



PURDUE MEXICO PROGRAM
Cuernavaca
May 20-21, 2014



***PARADIGMS IN
ENGINEERING UNIVERSITY PROGRAMS:
THE CASE OF MEXICO***

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OUTLINE

- **Engineering educational programs in Mexico: A critical review**
- **Historical background**
- **Economic policy based on the substitution of imports**
- **Extraordinary increase of high educational programs (70's and 80's)**
- **The new millennium: participation in the fully open market and global economy**
- **Deeper knowledge, rapid changing technology, and unforeseen possibilities for informatics**
- **Role of engineers**
- **New educational programs with different contents and shorter duration**

REVIEW AND MODIFICATION OF ENGINEERING EDUCATIONAL PROGRAMS

- **Based on a methodical and careful diagnosis**
- **Evolution of the profession in response to:
the economic activities of better profit value, and
the general progress of the society**
- **Modify radically a plan of study by its obsolescence with respect to the
current technologies**
- **A specific program is no longer necessary due to saturation of the labor
market or because it is satisfactorily offered**
- **A deep analysis that take into account the problems and expectations
of the economic activity where is situated**

HISTORICAL BACKGROUND

- Original settlements of important civilizations: Toltec, Maya and Aztec with great achievements in astronomy, construction, water works and agriculture (1521)
- Three centuries of Spanish colony: trade and production of agriculture and mining products
- Mestizo population, a single religion and a single language
- Independence. 19th century: internal wars; foreign interventions; lost of half of the territory
- Important social, economic and political changes resulting from the 1910-1929 period (Mexican Revolution):
- Land reform, large irrigation works, extensive electrification, and industrialization; expansion and improvement of education

ENGINEERING EDUCATION PROGRAMS and PROFESSION FRAMEWORK

The first program for the formation of engineers in Mexico was founded by president Benito Juárez (1861-1872); but only after the first quarter of the XX century this profession acquired its full presence as part of college education.

- Engineers for infrastructure works and industrialization;
- Economic model of substitution of imports
- Generalist type of engineers: Extensive capacities for construction, production, installation and maintenance of equipment; abilities for technologies adaptation; and administration of large projects
- beg 60's, UNAM, IPN and very few schools in the provincial states, provided the demand for engineers by the nation. Not enough in quantity but satisfactorily in quality. UNAM closely represented 40% of the total.

ENGINEERING EDUCATION PROGRAMS

- Last quarter of XX century: emerging technology; tremendous industry development impelling informatics and telecommunications
- Abrupt change to open market and global economy in the 80's and 90's; free trade treaties (NAFTA)
- Extraordinary increase in the number of educational programs in engineering during the 70's and 80's:

	Schools	Programs	Students
1968	70	19	44,000
1983	160	150	248,000
1998	237	>250	447,405
2000	~	~	514,000
2014	>	>	>>

Demand for engineers fulfilled by many institutions:

- Fast growing private and public universities
- Consolidated system of technology institutes
- New educational systems
 - Appropriate criteria, programs and operating structures
 - Regional permanence of graduates, etc.

Any action carried out at UNAM and similar institutions, will impact very little on the nationwide *quantitative* offer.

However, it represents an opportunity in the *qualitative* sense, as these federal institutions comprise an influential high-quality academic staff, first-level research facilities and a well-set physical plant.

They may keep their leading position to offer vanguard engineering education programs to the contemporary society and can induce other institutions (as it has done it in the past) for substantial advances in the way of teaching engineering.

ENGINEERS REQUIRED AT PRESENT

- **Society 21st century:** Extensive, sustained and continuous change in use of technology; global market of enormous competence and interdependency; capacity of communication
- **Engineering activities:** Scientific advance; technology innovations (extraordinary speed)
- **Real offer and demand of engineers;** quality vs. quantity
- **Engineers:** New abilities to design, build, manufacture and operate goods with aggregated value of technology and more efficient in their function, to the lowest possible costs
- **Deepening his knowledge of diverse disciplines,** to expand his capacities of information and to develop his creativity
- **Clearly identify what are in reality the functions of an engineer in the society and which should be his real professional capacities**

- What are the intellectual processes of engineers?
- In what context do engineers exercise their profession? In which they learn?
- What *know-how* and capacities require?
- How some are acquired and how do engineers develop others?
- What curriculum contents, methods and environments of learning are suitable?
- Which can be learned in the school?
- Which can be learned only in practice?

REFORM OF ENGINEERING UNIVERSITY PROGRAMS

- Diagnostic review of an engineering program and the consideration of the role of engineers in a changing society

⇒ necessary modification of the plans of study

- Generally based on educational models (diverse institutions in different countries)

- Very numerous, with substantial or subtle differences

- Prevailing forms of teaching at many educative institutions in Mexico:

- inflexible curricula: no different sequence;
- no subjects from different departments;
- no students mobility

Professors:

- **limited to lecturing (reverenced; authoritarian)**
- **transmit encyclopedic knowledge**
- **professor experiences far from reality**

Teaching:

- **based on exercises**
- **grading is the only measurement of learning**
- **classes repetitive and monotonous**

Students:

- **eyewitness classes essential**
- **receptive and passive (obedient)**
- **indifferent about socio-politics and economics**

At the end: students are only interested in approving subjects

CONSERVATIVE (TRADITIONAL) MODIFICATION

- Restrictive option and of short range
 - Updating of the programs
- Based on the engineer profile of the 70's
- Excessively optimistic and insufficiently clear objective: engineer with large attributes and possibilities of professional development to comply an extensive assembly of needs of the country
- Practically the same program of today; only adaptations are proposed

CONSERVATIVE (TRADITIONAL) MODIFICATION (cont'd)

- **Continuation with the stiff attitude in the teaching-learning process, accord with the old-fashioned, traditional education in Mexico**
 - **School of engineering: situation of clear disadvantage in few years**
- **Wasteful of the present good level academic staff of professors and the exceptional laboratory and mechanical shops**
 - **Serious threat to the continuance of the careers**

Octavio Paz, the Nobel laureate, said:

“...a problem of Mexicans is their strong attachment to traditions”.

He was not referring to festivities; he was pointing out the resistance of Mexicans to change in many aspects of life.



SUBSTANTIAL AND MEANINGFUL (RADICAL) MODIFICATION IS POSSIBLE

- **Focusing on learning and not on teaching**
- **Time reduction to less than eight semesters (as now in European educational systems)**
- **Academic staff (a) full-dedication professors for the basic and engineering sciences (both kind of subjects should be thought by engineering professors), with participation (but not only) in research activities; and (b) highly scholar professional engineers for those applied subjects connected to the practice of engineering.**

SUBSTANTIAL AND MEANINGFUL (RADICAL) MODIFICATION (cont'd)

- Students: new techniques of communication; work as a team; creativity**
- Subjects on engineering practice offered to freshman students (systems modeling, optimization, global vision and social impact of engineering)**
- Prioritize the skillful aspects against the pure informative
 - Students mobility to other universities**
 - Open involvement in socioeconomic issues****
- Participation of all the actors, especially the student, that contemplate technical innovations of teaching, self-learning, use of informatics and stimulation of creativity.**

CONCLUDING REMARKS

- Clear vision of the real demand of professionals
- Deep transformation of the plans of studies
- Realistic vision of the socioeconomic situation and its time perspective
- Tremendous technological change of today
- Use dynamism to impel teaching methods
- Objective: high-quality engineers for the vanguard of development
- International-class engineering vision (among the better of the world in few years)
- Appropriate evaluation and certification





The background of the slide is a photograph of a sunset or sunrise over a vast body of water. The sky is a deep blue with wispy white clouds. A bright, multi-colored rainbow is visible on the left side of the image, extending from the horizon towards the top left. The water in the foreground is dark blue with gentle ripples.

Renewed opportunities within

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