

Congruence between non technical market required competences and competences met by new engineering programmes. The case of Spain

José Albors-Garrigós¹
Blanca de-Miguel-Molina
Maria-del-Val Segarra-Oña

Management Department, Ind. Engineering College,
Universitat Politècnica de València, Valencia, Spain
¹albors@omp.upv.es



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1. Objective

Analysing how **non technical competences** are addressed by engineering graduate courses...

... and especially...

... those that have been recently designed following the European Space of Education drawn by the Lisbon Agenda.

2. Competences and Engineering education

- **Competence:** ... "the potential capacity of an individual to successfully (according to certain formal or informal criteria, set by oneself or by somebody else) handle certain situations or complete certain task or job" ... (Ellström, 1994).
- Competences may be viewed from different angles (Ellström, 1997):
 1. Offering side:
 - a) **formal competence** : amount of time spent in training and educational activities
 - b) **actual competence:** education and individual professional and human experiences
 2. Demand side:
 - a) **official demand for competence:** actual competence requirements of a certain job
 - b) **real competence required** by the job

- European Ministers of Education convened in **Bologna on the 19th of June 1999** described **competences** as "*a dynamic combination of attributes..... to attitudes and responsibilities that describe the learning outcomes of an educational programme..*" (European Commission, 2005)
- European Commission (2005) includes:
 - **cognitive competence**: use of theory and concepts, as well as informal tacit knowledge gained experientially,
 - **functional competence** (skills or know-how): things that a person should be able to do,
 - **personal competence**: knowing how to conduct oneself in a specific situation,
 - **ethical competence**: possession of certain personal and professional values.

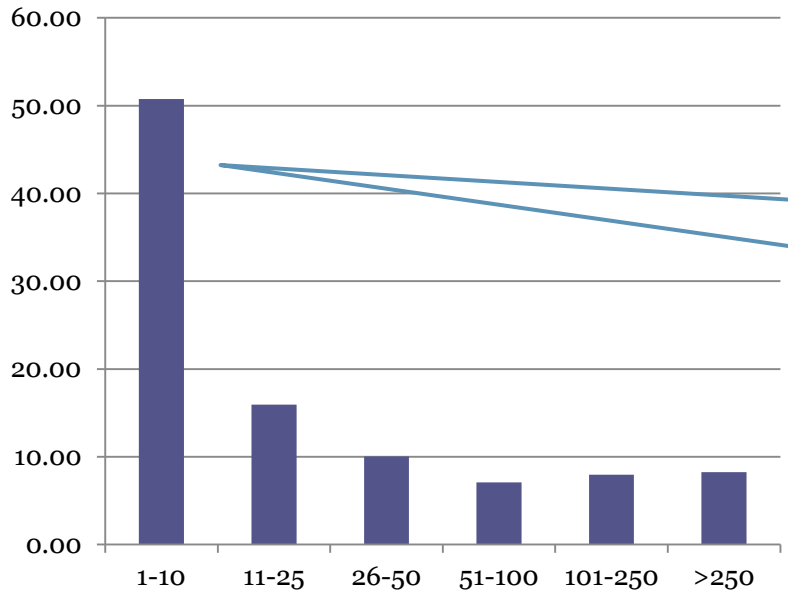
- **Challenges required by engineering education:**
 1. working in transdisciplinary contexts (Allan, 2008)
 2. working within transglobal environments (Swearengen et al, 2002; Chisholm, 2006)
 3. applying the acquired technical knowledge in diverse contexts (Lave and Wenger, 1991)
- **Engineering associations** worldwide have specified competences for engineering graduates:
 - ABET (*Accreditation Board of Engineering and Technology*) in the US requires competence in technology, communication skills and multidisciplinary teamwork.
 - EMF and WA (Washington Accord), recognize certain competences required for engineering practice: specific technical contexts and general contexts (individual and team work communication skills, ethics, finance understanding, etc.)
- **On the graduates side:** Passow (2012), in a survey of 4.300 experienced engineering graduates in the USA concluded that Graduates of 11 engineering majors rated a top cluster of competencies such as teamwork, communication, data analysis, and problem solving as higher than the rest of ABET competences.

We can conclude that it has been generally accepted that...

- **non technical competences** play a relevant role in the engineering graduate's professional development
- certain competences such as **communication skills, problem analysis and solving, team working and cooperating with others** are essential.

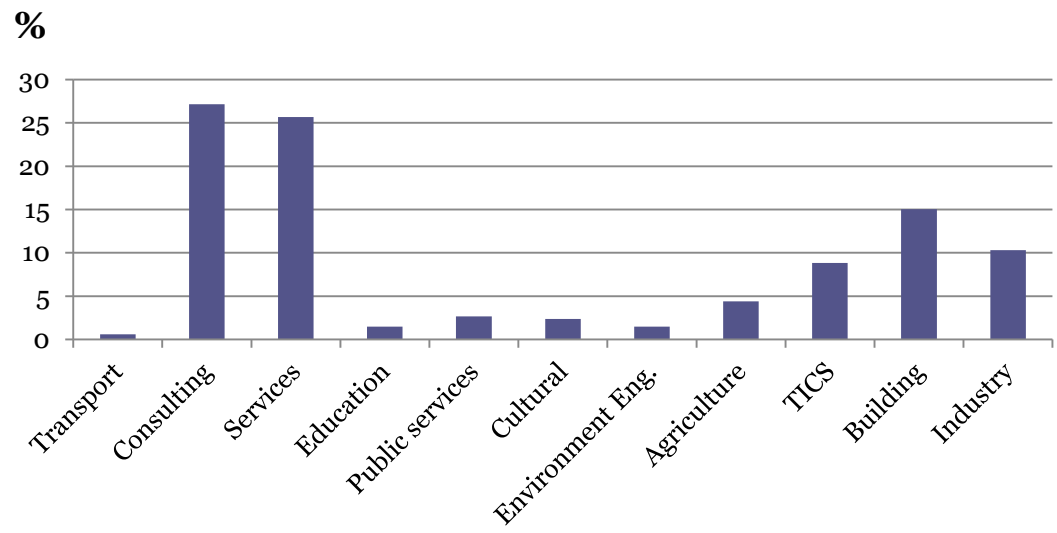
3. Research Methodology

- Based on a study and survey carried out at Universitat Politècnica de València (UPV), Spain, during 2010.
- The study analyses the competences demanded by firms employing UPV graduates and competences gap.
- The final sample:
 - composed by 339 firms with a sample error of 5.3% and 95% significance. The focus group of experts was composed by 13 selected firms.
 - predominance of SMEs.
 - market focus:
 - 34% of the firms had a regional activity
 - 35.1 % a national scope
 - 31 % had an international focus
 - 2.65 % of them where multinational firms.



Firms sample composition in relation to staff size : predominance of SMEs

Firms sample composition in relation to firm activity:
 A majority of engineering graduates have been employed in Consulting and Services sector including TICs while industry occupies only 1.32 %



The study addressed 23 competences:

- **Technical competences**
 - technical knowledge of their majoring area
 - knowledge of other areas
 - quality management knowledge
 - domain of computer information tools
- **Non technical competences**
 - personal skills:
 - analytical thought,
 - be able to work under stress,
 - time efficiency,
 - writing and oral communication skills,
 - leadership potential,
 - creativity and critical thought,
 - domain of foreign languages.
 - teamwork skills:
 - capacity for motivating others,
 - managing and coordinating projects,
 - capacity for detecting new opportunities.

4. Findings and discussion

- The conclusions of the study where that, in general, the surveyed firms were satisfied with the education level of the engineering graduates
- They recognized an **acceptable level of their technical competences** related to engineering disciplines (with the exception of quality management culture and tools)
- They identified **certain gaps in their non technical competences**: domain of foreign languages (English), time use efficiency, competences related to team work (project management and coordination), creativity skills, oral and written communication skills and leadership skills.
- Competences gap appeared to be more acute in SMEs.

Competences of engineering graduates	Ranking of competences as demanded by surveyed firms	Ranking of actual competences held by graduates
Competences for team work	1	4
Competences for working under strain	2	7
Ability to acquire new knowledge	3	3
Skills to motivate others	4	15 (-) GAP
Capacity for generating new ideas and problem solving	5	11 (-) GAP
Skills for Analytical thought	6	6
Negotiation skills	7	14 (-) GAP
Domain of Engineering disciplines	8	1
Efficient time management	9	5
Coordination competences	10	13 (-) GAP
Readiness to question pre-existing ideas	11	12 (-) GAP
Domain of computer tools	15	2
Knowledge of other areas or discipline	14	8
Written communication skills	12	9
Oral communication skills	13	10

Competences addressed by the new Bologna syllabus.

The case of GIOI

(Bachelor's degree in Industrial Engineering in Organization)

We review whether the design of the Bachelor's degree in GIOI covers properly the competences gap discussed previously

- 1) For this purpose we have reviewed the documents that support in detail the design of the degree including all compulsory subjects and the list of addressed competences as per the Bologna directions.
- 2) We will take specifically into account the results shown by the manufacturing sector.
- 3) We consider also which are the main gaps expressed in the manufacturing sector companies which is the ideal market for these graduates.

Gap in relation to those competences demanded by the manufacturing firms	Gap covered with the compulsory subjects of the degree	Expected to be covered? How?
1. Skills for foreign languages	---	YES: B2 level is required to obtain the Engineering Degree
2. Efficient time management	---	YES: A daily continuous schedule has been established in order for the students to organize their time resources
3. Readiness to question pre-existing ideas	YES	
4. Coordination competences	YES	
5. Skills in quality management	YES	
6. Competences for working under strain	---	YES: continuous assessment system for each of the degree subjects (but passing level...)
7. Capacity for generating new ideas and problem solving	YES	
8. Capacity for generating new ideas and problem solving	YES	
9. Ability to acquire new knowledge	YES	
10. Oral communication skills	YES	

- New Bologna program **incorporates new teaching methods** which are grounded on more experimental and context oriented systems: teamwork, case study, collective and individual problem solving, projects based learning, video and virtual interactive tools, etc.
- Another **competence which was not mentioned by the surveyed firms** covering the relationship **to ethics, law and risk** for engineering practice has been specifically addressed by the program.

5. Conclusions and recommendations

- a) The results of the analyzed research outline the **relevance of non technical competences** for engineering graduates, especially those related to teamwork, communication and interpersonal skills as well as creativity (problem solving skills and readiness to question existing ideas)

- b) The engineering graduates **non-technical competences** demanded by firms could be **classified** as follows:
- **Group competences**: time work, coordinating competences and project management, Negotiation skills, Skills to motivate others
 - **Individual competences**: working under strain, Analytical thought, Efficient time management, Domain of computer tools
 - **Creativity competences**: for generating new ideas and problem solving, Readiness to question pre-existing ideas
 - **Communication skills**: Oral, Written and negotiating skills
 - **Knowledge competences**: acquire new knowledge Knowledge of other areas or discipline

- c) It must be emphasized the **role of post graduate experience** for expanding engineering graduates competences by means of **contextualizing** their skills in a real work place environment.
- d) The **enterprise size** has a relevant influence in the **competences demanded** from engineering graduates.
- e) **Graduate practical experience programs** and stages are quite efficient in proving the development of actual competences.
- f) Although, still theoretical and somehow unspecific, **new engineering programs offer a closer approach to the demands** of engineering employers.
- g) a **focus on a global view** of engineering work **must be adopted** in extending the competences focus of engineering education.

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Thank you; Any Question?

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