# THE ENGINEER FORMATION IN BRAZIL EMPOWERING THE SCIENCE AND TECHNOLOGY BLEND

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***Abstract.*** *The ability to transform engineering basic sciences into technology and solving problems, are some of the main qualification requirements for an engineer, contributing for the society development and sustainable economic growth. However, it can be seen that few universities and education institutions in Brazil are effectively working in projects focusing on the society benefits and industry demands. This issue is related to the gap and lack of synergy between the engineering education institutions and market, where a more long term collaborative work should be developed. The companies globalization also requires the engineer of 21st. century be prepared for the world. The aggressive product time to market launching requires high expertise, experienced and trained professionals, able to speed up the development cycle, doing right at the first time, with quality and competitive cost. The correct combination of human intellectual capital and technology infrastructure is the driving force to achieve these goals and the key element for the success of the engineer formation. Investments and partnership programs in applied science oriented to solve real engineering problems for the benefit of the society should be increased. High challenges should be overcome to address the lack of updated laboratories and practical knowledge of strategic engineering disciplines like material and computational sciences, electronics, control systems, robotics, manufacturing processes, NVH (Noise, Vibration & harshness) and fluid dynamics. The aim of this work is to study the main reasons of these gaps, evaluating the key steps, difficulties and opportunities during the formation of an engineer. Data collection has been conducted by interviews with a range of participants among graduate, undergraduate students, professors, researchers, industry engineers and technical leaders. Finally, the results are then discussed and compared with recent studies reviewed in the literature. It is expected to generate a guideline for education institutions, universities, technological centers and companies that contributes for the process of preparing the Engineer of the Future.*

***Keywords****: Engineer; Science and Technology; Formation; Globalization.*

## 1. INTRODUCTION

Engineering is a profession that has been seducing people since middle age, becoming essential through the Industrial Revolution. Leonard da Vinci, considered the first-ever engineer, associated art with engineering in early XVI century. Thomas Young, a physician, studied several engineering concepts and developed the Young´s modulus near 1807. Nowadays, engineering continues attracting professionals from every knowledge areas. However, a great question still remains and it is important to know if the quality of engineer formation is aligned with the market needs.

New world trends demand a new kind of professional, capable to think global without losing the dimension of local peculiarities (Brito and Ciampi, 2008). It is necessary to give an engineering student the capacity to adapt to the market, making opportunity by the planned ability with creativity and flexibility and no more only reproducing known solutions (Belhot, 1997).

Engineering is a career of passion with high social content. Health, safety and human comfort depend on engineers and these professional help the economic development due to their capability to value the production with technological incorporation (IEL, 2006).

## 2. THE ENGINEER FORMATION IN BRAZIL

The engineering education in Brazil grew together with Brazilian development. Figure 1 shows the engineer courses evolution.

Since near 1980 the number of engineering courses in Brazil has been a strong growth however the quality of technological resource didn't have the same development demanding training needs to the engineer. This training can be supported by the company or in sometimes by the engineer.

Usually the time to prepare an engineer technical leader is near 8 years, after graduation. However the market demands to reduce this time. In order to achieve this goal the key engineer competences should be developed during the graduation.

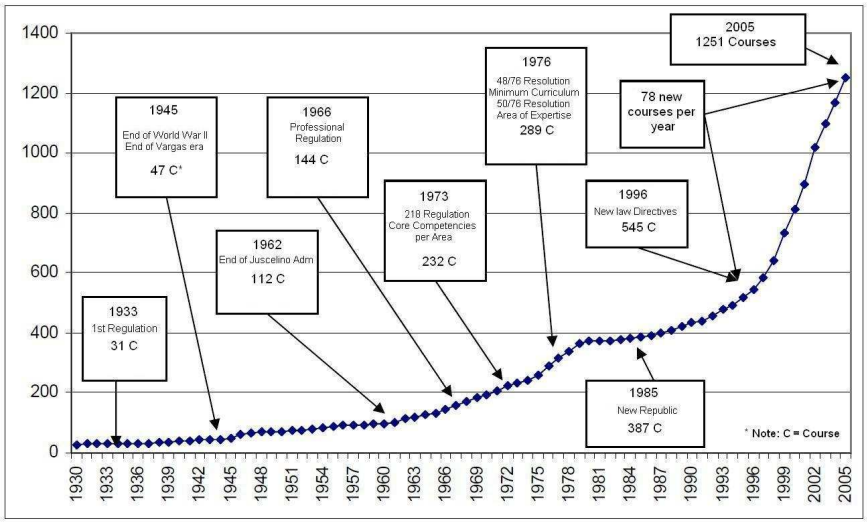


Figure 1. Engineering courses growth.

## 3. METHODOLOGY

The companies and universities need to work together for the benefit of the society. Knowing that, the engineering and the engineer play an important role in a developed of society.

Inside the society-company-university triangle there are relations with student, engineer, professor and market to achieve the better society development. The Figure 2 illustrates these relations

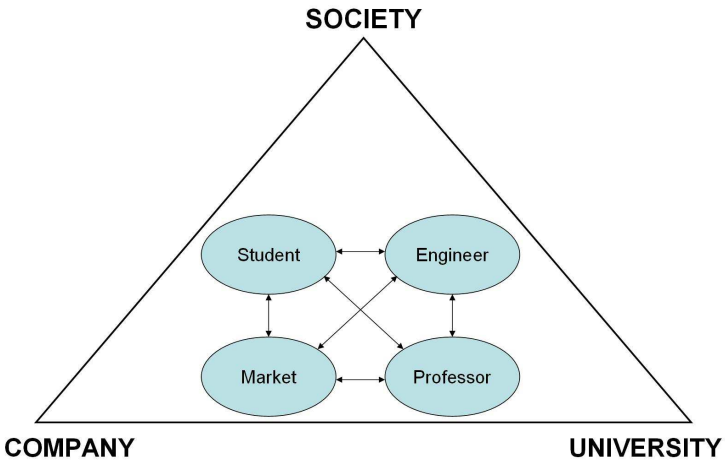


Figure 2. Relation triangle.

The aim of this work was to conduct a survey about the relation between university and market, analyzing the resulted contribution for the society, based on the impressions and opinions of students, engineers, professors and the market have.

Four surveys i.e. student, engineer, market and professor were built in homepage (http) specially developed for this work. It was possible only one answer (automatically controlled by IP). Electronic mail was send to each group through mailing list.

The four groups population size analyzed in these surveys are showed in the Table 1.

Table 1. The 4 group population investigated.

| Student | Engineer | Market | Professor |
|---|---|---|---|
| 100 | 99 | 20 | 17 |

The survey was conducted independent of the institution so, there were no specific questionnaires for each institution. The students are from various universities like USP, Unesp, ITA, Mackenzie, Unicamp, IFET-MA, Unip, Uninove, FMU, FESP, IME, etc., at least a student from the universities listed.

The multiple choice questions followed the guideline from Mattar (2001) where the list of options considered possible answer and it is required that at least one of them be selection. Nevertheless, the option "other" should be answered.

The questions that cover a specific subject with a range of answer were limited to four possible choices preventing the respondent select the middle option.

Data were compilation in an Excel spreadsheet. The result from each survey was confronted with another one to gain a comparative between them.

The discussion of results was focused in relation between university and market to contribution of society and in the technical development of engineer.

## 4. RESULTS AND DISCUSSIONS

The companies and universities should work together for the benefit of the society. Considering that, the aim of this work is to try to get an overview of the engineering education in Brazil and evaluate the gaps to achieve this goal. It was conducted through a survey with the four groups inside the society-company-university triangle (Figure 2).

The survey represents a sample view of this population. It is not intended to get a complete and statistical analysis of the engineering formation profile in Brazil, which should be object of a further investigation.

Table 2 summarizes this survey results, indicating the figure number where to find the graph results.

Table 2. Results to the 4 groups.

| Question | Engineering Student | Engineer | Professor | Market | Figure |
|---|---|---|---|---|---|
| 1 – Intellectual and physical resources | X | X | | | 3 |
| 2 – Technical lab – gaps | X | X | | | 4 |
| 3 – Opportunity to solve real engineering problems | X | X | | | 5 |
| 4 – Graduation activities level of importance | X | X | | | 6 |
| 5 – Graduation activities level of importance – to market | | | | X | 7 |
| 6 – University-Market relationship | X | X | X | X | 8 |
| 7 – Postgraduation course | X | X | X | X | 9 |
| 8 – Co-op student contribution | X | X | X | | 10 |
| 9 – Working in other areas than University (Professor) | | | X | | 11 |
| 10 – Engineer formation to market location (Professor view) | | | X | | 12 |
| 11 – Entry level engineer advantage | | | | X | 13 |
| 12 – Entry level engineer disadvantage | | | | X | 14 |
| 13 – Average time to prepare an engineer | | | | X | 15 |
| 14 – Key factors to hire a recent graduated engineer | | | | X | 16 |

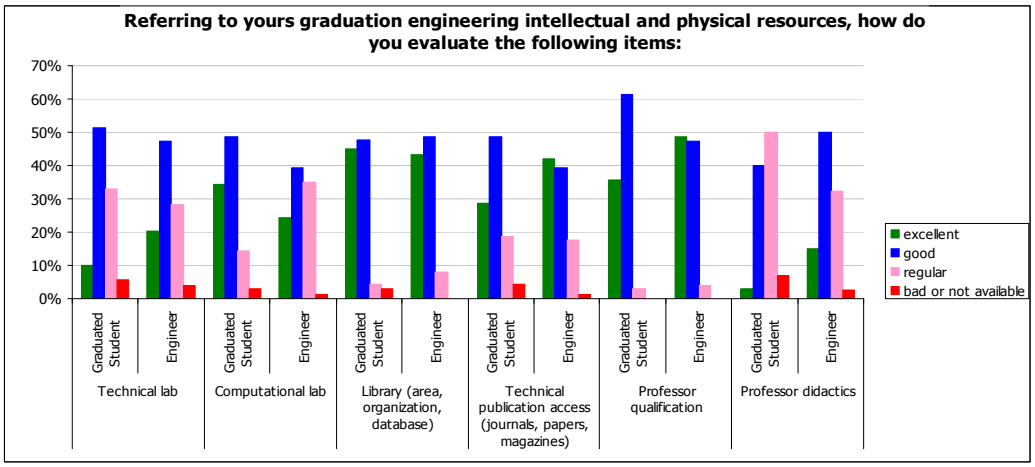


Figure 3. Intellectual and physics resources.

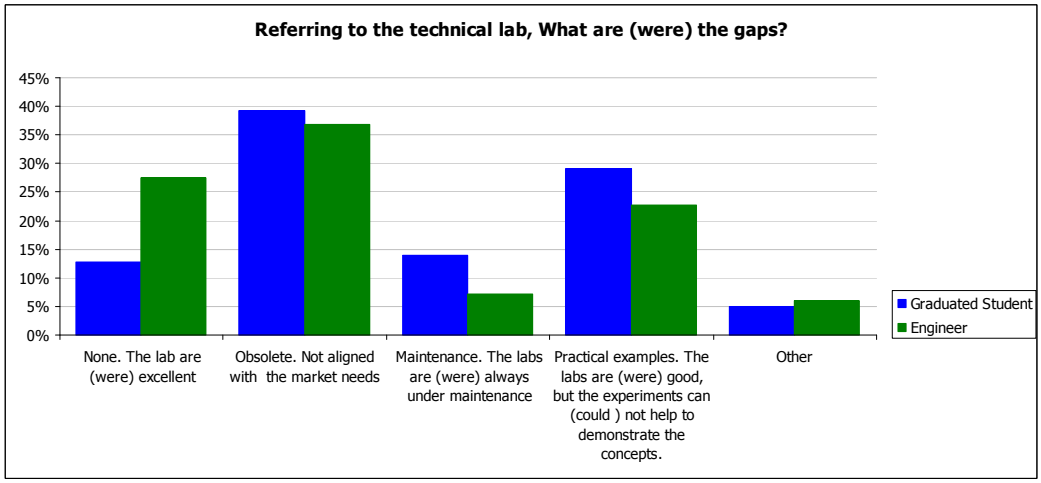


Figure 4. Technical lab – gaps.

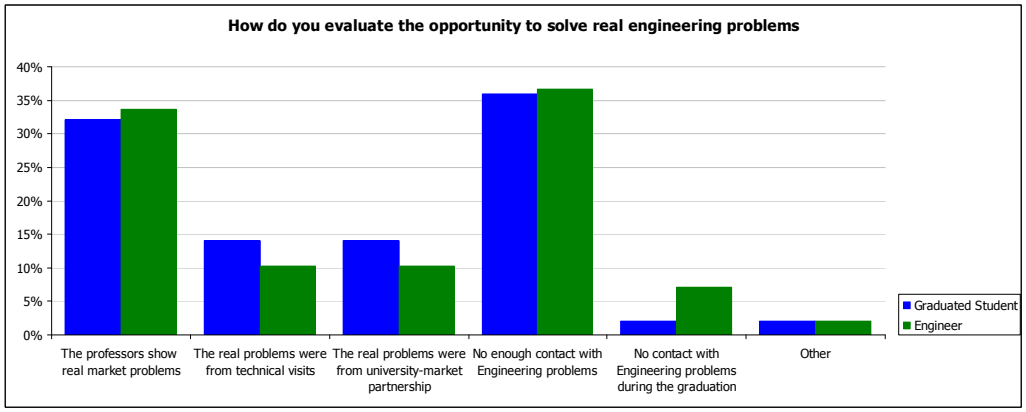


Figure 5. Opportunity to solve real engineering problems.

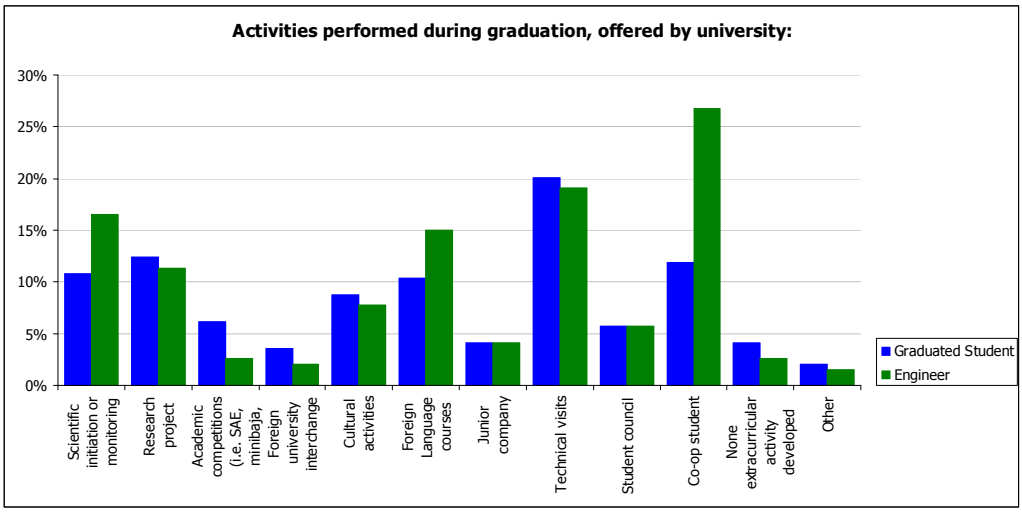


Figure 6. Graduation activities by level of importance.

Graphs presented from Figure 3 to Figure 6 showed questions addressed to student and to the engineer. The first questions were focused on the point of view of the graduation course. The population analyzed it was possible verify a homogeneous answer distribution when compared graduated student and engineer. The majority of the respondent chose excellent or good but it is possible verify some points of regular related to the technical lab, computational lab and professor didactics.

The majority of graduated student and engineer pointed the obsolescence of the technical lab a weak point.

In the Figure 5 it is possible verify a balance between the graduated student and engineer answers. While in one hand the majority answered that not have enough contact with engineering problems in the other hand the professor show the market real problems.

The graph showed in Figure 6 shows the graduation activities performed during graduation and offered from university. The great difference between graduated student and engineer in co-op student answer indicate in Figure 6 is related to the fact the graduated student had no opportunity to developed this activity yet. Figure 7 presented a point of view from market to importance activities to be developed by graduated engineer.

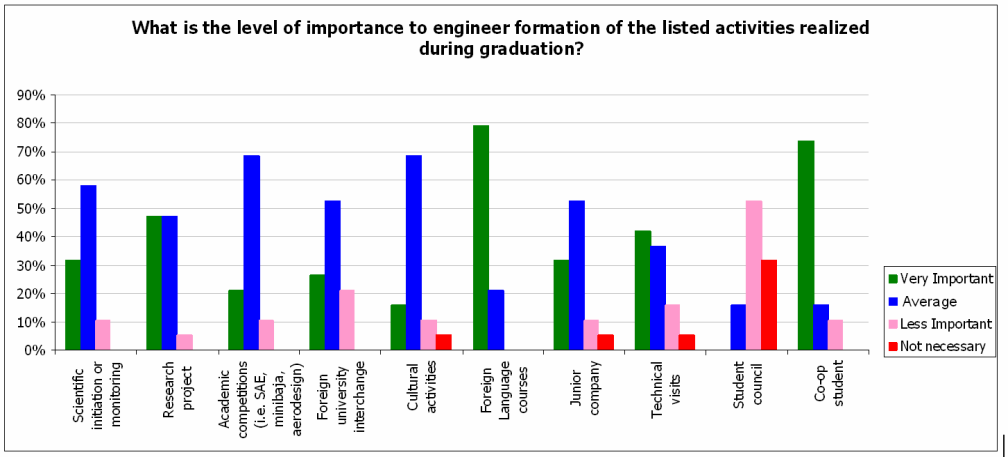


Figure 7. Graduation activities level of importance – to market.

In the graph above it is possible verify two points very important to the market: foreign language courses and co-op student however the majority of universities don't offer foreign language courses required for the graduation students need to get this competence by themselves.

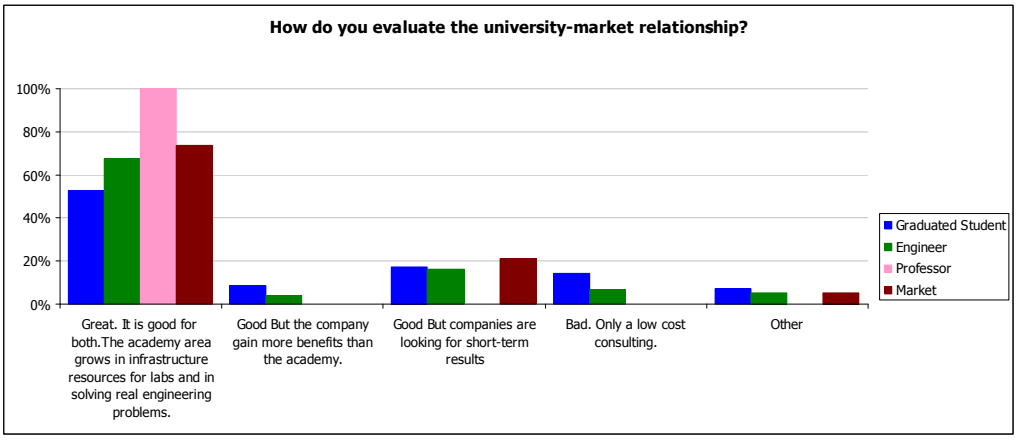


Figure 8. University-Market relationship.

Figure 8 shows the analyzed population opinion about university-market relationship. It is possible confirm to the majority of population this relationship is great and benefiting both academy and market area. This relation give a better infrastructure to university and with an improving in technical and computational labs and access to real engineering problems is possible to improve the view showed in Figure 3 and consequently the graphs showed in Figure 4 and Figure 5 have a better results. Other conclusion from Figure 8 is that 100% of professor supports the university-market relationship recognizing the benefits of this relationship.

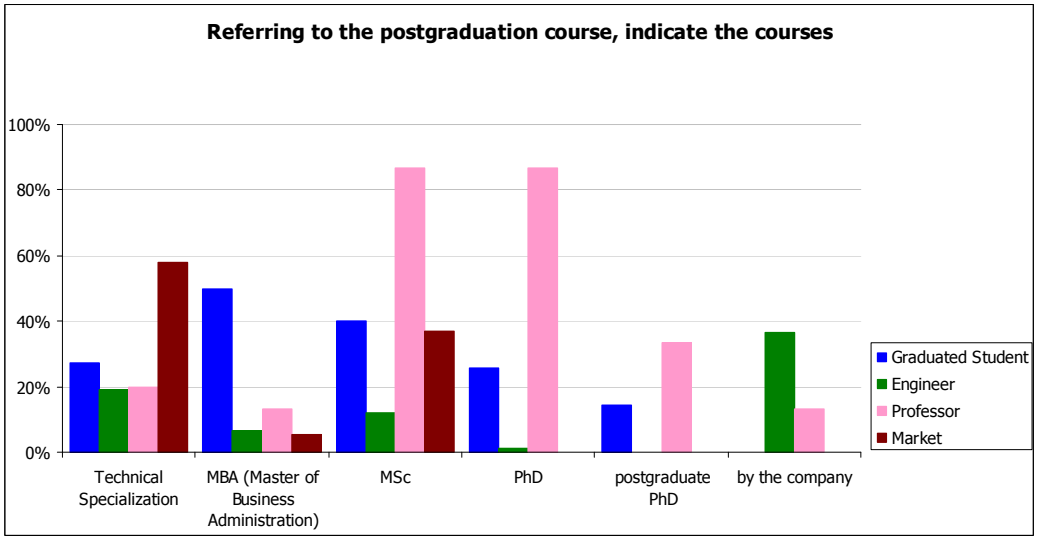


Figure 9. Postgraduation course.

The graph showed in Figure 9 analyzed the postgraduation courses. Graduated student chose the postgraduation courses planned. Engineer and Professor chose the courses that have completed and planned. Market chose the main postgraduation course to an engineer should be made. It is possible conclude the professor is the most qualified and it was expected. The majority of engineer did courses by the company or technical specialization. The half of Graduated student from the population analyzed opts to do a MBA while 40% intends to do an MSc too. It is can be concluded in the analyzed population the majority of graduation student wants do a postgraduation course but, when the student become a engineer and realizes the responsibilities that this profession give to them not everyone do or intends to do a postgraduation course. It may conclude that the student aims management courses because the majority elects the MBA as postgraduation course to be done.

The market looks for an engineer with technical specialization or MSc. In the end of this questionnaire the respondent had the opportunity to describe his personal impressions about this survey. An interesting comment about this postgraduation specific question is reproduced bellow:

*"It is time to eliminate the Brazilian industry paradigm that an engineer doesn't need technical knowledge and being capable of leading people is enough. Let's stop proliferating only "engineer managers", who has no need of technical knowledgement, where being a leader is the only requirement. Leadership and management are very important to the industry; however there is not enough space to many bosses. At the end if everyone is a leader who will do the hard job?"*

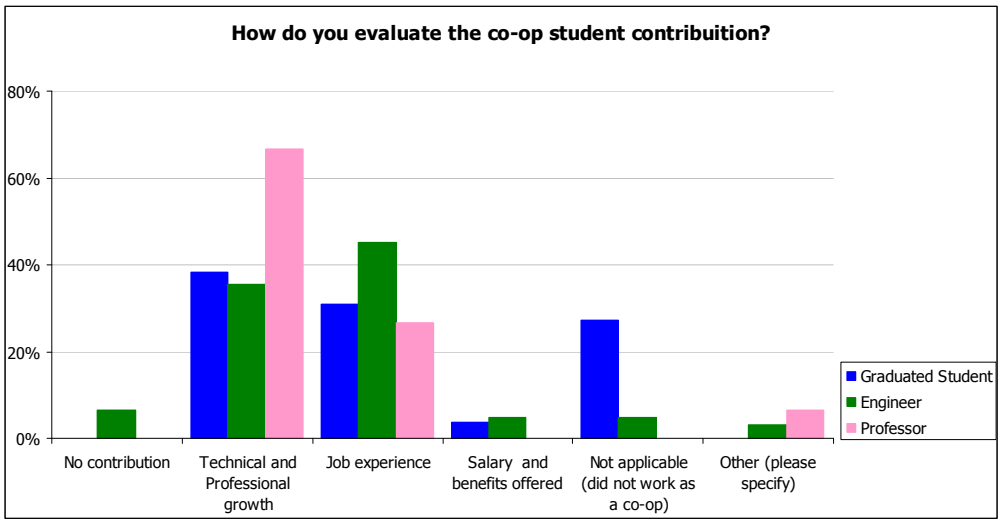


Figure 10. Co-op student contribution.

The graph from Figure 10 shows the co-op student contribution. The majority of respondent chose the technical and professional growth with job experience. The co-op student is very important to engineer to know the market and most of them are hired by the company where did the co-op time.

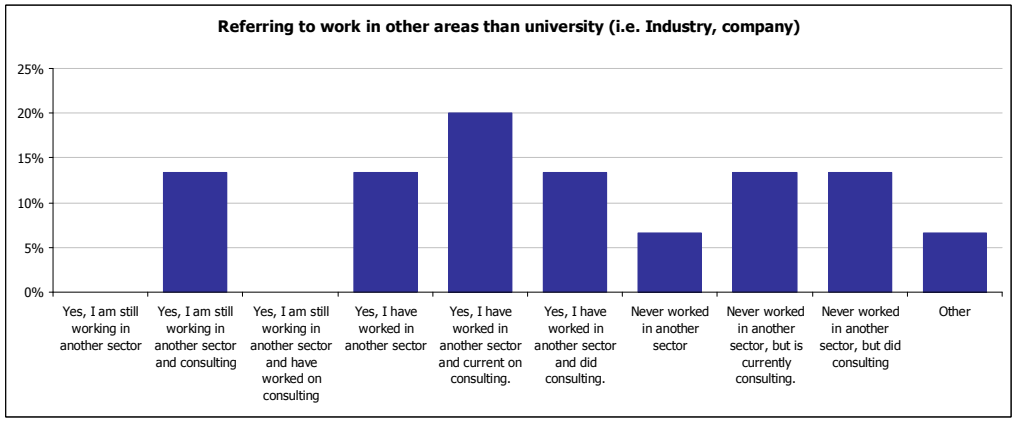


Figure 11. Working in other areas than University (Professor).

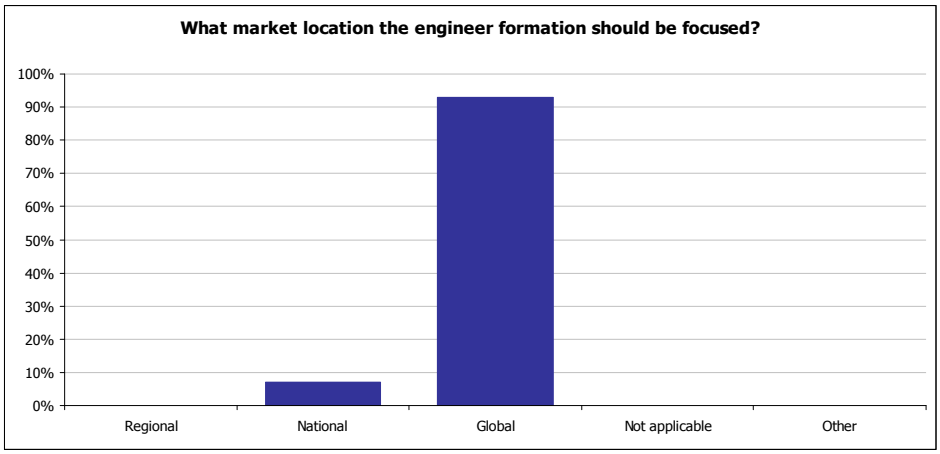


Figure 12. Engineer formation to market location (Professor view).

The majority of professors when questioned about working in other areas than university answered that have worked in another sector in the past and recently on consulting, but the graph showed in Figure 11 demonstrate the major of professor population analyzed have never worked in another sector (35% approximately) it would be a great opportunity to better understand market needs. In the Figure 12 they conclude that the global market location should be a focused to an engineer formation.

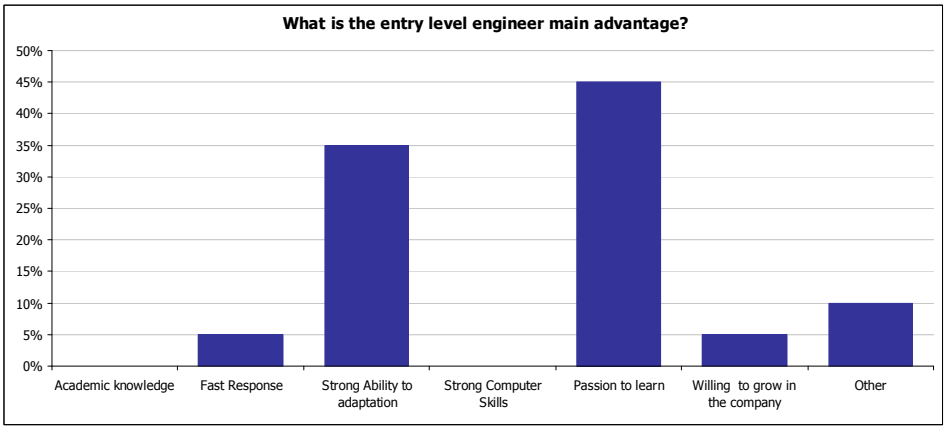


Figure 13. Entry level engineer advantage.

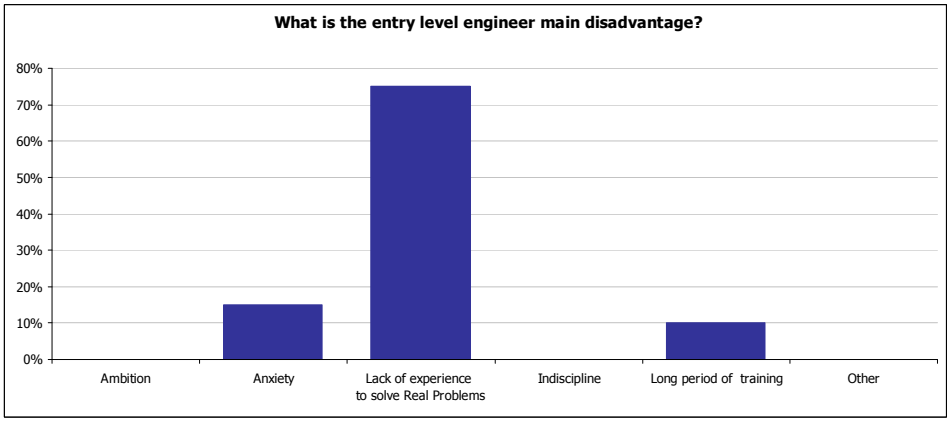


Figure 14. Entry level engineer disadvantage.

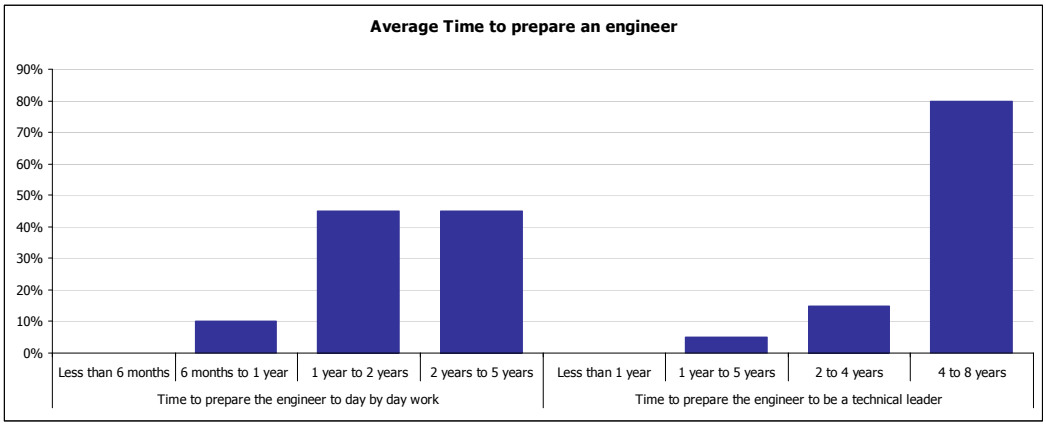


Figure 15. Average time to prepare an engineer

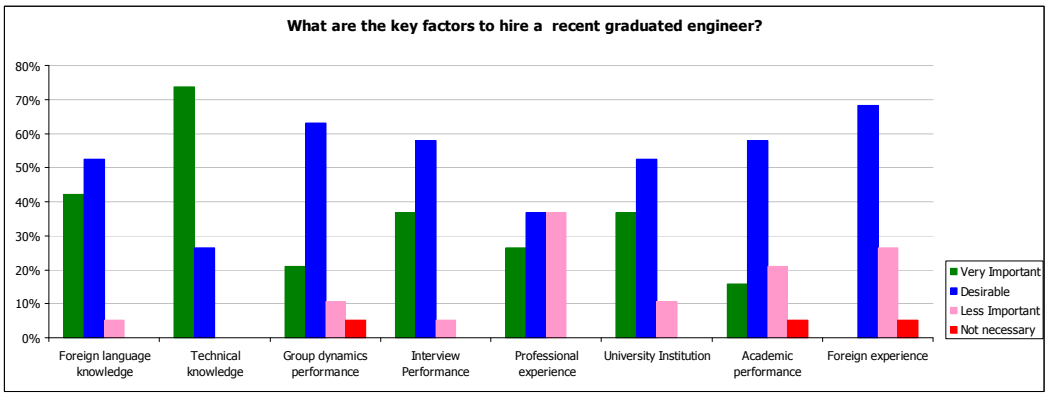


Figure 16. Key factors to hire a recent graduated engineer.

The advantage of entry level engineer is passion to learn followed by the strong ability for adaptation and the main disadvantage is lack of experience to solve engineering real problems.

The time to prepare an engineer is between 1 to 5 years to perform routine work and between 4 to 8 to prepare the engineer to be a technical leader.

To hire a recent graduated engineer the market considers the technical knowledge as main key and all other showed in the graph of Figure 16 are desirable.

## 5. CONCLUSIONS

Technical and computational lab could be better and the main gap of technical lab is they are obsolete. Most of graduated student and engineer don't have enough contact with engineering problems, however significant portion states the professors show real market problems during the classes, in other words, improving in contact with engineering problems is necessary.

Foreign language courses are great level of importance to the market but, are not well developed on the majority of universities.

The co-op student period is very important for the professional development of graduated student.

The relationship between university and market is approved for the majority of this analyzed population. This relationship benefits both university and market, including the graduated student and engineer in this niche.

Postgraduation course is very important to the engineer professional developed. The remaining question is what kind of course should be chosen. Graduated student thinks in MBA, engineer in technical specialization or courses by the company while market look for an engineer with technical specialization.

The majority of professors in this population don't have experience in other areas than university.

The main advantage of entry level engineer is passion to learn and disadvantage is lack of experience to solve engineering real problems. This main disadvantage could be improved through university-market relationship demonstrated in Figure 8.

Time to prepare an engineer is too long and its necessary prepare the engineer to the market when they still in the university.

## 6. ACKNOWLEDGEMENTS

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