

# The Graduate Engineering Programs at the UNAM-Mexico: Past and Future

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**Abstract-** The engineering graduate programs in Mexico are few and small. Formally, they appeared during the 50's and have only matured in some universities of the country. These programs began at the Universidad Nacional Autónoma de México (UNAM), National Autonomous University of Mexico, which has had the largest population, the greatest number of degrees obtained, and the most prestigious professors. In this article, I describe some features of the engineering graduate programs in Mexico, as well as, the characteristics of the graduate curricula at the Engineering School, which has the greatest number of engineering graduate areas at the UNAM. Finally, I comment our biggest challenge for the future and some strategies.

## The Graduate programs in Mexico.

Graduate studies in Mexico are a small part of the other educational levels as shown on table 1. Previously, when students are six or seven years old have to begin with the basic level, called "Primaria"; after that, they have to go on with three more years of "Secundaria" and three more of "Bachillerato". By this time, they have enough academic basis to enter into the bachelor level. Graduate students are able to develop any specialization, master or doctoral programs with a duration of one, two, three or four years for full time students respectively.

Level	1985		1997		Increment
	Students		Students		
	Number (thousands)	Percentage	Number (thousands)	Percentage	Percentage
<b>Primaria</b>	15,219.20	70.41%	14,650.60	63.48%	9.63%
<b>Secundaria</b>	3,969.10	18.36%	4,809.30	20.84%	21.17%
<b>Bachillerato</b>	1,427.80	6.61%	2,222.40	9.63%	35.62%
<b>Licenciatura</b>	961.5	4.45%	1,310.20	5.67%	36.36%
<b>Posgrado</b>	37	0.17%	87.70	0.38%	137.03%
<b>Total</b>	21,614.60	100%	23,080.20	100%	6.78%

Table 1. Number of students by education level in Mexico [1,2].

As shown in table 1, in 1997 the graduate population is 0.38% from the total student population, and 6.69% of the bachelor level student population. So 9.2 out of 10,000 people in Mexico have access to graduate studies. If this number of graduate students seems to be small, only 6,158 students are in doctoral programs [1]. Also 21,625 are performing specialization programs and 59,913 in the master level. In the engineering and technology area 1,354 graduate students are in specialties, 10,224 in master and 1,002 in doctoral programs [1].

Economical and technological levels in our country are dramatically different in comparison with the ones of our TLC partners, figure 1 shows some facts of population, and degrees obtained by graduate students from some other

countries per each 100 thousand inhabitants, according to the UNESCO statistics [3].

According to figure 1, the graduate students in Mexico are already comparable within other countries whose macroeconomics features are similar to ours, such as Chile, Spain or Italy.

Perhaps these graduate programs statistics can be disappointing, but we are very optimistic because the graduate programs in Mexico are growing. From table 1, we can see that the population of graduate students has arisen from 37,000 students during 1985 to 87,000 in 1997. The policy of our country, in particular the UNAM's, is to keep on growing constantly at this level in the next 10 years.

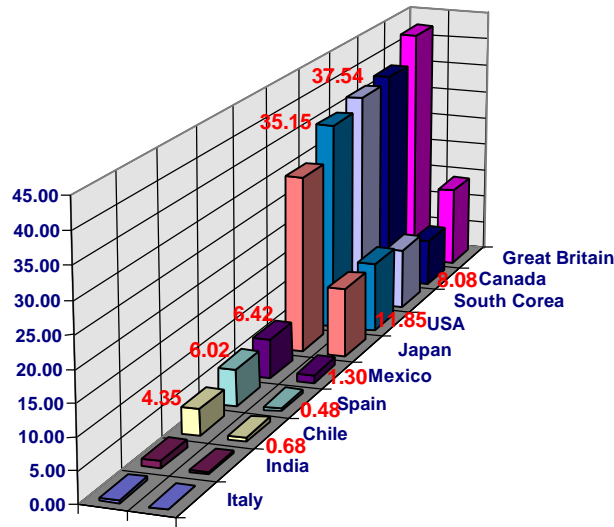


Figure 1. Population and degrees obtained by graduate students in engineering per 100 thousand inhabitants in some countries, in 1992 [3].

### The Engineering graduate programs at UNAM.

Most of the responsibility for these programs to grow will be on the UNAM. In our university, the first graduate engineering programs in Mexico were created 40 years ago, since then, this University has had the largest number of graduate students in the country. Now, our university has 15

areas of engineering in the master and doctoral programs, 13 of these, are offered at the Engineering School, “Facultad de Ingeniería”, campus CU, and two more in the Chemistry School at campus CU. At the Engineering School of the UNAM, the number of students has grown from 463 during 1993 to 1,085 at 1997 [4], see figure 2. We hope that into four more years the number of students will increase the double.

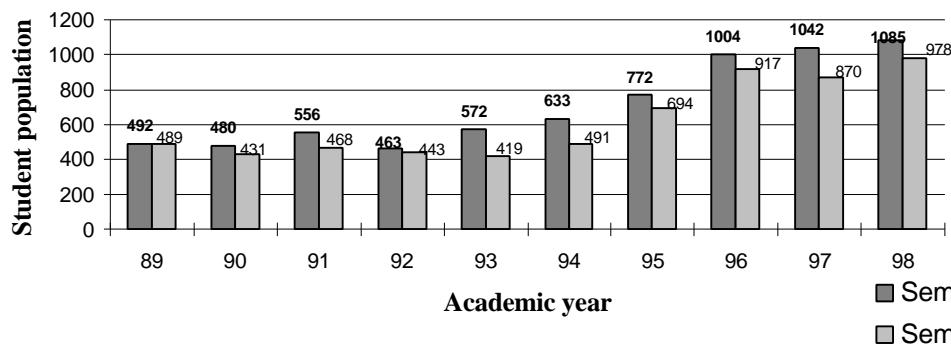


Figure 2. Graduate students population at The Engineering School, UNAM [4].

The engineering master program has 13 orientations: Construction, Electric (Areas of Control, Communications, Computing, Electronics, and Power Systems), Energy, Environment, Exploration of Energy Resources, Hydraulics, Mechanics, Operations Research, Petroleum, Planning, Soils Mechanics, Structures, and Transport.

The program has duration of two years, 4 scholar terms in all of its options. A characteristic is that the study program is defined individually by the student and the adviser, at any case students have to cover 76 credits. The program has 13 courses as shown in table 2, one has to be from the basic area, one of mathematics or physics, six from the major field, three from free elections courses that can be

chosen from the major field or from any other orientation, and finally, three courses of researching where the thesis is developed [5].

The objectives of the master program are three very different : 1) To develop experts on the area, 2) Teachers with high level, 3) Background for the performance of researching. This flexible program can be adapted to the requirements of the student, according with his professional objectives. This program was implemented in 1995. During 1996 there was a notable increment in the degrees obtained, see figure 2; in our opinion, one reason is because most of the students begin early their thesis.

Term	Courses	Credits
1	Basic Area Major Field Major Field Major Field	24
2	Major Field Major Field free election Researching Seminar	20
3	Major Field Free election Research I	18
4	Free election Research II	12
Total		76

Table 2. Master Program Courses [5].

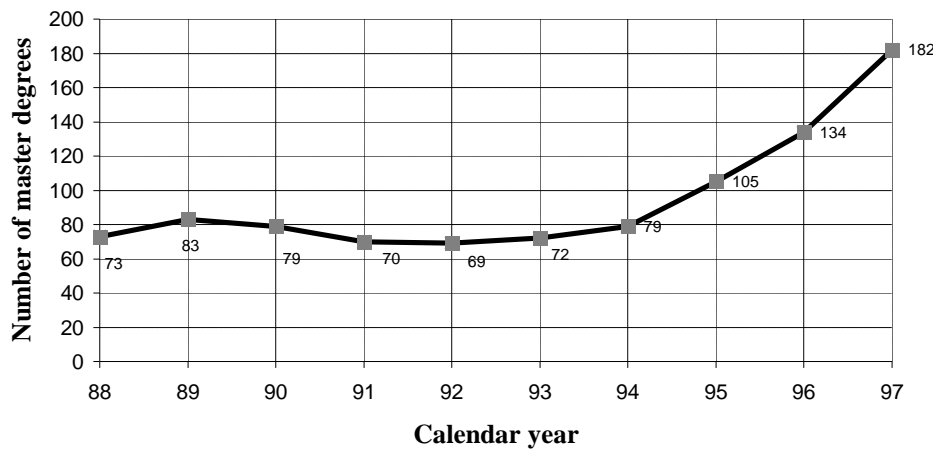


Figure 3. Master degrees at The Engineering School, UNAM by year [4].

The doctoral program has the same areas as the master program. It is a program focused on researching. Its objective is that students can develop an original research. Because of this, there are no obligatory courses, but as a previous request they have already taken a master program. The master degree is a very important academic requisite for the student to get involve into his own researching job [6].

Both, the adviser and the student design their plan of studies that could or could not include courses, but as a request there has to be at least four terms of researching seminaries, maximum eight; depending on the doctoral thesis advance. The researching seminaries consist of laboratory research during each term, at the end, the student has to present a report to an evaluating committee which is performed by a group of three professors, including the

adviser. This group will discuss whether the researching work deserves to be accredited during the term that it was worked for or not.

To be admitted in the doctoral program, the student has to present an entrance exam where there is a committee of three doctors who evaluate the technical background of the candidate on the area he wants to belong. This committee, as well as the evaluation, professors have to belong to a doctoral group, which every year is inquired to verify that the members have no lower level than the doctoral degree, excepting certain situations, as during active researching. Most of them are from the National Researchers System, formed and recognized by Conacyt, the national government agency for researching.

After being admitted, and already finishing the first researching seminary, they have to present a pre-doctoral exam. This consists of an evaluation of the ability of the student to develop his own research during a short period of time, and a new algorithm on his area. Eventually, on the second or third doctoral research, the student has to present his thesis defense where he has to explain his researching topic, the definition of the problem, as well as the

methodology and the algorithms used in solving the problem. It is requested both, the student and the adviser, that before presenting the thesis and grade exam, their research has to be accepted at least by two recognized international magazines or conferences.

The number of doctoral students has been growing, especially during the last decade, and this fact is because of the growing number of degrees obtained, see figure 4.

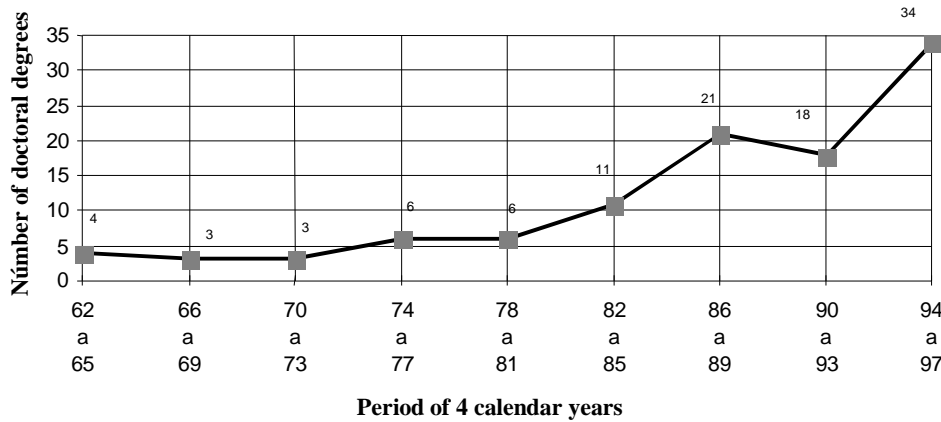


Figure 4. Doctoral degrees at The Engineering School, UNAM by each four years [4].

### Present and future of the Engineering Graduate Programs at Mexico

The geography and economic situation of the country has influenced definitively in the low development of the engineering programs at Mexico. In particular, the private companies' impact in researching and development has been quite low during this decade and others, 8% of the total. On the other hand, in countries like USA and Japan is around 70%. Most of this investment is from the public sector, and this proportion is done by the research projects of engineering at UNAM. Until now, most of the agreements signed with private companies have been to qualify engineers.

We do not have statistics of the graduate engineers from UNAM, however we know that most of them are in the educational and public sector. Since the commercial aperture of the country we have perceived a great demand of graduate engineers. Moreover, the educational sector is demanding a large number of full time professors, especially for doctorate level. According to the educational program formulated by the Mexican government, we need to provide graduate studies to 13,000 bachelor professors, in all sciences, who have not gotten a graduate degree in four years.

Without considering the graduate engineers demanding by the private or public sector, to satisfy the requirements of

the educational sector, it will represent a big challenge to our engineering schools for the next years.

### Conclusions

First, I have presented some statistics showing the graduate engineering programs in Mexico and UNAM. However, nowadays there is a large increment among the graduate students' population, so we are very optimistic about the future. Furthermore, the main challenge is to increase the relationships between private companies to join research projects, and to maintain the dynamic relationships with the public.

### References

- [1]. Anuario Estadístico 1997, posgrado, by Asociación Nacional de Universidades e Insituciones de Educación Superior, Mexico, 1996. Edit. ANUIES.
- [2]. Anuario Estadístico 1995, posgrado, by Asociación Nacional de Universidades e Insituciones de Educación Superior, Mexico, 1996. Edit. ANUIES.
- [3]. Statistical Yearbook 1994, by UNESCO. Edit. UNESCO Publishing & Bernann Press.

[4]. Reporte Interno Sobre Estadísticas del Posgrado en Ingeniería, by División de Estudios de Posgrado, Edit. Facultad de Ingeniería, UNAM, 1998.

[5]. Plan de Estudios de la Maestría en Ingeniería, by División de Estudios de Posgrado FI. México 1994. Edit. Facultad de Ingeniería,UNAM.

[6]. Plan de Estudios del Doctorado en Ingeniería, by División de Estudios de Posgrado FI. México 1990. Edit. Facultad de Ingeniería,UNAM.