DIPLOMAS VERSUS INDUSTRIAL NEEDS

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Abstract

A diploma is a certificate issued by an educational institution which testifies that the recipient has successfully completed a particular course of a study. Then, in the technical way of speaking, you are capable with your knowledge and skills to produce or make the ''new value'' for the industrial economy. The longer the time needed to be a real usable engineer after a study the worse curriculums or/and teaching methods of the study. Several things are needed in every ''process'': time, effort, knowledge, skills and finance. The technical study is the ''process of engineers making''. After the study finalization you are not an engineer, you have ''the paper'' proofing that you have basic knowledge and skills to do something and you are capable to realize and solve some technical issue. According some statistics from the German industry you are an engineer after 15 years spent in industrial companies solving practical issues. A great reference for the technical Faculty must be the number of quality engineers but not only the number of engineers. This paper deals with some thinking about how to make technical studies better oriented to the industry needs in our region. Also, the paper treats the connection of industry and faculty. Someone said: "To the optimist, the glass is half full. To the pessimist, the glass is half empty. To the engineer, the glass is twice as big as it needs to be."

Keywords

Technical study, company needs, learning outcomes, industry usable engineer.

1 INTRODUCTION

The relationship between universities/faculties and the industry could be seen in three important aspects: educational, scientific-research, and professional. This paper looks at the first - an educational aspect in order to design engineers for the industry. According to the experiences in the region (or wider) "at the site" the situation has suggested that the capability of engineering graduates does not meet wholly the expectations of industry employers. The most of them appoints to the lack of not skills but basic engineering knowledge and way of thinking to the "bone of the problem". A significant number of graduates depend on the support of modern technology. Does this mean that with disconnection of electricity in the future office their knowledge or skills would vanish? When we look back, we see that with each new decade of time the concept of graduate mechanical engineer gets new forms.

2 ENGINEERING AND DESIGN

There are many definitions of the term engineering, [1,2]: "Engineering is a profession concerned with the creation of new and improved systems, processes, and products to serve human needs. The central focus of engineering is design, an art entailing the exercise of ingenuity, imagination, knowledge, skill, discipline, and judgment based on experience. The practice of professional engineering requires sensitivity to the physical potential of materials, to the logic of mathematics, to the constraints of human resources, physical resources and economics, to the minimization of risk, to the protection of the public and the environment." The engineering design process involves a rigorous set of steps to create or enhance a product, process, or system. Industry and engineering practice have undergone significant evolution in the past few decades; it therefore seems appropriate that engineering education must do the same in order to maintain an effective pace. Regardless of how significant the changes to engineering practice have been, engineering education tends to respond very slowly.

In the Grinter report [1,3], it was stated that "we do not seem to have produced an equivalent counterpart in the reorganization of engineering curricula" to meet the great changes in engineering practice. Five decades after this report was published, how many engineering faculties can truly claim that their programs have evolved in terms of core content and methods of instruction in order to maintain pace with modern professional engineering practice?

As stated by Todd et al [4], **"It is sometimes forgotten that industry is an important customer of engineering education. Ignoring this relationship has produced graduates that often fail to meet the changing needs of industry in today's competitive environment."** Industry has a set of given needs that it requires of new engineering graduates to fulfill. As the result of some industry survey, a number of significant weaknesses in engineering graduates were pinpointed by industry. Engineering graduates were found to: be technically arrogant; lack understanding of manufacturing processes; desire complicated and "hightech" solutions; lack in design capability and creativity; lack in appreciation for considering alternatives; have a poor perception of the overall project engineering process; have a narrow view of engineering and related disciplines; have weak communication skills; and have little skill or experience working in teams. A list of top topis and activities demanded from the industry is specified in Table 1.

New engineers generally must come to work with a solid technical education, a logical thought process, good work ethics, and computer literacy.

Table 1 List of topics and activities

Top 10 Industry Demanded Topics	Top 5 Industry Demanded Activities
Teamwork	Team design projects
Engineering design specifications	Openended problem solving
Design for manufacture	CAD solid modeling
Overall design process	Interdisciplinary design projects
Design for assembly	Design reports (written)
Creativity methods	
Project management	
Product testing	
Tolerancing	
Solid modeling	

"To compete in today's global economy, companies need people with diverse skills, ideas, and knowledge [5]." Engineering students must be able to evolve with a rapidly changing industry. The Boeing Company has identified a list of desired attributes for engineering graduates. Compiled by Lahidji [6], the aerospace giant states that a successful graduating engineer must have:

- A good understanding of the engineering fundamentals,
- A good grasp of the design and manufacturing process,
- A basic understanding of the context in which engineering is practiced,
- A multidisciplinary systems perspective,
- Good communication skills,
- High ethical standards,
- An ability to think critically and creatively as well as independently and cooperatively,
- An ability and the selfconfidence to adapt to rapid/major change,
- A lifelong desire and commitment to learning,
- A profound understanding of the importance of teamwork.

In the manner of an adequate engineering education, there are several points of view. Firstly, students want the best educational experience possible. Eventually, these undergraduate students will want to be able to find good jobs. In our case the first graduate's question is about salary, but not about the quality of the job, or the quality of myself with my knowledge. In kind, employers want to be able to hire young, new graduates – who have the skills of experienced veterans and are prepared to do any job effectively and efficiently! Professors are often torn between teaching and the demands for research. Universities want their programs to be financially successful – and to be viewed as exciting opportunities for future students. Society is hoping for a graduate who will design the best possible engineering system – and who will protect society from harm. Each of these stakeholders has demanding expectations, and engineering education needs to find balance in responding to all.

Good engineering education is about the process; engineering students must learn how to think like an engineer. For engineering education to successfully evolve, it will require the effort of the entire engineering profession – from education through industry.

List of problems could be made on experience of feedback relation to the companies:

- Lacking in hands on experience; little to no preparation for realworld problems,
- Lacking in oral and written communication skills; difficulties conveying ideas orally and written,
- New graduates have no multi or interdisciplinary experience; have difficulties working with other employees (older, nontechnical, etc.)
- Schools have focused too many resources on developing theory and academics; narrow education,
- New graduates have no experience with the design process or design methodology,
- Professors present courses poorly and have little or no training; faculty appears to be employed mainly for research skills,
- Students have no concept of the safety, regulatory, or liability requirements one must meet in order to complete a design,
- New graduates have little experience planning a project from start to finish; few project management tools are taught,
- New graduates lack the ability to think critically; unable to critically analyze a design and its potential risks.

3 "COLORFUL IMAGES" KNOWLEDGE

In the last 25 years of education in the field of engineering sciences has undergone significant changes, both in terms of teaching, but also in terms of the formation of students as future engineers. From the one side, software development and other technical solutions, IT technology and the Internet, which made classes more functional, and availability of information made easily, etc. but caused that students were now more reliant on skill and technique, but the essential engineering knowledge concerning various engineering disciplines, as well as understanding of engineering problems and solve their essentials, including suggestions for improvements or patents, are out of the range in many cases.

For example, many students are very happy to draw 3D models of individual elements or assemblies, but at the same time, a significant number of students hamper their ability to visualize and presenting problems in his head, Figure 1. This problem may come up with the engineering work at the site. Then, if students are not taught the proper fundamentals of design, in order to be able to make all technical documentation of components and elements of some assembly in all proposition techniques with proper views, sections and other characteristics, because technical documentation shows skills and knowledge of designers, whether technically literate or not.

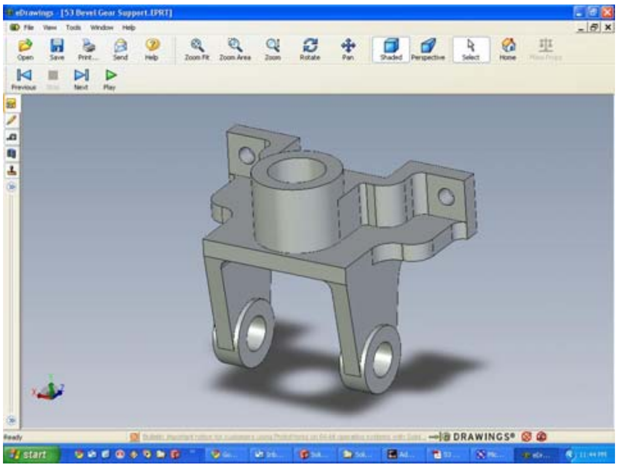

Figure 1 3D SolidWorks model

When using, for example, stress-strain analysis a significant number of students can not interpret the resulting images of structural response to the input of parameters and boundary conditions, and provided that it is done properly, Figure 2. Optimizing structures based on kinetic and potential energy, maximum stress, different types of stress, then take into account the elements of the dynamic behavior of structures, those are all parts of the necessary engineering knowledge, and students in their education are not able to achieve that from a certain reason.

Because of that we can rightly speak of "colorful images'' knowledge, because a significant number of students attain the skills to create models and some analysis, but there is no fundamental understanding of engineering or introduction into the problem. Also, a special problem is the understanding of the technology, and then understanding the development of the project that students receive after graduating when come to the industry. Thus, after graduating the student is required some specified period of further learning and personal development, so they could well respond to the needs of the industry. The time needed depends on the knowledge received and personal effort during the study.

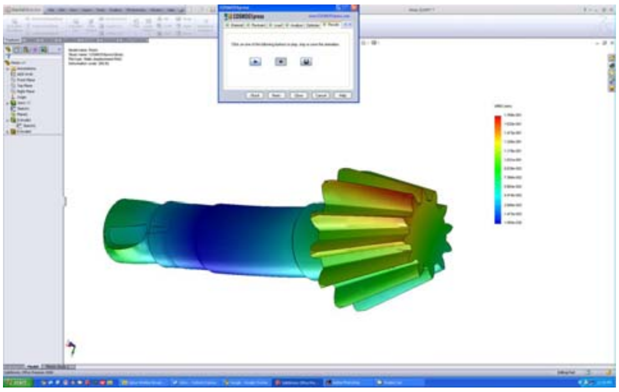

Figure 2 Stress-strain analysis of 3D problem

Unfortunately, a quite number of students doesn't realize the term ''study'', not realizing that the main responsibility for the knowledge received is based on their personal engagement and initiative. The knowledge can't be ''implanted in the head''. Getting the knowledge is a process which must be trained and must go ''through the arms and head''.

4 TWO WAY STRATEGY

Engineering education has evolved since its origins. One of the strongest features of engineering education, in fact, has been its resilience and flexibility, and its ability to adapt and evolve as new challenges, opportunities and new realities become apparent. Some have attempted to provide pathways to the future of engineering. Despite the appearance of confusion that sometimes seems to be associated with engineering education, there are discernable trends: advancing fields, refocusing priorities, enhancing professionalism, advancing teaching and learning methods and increasing diversity.

Emerging engineering fields in new areas are likely to increasingly develop in the future corresponding to advances in science. It is not easy to predict these areas with certainty, but based on past trends some examples of new engineering fields include nanoengineering, biomaterials and biotechnology engineering, computational engineering, health and genome engineering, and engineering for sustainable development and sustainable energy, [7].

There are two concepts of learning according to the main strategy and needs: problem-based learning and project- based learning. Both concepts have their specific tasks and in some way should be realised in combination:

- Both have a large number of phases or stages through which to pass during the project or problem.
- Both start with an identified problem or situation which directs the students' area or context of study.
- Student initiated research is relied upon for the student to progress through the project as well as for their own learning.
- Both require high levels of student initiative, students need to develop motivation and organisation skills.

- Both lend themselves to long-term projects.
- Both are open ended with regard to outcomes, allowing the student the opportunity to choose, after appropriate research an outcome that interests them.
- Observational skills are identified as having a high priority, especially in the initial stages during identification of the problem.
- Student reflection is an important aspect of both models, the student is encouraged to evaluate fully the outcome they have achieved.
- Both rely upon group work.

Project-based learning approach specifics are:

- Project tasks are closer to professional reality and therefore take a longer period of time than problem-based learning problems (which may extend over only a single session, a week or a few weeks).
- Project work is more directed to **the application of knowledge**, whereas problem-based learning is more directed to **the acquisition of knowledge**.
- Project-based learning is usually accompanied by subject courses (eg. maths, physics etc. in engineering), whereas problem-based learning is not.
- Management of time and resources by the students as well as task and role differentiation is very important in project-based learning.
- Self-direction is stronger in project work, compared with problem-based learning, since the learning process is less directed by the problem.

It therefore seems that project-based learning is likely to be more readily adopted and adapted by university engineering programs than problem-based learning. The use of project-based learning as a key component of engineering programs should be promulgated as widely as possible, because it is certainly clear that any improvement to the existing lecture-centric programs that dominate engineering would be welcomed by students, industry and accreditors alike.

Several instructions could be summirise, as strategy points in engineering education:

- Develop the concept of teaching based on interactive lecture, encouraging a large independent work of students and the quality of basic understanding of engineering items, especially for the first few years of graduation.
- Develop the concept of ''real studying'', not only ''collecting of information'',
- Improving communication and links between industry employers and educationists to create a clearer direction for student learning based on more practical issues.
- Making the curriculum content more relevant to current and future needs of engineering industry.
- Restructuring/redefining classroom pedagogy so that it incorporates essential skill-attributes.
- Encouraging students to obtain the needed skill-attributes through a structured and wellplanned industrial internship programme,
- Making essential soft-skills education compulsory in the engineering curriculum, etc.

The principal skill gaps identified were attributed to skills such as interpersonal communication, project planning/scheduling, people management, problem solving and team management. There are some skills which couldn't be read from books, because nothing could replace or fulfill the "practical knowledge and experience". Over the semesters students must be more and more included in projects concerning industrial needs.

5 CONCLUSIONS

If there is a wish of achieving the full interaction of education and industry needs, educators must take a look not only at *what* is being taught, but also at *how* it is being taught. There are basic disciplines and themes in essential engineering lows and knowledge based on for example Newton’s principle, Bernoulli’s principle, mathematics relations and equations, but there is a great difference through decades about applying it in the manner of needs and methods in modern concept of engineering in industry. At this time it can be realized that the full connection of education methods and industry needs isn’t fulfilled. A structured program to enhance learning in the identified areas of need must be implemented in order to achieve acceptable outcomes in engineering education.

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