

## Creating a New Engineering Program in a Developing Country

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### Abstract

Education is a government responsibility in Brazil. Thus, there are free public schools at every level. Naturally, there are also their private counterparts. These private elementary and middle level schools have turned into the best schools, leaving the government schools behind. At the college level though, the opposite has come about. In most cases, the federal (governmental) universities are the best. Therefore, entering such schools has become a big prize for those students who get to make it. While private universities charge students with high fees according to the costs of laboratories and the demand for courses, public universities are completely free for students. Most Research & Development projects developed in the country have been originated in public universities. They are also sponsored by the government and grow very fast. Application to these universities is very competitive at the student level and also for taking staff and other job positions. Nonetheless, public universities are run under a strict budget. Faculty, staff as well as students can only enter government universities through highly competitive yearly examinations. This paper is a report about the successful effort of the Dean of the College of Technology at UFF in creating three new undergraduate programs, Oil and Natural Gas Engineering, Environmental Engineering, and Physics Engineering, without any additional budget from the government and without any increase in faculty. This paper is about turning challenges into success. The ideas for the new programs, the strategies, and the final accomplishment are shown as examples of how ideas can turn out into projects.

### Introduction

Each state in Brazil is provided with at least one government-sponsored university. Such universities are completely free for students. This fact allows for many students who otherwise would not have any possibility to pursue an academic degree. Entrance to these schools can be very competitive, reaching the rate of 30 or 40 candidates for each available seat for enrollment. Entrance is granted upon being successful at a yearly very hard and competitive college entrance examination. Some students need to take it for two, three years in a row until they succeed. Despite the government budget limitations, federal universities must increase the number of enrolled students and this is no small challenge.

This work aims at describing the strategies used for the creation of three new undergraduate Engineering programs at a Federal Fluminense University under real budget limitations, without

hiring any new professor. It can be used as a model for universities in other developing countries facing similar challenges.

### **The Impact of technological Advancements in the engineering practices**

Despite the fact that engineering work has always been ahead of human development, the basic engineering work itself has changed very little. Ever since its existence, the engineering professional practice has always been based on the use of scientific and theoretical knowledge towards improving or building structure and machines. [1] The engineering profession has always aimed at serving human beings by improving their quality of life and bringing happiness to mankind.

Nevertheless, the methods for generating engineering solutions have continuously changed. The availability of both new tools and new techniques as well as new processes for data selection and processing have continuously improved the engineers' ability to improve mankind's living conditions.

Engineering is the ability of generating new knowledge based on previous scientific and technological advancements. This field of knowledge is completely different from the fine arts. Seldom will one artist's ability for producing a masterpiece greatly influence another artist's ability for producing similar results. Engineering has to be studied and practiced. It is always necessary to learn from past and latest advancements to increase the complexity and advancements of the engineering activity. Throughout the years, the engineering profession has become more and more challenging. This is a continuous process, difficult and ongoing procedure which has been growing throughout the years, faster each day, bringing much satisfaction and happiness for those men and women who dedicate their lives to the engineering profession. [2]

Technology itself brings about challenges which must be faced each day by those people who deal with new society requirements which demand innovative solutions. Therefore, everyday, new attributes and new attitudes are required from engineering professionals. These professionals must receive updated knowledge and practical training so that they can efficiently perform their activities. Thus, engineering schools need to perceive that the new generation of young engineers are duly prepared to respond for the new technological challenges.

Engineering curricula must be frequently reviewed and updated. Moreover, as new engineering programs are established, they must comply with the demands of completely new areas of engineering careers.

### **The flexibility of UFF administrative structure for the establishment of new programs**

Universidade Federal Fluminense – UFF, located in the state of Rio de Janeiro, Brazil, offers undergraduate and graduate programs to about 32.000 students. The academic structure allows the organization of new programs without much financial costs and with a small increase in the number of newly-hired professors.

Each program is run by a collective body of professors called “*Coordenação de Curso*” which is in charge of setting all the rules and needs of registered students for that program. This board is directed by a chairman or coordinator. This professor is in charge of selecting subjects to be included in the program. He and his board will also set the program requirements, goals and objectives, the criteria for students’ evaluation and desired performance ever since they come into the program up to their completion date.

It is a matrix system on which the ‘*Coordenação de Curso*’ is directly under one of Four Academic Colleges: College of Technology, College of Medical Sciences, College of Fine Arts, College of Social Sciences. The “*Coordenação do Curso*” is in charge of requiring directly to each Academic Department of the University, the specific subjects they need for their program, and defining the main characteristics which are suitable to compose their program such as number of weekly hours, laboratory activities, course program, etc. Each “*Coordenação do Curso*” is independent from each School or department. This academic freedom allows for free negotiation with the departments offering the subjects required for each graduate or undergraduate program at UFF. Departments should understand “*Coordenações de Curso*” as their clients for offering courses. Department budget is proportional to the courses they do offer for different programs within the university.

The matrix structure just described allows “*Coordenações de Curso*” the possibility of improving program contents and to dedicate completely to the improvement, organization and quality of each specific program. When well organized, this structure allows the Academic Colleges the use of the existing university resources to continuously improve as well as update the existing programs. Eventually, it will promote the establishment of new courses in accordance with the demands for new knowledge and skills.

### **The Creation of New Engineering Undergraduate Programs at UFF**

At UFF, four institutes integrate the College of Technology: two schools of Engineering, being one in the City of Niteroi and another in the City of Volta Redonda; the Computer Science Institute and the School of Architecture and Urbanism in Niteroi. These schools hold a total of 14 departments. At the College of Technology, we have continuously worked towards improving the university academic programs, so as to comply with contemporary demands and needs of the engineering profession. During the last 3 years, under our term as Director (Dean) of the College of Technology, five graduate programs have been successfully created: 2 Master programs, Architecture and Telecommunication Engineering; and 2 Doctoral programs, Mechanical Engineering and Systems Engineering.

New undergraduate programs, however, require more efforts, since they only start from new ideas, or better, from new needs and demands for people with new abilities. Such ideas will also generate new technological requirements and tools. As new demands are fulfilled, the eventual outcome will be social and economic change to people. Engineering breakthroughs will always affect the way society lives. Depending on the kind of impact, it may affect different geographic areas in different ways.

We present now three new engineering-related programs which have come about from society new demands: the Oil and Natural Gas Engineering Undergraduate Program; the Environmental Engineering Undergraduate Program; and the Physics Engineering Undergraduate Program.

### **The Oil and Natural Gas Engineering Undergraduate Program**

Nowadays, there is a growing industry related to the production and process of oil and natural gas in Brazil. Since 1995, PETROBRAS, the Brazilian Oil Company, as well as many other foreign companies have heavily invested in the oil industry in the country. According to studies developed by ONP – Brazilian National Oil Organization, the nation will need a very high number of oil engineers and specialists for the next 10 years. Most of these job offers will be located in the State of Rio de Janeiro, the main oil producer area in the country. However, there are only three undergraduate oil engineering programs in Brazil.

Thus, the Dean of the College of Technology at UFF established a Committee of Professors in the Department of Chemical Engineering with the objective of developing studies for the creation of an Oil and Natural Gas Engineering Undergraduate Program [3].

The objective of this action was to finally establish a program to provide new engineers with a comprehensive knowledge of all the items involved in the research, extraction, transportation and processing of oil and natural gas. Environmental protection, and safety for people working on the oil industry are also expected to be seen as priority matters in the program. Environmental protection, of course, extends much beyond natural gas and oil production.

The committee in charge of creating the Oil and Material Gas Engineering undergraduate program was successful. The new program was approved at every university administrative level. UFF is expected to make enrollment available for 30 new students in Oil and Material Gas Engineering, in 2007 first semester.

### **Environmental Engineering Undergraduate Program**

The technological requirements and the deep impacts of engineering action on the environment have turned out to be critical and challenging for all of us, and mainly for the academy. We do recognize the need to qualify our future engineers to deal with the need to protect our planet from environmental degradation. We realize the need for engineering professionals with both a deep understanding of negative engineering impacts on the environment and the ability to protect it. It is important to notice that this professional must be aware that he should not avoid scientific and technological advancement, but must be able to counterbalance costs and benefits, considering the importance of keeping the quality of the environment.

Thus, the Dean of the College of Technology at UFF established a Committee of Professors in the Department of Civil Engineering with the objective of developing studies for the creation of a program in Environmental Engineering [4].

The statement objective in this case was to qualify an engineer professional to be able to look for solutions for environmental questions, to foster social and economic development brought about by the environmental equilibrium, promoting the quality of life and maintaining the integrity of the environment. The environmental engineer to be qualified by UFF should be able to develop actions on environmental analysis and diagnosis. He should be able to control the quality of the environment as well as to promote environmental recovery.

The committee in charge of creating the Environmental Engineering undergraduate program was successful. The new program was approved at every university administrative level. UFF is expected to make enrollment available for 40 new students in Environmental Engineering, in 2007 first semester.

### **Physics Engineering Undergraduate Program**

Recent advancements in Modern Physics and Science of Materials will surely have a great impact on most other areas of technology and engineering, and require a new engineer. This new engineer should be highly qualified for a general application of modern science in engineering, with solid knowledge of theoretical Modern Physics, Chemistry, Advanced Mathematics and Computer Modeling. He should also demonstrate leadership and knowledge of environmental economics and social science. In sum, this contemporary need points to an engineering professional who can face the challenges of the rapid engineering advancements, without causing drawbacks to development.

Therefore, another committee was established. This was a multi-departmental committee integrated by professors from different departments: Physics, Computer Science, Chemical Engineering, Mechanical Engineering, Electrical Engineering and Systems Engineering. This committee objective was to set the desired profile of the new engineering professional [5].

In Brazil, there is only one such program, Physics Engineering, at Federal University of São Carlos, in the state of São Paulo. Actually, this program is aimed at talented young Engineering students. In the State of Rio de Janeiro, it is expected that this kind of engineering program will qualify professional for the design and application of new technological ideas. It is also expected that it will become an attractive program for the best minds among young engineering students.

The Physics Engineering program is still under study, due to its complexity. It involves professors from different departments, and it will require the use of resources from different departments and of different laboratories.

### **Conclusion**

The flexibility of the present organizational structure at UFF provides the support of professors and human resources from different departments to allow the establishment of new programs with specific requirements and levels of complexity as those just described in this paper. So, the university can meet society demands without the need to hire many new professors. In most cases, it is possible to establish a new undergraduate program, making enrollment available to many students, by hiring just a small number of new professors.

This organizational structure may seem too complex for an outsider, but it turns out to be very convenient and economic for the creation of new programs without high costs. Day by day Federal Universities face more and more restrictions in terms of federal budget, while the number of yearly newly-hired professors does not follow the rate of retiring professors. Therefore, the cost is an important parameter to be considered because of the limitations of Federal Universities in Brazil,

This work reports on how the College of Technology has dealt with the need for updating existing programs and/or creating new ones so that Higher Education at UFF can follow contemporary scientific and technological development. Naturally, the same kind of need eventually arises in other fields of knowledge within other UFF Colleges as well as in other universities. When that need comes about, both identifying it and responding to it can be paramount for the improvement of higher education in Federal Universities. We hope this work can function as incentive for educational institutions to turn their academic structures flexible so they can create new undergraduate programs when the society demands become evident.

## References

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[3] DTS – CTC Number 34 dated October 6, 2003.

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[5] DTS – CTC, number 47, dated November 11, 2003.

World-Wide Web URL: <http://www.uff.br>

## **Biography**

WAINER S. SILVA is Dean of the College of Technology at Federal Fluminense University in Rio de Janeiro, Brazil. He joined UFF in 1974, and has been a Full Professor since 1988. He earned his B.S. in Telecommunication Engineering from UFF, his M.S. in Electrical Engineering from Military Institute of Engineering, and his Ph.D. in Electrical Engineering (1983) from Vanderbilt University, in the USA. Dr. Silva teaches at the undergraduate and graduate level and has published extensively on his field of knowledge and also on teaching engineering.