



New Trends in Engineering Education

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Abstract

- The objective of this presentation is to revisit the engineering education in the light of the educational, social, and market changes that have been taking place in the last ten years. These changes have a direct impact on engineering education as they give rise to a new way of looking at engineering by incorporating an important liberal arts component in the curriculum.
- The presentation will call for an urgent change, which will give UOB an added value as a leading institution in engineering education.

The Problem

- Newly recruited engineers usually need time to adapt to the on-hand required performance.
- A large number of engineers shift from their initial field of specialization to totally new areas.
- The market questions the content of the engineering curricula, and its demand is driven by communicative and cultural needs.

The Statement

- Adopting a new look at engineering education in the 21st Century is a must. This requires a re-evaluation of the ongoing curriculum to draw attention to the importance of the non conventional components of such an education.
- Re-evaluation of the curriculum means :
 - redefining the learning objectives and outcomes;
 - readjusting the content to the needs of the market and its relation to the other university and pre-university curricula;
 - adopting new teaching/learning methodologies.

Objectives

- The presentation will highlight the following :
 - 1 - the new profile of the engineer in response to the market demands.
 - 2 - the engineer as an interface between technology and human beings.
 - 3 - the preparation for engineering education at an early stage.
 - 4 - the new approach to the building of the engineering curriculum which considers a multi-disciplinary vision as a must.
 - 5 - the Implementation of a new learning/teaching methodology, which takes into consideration the multi-faceted aspects of the expected performance of engineers, mainly: problem solving, applied research, and concept development.

A new profile for a new world (1)

- In its *Millennium Project (MP)*, the University of Michigan published a document entitled *Engineering for a Changing World* that aimed to be “a road map to the future of Engineering practice, research and education”.
- Researchers are taking seriously the challenges raised by a new era where professionals are facing problems for which they were not prepared.
- These challenges question issues related not only to the content of the engineering curriculum, but also to its learning methodologies and evaluation procedures, to its relation to other fields of knowledge, and finally to its aptitude in forming individuals able to adapt to our fast changing world.

A new profile for a new world (2)

- On the other hand, new approaches in Education make it clear that the chain of knowledge is a continuous one, and that information gathered monolithically and disruptively is a poor resource for efficient future impact .
- Speaking about engineering education, Bordogna considers the following items as an integral part of this educational process:
 - i) language and multicultural understanding
 - ii) ability to advocate and influence
 - iii) team work.

A new profile for a new world (3)

- By stressing the scientific aspect of engineering as a discipline, we forget how important it is to be, at the same time, open minded and communicative in order to perceive the needs of the society on one hand, and to convey and advocate the technological message on the other.
- The MP of the University of Michigan sends the following revolutionary claim: “To establish engineering as a true liberal arts discipline, similar to the natural sciences, social sciences, and humanities, by imbedding it in the general education requirements of a college graduate for an increasing technology-driven and –dependent society of the century ahead”.

The Engineer as an “interface” (1)

- Technology is becoming more and more an integral part of human life.
- Using technology needs the adequate support to give technology a human dimension.
- Engineers are to be the advocates of this “human” aspect of technology.

The Engineer as an “interface” (2)

- ◊ A totally new aspect of engineering: the liberal arts one.
- ◊ some examples are:
 - ◊ the engineering aspect of famous buildings considered as a human heritage
 - ◊ the role of engineering in the evolvement of civilization through the ages
 - ◊ the continuous role of engineering in providing solutions for the welfare of human kind.

The Engineer as an “interface” (3)

- ◊ Engineers are not only concerned with applied sciences.
- ◊ To perform adequately, they need to be :
 - ◊ highly motivated in orienting their work to serve their communities
 - ◊ very sensitive to moral and ethical issues
 - ◊ knowledgeable in the social and cultural domains in order to maintain the link between technology and community needs and priorities.

The early stage (1)

- Q.: Who is the future engineer?
- R.: The one who is good in Mathematics!!!
- This answer is sure enough to:
 - alienate a large number of young students
 - create false ideas about the profession
 - undermine the university's approach to Engineering.

The early stage (2)

- Because of the educational continuum, a new benchmarking of the engineering education requires a change of mentality towards the profession and a cognitive preparation that must start in the pre-college stages .
- With the evolution of new technologies, engineering seems to be the most challenged profession today and hence is the one that is mostly in need of a new approach to the K-12 curriculum to take into consideration this new profile of the engineer .

The Curriculum Building (1)

- ◊ Usually engineering curricula are driven by the technical needs which are considered as being “THE must”.
- ◊ The new challenges have come to stress other components as being as indispensable as the technical ones. Mainly:
 - ◊ the communicative component
 - ◊ the high mental skills component
 - ◊ the cross disciplinary approach

The Curriculum Building (2)

- As mentioned earlier, Bordogna considers the following items as an integral part of this educational process :
 - i) language and multicultural understanding
 - ii) ability to advocate and influence
 - iii) team work.
- New tools of communication through multimedia and new technologies are now available and can be heavily introduced in the college education program.
- This will need a new look at the curriculum in order to merge language skills and new techniques of communication along with team work, group debates, presentations etc. into its requirements.

The Curriculum Building (3)

- It is universally accepted that mastering high mental skills is a must in university education. In many countries, engineering is considered a five - year degree, and as such requires the mastering of such skills.
- Looking at the actual status of such curricula, one can see that there is no systematic way of ensuring that such acquisition has been done. Even at the undergraduate level, curricula do not mention the introduction of critical thinking or scientific methods as part of their requirements.
- This also will need a new look at the curriculum to make such skills an integral part of the expected outcome of the learning process.

The Curriculum Building (4)

- At the same time, and as a result of the narrow vision of engineering education, all other aspects of a university education are minimized.
- Nowadays, engineers perform in a totally new environment. They are global professionals, challenged by new opportunities for work and they are asked to adapt themselves to changing conditions which require from them an open mind approach, and acute cultural awareness.
- This attitude to engineering education has to be adopted as part of the personality building process of the future engineer. Teaching history, geography, economy, and civilization is not a luxury in the curriculum. It has to become a must.

A new methodology for a new engineering curriculum (1)

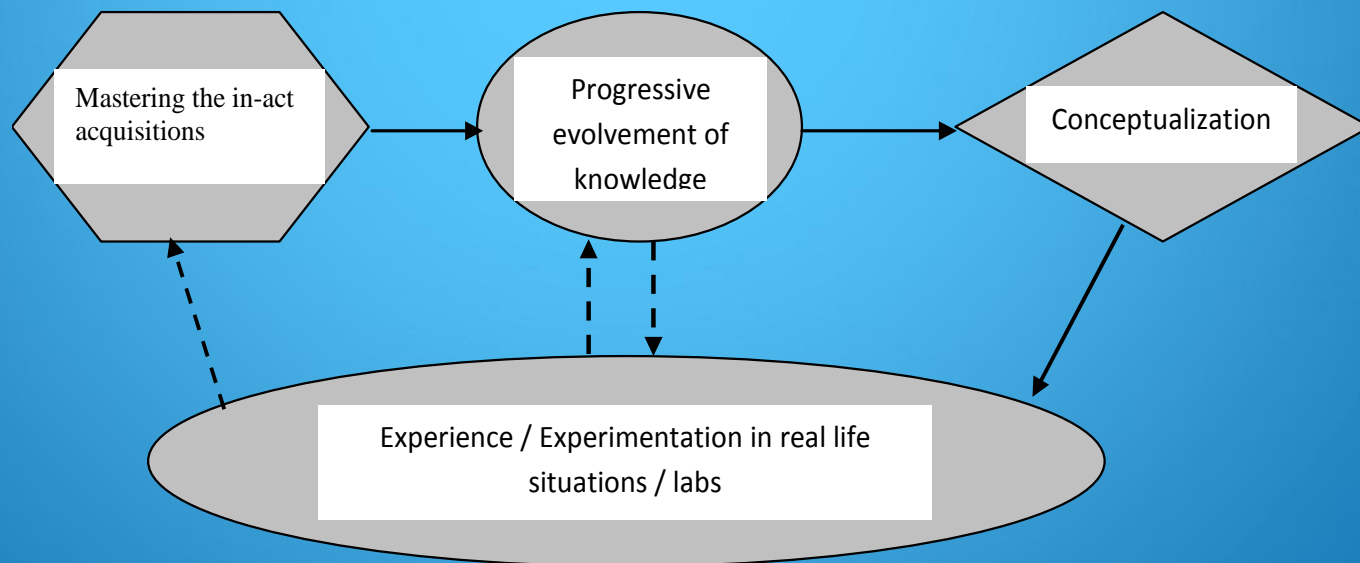
- « Conceptualization » is the dynamic process of knowledge acquisition which is in itself a complex system. This is a system where information, skills, competencies, high mental skills, language mastery, and different techniques are involved within a pedagogical environment. This environment, in turn, depends on the learner, the social situation, and the learning process.
- This is why conceptualization goes far beyond the acquisition of one single concept, and is a cognitive continuum.
- One of the key elements of the cognitive process is its respect of the *natural order* of acquisition which takes place always as a result of an *in-act* appropriation of knowledge.

A new methodology for a new engineering curriculum (2)

- In the cognitive dynamic process, experimentation is not an aim but is only a phase. Its role is to lead to the knowledge appropriation through the in-act acquisitions. A typical model creates a dialectical relation between action and theorization, and this is why it may be better associated with a Problem/project Based Learning strategy .
- A PBL strategy seems to be one of the strategies that is closest to the cognitive process .
- Two main questions need to be answered and monitored :
 - (i) How does a PBL strategy help in developing such a curriculum?
 - (ii) What are the quality requirements that have to be implemented in order to make sure that the PBL strategy will ensure the expected productivity?

A new methodology for a new engineering curriculum (3)

Ø The following shows an adequate flow of the cognitive approach:



A new methodology for a new engineering curriculum (4)

- Utilizing conceptual field theory as a basis for curriculum design has two direct imperatives: (i) the experience of the learner must serve as a cognitive base for knowledge building, and (ii) educational planners must consider the interdisciplinary nature of knowledge.
- The content for any academic curriculum can no longer be conceived of as a juxtaposition of courses offered in different service departments with a concentration in the department of specialization.
- The dialectical inter-action between practice and knowledge acquisition has to become an integral part of the strategy.

A new methodology for a new engineering curriculum (5)

- Considering the schematic model of a PBL strategy from a cognitive point of view, one can say there are five successive levels that need to be thoroughly examined:
 - Establishing the correspondence between the pre-requisites. This aims to make sure that the students have the needed skills to work on a specific “problem/project”.
 - Examining the nature of the problem from a procedural point of view. This aims to specify the competencies needed to sustain the learning process.
 - Examining the adequacy of the problem to content development. This serves to clarify the role of the problem project in making the learner move from one level of knowledge to another new one.
 - Clarifying the steps of the typical solution. This aims to set down the reference for guidance in tutoring and leading the learner to the desired conclusions.
 - Establishing assessment criteria.

A new methodology for a new engineering curriculum (6)

- When applying such strategies, educators are often asked about the theoretical background of their approach. But there are also more specific issues that are of concern, mainly :
 - A – When does such a strategy begin to be applicable?
 - B – Is such a strategy applicable in isolated cases?
 - C – Is such a strategy an institutional methodology or is an instructor driven one?
- Such questions help to avoid surprises in the pedagogical endeavor, and are rooted in the prevailing atmosphere within the academic body which is resistant to changes.
- Never the less, these questions are challenging for the future planning and implementation of new pedagogical trends with a quality assurance background.

Conclusion (1)

- ◊ I tried in this presentation:
 - ◊ to show why there is a need for change
 - ◊ to pin point the discrepancies between the ongoing Engineering curricula and these needs
 - ◊ to propose adopting well defined strategies and processes in order to meet the requirements of the new global market for engineers.

Conclusion (2)

- ◊ And what about engineering education in UOB?
- ◊ Our graduates are doing well in graduate and postgraduate studies.
- ◊ Our graduates fit the actual market of the region.
- ◊ Do our graduates fit with the emerging global market? That, I doubt!

Conclusion (3)

- Our program, when first established, was a pioneer in the field in terms of structure.
- This pioneering spirit has to continue by adopting an avant-garde teaching/learning strategy.
- It is high time to call for such a change, which will give our program once more the added value it had.