ENGINEERING STUDENTS PERCEPTION OF THE SKILLS OF AN ACTUAL ENGINEER

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Abstract *¾ Engineers are involved in the implementation, application, operation, design and management of projects and processes, changing the type of work with the specific engineering field. The world in which engineers operates at the beginning of this century, is characterised by the diverse, profound and incessant changes occurring in technology, natural environment and society expectations. The recent review of engineering education indicates that there are a variety of roles of professional engineers which need to be reflected in engineering formation. Engineering can be considered at this moment as a broad discipline that embraces knowledge and training in science and mathematics, business and management, social science and computer technology. We think that engineering students perception of the work and skills of an actual engineer is not according to that reality, because the actual curriculum do not include those skills and the curriculum has a tremendous influence in the thought of the students. So in this work we make a study of the students perception of the more important skills of the actual engineer.*

Index Terms ¾ Engineering education, actual engineer, engineer skills students perception.

INTRODUCTION

An historic analysis of the work and skills of an engineer let as to distinguish three classical conceptions of engineer which have been basic in the design of curricula in engineering education [1].

The first conception considers an engineer as a super technician able to design, create and build technical objects and manage technical of technological processes. Priority is given to technical and technological knowledge and to transfer of specialised know-how. All this conducts to an utilitarian approach of engineering education that can be observed in the curriculum, and in the reduced length and the narrow specificity of the educational and training process.

The second conception considers an engineer as concerned with creating information, concepts, principles and programs on which the design and production of engineering products and systems can be based. Engineering education is directed towards engineering research, so the future engineer is exposed to a deep knowledge of mathematics and physical sciences, but is also skilled for taking part in research activities.

The third conception considers an engineer as someone who can supply a global answer to social and human needs. The engineer assembles technologies, resources and means in order to appropriately solve the given problem. Engineering education is mainly a general and multidisciplinary education, with emphasis put on theoretical subjects and methodological knowledge. The future engineers is exposed to very stimulating socio-cognitive influences, but is also taking part in many projects developed by industry, though is not oriented toward research

Nevertheless, the world in which engineers operate at the beginning of this century is characterised by the diverse, profound and incessant changes occurring in technology, natural environment and society expectations. The role of the engineer is now changing and taking in mind that technical aspects of engineering and technical skills formation are very important, the work in a multidisciplinary environment make also necessary the inclusion of other non-technical subject in the formation of engineers.

The Accrediting Board for Engineering Technology (ABET) of USA defines engineering as follows: engineering is the profession in which a knowledge of the mathematical and natural sciences, gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind [2].

So engineering is a profession concerned with the creation of new and improved systems, processes and products, to serve human needs as they are expressed by individuals, communities, governments and corporations. Its central focus is design, an art entailing the exercise of ingenuity, imagination, knowledge, skill, discipline and judgement based on experience. The practice of professional engineering requires sensitivity to the physical potential of material, to the logic mathematical analysis, to the operational principles of processes and systems, to the constraints of human resources, physical resources and economics, and to the social and environmental context for society, now and into de future.

The Institution of Engineers of Australia defines engineering as follow: engineering is a profession directed towards the application and advancement of skills based upon a body of distinctive knowledge in mathematics, science and

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technology, integrated with business and management and acquired through education and professional formation in an engineering discipline. Engineering is directed to developing and providing infrastructure, goods and services for industry and the community [3].

The recent review of engineering education indicates that there are a variety of roles for professional engineers, which need to be reflected in engineering formation [4].

Engineering can be considered at this moment as a broad discipline that embraces knowledge and training in science and mathematics, business and management, social science and computer technology. So a wide range of skills can be considered as necessary to the actual engineer, including problem solving skills, research and development skills, computer skills, management skills, communication skills, etc.

But we think that engineering students perception of the work and skills of an actual engineer is not according to that reality, because the actual curriculum do not include those skills and the curriculum has a tremendous influence in the thought of the students. So, in this paper we make a study of the students perception about the more important skills of the actual engineer [5]. In this paper we show the first results of a wider study at different levels of the engineering world, that is, at the level of students, academics, industrial personnel and non-experts.

METHOD

Subjects for this study were randomly chosen from groups of students enrolled in Industrial Technical Engineering (ITE) (a three years degree) and Industrial Engineering (IE) (a five years degree). The distribution of students was as follow: forty three students of the first year of ITE, twenty six students of the first year of IE and twenty students of the third year (last year) of ITE.

The interview instrument is a questionnaire that includes seven generic basic skills developed by specific skills related with the generic ones (Table I). Each skill must be punctuated from 1 to 10 according to its importance in the professional work of an actual engineer.

Results are represented in three categories of agreement with the statement, low (1 to 4), medium (5 to 7) and high (8 to 10), as percentage of students giving that punctuation.

RESULTS AND DISCUSSION

First skills we have study are related with scientific and technical knowledge. Results are shown in table II. These skills are highly assessed by all the students, but it is outstanding that statements "scientific knowledge" (2.a.) and "proficiency in foreign languages" (2.d.) are highly punctuated by the students of last year of ITE, while statements "engineering fundamentals knowledge" (2.b.) and "computational science and technology knowledge" (2.c.) are highly punctuated by the students of the first year of IE.

Table I. Interview instrument about the more important skills of an actual engineer.
1. Scientific and technical skills.
1.a. Scientific knowledge.
1.b. Engineering fundamentals knowledge.
1.c. Computational science ad technology knowledge.
1.d. Proficiency in foreign languages.
2. Engineering practice skills
2.a. Measure international systems knowledge
2.b. Knowledge of engineering codes, regulations and guidelines.
2.c. Understanding of the most common technical tests.
2.e. Obedience to the ethics codes of the engineering.
3. Intellectual skills
3.a. Logic reasoning ability
3.b. Problem solving ability
3.c. Design skills
3.d. Research skills
4. Trade and economical knowledge
4.a. Factory direction knowledge
4.b. International marketplace
4.c. Personnel selection and human resources ability
4.d. Bidding procedures.
5. Understanding of national and international history and culture.
5.a. Humanity common history understanding.
5.b. National history and development understanding
5.c. Economic and political structures knowledge.
5.d. Multiculturalism understanding and acceptation.
6. Social skills
6.a. Communication and relation ability
6.b. Team work ability
6.c. Organisation, coordination and direction abilities
6.d. Lifelong learning and innovation.
7. Attitudinal skills.
7.a. Flexibility and functional mobility
7.b. Tolerance
7.c. Social and environmental awareness.
7.d. Other skills (commitment, integrity, etc)

Table II. Scientific and technical skills.				
		Low	Medium	High
1.a.	1º ITE	2	44	54
	3º ITE	0	30	70
	1º IE	8	31	61
1.b.	1º ITE	2	33	65
	3º ITE	0	40	60
	1º IE	0	15	85
1.c.	1º ITE	5	44	51
	3º ITE	0	50	50
	1º IE	8	23	69
1.d.	1º ITE	12	55	33
	3º ITE	0	40	60
	1º IE	0	46	54

Table III shows that all groups of students consider engineering practice skills of middle-high importance in the formation of an actual engineer, but less important than scientific and technical skills. Students of first year places more importance on statements "measure international systems knowledge" (2.a.) and "understanding of the most common technical tests" (2.c.), while students of third year place more importance on statements "knowledge of engineering codes regulation and guidelines" (2.b.) and "obedience to ethics code of engineering" (2.d.).

Table III. Engineering practice skills.				
		Low	Medium	High
2.a.	1º ITE	7	42	51
	3º ITE	0	60	40
	1º IE	8	38	54
2.b.	1º ITE	2	58	40
	3º ITE	0	50	50
	1º IE	15	46	39
2.c.	1º ITE	5	56	39
	3º ITE	0	50	50
	1º IE	8	23	69
2.d.	1º ITE	9	67	24
	3º ITE	0	60	40
	1º IE	23	46	31

Table IV indicates that all groups of students consider intellectual skills of particular relevance in the formation of an actual engineer, being the best assessed the "problem solving ability" (3.b.). It must be pointed up that "logic reasoning ability" (3.a.) is much highly assessed by students of the last year of ITE than for the students of the first year of both ITE and IE.

Table V shows that all groups of students consider trade and economical knowledge of middle importance in the formation of an actual engineer. It must be emphasised that approximately one third of the students of IE consider this subject as low important and more than a half of middle importance.

Table IV. Intellectual skills.				
		Low	Medium	High
3.a.	1º ITE	2	40	58
	3º ITE	0	10	90
	1º IE	0	31	69
3.b.	1º ITE	0	14	86
	3º ITE	0	20	80
	1º IE	0	8	92
3.c.	1º ITE	0	44	56
	3º ITE	0	20	80
	1º IE	8	14	78
3.d.	1º ITE	0	33	67
	3º ITE	0	20	80
	1º IE	0	31	69

Table V. Trade and economical knowledge.				
		Low	Medium	High
4.a.	1º ITE	2	65	33
	3º ITE	0	50	50
	1º IE	23	31	46
4.b.	1º ITE	16	63	21
	3º ITE	0	90	10
	1º IE	31	46	23
4.c.	1º ITE	16	70	14
	3º ITE	0	90	10
	1º IE	31	54	15
4.d.	1º ITE	33	51	16
	3º ITE	0	80	20
	1º IE	38	47	15

Table VI shows that all groups consider the understanding of national and international history and culture of low or middle importance in the formation of an actual engineer.

Table VI. Understanding of national and international history and culture.				
		Low	Medium	High
5.a.	1º ITE	35	56	9
	3º ITE	0	100	0
	1º IE	69	31	0
5.b.	1º ITE	42	49	9
	3º ITE	0	80	20
	1º IE	69	31	0
5.c.	1º ITE	31	67	2
	3º ITE	0	80	20
	1º IE	46	46	8
5.d.	1º ITE	42	49	9
	3º ITE	0	100	0
	1º IE	15	54	31

It must be showed up that "humanity common history understanding" (5.a.) and "national history and development

understanding" (5.b.) are considered as low important for a majority of IE students.
Table VII shows that all groups of students consider very important in the formation of an actual engineer the social skills, mainly "team work ability" (6.b.) and "organisation, coordination and direction abilities" (6.c.), while "communication and relation ability" (6.a.) and "lifelong learning and innovation" (6.d.) are not so well assessed.

Table VII. Social skills.

		Low	Medium	High
6.a.	1º ITE	9	44	47
	3º ITE	0	30	70
	1º IE	8	38	54
6.b.	1º ITE	0	28	72
	3º ITE	0	0	100
	1º IE	8	31	61
6.c.	1º ITE	2	35	63
	3º ITE	0	10	90
	1º IE	0	31	69
6.d.	1º ITE	0	47	53
	3º ITE	0	40	60
	1º IE	8	38	54

Finally, table VIII indicates that all groups of students consider the attitudinal skills of middle-high importance in the formation of an actual engineer. Nevertheless, "tolerance" (7.b.) and "social and environmental awareness" (7.c.) are considered of middle importance by the students of the first year of IE. In general these statements are better assessed by the students of the third year of ITE than for the students of the third year of the same degree.

Table VIII. Attitudinal skills.

		Low	Medium	High
7.a.	1º ITE	5	56	39
	3º ITE	0	50	50
	1º IE	8	38	54
7.b.	1º ITE	16	44	40
	3º ITE	0	30	70
	1º IE	23	54	23
7.c.	1º ITE	5	23	72
	3º ITE	0	10	90
	1º IE	8	54	38
7.d.	1º ITE	14	37	49
	3º ITE	0	30	70
	1º IE	16	46	38

CONCLUSIONS

All groups of students consider intellectual skills and scientific skills of particular relevance in the formation of an actual engineer, while engineering practice skills are considered as less important.

Trade and economical knowledge and understanding of national and international history and culture are considered by all courses of low importance in the formation of an actual engineer, though some of those students will realise management functions in their future jobs and others will move to other regions, or even countries, to find an appropriate job.
Social skills are considered by all groups of students very important in the formation of actual engineers, but attitude skills are not considered so important.

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