

# The Formation of the Entrepreneur Engineer

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**Abstract:** The present work draws a comparison between the ideal civil engineer for the market and the entrepreneur, pointing out the necessary professional characteristics in order to meet companies' expectations. It presents newly-graduated students' situation, giving special emphasis to the deficiencies in the engineering teaching as well as some solutions to make the engineer follow the technological revolution and keep up with many of the currently existing forms of knowledge. It is verified that the quality of higher education is related to the development of the country area. More industrialized areas have easier access to research resources, agreements between construction companies, university and financial institutions, laboratory services and some others. This allies science to the development of society. In addition, one may notice employers' greater concern with being than with knowing, justifiable by the perspectives of modern times, a civilization concerned with moral qualities. There is no way out for civil engineering apart from the interaction among university, construction companies, materials suppliers and other companies involved. The development of medium and long term research is a key factor, since competitiveness demands innovation. Education is the way out, but many things must be changed. The responsibility is not restricted to the government, through a politics concerned with knowledge. It is also the institutions' role to provide students and teachers with ways to develop a methodology that makes a professional able to meet market's needs. There is no sense in forming a laborer unable to execute his/her own work. It then becomes a matter of where such a worker could be placed. This individual will probably be one more person to figure in a hard Brazilian social problem, unemployment.

**Keywords:** entrepreneurship, engineering, teaching, market's needs.

## 1. Introduction

It has been noticeable the need for some change in higher education, as well as the development of a policy which allows for everybody's access to technology.

Which is, after all, the true significance of technology, when it is many times a privilege restricted to those who can afford it? Capitalism is not concerned with performing social tasks in accordance with the technical advance obtained. Science itself does not guarantee a society freed from poverty, once it is modeled by the dominant production relations.

The newly-graduated civil engineer is ready to perform services related to the technique of engineering, having not much more than some basic notion about human sciences, such as management and economics. However, the main demands of the work market are for management, administration and interpersonal skills. Technique, in this way, presents itself as essential; still, practice in work itself is the key factor to determine the engineer's qualification.

Such a discrepancy between the interests of the market and the formation of professionals by universities may be observed in the great amount of unemployment which exists in the country, and the lack of competent professionals in large companies. In this view, it is essential for the good engineer to have characteristics of an entrepreneur. What is then proposed here is the engineer-entrepreneur, who is concerned with all areas involved in entrepreneurship, from suppliers to clients.

This work presents a parallel between the ideal entrepreneur, the newly-graduated engineer, and the expectations of the market for such a professional, pointing out the most visible deficiencies in the teaching of entrepreneurship, as well as the necessary changes in the engineering course in order to meet the needs of the companies.

## 2. Justification

The concepts of "engineering" or "engine" came from Renaissance Europe, derived from the Latin word *ingenium* which means genius, creative talent, inventive power. In that time, the word used to refer to almost all those who dealt with projects, basing their crafts on solid knowledge about geometry and mechanics, which had been

inherited from Antiquity and the Middle Ages<sup>1</sup>. Eminent engineers, such as Leonardo da Vinci, have never been forgotten.

In the eighteenth century, during the Enlightenment period, several engineering schools were founded in order to meet the needs due to the construction of bridges and roads. After the *First Industrial Revolution*, at the end of the eighteenth century, the development of the steam engine led to the beginning of industrialization. It expanded throughout the nineteenth century, outlining then the social and economic roles of engineering, willing to reduce, by the use of machines, the use of human force.

The *Second Industrial Revolution* reached the United States, which developed modern techniques of industrial production within the automotive industry. Taylor set out the basis of organization and management of industrial production, which would soon become basic requirements for the twentieth century engineer, who would act as a manager, taking organization and management responsibilities<sup>1</sup>.

After the *Second World War* there was the growing of industry and scientific research, adding new technologies to engineering. In the Third Industrial Revolution, during the second half of the twentieth century, new technologies of communication came about, whose explosion speeded up the globalization of economy.

The modern engineer acts as an administrator, project and production manager, and even as a trader of products and services. Thus, due to such large field of action, it becomes hard to set out all the possibilities for the engineering course. In this case, specialization seems to be a way out<sup>2</sup>. The world is now facing another historical change. After the Industrial Revolution, which started last century, we are now going through the Revolution of Knowledge and Technology. There are expectations of changes in several areas: economy, politics, ideology and culture, which would essentially alter the way people behave and think.

In such an important transitional phase, it is crucial to rethink objectives and methodology of higher education. We are going through a moment in which the teaching of civil engineering must be changed since there are currently a higher awareness of human interrelations<sup>3</sup>: “Linear, segmented, standardized and repetitive work, typical of the Taylorist and Fordist technological pattern, has been replaced by a new modality marked by integration and flexibility”<sup>4</sup>.

### 3. Objectives

- Identifying whether the newly-graduated engineer owns entrepreneurial characteristics (and which ones);
- Identifying which entrepreneurial characteristics the engineer must have in order to meet the demands of the work market;
- Identifying the deficiencies of the engineering courses as well as suggesting changes to improve teaching within them;
- Comparing the ideal entrepreneur to the ideal engineer for the work market;
- Showing the correlation between the development of a certain region and quality of teaching;
- Presenting the way in which entrepreneurship may improve engineering courses.

### 4. Economic development and entrepreneurship

We can try to relate the quality of universities to the level of development of a certain region. We can see that the most economically powerful ones have the largest companies, higher competitiveness and higher concern with quality. This condition asks for higher investment in research, which is mainly developed at universities.

In order to develop new technologies, the existing ones must be assimilated by companies, so that flaws may be detected and then incorporated into the new study. The value of knowledge resides in the transformation which it may cause in society<sup>5</sup>.

In tune with this, Japanese companies have shown world leadership as far as technological performance is concerned and their students have obtained the best results in international evaluation tests of teaching quality.

The following table shows the number of courses in each region of Brazil, in which we can notice that the south-eastern region has over 60% of all courses in the country.

Table 1. Undergraduate Courses of Engineering - Regional Distribution

REGION	NORTH	NORTH-EAST	SOUTH-EAST	SOUTH	CENTRE-WEST	LEGAL AMAZON
COURSES	4.1 %	12.2 %	61.0 %	28.8 %	3.8 %	5.2 %

Source: SESu/MEC - Adapted by Marcos Ximenes Ponte (1996).

Nowadays, the interaction university-companies happens by means of counseling and some short term projects. However, if companies maintained medium and long term research, via financial support as well as partnership with other companies, not aiming at immediate profit but at continuous research, results would be continuously extended, which would lead to the definition of new products. Students involved in such projects would promptly be ready to be employed by companies. Besides, such companies could support projects developed by students and, later, benefit from the results <sup>6</sup>.

## 5. Structure of the teaching-learning process

It has been common sense that absolute knowledge does not exist. Every day new information is added to studies, which leads to constant improvement of the learning process.

According to the last educational reformation, emphasizing applied science, the aim is to stimulate students' creativity as well as make them more critical, that is, develop the ability to think and create; educate citizens as complete and creative human beings <sup>7</sup>.

Teaching is an enterprise, just like a good work of engineering, made up of three phases: planning, execution and evaluation of results. Planning is based on the sort of professional which is wanted, execution is based on the planning process, and the evaluation of results is done during and after execution <sup>8</sup>.

When comparing the curricula of Engineering Courses at Federal University of Goiás (UFG) and Federal University of São Carlos (UFSCar) in São Paulo, we can see that the class load in the latter is heavier, which partially answers for the better formation of its students. Still this cannot be taken as the main state is questions more industrialized. This can allow for partnerships among companies and university which generate work and projects developed by students and teachers, qualified services for the companies and the development of society itself <sup>9</sup>.

## 6. Demands of the work market

In January 1998, the Poli-technical School of Engineering at USP (POLI/USP) ordered some research about companies in São Paulo. Financed by the Companies Federation of São Paulo (FIESP), such research aimed at tracing the profile of the ideal engineer which would be demanded by the year 2002. The research involved 17,518 commercial establishments in São Paulo and it was performed from December 1997 to January 1998 <sup>10</sup>.

53% of the questionnaires were answered by managers and supervisors; 31% by directors; the remaining ones by analysts, counselors and companies presidents and vice-presidents.

Out of 72 characteristics, the 16 attributes which were best valued were as follows (the sequence shows the degree of importance): 1°. Concern with quality, 1°. Group work skills, 2°. Ability to deal with changes, 3°. Awareness of the role of the client-consumer, 3°. Basic notions regarding computer science, 4°. English language skills, 5°. Fidelity towards the company in which he/she works, 6°. Concern with professional ethics, 6°. Professional ambition, 7°. Planning skills, 7°. Awareness of the needs of the market, 8°. Straight character, 9°. Global vision of his/her profession, 9°. Ability to save resources, 10°. Concern with safety at work, 10°. Leadership skills <sup>10</sup>.

The demand is almost entirely related to qualities of BEING and less to technical KNOWLEDGE: "It is an individual who tries to regard quality as a constant duty, searching for perfection in the exercise of his/her professional activity. It is an individual who knows how to live and be sociable, who is concerned with ethics, personal dignity, someone with personal honor, who can face changes and has well developed personal intelligence, which means having self-knowledge and being able to grant the value of the other. It is an autonomous being, with decisional and critical skills, so that he/she can evaluate and trust his/her sources of information as well as produce knowledge" <sup>10</sup>.

The participation of companies in the formulation of the engineering courses curricula is essential for a closer approximation between institutions and the reality of the work market <sup>11</sup>. The knowledge which has been constantly incorporated, together with the growing demands in the exercise of engineering have generated higher anxiety as for the domain of some techniques by the professional individual. The use of programs to replace problem schematization and development damages the logical reasoning.

In the eighties, in comparison to the nineties, engineers used to have a more solid formation in the basic sciences of his/her profession: Physics and Mathematics. They used to be more skillful in solving problems, had a more systemic view on reality and better logical reasoning. From the nineties on, however, the use of computers has been emphasized. Students perform a great number of experiences, reach solutions, but do not learn from these

experiences, as the ones from the previous decade did. On the other hand, they use computer science and means of communication in a more productive way <sup>11</sup>.

Some research done by Santille, Schlouchauer and Jucá (SSJ), a company specialized in young professionals training, concluded that creativity is the quality which newly-graduated regard as the most important one. Curiously, characteristics such as intelligence and group work skills received the lowest ranking by the 600 young professionals who took part in the research, as we can see in the following table:

Table 2. Qualities pointed out by young professionals as necessary to be successful in the work market (%):

Ranking of qualities	%
Creativity	16.9
Persistence	13.1
Dynamism	11.8
Leadership	11.0
Determination	10.5
Learning willingness	10.1
Dedication	8.9
Initiative	8.4
Flexibility	8.4
Group work skills	8.0
Intelligence	1.7
Professionalism	1.3

Source: Santille, Schlouchauer and Jucá (SSJ) <sup>12</sup>.

## 7. Engineer-Entrepreneur

The civil engineer is many times hired to work in a small constructor or sets up his/her own business and starts dealing with situations for which he/she is not duly prepared. After all, more general disciplines, such as Social and Human Sciences, Economics, Administration and Environment Sciences are insufficient to entail all knowledge necessary for managing his/her business. It has been noticed that the ability, acquired at university, to manage an enterprise is mainly due to the fact that studying engineering stimulates the part of brains responsible for logical reasoning <sup>8</sup>.

The basic requirements for an entrepreneur are: risk perception; total commitment; vigor, enthusiasm; trading knowledge; self-employment opportunity <sup>13</sup>. As far as the construction manager-engineer is concerned, such qualities become essential for the success of the enterprise and, in this case, it is not possible to separate the engineer from the entrepreneur. There is great advantage in dealing with small investments, since risks are low, easily identifiable, understandable and manageable. However, great investments, like the most of the building constructions, bring about significant financial risks, which may prove to be hard to identify. Besides, capital is very often stretched to the limit.

There are a number of characteristics which make entrepreneurial activity successful <sup>14</sup>, as follows:

- Capacity to take up risks: the capacity to face challenges, try a new investment, put his/her own patrimony to risk, as well as others', to risk when trying to reach his/her goals;
- Sense of opportunity: being constantly tuned with what happens around;
- Leadership: the capacity to use influential power in the sense of solving subordinates' problems when executing their activities;
- Flexibility: to change everything, in order to adapt his/her organization according to the change of the environment;
- Persistence: the capacity to define and keep his/her company's way towards success;
- Global view of organization: regard organization as a process of meeting the client's needs, in permanent interaction with the environment where he/she acts;
- Modernization: the capacity to learn more and more about things related to organization, clients, suppliers, partners, competitors and employees;
- Organization: to define where and how to go, guaranteeing the execution of plans, evaluating and correcting digressions;
- Innovating spirit: to transform ideas in concrete and dynamic facts, which may guarantee the permanent evolution of the company;

- Creativity: to conceive new ideas and solutions without fearing failure.

For the general public, the figure of the engineer is associated to the notion of leadership in some technical activity. The engineer, owner of scientific and technological competence superior to the other actors of production, has certain authoritative power over them<sup>1</sup>.

A study was done in England and published in 1994 in the periodical *European Journal of Engineering Education*, with data obtained from 492 responses to a questionnaire. The questionnaire was sent to a sample of 1,276 engineers graduated at English technical universities and having a twelve-year professional career and the study presents the following conclusion<sup>1</sup>:

- there is no noticeable correlation between efficiency or professional success, measured by salary, and the degree of school reports data or the marks obtained during the formation as an engineer;
- there is remarkable correlation between professional success and a number of personal factors, such as: self-confidence, intensive work skills, character, initiative, enthusiasm, motivation, communication skills, management and group work skills, physical appearance, ambition and others.
- The degrees of Masters and Doctorate had no influence over the professional success measured by the only criterion, salary.

The companies which were interviewed recommended that the engineering curricula reinforced the following areas: administration, problem solving methodology and group work.

## 8. Conclusion

This study has found out that the teacher, as a leader, must point out the way to be traced, according to the student's interests, that is, provide the sources of research and directions to be followed. The institution must have structure to provide the necessary information or ways to search for it. The student will then face difficulties and doubts and these will be part of the learning process. The leading teacher raises the interest, and the university provides the ways and tools for students' search for goals.

The formation of the engineer has to include the development of entrepreneurial characteristics, in order to meet the demands of the market. Entrepreneurism in teaching is a philosophy which pervades all contents.

There is no way out for civil engineering apart from the interaction between university, construction companies, material suppliers and other companies involved in this area. The development of medium and long term research is part of the development, since competitiveness asks for innovation. In the globalized world, education is the way out. High competitiveness between companies demands new form of organization, in which there is only room for entrepreneurial individuals.

## References

- [1] SACADURA, Jean-François. A formação dos engenheiros no limiar do terceiro milênio. In: LINSINGEN, Irlan Von; et alli (org.). Formação do Engenheiro. Florianópolis, Editora da UFSC, 1999.
- [2] PONTE, Marcos Ximenes; BELLESI, Lia Marques. O Ensino de Engenharia para o Século XXI. UNAMAZ - Associação de Universidades Amazônica. Belém - PA, 1996.
- [3] BAZZO, Walter Antônio & Pereira, Luiz Teixeira Do Vale. Ensino de Engenharia: novos desafios para a formação docente. Tese de doutorado. Editora da UFSC. Florianópolis - SC, 1998.
- [4] MACHADO, Lucí lia Regina De Souza. A Educação e os Desafios das Novas Tecnologias. In: Novas Tecnologias, Trabalhos e Educação: um debate multidisciplinar, 4a edição. Petrópolis - RJ, 1998, p.169-188.
- [5] SAVIANI, Demerval. O Trabalho como Princí pio Educativo frente às Novas Tecnologias. In: Novas Tecnologias, Trabalhos e Educação: um debate multidisciplinar, 4a edição, pp.151-169. Petrópolis - RJ, 1998.
- [6] BERMUDEZ, José Carlos Moreira. A educação tecnológica precisa de uma polí tica. In: LINSINGEN, Irlan Von; et alli (org.). Formação do Engenheiro. Florianópolis, Editora da UFSC, 1999.
- [7] DEMO, Pedro. Profissional do Futuro. In: LINSINGEN, Irlan Von; et alli (org.). Formação do Engenheiro. Florianópolis, Editora da UFSC, 1999.
- [8] BRINGHENTI, Idone. Ensino na Escola Politécnica da USP: fundamentos para o ensino de engenharia. Escola Politécnica da Universidade de São Paulo. São Paulo -SP. 1993.
- [9] MINISTÉRIO DA EDUCAÇÃO E CULTURA, SECRETARIA DO ENSINO SUPERIOR. Curso de Engenharia: Estruturas Curriculares. Vol. 1 e 2. Brasília - DF, 1980.
- [10] MORAES, Maria Candida. O perfil do engenheiro dos novos tempos e as novas pautas educacionais. In: LINSINGEN, Irlan Von; et alli (org.). Formação do Engenheiro. Florianópolis, Editora da UFSC, 1999.
- [11] SILVA, Décio da. O engenheiro que as empresas querem hoje. In: LINSINGEN, Irlan Von; et alli (org.). Formação do Engenheiro. Florianópolis, Editora da UFSC, 1999.
- [12] VEJA. Ranking das Virtudes. Editora Abril, ed. 1643, ano 33, nº 14, p.151. São Paulo, SP, 2000.
- [13] PETERSON, MARK A. The Complete Entrepreneur. Hauppauge, New York, U.S.A. 1996.

- [14] SERVIÇO DE APOIO ÀS MICRO E PEQUENAS EMPRESAS (SEBRAE). Iniciando um pequeno grande negócio. Apostilas do curso, módulos I a V. Goiânia, GO, 1996.