Alive Engineering Education

Innovating Engineering Education beyond Borders

BOOK ORGANIZERS
Getúlio Antero de Deus Júnior
Leonardo Guerra de Rezende Guedes
Marcelo Stehling de Castro
Marcos Lemos Afonso
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Rodrigo Pinto Lemos

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CHAPTER 26

Historical Pathways of The Teaching of Engineering in Brazil

Eduardo Nadaleto da Matta[*], Marcelo Marques Gomes[♦], Roberto Scalco[▲] and Marcelo Furlin[▼]

[*]Centro Universitário do Instituto Mauá de Tecnologia, São Caetano do Sul, Brazil

E-mail: eduardonadaleto@maua.br

[♦]Centro Universitário do Instituto Mauá de Tecnologia, São Caetano do Sul, Brazil

E-mail:marcelo.gomes@maua.br

[▲]Centro Universitário do Instituto Mauá de Tecnologia, São Caetano do Sul, Brazil

E-mail: roberto.scalco@maua.br

▾Faculdade de Humanidades e Direito da Universidade Metodista de São Paulo,

São Bernardo do Campo, Brazil

E-mail: marcelofurlin267@gmail.com

Abstract: The new challenges faced by Engineering in the 21st century require a closer look at Engineer education. The economic and social development of a country is based on human capital, responsible for making a difference in productivity and competitiveness among nations. Therefore, training and qualifying human resources continually is a must. As Engineering occupies an important position in the generation of knowledge, technologies and innovations, the quality of Engineering undergraduate courses offered in Brazil must be continuously improved in order to increase productivity and stimulate the possibilities of economic growth. The present paper aims to analyze how the teaching of Engineering has developed in Brazil from a historical point of view by analyzing the National Curriculum Guidelines (Diretrizes Nacionais Curriculares - DCNs), and by considering the profession and its military origins. Due to the complexity of Engineer training, the main elements to be considered in this analysis are the human factor and the revision of the DCNs. To our understanding, those challenges are not related to traditional content subjects taught only in Engineering courses, but also in Biology, Medicine, Psychology, Sociology, Economics courses, among others. This paper also discusses different DCNs for Engineering, placing special emphasis on its latest

version approved in July 2018, and comparing it with a new proposal sent to the National Education Board (Conselho Nacional de Educação - CNE) in April 2019. Our findings reveal that the current curriculum for Engineering undergraduate courses no longer meets career expectations of new Engineers. The Engineering curriculum can no longer be viewed as a set of specific content subjects, it must also cover areas related to people, their needs, expectations and behaviors.

Keywords: Engineering, Engineering Education, History of Engineering, National Curriculum Guidelines, DCN.

26.1 Background

According to the 2019 proposal for Engineering National Curriculum Guidelines outlined by the Entrepreneurial Mobilization for Innovation (Mobilização Empresarial pela Inovação - MEI), the Brazilian National Confederation of Industry (Confederação Nacional da Indústria - CNI) and the Brazilian Association of Engineering Education (Associação Brasileira de Educação em Engenharia - ABENGE)[1], the number of Engineering graduates produced in Brazil is still small if compared to that of other countries. In Brazil, undergraduate courses are regulated by National Curriculum Guidelines (Diretrizes |Nacionais Curriculares - DCNs), designed and enforced by the National Education Board (Conselho Nacional de Educação - CNE). Those guidelines are applied to all undergraduate courses to promote learning equity, ensuring that all students have access to basic content subjects; however, without ig-

noring the different local contexts. Thus, as we understand, those guidelines should be flexible enough to meet the needs of diverse contexts, aiming at their continuous improvement and the integration of technological as well as methodological innovations.

26.2 Purpose/Hypothesis

Since we believe Engineering occupies an important position in the generation of knowledge, technologies and innovations, it is of paramount importance that the quality of Engineering undergraduate courses offered in Brazil must be improved in order to increase productivity and stimulate the possibilities of economic growth. The review of DCNs is essential in this process. DCNs comprise a set of regulatory principles, rules and procedures that guide Universities in the formulation, articulation, implementation and evaluation of their pedagogical proposals. Thus, as we understand, those guidelines should be flexible enough to meet the needs of diverse contexts, aiming at their continuous improvement and the integration of technological as well as methodological innovations.

26.3 Design/Method

The present paper aims to correlate the history of Engineering training in Brazil with the history of education in the country, by analyzing the DCNs for Engineering courses. To begin with, it is necessary to understand what Engineering is. The proposal designed by MEI/CNI and ABENGE presents one of the

oldest and best-known definitions: “Engineering is the art of directing the great sources of power in nature for the use and convenience of man1”[1], Thomas Tredgold (1788-1829). In Brazil, Engineering projects began with the arrival of Engineer-officers commissioned to construct civil and religious buildings. After the Brazilian Revolution of 1930 and the rise of Getúlio Vargas to power, the expansion of public power and government bureaucracy, with the help of agencies related to economic policies at several levels, was crucial for the advancement of capitalism, allowing the emergency of two new fundamental classes: the industrial bourgeoisie and the urban proletariat[2]. In that scenario of developmental advancement, the then president of Brazil, Getúlio Vargas, passed Decree N. 23,569, on December 11, 1933, regulating the practice of Engineering, Architecture and surveying professions [3]. Such regulation was revised by Law N. 5,194, on December 24, 1966, later known as the Law of CREA (Conselho Regional de Engenharia e Arquitetura - Regional Professional Association of Engineers and Architects)[4]. In 1946, with the enactment of the Federal Constitution (paragraph d, section XV, article 5), the Union is granted the right to legislate the guidelines for national education[5]; however, only 15 years later, on December 20, 1961, Law N. 4,024, the Brazilian National Education Law (Lei de Diretrizes e Bases da Educação Nacional - LDBEN), was passed, followed by the creation of the Federal Council of Education (Conselho Federal de Educação - CFE), responsible for administering elementary, middle, high school, and higher education systems. As far as higher education is concerned, the council is responsible for “establishing course duration and minimum curriculum[6]”, according to Decision CFE N. 48 (April 27, 1976)[7]. That decision “[...] favored the accumulation of content as a guarantee for the education of a good professional and learning process was exclusively teacher-centered[8]”.

26.4 Results

As a consequence, the resolution, on one hand, was criticized since, "[...] it allowed no flexibility in curriculum design by determining minimum syllabuses for the courses with different durations[9]"; on the other hand, it was approved by some teachers who reported that it "[...] provided great flexibility by allowing higher education institutions to define specific contents[9]". The Chamber of Higher Education (Câmara de Educação Superior - CES) set out the DCNs for Engineering courses through Decision CNE/CES N. 11 (March 11, 2002)[10], introducing the following changes:

1. minimum curriculum with prerequisites no longer required;
2. development of student's skills and abilities instead of a content-based approach;
3. student-centered learning replaces teacher-centered learning, students are stimulated to play active roles in their training.

The faculty was directly affected by the new scenario since "[...] the changes in legislation indicates that teachers must master not only technical knowledge, but also teaching/learning methods and approcahes[11]". The proposal designed by MEI/CN and ABENGE was submitted to the National Council of Education/Chamber of Higher Education (CNE/CES) for appreciation in March 2018. The proposal suggested minor and major changes in items of the decision and added others. The main items can be considered innovative: competence-based training, entrepreneurship teaching, Pedagogical Project, freshman welcoming activities as well as faculty development programs.

The proposal by MEI/CNI and ABENGE anticipates the following:

> The main point is to add more meaning, dynamism and autonomy to the learning process in Engineering, by engaging students in practical activities, preferably since the beginning of the course. Some of the strategies are: active methodology-based learning, concrete problems solving, interdisciplinary knowledge-based activities, among others, aiming at improving teaching techniques and reducing University dropout rates[1].

DCNs should, then, be capable of promoting modernization in Engineering courses, by updating content, focusing on the student as an active producer of knowledge, integrating companies and University, prioritizing interdisciplinarity and transdisciplinarity as well as enhancing the important role of teachers as change agents inside and outside the classroom. The multifaceted demand for Engineers should be reflected in a multifaceted supply of University-level Engineering programs as well.

The development of curricular guidelines for Engineering courses must anticipate flexibility and innovation so that Engineer training in Brazil can reach levels compared to those of world centers of excellence.

26.5 Conclusions

Through the history of Engineering and Engineering Education in Brazil, we can notice that they have been strongly aligned with the different histo-

rical periods and educational reforms in the country. The military origins of Engineering in Brazil and in the world are also evident.

Based on the education in Engineering we have had and on our teaching experience, we can confirm that teaching Engineering in Brazil until 2002 can be correlated with several government decisions and its inherent traditionalism: such decisions determined the way courses should be. This traditional teaching model is explained, at least in part, by the military origins of Engineering.

As a result, such traditional practices are continuously reproduced due to the Engineering Education professors have had. This is our case: we are highly qualified from a technical point of view, but poorly prepared from a didactic-pedagogical point of view. In order to establish innovative guidelines, to design and implement new curricula for Engineering courses, we need to imagine a professional capable of coping with unpredictable situations. Whatever the change in teaching methodologies is, the faculty must be highly valued.

The current curriculum design no longer meets what is expected from an Engineering graduate. This is probably the reason for alarming dropout rates in Engineering courses and repeat complaints about recent graduate's lack of preparation for social challenges and the work force.

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