Strengthening Engineering Education in Brazil

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***Abstract* - The article analyses the Engineering profession and education in Brazil by comparing international and Brazilian contexts. It also demonstrates the perception of industrial leaders according to which there is a shortage of Engineers in the market, and the fact that the next generation of Brazilian Engineers should hold new skills. It is a short version of a long report presented by the Brazilian Industry Confederation (CNI) and basic document for discussions at the International Seminar "Strengthening the Field of Engineering in Brazil", held in November 2014, where specialists from university, industry and government came together to debate means to transform Engineering education in Brazil.**

Keywords - Engineering Education; Brazil; University-Industry Cooperation; Innovation.

1 INTRODUCTION

In spite of the fact that Brazil has shown a considerable economic growth for a few decades, the country is now close to a recession and has recently undergone two consecutive quarters of falling economic output. This is a serious problem that requires strategies that will improve economic productivity. Engineering is a key sector in furthering the country's economic growth through expanding the creation of new technology and high value-added exports.

Currently, there is a perception among Brazilian entrepreneurs of a shortage of engineers in several industry sectors. These professionals also believe engineers frequently lack the necessary skills to innovate, which puts the country's long term economic growth and sustainability at risk. The appropriate quantity and quality of human capital within the field of engineering are essential components to be revaluated in order to promote innovation and competitiveness in the engineering sector.

2 INTERNATIONAL AND BRAZILIAN CONTEXTS

Brazil does not lie in a comfortable position in BRICS countries and other natural competitors because it produces fewer new technologies, patents, and scientific articles in the field of Engineering. The profession has also shown a lower number of PhDs compared to Medicine, even though the amount of Engineers is higher than that of physicians (630 thousands against 346 thousand). There are few PhDs Engineers in Brazilian companies compared to most OECD countries. The vast majority of Brazilian doctors in Engineering remains in universities and research centers and very few are in industry.

Table 1 - Brazil and selected countries, rankings comparison

	Scientific Output	Citations	H Index (impact)	Global Innovation Index 2014	OECD Patent Database 2012
Brazil	13	17	22	61	25
China	2	2	16	29	3
Russia	15	22	21	49	21
India	7	13	23	76	14
South Africa	34	33	34	53	28
South Korea	12	14	19	16	5
Japan	7	8	6	21	2
USA	1	1	1	6	1

Source: Scopus 2013.

The figures demonstrate a considerable problem: the poor interaction between universities and companies makes unlikely the generation of a higher number of patents. Such low register of patents in Brazil also stems from the poor penetration of the country's industry in the competitive international technology market. A study conducted by the World Bank ranked Brazil 26th among high-technology product exporters.

Primary commodities represented 40% of total Brazilian exports. Medium and high-technology intensity products represented slightly more than 30% due to product's low level of innovation. Worldwide, 60% of exported products hold medium and high-intensity technologies.

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According to the Global Competitiveness Index by the World Economic Forum, published annually, Brazil's ranking has been shifting between 55th and 72nd over the past years, out of 140 countries. Brazil's education system has strongly contributed to this position. PISA exams have drawn the attention to the low quality of Brazilian education in the following assessed themes: Reading, Mathematics and Sciences (the Ability to Solve Problems was not conducted in 2012). A summary of these results are described in Table 2:

Table 2 – Position of Brazil in the OECD PISA 2012 Exam:

Total of 61 countries	Reading	Mathematics	Sciences
Brazil	**51st**	**54th**	**55th**
Brazil compared to 8 Latin American countries			
Brazil	**5th**	**5th**	**6th**

Source: PISA.

Brazilian Engineering has been the subject matter of a number of debates at various levels, including the press, business sectors, educational institutions and bodies representing the field and the government. Does Brazil have enough Engineers to keep up with its economic growth? May the shortage of Engineers be a hindrance to progress?

When using OECD countries with similar Brazilian GDP as reference, until recently, Brazil graduated a significantly reduced number of Engineers per year (30,000 until 2009). The industry shortage of Engineers was announced when Brazil's GDP was increasing at 7% per year, and the number of students graduating from Engineering courses in Brazil was almost stationary.

The Engineering Union of Paraná (Sindicato dos Engenheiros do Paraná - SENGE) has produced one of the most comprehensive studies on the activities linked to engineering professional practice in Brazil and draws upon the insight of employees, managers, and owners on engineering companies. According to the study, in 2009, 244,000 Engineers had a formal, traditional job, while 80,000 worked as independent Engineers and 100,000 performed other activities directly related to Engineering, reaching a total of 422,000.

Considering the difficulties to estimate demand for Engineers in a given country, the comparison with international averages may help determine the situation in Brazil, in order to verify whether Brazilian indicators are according to the expectations obtained internationally, on the basis of national data. In the OECD, the data obtained from the European Engineering Report 2009-2012 (VDI) indicates an average of 11 Engineers in the labor market per 1,000 inhabitants. In the USA, this number is nearly 9, while in Brazil it is less than 2.3.

Based on a European Engineering report issued in 2010, UNESCO indicates the number of graduate Engineers in European countries. The study demonstrates that the number of graduate Engineers, in Brazil as well as in OECD countries, is greater than the number of professionals effectively in the labor market. In OECD countries, there is an average of 26 engineers holding a diploma for every thousand inhabitants, while there are only 11 engineers in Brazil's labor market for the same amount. In Brazil, there are 3 engineers with a diploma for 1,000 inhabitants.

Table 3 compares the number of graduated Engineers over the past ten years in Europe, the USA and Brazil according to the OECD classification for Engineering, Manufacturing and Construction. The conclusion from this data is that Europe has more Engineers in the labor market and graduates more Engineers per 1,000 thousand inhabitants than the USA, which, in turn, graduates more Engineers than Brazil.

Table 3 – Graduated Engineers

Graduated Engineers over the past 10 years per 1,000 inhabitants	
Average of European countries	**7.55**
USA	**4.42**
Brazil (only Engineering)	**1.49**
Brazil (Engineering, Construction and Production Field)	**2.10**

2.1 The Superior Technology Courses (CST)

The modality of Superior Technology Courses (Cursos Superiores de Tecnologia - CST) is a more recent degree in higher education in Brazil. Its start dates from the 70's, but its numbers only recently are meaningful in the higher education scenario in the country.

The slow growth originates from the Brazilian culture. In the country, practical education is perceived to be inferior, at the time that the traditional, theoretical and abstract knowledge has been the paradigm of good education.

This prejudice against the more practical degrees reaches the Superior Technology Courses (CST), considered by many educators and some companies, of being of poor quality. Contrary to what happens in many countries with the highest levels of innovation, the widespread prejudice against these courses contradicts trends on education. Many worldwide technological courses are offered in federal or private institutions with great quality, frequently better than various engineering courses offered today in Brazil.

The CST can provide the willingness for professional's insertion in the labor market, with more practice on modern equipment than traditional baccalaureates. In addition, graduates from these courses can complement teams of Engineers with functional and financial advantages in most of the companies.

In Europe, one third of students in higher education are enrolled in the technology type (called 5B). Of this total, about one third of the students are majoring in engineering and related areas.

The most technologically developed European and North American countries are firmly committed to the expansion

and improvement of courses such as the type 5B. This strategy is also strengthened when companies participate on the training of students, showing that public-private partnerships are essential for the education in a country.

3 LIMITATIONS OF BRAZIL'S ENGINEERING EDUCATION

According to the latest 2011 Innovation Research (PINTEC), conducted by the Brazilian Geography and Statistics Institute (IBGE), 72.5% of the interviewed companies emphasized the lack of qualified personnel as one of the primary obstacles for innovation.

Currently, industry in Brazil and worldwide expects Engineers with personal abilities that transcend the objective and quantitative reasoning skills, traditional on the Science, Technology, Engineering, and Math (STEM) courses. It is necessary for students to develop characteristics of leadership and teamwork, entrepreneurism and general knowledge of non-scientific fields. The domain of which has been shown to be increasingly important for the modern education of an entrepreneurial and innovative Engineer.

Recently, UNIEPRO (a think-thank in the Brazilian Industry Confederation) has promoted an important research among Brazilian company managers, with the objective of discovering the main Engineers role in country, considering the current and the future required competencies, personal skills and technical abilities on these professionals. Activities could be classified in three groups in decreasing order of mentions: management, traditional technical activities and innovation (R&D).

The new study confirms the findings of previous CNI studies, pointing out the need of soft skills competencies, better high schools and elementary education in the country, basic requirements for a good scientific and technical formation for innovative personnel. It also indicates a demand for cognitive, behavioral, functional and technical skills required for innovation, such as creativeness and critical thinking, inductive reasoning, entrepreneurship, managing risks and the capacity of solving new problems.

Finally, the study shows the necessity of improving the higher education in the country, from the focus on critical thinking to an increased emphasis on more creative thinking.

3.1 STUDENT RETENTION AND GRADUATION

Despite the significant increase in the number of Engineering enrollments over the past decade (66% from 2009 to 2012), it is still necessary to reduce dropouts as well as increasing the number and the quality of Engineering graduates in the country. Brazil graduates in Engineering only about 7% of all its holders of an undergraduate diploma, which is far less than any other OECD country (approximately 12%), and South Korea (around 23%). The annual dropout rates in Engineering in Brazil is greater than in Law and, sometimes, greater than in Medicine. Shortages on the solid basic school education and the lack of motivation between students provoked by the densely theoretical engineering curriculum are among the main factors considered responsible for increasing the dropout rates.

It is important to emphasize the considerable differences between dropout rates in public and private sectors (see Table 04).

Table 4 – Annual Dropout Rates on Engineering Courses in Brazil from 2010 to 2011

DROPOUT FROM PUBLIC HIGHER EDUCATION INSTITUTIONS	DROPOUT FROM PRIVATE HIGHER EDUCATION INSTITUTIONS	TOTAL DROPOUT FROM HIGHER EDUCATION INSTITUTIONS
7.29%	**20.96%**	**16.02%**

Source: Censo (2011).

In addition, it is relevant to note that Engineering graduation rate in Brazil is reasonably constant, whether in the public or private sector, except for a slight upward variation in the year 2005. The graduation rate in the public sector is 56% (only 56 graduated for every 100 students enrolled in the first year), while for the private sector the rate is 37%.

Full time degree is an important factor to consider in order to reduce dropouts. Extra time on the graduation can be used for improving required capabilities and renewing courses curriculum and teaching techniques.

3.2 THE CST COURSES

Superior Technology Courses had in 2012 almost one million students, 14% of the undergraduate enrollments in Brazil. Despite the comparative low enrollment rate, admissions on these courses are growing faster than the average growth of higher education as a whole.

The field of Engineering, Manufacturing and Construction corresponds for 9% of the total enrollments in CST, 90% of these are in-person courses.

Despite of the fact that yearly dropout rates in these courses in the area of Engineering, Manufacturing and Construction are higher (around 25%) than those in Engineering, the graduation rates of CST have shown similar results. It is relevant to note that superior technology courses takes three years long, at the time Engineering degree lasts five years.

The reasons of the high dropout rates in the CST are the same as those for the bachelor degrees: difficulties with high school contents (math and sciences), financial problems and the lack of institutional programs to modernize colleges, among others.

In general, in Brazil and abroad, a student of technology course costs per year around 60% of baccalaureate students, but CSTs are shorter than baccalaureates, making the cost to form a technologist around 45% of the cost of a bachelor.

3.3 CURRICULA

According to a study conducted by UNESCO in 1998, a professional able to meet the challenges of the 21st century should have the following skills and characteristics: be adaptable, be capable and willing to contribute to innovation and be creative; deal with uncertainty; seek for a lifelong

learning; be social; be able to communicate with effectiveness; work in teams and assume responsibilities; and, last but not least, be an entrepreneur. In addition to these characteristics, this professional should domain several languages and understand different cultures.

Only a reduced number of these characteristics are comprised by the Brazilian Engineering curricula, and there is a strong reaction by professors and students to incorporate these new activities, which do not belong to the "hard skills" set.

The education of an Engineer for the 21st century has been the theme of a number of academic studies, seminars and actions toward the analysis of new responsibilities for Engineers, considering their responsibilities on society, technological advances and international economic trends. In addition, it is relevant to notice that the most successful companies that have emerged in the last ten years in the stock exchange did not emerge because of the science or technological, but based in new forms of thinking and communicate.

3.4 Premature specialization

The excessive specialization of undergraduate Engineering courses has not resulted in an increased demand for graduate courses nor in a reduced dropout rates. In a time when academic mobility is relevant and two-course diploma are valued, for which Europe has been conducting comprehensive integration studies, how could society benefit from so many Engineering specialties in the country?

Technology has advanced at an accelerated pace and premature specialization may reduce knowledge and induce a highly specific understanding of something that will not last long.

4 STRATEGIES FOR IMPROVING ENGINEERING EDUCATION

4.1 Internationalization of engineering schools

The internationalization of Brazilian Engineering schools is vital to expand the knowledge network in the field. International universities increase cooperation in international research projects as well as its effectiveness and, at the same time, generate a natural benchmark to assess the quality of schools, creating the need for constant evolution.

Therefore, it is necessary to attract international talented people; introduce foreign language courses, especially English; provide incentives; approximate academic teaching to market; and provide flexible and competitive salaries for professors. In another measure, sending students abroad at several levels of education brings important contributions to the country since adds specific professional knowledge, gives students the opportunity to be exposed to new cultures and establish important international professional relationships.

Experts suggest that sending personnel abroad could be more effective than bringing people to Brazil, for example. This strategy is appropriate if the Brazilian visitor is fully integrated in the university routine, not only participating in a research group where commonly not exposed to the new trends about teaching and management activities, institutional decision making processes and priorities. The same is valid for visiting professor from abroad, where their educational experience is much better absorbed if the can stay for long periods and participate in departmental decisions.

The international exchange program from the Brazilian Government, with a substantial number of scholarships (more than 70 thousand), which allocates 55% of them to engineering programs, could follow some of these strategies.

4.2 Increase the quantity of students in engineering degree programs and STEM PhD programs

It is necessary also to expand graduate courses and place these graduate professionals in companies. In the USA, doctors in Engineering represent 14% and doctors in Sciences represent 24%; in South Korea, they represent 26% and 12%, respectively. In Brazil, out of the totality of doctors, 11% of whom are in the field of Engineering and 10% of whom are in the field of Sciences. Brazil has less doctoral students in Sciences, Computing and Engineering than the majority of OECD countries.

Brazil is experiencing a reduced number of PhDs in industry, as Brazilian graduate courses are primarily designed for an academic career. Figures show that 95% of doctors in Brazil work for universities and only 1.7% work for companies. The average percent in OECD countries is 18%. In the USA, 34% of PhD graduates work in the business sector and more than 60% of doctors graduated from Engineering work for companies. Stricto sensu graduate courses in Brazil have extremely academic character and lack professional activities that should be performed in companies. The compulsory sequence broken down into undergraduate degree, master's degree and doctor's degree, without professional experience being required, makes doctors in Engineering to have a scientific and not technological bias, hindering their adaptation to companies' production process.

Considering that PhDs would be more devoted to academic work relating to theory and research, Masters degrees in Engineering should focus on the practical experience and knowledge. The MSc in Engineering should deal with real practical problems, moving away from the present expectation of being an introduction to academic research.

4.3 Obtain professors with strong academic and professional experience

Qualification and professional experience should be prioritized in hiring professors in Engineering schools, strengthening practical work experience outside of academia. The majority of these professionals have a number of degrees but insufficient or no professional experience in the labor market. This feature compromises the teaching in Engineering, as it hinders the so-required connection between theory and practice.

Companies are not yet taking full advantage of the knowledge acquired by the MSc's and PhDs in engineering.

One way to reduce this problem could be to hire a minimum percent of the faculty with some years of experience in industries (five years, for example).

4.4 INCENTIVE SYSTEMS

Only a vigorous incentive program to update Engineering courses in Brazil, counting on concrete stimuli for projects that could sustainably introduce the necessary changes, based on assessments and proposals made by national and international specialists, would be capable of modifying the current scenario in the medium term. The results of Engineering courses and the quality of Engineering professionals should be monitored and assessed. Educational institutions, industries and other groups from society should conduct this follow-up in order to continuously develop the Brazilian Engineering system.

In regard university-industry cooperation, the effectiveness of this interaction is insufficient in the country, leading to limited innovation, low number of patents and insignificant international competitiveness in high-value-added sectors.

5 PRELIMINARY PROPOSALS FOR IMPROVING ENGINEERING IN BRAZIL

5.1 IMPROVE THE QUALITY OF ENGINEERING EDUCATION

a) **Implementation of specialized study groups in engineering education.** Formed by professionals of the Engineering area, these groups would have the purpose to define measures in order to leverage the education of Engineers in Brazil by developing a reliable database for analysis of best practices in Engineering teaching of national and international origin and following-up projects of change in the Engineering courses in Brazil.

b) **Creation of a vigorous incentive programs to update Engineering courses in Brazil**. Such a program would have to count with concrete stimuli for projects introducing the necessary changes on a sustainable basis, grounded in appraisals by national and international experts. The quality of engineering courses and of its professionals must be monitored and examined by education institutions, its financers, industries and society as a whole.

c) **Increase integration between Engineering courses and the private sector**. This integration should necessarily include the participation of companies' personnel in the formulation of curricula, internships and training of students along with assessment of former students with respect to their experience in the labor market. It could also encourage the creation of technological research centers associated with universities.

d) **Creation of a national retention program for Engineering courses**. By updating the Pro-Engineering Project, a permanent working group would study the reasons for dropouts from Engineering courses, unify the methodology for its calculation and create a competitive program to finance anti-dropout measures for public and private institutions, including studies of dropout, anti-dropout measure proposals and goals to be achieved within 3 to 5 years.

e) **Undergraduate-graduate integration**. This plan of action would encourage continued education of undergraduate and graduate students, specially through a professional Master's degree fast-track, by introducing subjects and activities from graduate curricula, such as optional or supplementary activities in undergraduate courses.

f) **Create programs to support Engineering schools in actions performed together with elementary and high schools**. This would involve public and private schools, in order to encourage logical spirit and capacity of innovation of the students of these educational levels.

g) **Revaluation of the Engineering Syllabus Guidelines**. Due to the pulverization of areas of specialization in Engineering and the growing internationalization of university education (Bologna process, among others), it is necessary to review legislation regarding Engineering Education to take into account the compatibility of Brazilian courses with international standards.

h) **Prioritize professional Master's degree programs in Engineering**. These degrees would have a specific requirement for the participation of students in projects side by side with industry, valuation and support to professional Master's degree in Engineering and granting of scholarships. There would also be specific programs directed towards Engineers intending for an academic career.

5.2 ACHIEVE INTERNATIONAL COMPETITIVENESS STANDARDS

i) **Evaluation and ranking**. It involves creating a program of international benchmarking and best practices of the main Engineering courses that would be preceded by a visit of international specialists to conduct a global appraisal of Engineering in Brazil and proposals of advances in the education in this field. It would be equally interesting and even necessary to create a special team for missions of studies to compare the Brazilian experience with that of the best international practices in teaching Engineering.

j) **Implementation of internationalization programs for academic staff and stimulation of meritocracy**. It involves creating financial support and making residency and fixation of foreign professors in Brazil simpler. It would also entail the reviewing of the academic carrier legislation, in order to meet the peculiarities of professors, researchers and innovators, which are not properly contemplated in Brazilian law. The objective would be to make it more difficult for professionals to obtain stability in universities, create incentives for the best professors, facilitate cooperation with external bodies, give incentives to innovation and foster participation of universities in the results of R&D activities, seek support from Congress, Brazilian Bar Association and respective Executive Ministries for solutions of problems holding a labor nature.

k) **Positioning of five Engineering courses among the world's 100 best colleges within 15 years**. This goal would help improve capacitation of academic staff, publishing of technical and scientific works and production of licenses and patents.

5.3 Catalyze Innovation

l) **Creation of Research & Development centers linked with the Engineering schools**. Stimulate and support the creation of such centers, in order to enable academic staff to work on real problems based on companies and government demands, making use of academic competence to solve problems and train graduate and undergraduate students to the Engineering practice inside the campus's structure.

m) **Incentive for innovation projects**. These would be developed by student teams supervised by professors and Engineers working for companies.

n) **Creation and financing of a national support network for small and medium-sized entrepreneurs**. This would entail the creation of a program similar to "dial-technology" for projects with innovative content, developed by universities by using the competence installed in the different institutions and by counting with the participation of junior companies or teams of students guided by professors and technicians.

5.4 Workforce Development & Technical Training

o) **Find mechanisms for the creation of a fast-track between technicians, superior technology courses and bachelor degrees in technology areas**, through the recognition of skills acquired at each level of training, bureaucratically not limited to the identification of subjects offered at different levels of education.

p) **Increasing the choice of CST courses** through incentives and professional valuation, especially in areas related to Engineering, supported by online education in regions where deemed necessary, to achieve in 5 years 30% total enrollments in higher education.

q) **Involve companies from different areas in the formation of the educational project of professional careers.** Also, involve companies in the curriculum discussion and evaluation.

6 CONCLUSION

A true revolution in the way Engineering is taught in Brazil is fundamental for the country to increase its productivity and keep pace with the most innovative countries. The quality of engineers and technologists and the ability of companies to innovate are key to improving industry's competitiveness.

Engineering schools must graduate professionals with the capacity to innovate. Those engineers must develop personal skills that transcend the objective abilities acquired in traditional courses. Values such as leadership, teamwork, entrepreneurship, along with general knowledge in non-scientific areas is proving increasingly important for the formation of the modern entrepreneurial and innovative engineer. According to the 2011 edition of the "Research in Innovation" (PINTEC), conducted by the Brazilian Institute of Geography and Statistics (IBGE), 72.5% of interviewed companies declared that the absence of qualified professionals is one of the main obstacles to innovation in Brazil.

Despite the large increase in enrollment over the past decade, it is still necessary to reduce the dropout rate and increase the number of engineering graduates, to meet existing demands. The dropout rate is estimated to be around 61% in engineering courses, while medicine and law rates are at 5% and 47% respectively. Among the factors identified as responsible for the high dropout rate is the lack of solid basic schooling and poor curricula in engineering courses. In Brazil approximately 7% of Engineering students graduate as engineers, a far lesser rate than the OECD countries (approximately 12%) and much different from South Korea (23%).

The wide range of options in training and professional practice in engineering must go through a restructuring process. The worldwide trend is to graduate non-specialized engineers, leaving further study for postgraduate courses (Masters, Doctorates or another type of specialization).

The internationalization of Brazilian engineering schools allows the formation and growing of knowledge networks in this area of study. The most internationalized schools increase cooperation on international research projects and their efficiency while generating a natural benchmark for the evaluation of the quality of their own schools, creating the need for constant evolution. Therefore, it is necessary to attract international talents, introduce courses and training in foreign languages (particularly in English) and offer incentives for academic teaching, such as flexible and competitive salaries. Another important measure is to send students abroad at the various levels of training. This initiative brings important contributions to the country as a whole, not only in terms of specific professional knowledge, but it also in the broadening of the student's knowledge of new cultures. It equally establishes professional networks in an international level.

It is also necessary to expand postgraduate training. In the US, only 14% of students obtain a Doctorate degree in engineering, while the figure is equal to 24% in Sciences. In South Korea these numbers are 26% and 12%, respectively. In Brazil, there are 11% of doctoral graduates in Engineering and 10% in Sciences. Brazil has less doctoral graduates in the Sciences area, information technology and engineering than the vast majority of OECD countries.

There is also a need of placing students with a higher level of education as working professionals. Brazil holds a low

number of doctoral graduates working in industries, as most Brazilian postgraduates opt for an academic career. Total figures demonstrate that 95% of graduates in Brazil work in universities and only 1.7% in industry. In the US, 60% of graduates in Engineering are professional workers in industry.

Master and Doctorate programs in Brazil are of an extremely academic nature, with little emphasis on the practical aspects relevant to the professional activities of companies. The present mandatory route of taking an undergraduate course, followed by an academic Master and Doctorate degrees without professional activity result in Engineers having a non-practical bias, which presents difficulties in adapting to the production process of companies.

Differently, qualification along with professional experience should be prioritized when hiring faculty members in Brazilian Engineering schools, in order to enhance practical industrial experience. Present faculty members have, to a large extent, many qualifications, but little or no experience in the labor market. This may, to a varying degree, have a negative impact in Engineering teaching, by hindering the much needed connection between theory and practice. Brazilian Masters and Doctors in Engineering (qualified with almost no practical skills) are not bringing their knowledge to the production sector.

The absence of a qualified and diversified system for training engineers with several different specializations, according to productive sectors and socio-graphic regions is evident. Therefore, it is desirable for Brazil to have a system which is adaptable to its various needs, regional characteristics and stages of development in different areas of production of goods and services.

The results of engineering courses and the quality of the professionals should be monitored and evaluated. Such monitoring should be made by educational institutions, their financiers and society as a whole, in order to continually improve Engineering in Brazil.

It is necessary to invest in the readjustment of professional, long-term goals in engineering as early as in high schools years. Proper training in Engineering demands an improvement of basic education, with emphasis on mathematics, physics and chemistry. These disciplines, in addition to communication, speech and language, are requirements of the new development paradigm of the contemporary world.

Despite a great challenge, a thorough reform in engineering courses in Brazil is adamant for the country's sound development. It should be held as a priority in the political agendas on both public and private sectors.

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