDIO within IME will start with the Mechanical Engineering Programs, with a complete benchmarking related with the program curriculum, workspace, and teaching and learning methods. After the curriculum benchmarking, there will be a definition of the learning outcomes associated with the skills (outlined in the CDIO Syllabus) and the knowledge expected from a mechanical engineer and the skills associates with the innovate concept of Brazilian Army Transformation. Each benchmarking process will be preceded by a improvement process: the program curriculum improvement, in order to introduce the concept of Integrated Curriculum in the program and realized in a program-course mapping (CDIO Standard 3); the improvement of teaching activities and methodologies, that introduces new learning methodologies (CDIO Standard 7 and 8); new assessment methods, aligned with the Brazilian rules, must be realized (CDIO Standard 11); and the workspace improvement project will use existing spaces and there will be prioritized changes that could produce effectiveness, reliability and visibility in the transformation process (CDIO Standard 6). To further improve the Mechanical Engineering curriculum, two project courses will be introduced. These courses, in

the third and fifth years, will complement the first-year engineer course in the experiences of design-build-implement (CDIO Standard 5).

OPEN QUESTIONS

The improvement process of the IME education has some open questions, and this paper highlights two of them: The three intended project courses, should they be new courses or modifications of the existing courses? In the case of new assessment methods, how will the implemented changes comply with the Brazilian rules and the constructive alignment concept?

CONCLUSION

This paper described the motivation of IME to implement an improvement process in their engineering education, through the adoption of the CDIO framework and new methodologies of teaching and learning. It was presented the engineering education at IME and the reasons for why and how to change. The steps that were taken until March 2016 were discussed and the further actions and the open questions related to adapting and implementing CDIO at IME were presented. It is expected that with these new actions the implementation of the CDIO framework will be successful at IME and that it will permit, gradually, the improvement of all engineering education program and the graduation of engineers more capable in the practical work of engineering. Lastly, it is intended to introduce the Military Institute of Engineering in the CDIO community, through faculty participation in meetings and conferences.

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