



This presentation and the paper, with additions and modifications, are part of the preliminary documents that were prepared and submitted by the author to the Faculty of Engineering of the National University of Mexico (UNAM), to frame the most recent reform of the programs for the B.S. degree in engineering, conducted in the years 2004-2005.

## CONTENTS (Abstract)

- Engineering educational programs in Mexico: A critical review
- Historical background
- Extraordinary increase of the number of universities and educational programs during the 70's and 80's
- Economic policy based on the substitution of imports
- Generalist type of engineer suitable for the industrialization period
- 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 THE EDUCATIONAL PROGRAMS

- Based on a methodological and careful diagnosis
- Self-evolution of the profession in response to the economic activities of better profit value
- Diagnosis
- Modify radically a plan of study by its obsolescence with respect to the technologies
- A specific program is no longer necessary by 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. 19<sup>th</sup> century: internal wars; foreign interventions; lost of half of the territory
- Important socioeconomic changes 1910-1929, (long and violent internal civil war) ended with colonial practices (land exploitation): agriculture reform, large irrigation works, extensive electrification, and industrialization begun
- Expansion and improvement of education

## ENGINEERING EDUCATION

- Economic model of substitution of imports
- Engineers for infrastructure works and industrialization;
- Generalist type of engineers: Extensive capacities for construction, production, installation and maintenance of equipment; abilities for technologies adaptation; and administration of large projects
- Extraordinary increase in the number of universities and educational programs during the 70's and 80's
- 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 )

## ENGINEERING EDUCATION EVOLUTION

1968:
70 schools
19 programs
44,000 students
1983:
160 schools
150 programs
248,000 students
1998:
237 schools
250-300 programs
447,405 students
2000:
514,000 students

## ENGINEERS REQUIRED AT PRESENT

- **Society 21<sup>st</sup> 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
- **Deepen 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**

- Which 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?,
- What can be learned in the school?,
- What 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 student mobility
  - Professors limited to lecturing (reverenced; authoritarian)
  - Objective: transmit encyclopedic knowledge; professor experiences far from reality
  - Students: eyewitness classes essential; receptive and passive (obedient)
  - Classes repetitive and monotonous
  - Teaching based on exercises; grading is the only measurement of learning
  - Indifference about political, economic and social issues
  - At the end: students are only interested in approving subjects

## CONSERVATIVE (TRADITIONAL<sup>[1]</sup>) 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 required

[1] Octavio Paz, the Nobel laureate, said: "a problem of Mexicans is their strong attachment to traditions", with reference not to festivities, but to their resistance to change.

## 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

## **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 skilful 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

