A Critical Look At Civil Engineering In The European Higher Education Area: The Case Of Spain

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ABSTRACT

On 25 May 1998, the European Higher Education Area (EHEA) was constituted in Paris. It established the need to create a common Higher Education for all the countries of the European Union. Accordingly, the Declaration of Bologna was signed on 19 June, 1999, defining the actions necessary for Universities to adapt to the EHEA, and after ten years of study, it was put into action in Spain in 2010. This article aims to analyse the problems surrounding Education in Civil Engineering in Spain, under the dictates of the EHEA, in order to establish a Contingency Plan comprising Actions for Quality Improvement, after of the first two years of implementation of the EHEA in the Degree of Civil Engineering in the University of Granada.

Keywords: European Higher Education Area, EHEA, Civil Engineering Education, Spain, University of Granada.

1. INTRODUCTION

For over two centuries now, the capacities acquired by engineers during their education have depended substantially on the country where they studied. However, the requirements of an increasingly globalised world and the globalisation-oriented education policy promoted by the OECD (Organisation for Economic Co-operation and Development) (Kivinen et al., 2003) have generated a need for these capacities to transcend national borders (Lucena et al., 2008; Floud, 2006). In Europe, differences existing between countries make professional mobility difficult (Hernaut, 1994), largely due to the diverse professional regulations traditionally required (Maffioli et al., 2003), deriving from educational disparity. For this reason it was necessary to restructure European Higher Education (De Asís et al., 2010), in order to define a common university space where convergence among countries could be facilitated (Kivinen et al., 2003).

To this end, on 25 May, 1998, The European Higher Education Area (De Asís et al., 2010; Rodríguez-Vellando, 2009) (EHEA) was signed in Paris. This document established that the convergence of European Union Member States should not only involve economic terms, but also areas of knowledge (Sorbonne Joint Declaration, 1998), adapting curricula in terms of structures, contents, learning attributes, learning tools and assessment methods (Maffioli et al., 2003). All the Member States were called to make joint efforts to create a system of Higher Education (Maffioli et al., 2003), in which the cultural heritage of each country would be preserved (Filippov, 2006), while the presence of Europe in the world could be consolidated by means of continuous improvement and updating of the education of its citizens (Suárez, 2000). This idea took shape on 19 June, 1999, in the so-called 'Bologna Declaration' (Bologna Joint Declaration, 1999), which set out the actions to be taken by universities to adapt to this new philosophy (De Asís et al., 2010; Van der Wende, 2000):

- Promote **mobility and cooperation**, eliminating obstacles for professional activity, formation and research.
- Adopt a system based on **two formative cycles** (Anglo-American Model; Floud, 2006): Degree (180-240 ECTS; 60 ECTS per academic year) and Master (60-120 ECTS; 60 ECTS per academic year). The Degree is established as the adequate level of qualification in the European labour market, and the Master provides specialization and gives access to Doctoral studies.
- Establish a system of credits —the **ECTS** (European Credit Transfer System)— as an adequate means of promoting student mobility.

Yet certain flexibility in the duration of education in **two cycles** proposed by the Bologna Declaration (Degree in 3-4 years, Master in 1-2 additional years) led countries to finally opt for different configurations in view of the national tradition (Maffioli et al., 2003), despite the emphasis on convergence in the many meetings taking place in the arena of the EUCEET (European Civil Engineering Education and Training, a thematic network funded by the European Commission) (Rodríguez-Vellando, 2009).

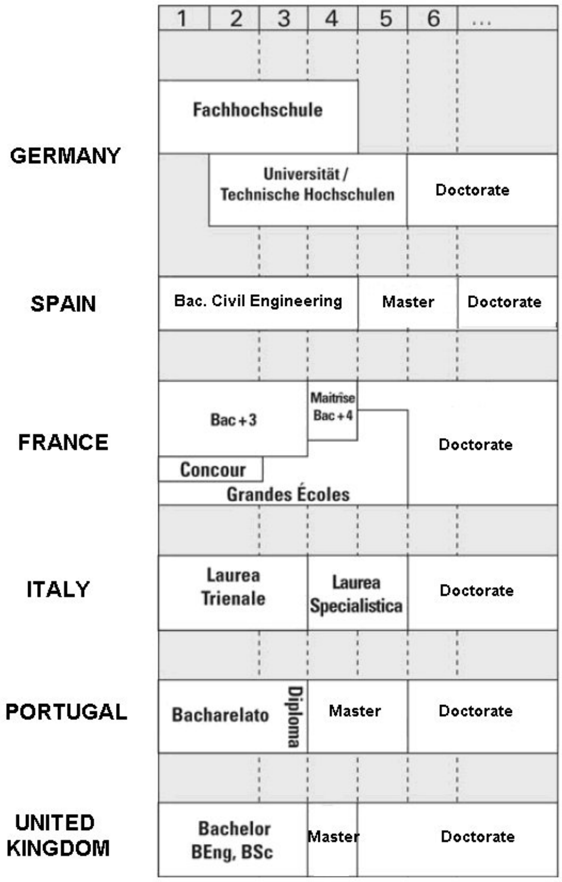

Fig. 1. Engineering studies in Europe after adaption to the EHEA

In Spain, as in the rest of the European Member States, changes were filtered through the existing status of the profession and its tradition. Higher Civil Engineering, here known as *'Engineer of Roads, Canals, and Ports'* (ERCP) (the denomination of Spanish Higher Civil Engineering previous to the EHEA consisting of 5-6 years of study), was heavily influenced by the 1802 model of the *'École Nationale des Ponts et Chaussées'* of Paris, in turn founded in 1747 (Martínez et al., 2007; Marañón, 1999), with its strong theoretical basis and research orientation (Maffioli et al., 2003).

In parallel, 1854 saw the creation in Spain of the branch of Engineering called *'Public Works'* (Spanish Royal Decree of 12 April, 1854), ratified in 1969 as *'Technical Engineer in Public Works'* (TIPW) (in Spain the first university formative cycle of Civil Engineering previous to the EHEA, consisting of three years of study) (B.O.E. 13 November, 1969). In contrast, Higher Engineering has always entailed a broader scientific foundation in the first years (Suárez, 2000) (Table 1), stricter requisites for access, and above all, a determinant nature that lends full, direct legal competence to exercise the profession. This is not the case in countries such as the United States, where competence must be corroborated through a posterior process of accreditation (Prados et al., 2005). The sound scientific basis and direct attribution of full professional competence has no doubt led to the enhanced prestige of the Spanish Degree with respect to other countries (Martínez et al., 2007; Gómez, 1984), and favourable conditions for employment of Spanish Engineers during the 20th century (the engineers from this school are employed in Spain, Europe, Latin America and other countries around the world mainly African countries situated along the Mediterranean Basin)

(Martínez et al., 2007).

Table 1. Comparative example of the basic formation in 'Engineer of Roads, Canals, and Ports' (Univ. of Granada) and in Technical Engineer in Public Works (Univ. of Cadiz), (Spain).

SUBJECT	**CREDITS First Year** **Engineer of Roads, Canals, and Ports, Univ. of Granada**	**CREDITS First Year** **Technical Engineer in Public Works, Univ. of Cadiz**
Mathematics	28.5	18.0
Physics	15.0	12.0
Technical drawing	7.5	7.5
Information technology	4.5	0.0
Geology	12.0	4.5
Business	6.0	6.0
History	4.5	0.0
TOTAL	**78.0**	**48.0**

Given this background, and after a complex process of debate lasting a decade, the Spanish Royal Decree 1393/2007, 29 October, established that Civil Engineering studies in Spain under the EHEA would comprise four years to attain the Degree (240 ECTS), and one or two additional years for the Master (nearly all the Universities finally opted for two years, that is, 120 ECTS). The EHEA Master program thus came to be called '*Master of Engineer of Roads, Canals, and Ports'*, in order to conserve the original name of the profession, as Adams put it, 'to connect the new and the old' (Adams et al., 2011). Although the core denomination used for the Degree would translate as 'Civil Engineering', some Spanish Universities have added distinctive qualifying terms (altogether, 26 Spanish Universities currently offer Degree studies in Civil Engineering).

This configuration (Degree of 4 years + Master of 2 years) has stirred debate ever since its implementation (Carabaña, 2006). It departs from the pre-existing model (first cycle of Engineering of 3 years, Higher Engineering a total of 5 years), and does not fit the predominating model in Europe where, except for Germany and the *'Grandes Écoles'* of France, the Degree calls for 3 years of study (Fig. 1).

At any rate, education in Higher Engineering in Spain has gone from requiring some 400 credits to just 360 ECTS (240 Grade + 120 Master). This reduction has generally implied a lesser number of hours dedicated to the basic scientific subjects (Suárez, 2010) (Table 2). Moreover, the restructuring of contents, a task undertaken independently by each University, has given rise to Degree study programs that are even more dissimilar than before (Table 3). In sum, the objective of convergence —even among Spanish Universities— is increasingly difficult to fulfill.

Table 2. Credits in the Basic Subjects before and after Implementation of the EHEA at the University of Granada (Spain)

SUBJECT	CREDITS before EHEA	ECTS (after EHEA)
Mathematics	28.5	18
Physics	15.0	15
Technical drawing	7.5	6
Information technology	4.5	6
Geology	12.0	9
Business	6.0	6
History	4.5	0
TOTAL	**78**	**60**

Table 3. Comparative example of the subjects in the 'Module Specific Technology for Civil Construction' at the University of Granada and at the Technical University of Madrid (Spain)

UNIVERSITY OF GRANADA		TECHNICAL UNIVERSITY OF MADRID	
SUBJECT	**ECTS**	**SUBJECT**	**ECTS**
Civil construction	9		
Coastal Engineering	6		
Building construction	9	Building construction	7.5
Railways	6	Railways	4.5
Highways	6	Highways	4.5
Underground space	6	Underground Space	3
Environmental Engineering	6	Environmental Engineering	4.5
		Concrete and steel structures	9
		Tunnelling	3
		Transports	4.5
		Construction management	3
		Road surface	4.5
TOTAL	**48**		**48**

Adaptation to the credit system of the **ECTS** is another problematic terrain. Under the previous system, only the presence of the student in class was taken into account (10 hours of teaching per credit); yet the new ECTS credits also count the work the student must produce to pass the subject (Carabaña, 2006; Maffioli et al., 2003) —a total of 25 hours, without specifying the percentage of classroom hours (in Spain they vary from 20% to 40%). Many Degree programs in Civil Engineering, such as that of the University of Granada, have opted for 40% (UGR, 2010), so that the classroom hours of the student are still 10 hours per credit, as under the traditional system.

Meanwhile, the conceptual novelty underlying the ECTS is the transition from teaching conceived as the transmission of contents from a professor to a student, to a form of learning rooted in the autonomous activity of the student and his or her acquisition of competence (De Juan et al., 2011) and ability to transfer knowledge to any field (Caribaño, 2008). This implies a lesser number of students per class, greater emphasis on practical or laboratory lessons, more independent work done by the student, and personalized attention on the part of the professors, at the expense of classroom hours, all of which translates as an increased cost of education (Floud, 2006). These growing needs have met with a situation of economic crisis in Europe that impedes hiring more professors. As a result, we find crowded classrooms and a generalised dissatisfaction on the part of the professors, who are obliged to introduce new teaching methodologies designed for a much smaller number of students per class (Nieva et al., 2011).

In short, we may say that the adoption of the EHEA in Civil Engineering Education in Spain has proven to be a cumbersome process (De Asís et al., 2010), full of obstacles (Munar et al., 2009), representing one of the greatest changes in the field in recent years (Floud, 2006), and perhaps further hindered by the particular configuration of a profession that goes back to 1802 (Marañón, 1999.). The panorama is laden with contradictions between the general trends developed in the Bologna process and the specific needs of technical education (Hedberg, 2001). Firstly, modifications in the duration and configuration of Engineering studies, far from convergence, do not favor mobility among Spanish Universities or beyond them, in Europe (not all Member States have opted for similar systems). Secondly, we have moved from the traditional teaching model focused on the transmission of contents by a teacher in a classroom to a new model requiring independent study, which calls for a greater number of supervising professors and therefore more funding for our Universities (Masjuan et al., 2008). This is simply not feasible in the current economic straits. It is therefore evident that the academic results, and the attempts at convergence, will not live up to expectations.

2. PURPOSE

Having analysed the antecedents of the EHEA, and in light of the a priori doubts about the benefits of this system for Civil Engineering studies in Spain, we need to examine the main problems generated two years after inception of the new undergraduate programs. Our main objective is now to elaborate a Contingency Plan that proposes strategies and actions toward improvement that will help alleviate or resolve these problems, achieving the original objectives of the EHEA while enhancing the quality of the study plans and the overall formation of our students. Along these lines, a series of steps were set forth:

- Apply SWOT analysis (strengths, weaknesses, opportunities, and threats) to the adoption of the EHEA, as a tool in strategic decision-making, to identify key strategic features, and use them to make changes.
- Discover any deviations from the original objectives marked by the EHEA.
- Analyse the academic results of the students.
- Manifest the degree of satisfaction on the part of professors and students regarding the new system and the changes involved.
- Propose strategies to heighten the quality of the Degrees earned.

3. METHODOLOGY

3.1. Information Sources

In light of the Spanish Royal Decree 1393/2007 passed by the Spanish Government for the implementation of Degrees under the EHEA, the University of Granada, like the rest of Spain´s Universities, established a 'System of Internal Guarantee of Quality', coordinated by a Quality Commission within each Faculty, to appraise the consequences of the EHEA by means of a 'Plan for Improvement of the Degree Studies' every two years (Rodríguez et al., 2012a). This was to provide the basis for evaluations every five years of the status of a given study program by the ANECA (*Agencia Nacional de Evaluación de la Calidad*, or 'National Agency for Quality Evaluation'), and a posterior Accreditation of the Degree. Inspired by the Accreditation Board for Engineering and Technology (ABET) in the United States (Rugarcia, 2000), this process of accreditation could lead to denial of the Degree if the objectives set forth in the Study Plan were deemed to have gone unfulfilled (UGR, 2010).

The 'System of Internal Guarantee of Quality', a novel aspect of Spanish Universities, clearly offers a unique opportunity to examine specific problems with the new educational system and establish strategic lines for improvement in Spanish Higher Degree Programs. Accordingly, the Higher Technical College of Civil Engineering of the University of Granada created its own Quality Commission, constituted by a Degree Coordinator, a member of the Director´s team, a member of the Administrative Staff, a student representative, and a representative professor from each Department. The main functions of this Commission are (Rodríguez et al., 2012a):

- Ensure the development of the System of Internal Guarantee of Quality:
    - Analyse the information related with quality and propose guidelines for follow-up.
    - Enhance and ensure coordination among professors.
    - Define proposals for improvement, divulge them, and coordinate their implementation.
    - Carry out, every two years, a follow-up report of the Degree studies in view of the guidelines of quality established.
- Strengthen the participation of all groups involved (students, professors and Administrative/Service personnel) in the evaluation and improvement of the quality of the Degree studies.
- Oversee that efficiency and transparency prevail as principles of management.
- Take measures to facilitate the continuous and systematic improvement of Degree studies under the EHEA.

This Commission has met every trimester since the implantation of the new study program in September, 2010, creating the **'Plan for Improvement of the Degree in Civil Engineering'** (UGR, 2012b), based on **information provided by students and professors** during the meetings, and the **processing of academic results of the students** in the academic years 2010-2011 and 2011-2012 (Rodríguez et al., 2012a). This plan is the source of information used for the SWOT analysis described below.

3.2. SWOT analysis

SWOT is an acronym for strengths, weaknesses, opportunities, and threats. SWOT analysis is a widely-used tool in strategic decision-making. It can aid businesses or other organizations in identifying key strategic features, and apply them in order to introduce effective changes in the business. The idea is to identify internal aspects and external factors that are favourable or unfavourable, in order to consolidate strengths, minimize weaknesses, profit from windows of opportunity and eliminate or reduce threats. SWOT analysis can be considered as a precursor to strategic planning in organizations and business (Houben et al., 1999), although it has also been used extensively in higher education (Dyson, 2004; Gordon et al., 2000).

A SWOT matrix makes it possible to directly compare strengths with opportunities, strengths with threats, weaknesses with opportunities, and weaknesses with threats. It serves to confirm whether the relationships between them are positive, negative or neutral. It also helps determine whether the strengths and weaknesses identified might permit or impede the exploitation of opportunities, or whether they increase or decrease the threats.

To apply the SWOT analysis methodology to the evaluation of the Civil Engineering in the European Higher Education Area in the University of Granada, the following strategic planning process was used:

- Identification of strengths, weaknesses, opportunities and threats.
- Preparation of a contingency plans. A set of common strategic actions is appropriately developed applying the following guidelines:
  - Build on Strengths
  - Eliminate Weaknesses
  - Exploit Opportunities
  - Mitigate the effect of Threats or counter-act the threats

4. RESULTS

4.1. Identification of Strengths, Weaknesses, Opportunities and Threats.

After collecting and analysing the information available from the 'Plan for Improvement of the Degree in Civil Engineering' (UGR, 2012b), the SWOT methodology was applied. Results are shown in Table 4, and highlighted below.

Table 4. SWOT analysis (Strengths, Weaknesses, Opportunities and Threats): results of evaluation of the Civil Engineering Degree in the University of Granada (Spain)

STRENGTHS	**WEAKNESSES**
S.1. High number of applications for entry; over 4 times greater than number of vacancies.	**W.1.** Lack of previous knowledge on the part of the students.
S.2. High average mark of the new students.	**W.2.** Elimination of humanistic subjects and reduction of the basic subjects under the EHEA.
S.3. Orientation course for the first-year students.	**W.3.** High number of students admitted (200 per year).
OPPORTUNITIES	**THREATS**
O.1. Creation of the 'System of Internal Guarantee of Quality' supervised by a Commission that monitors and follows up actions toward improvement.	**T.1.** Difficulty in adopting teaching methodologies focused on more independent student learning.
	T.2. Irregular academic results.
	T.3. Dropout rates.
	T.4. Limited resources of the 'Orientation course for first-cycle students'.

STRENGTHS

The main Strength identified is directly related with the excellent external assessment of the Degree, which results in over **4 times as many student applications as the number admitted (S.1.)** (in 2011 the demand/supply ratio was 418%; http://www.ugr.es/~calidadtitulo/web/p1b2012.pdf). For this reason, **the average mark of the students admitted is very high** (8.4 out of 10) **(S.2.)** (Rodríguez et al., 2012b), and the student profile overall is of high potential.

The existence of the so-called **'Orientation Course for first-year students of the Civil Engineering Degree' (S.3.)** complements the formation of newly admitted students in terms of basic subject matter, and provides the groundwork for facing Technical Studies by organizing study material in a more efficient manner (Alegre et al., 2011). The classes are imparted by professors responsible for the first-year subjects, which strongly benefits the students.

OPPORTUNITIES

The most relevant Opportunity with regard to the EHEA is, clearly, the creation of the **'System of Internal Guarantee of Quality'** and the corresponding **'Quality Commission' (O.1.)**, to analyse problems with the new educational system and make proposals for improvement within the 'Plan for Improvement of the Degree' (UGR, 2012b). This system allows for dialogue on common ground between professors and students, enriching input and feedback.

WEAKNESSES

The most noteworthy Weaknesses detected are closely associated with the present traits of the University system in Spain; namely, there is a **deficit of previous knowledge among the student body (W.1.)**. As underlined by García-Almeida (2012), previous knowledge is fundamental for University students to absorb later contents and obtain good academic results (García-Almeida et al., 2012). In the meetings with first-year professors, the lack of preparation of the new students in basic scientific matters was a recurrent topic (Table 2), even though these students had a high average grade for entry to the University. This would point to a deficient testing program for access to the University, which has been the object of heated debate for many years already (Muñoz-Repiso et al., 1999; Grau et al., 2002).

In second place, the reduction in total credits imposed by the EHEA has meant the **elimination of the subjects of a humanistic character that were previously part of the curriculum** (History and Engineering Ethics) **and adjustments of the basic subjects (W.2.)** (Table 2), a move in the opposite direction of the 'Ideal Education in Engineering' defended by numerous authors (Monteith, 1994): a liberal education in philosophy and arts, and cultivation of human qualities, together with training in mathematics and science, in that order of priority (Monteith, 1994), and transmission to future professionals of a sense of ethical and societal responsibility (Gorman et al., 2001). This would be complemented by a marked trend toward Socio-Technical Engineering Education, to link Research and Practice (Turns et al., 2006) in a field characterized by a certain propensity to separate the technical from the social (Adams et al., 2011). An engineer is not the equivalent of a scientist, as math and engineering science are merely tools for development, not ends in themselves (Seely, 1999), but the integrated advancement of mathematical and scientific concepts is indeed desirable (Bucciarelli et al., 2000), in a context of understanding and application, reconciling the abstract and the concrete (Adams et al., 2011). In other words, professors and the field as a whole should aspire to a translation of scientific principles into engineering practice (Burnet et al., 1994), maintaining a balance between concrete and abstract contents (Felder et al., 2000).

Finally, the **high number of new admissions** (200 per year) (**W.3.**), makes it difficult to establish adequate programs for following up the first-year students, especially in the face of a shrinking teaching staff. Mentors are key figures for students making the transition to the University (Valverde et al., 2003), and they help reduce dropout rates, which range between 20% and 50% of students in Spanish Engineering Higher Technical Colleges (UTEC, 2008). The Degree in Civil Engineering of the University of Granada has set a threshold value of 30% as the highest tolerated value for abandoning studies (UGR, 2010), and this figure is closely related with the success of mentor programs.

THREATS

Linked with the Weaknesses inherent in the present-day University system, a series of Threats interferes with the Quality Guarantee System. Most importantly perhaps, an excessive number of students per classroom has generated considerable **difficulties for adopting teaching methodologies oriented toward more independent student learning and production (as foreseen in the EHEA) (T.1.)**, causing additional problems in the knowledge transmission (Nieva et al., 2011), accompanied by manifest dissatisfaction on the part of professors and students alike. In the first academic year of Civil Engineering Degree studies, 87% of the classes had more than 65 students (the maximum established by the University of Granada; UGR, 2012a). In the second year, this figure rose to 93%. Clearly, such figures are incompatible with the indexes of quality proposed in incompliance with one of the most basic prerequisites set forth for adaptation to the EHEA.

Such contradictions have repercussions for the academic performance of students. As reflected in Fig. 2, there is a remarkable increase in passing marks during the academic year 2010-2011 with respect to the previous one, when the EHEA was not yet in effect. According to the professors, this can be explained by the generally lower demands made upon the students for a passing grade. Such a trend would logically result in a deficit of knowledge in later years. For this reason, in the following year (2011-2012), the Higher Technical College attempted a more realistic evaluation, resulting in 20% fewer passing marks. Such **irregular academic results (T.2.)** stand as a clear Threat for the achievement of quality objectives in the Civil Engineering Degree study program, revealing a dire need for improvement.

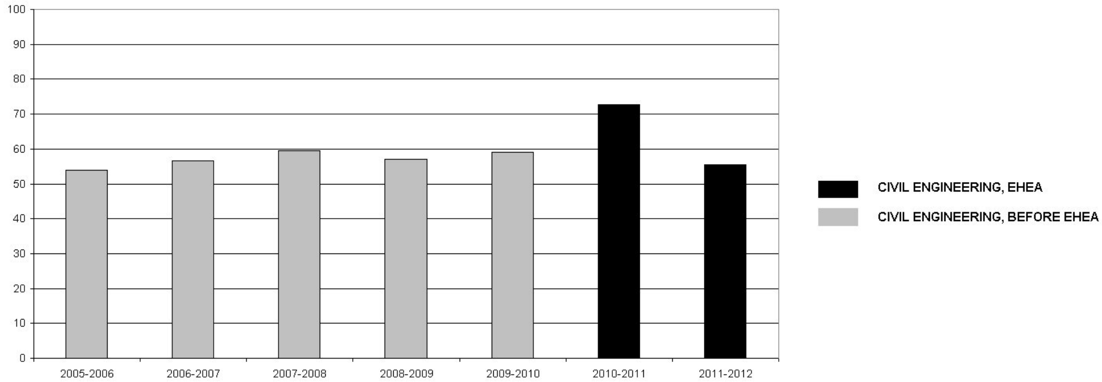

Fig. 2. Percentage of credits passed by the students in the Civil Engineering Degree at the University of Granada (Spain)

Substantial disparity can also be seen in the **results of groups in one single academic year (T.2.)**. A look at passing grades between the groups who have class in the morning versus the afternoon shows over 20% more morning passing grades in 2010-2011 and nearly 15% more in 2011-2012 (Rodríguez et al., 2012b). This may be because the students who choose a class early on in the registration process are the ones with better incoming average mark, and prefer the morning timetable, while the ones with poorer incoming grades end up in the afternoon classes. Nevertheless, a look at the average mark of access to the University of the students in the first year in 2010-2011 shows that the morning groups have an average incoming grade of about 8.6 out of 10, whereas the afternoon groups have a mark of about 8 out of 10, a difference that is insignificant (Rodríguez et al., 2012b). Many students explain that the hours of class, study and sleep are better utilized when classes are given in the morning hours, and prefer to sign up for the earlier classes. Yet if all teaching was scheduled in the morning to enhance student performance, there would be other conflicts (e.g. for students who have part-time work in the daytime), and a need for more resources in terms of professors and classrooms, making this measure impractical in the current context.

As a result of the main Weakness described, the excessive number of students in the classrooms, a very considerable Threat arises, **the dropout rates (T.3.)**. This fact, traditionally attributed to the difficulty in subject matter imparted, also stems from the lack of connection between student and professor. The importance of creating connections and interacting with students is undeniable (Adams et al., 2011; Conley et al., 2000). It is impossible to monitor the progress of all students, and some will invariable fall through the cracks in the system before finishing their courses. A comparison of the so-called 'Total Pass Rate' (considering the number of total credits per academic year) with the 'Success Rate' (considering only the number of credits of exams taken) (Rodríguez et al., 2012b), (Fig. 3) shows the difference to be greater than 15%, indicating a considerable percentage of abandoned subjects. Similarly, the goal set by the Universidad de Granada and its Degree in Civil Engineering Program in the face of future evaluations by ANECA is 60% for 'Total Pass Rate' and 80% for 'Success Rate' (UGR, 2010). As seen in Fig. 3, these rates are lower in the academic year 2011-2012, suggesting a need to take measures in this direction.

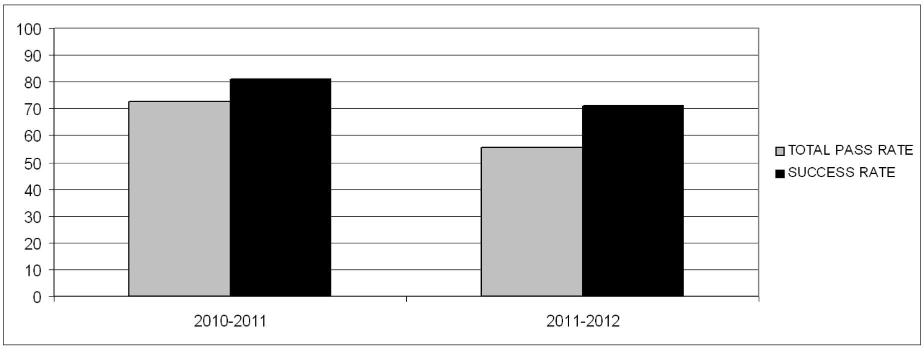

Fig. 3. 'Total Pass Rate' and 'Success Rate' of Civil Engineering Degree in the University of Granada, (Spain)

Finally, the **limited resources** of the **'Orientation Course for first-year students' (T.4.),** has given disappointing results. The number of hours applied is clearly insufficient, according to the professors involved; besides the teaching hours of the professors are not acknowledged, turning this into an entirely altruistic initiative. Clearly, in view of the deficit in incoming student knowledge, there is a need to reinforce this course through adequate funding.

4.2. Preparation of a contingency plans

The results of the SWOT analysis served as the groundwork for a Contingency Plan (Table 5), formulating strategic actions to build on the Strengths, to eliminate the Weaknesses, to exploit the Opportunities and to mitigate the effect of Threats. We also explored associations between the strategies defined around the Strengths, Weaknesses, Opportunities and Threats described, as some actions could help achieve more than one goal. Launching this Plan and its 5 strategies would bring us closer to the original objectives of the EHEA, improving the study programs and students´ academic performance.

Table 5. Contingency Plan; Strategies and Actions for Quality Improvement of the Civil Engineering Degree at the University of Granada, (Spain)

SWOT STRATEGIES	SWOT	ACTIONS FOR QUALITY IMPROVEMENT
A. Improve diffusion of the degree to maintain high demand of access and attract the best students.	**S.1.** **S.2.**	**A.1.** Improve information available on the Web about the Degree, results, and access to the job market.
		A.2. Organize Career Fairs and Information Days for high school students to publicise the Degree.
B. Improve previous formation of students admitted to the University.	**W.1.** **S.3.** **T.4.**	**B.1.** Adapt and improve the process of access to the University.
		B.2. Fortify the 'Orientation course for first-year students'.
C. Reinforce the activity of the Quality Commission.	**O.1.**	**C.1.** Involve professors and students in decision-making to improve the Degree program.
D. Reinforce basic subjects.	**W.2.**	**D.1.** Propose changes in the Study Plan, increasing the number of ECTS dedicated to basic subjects.

E. Reduce number of students per class and support mentorship.	**W.3.** **T.1.** **T.2.** **T.3.**	**E.1.** Decrease number of students admitted.
		E.2. Increase number of classes.
		E.3. Increase number of morning classes.
		E.4. Increase number of professors.

The Higher Technical College of Civil Engineering of the University of Granada has recently embarked on some of the directions for improvement defined in this plan, specifically, those related with its competences. We will have to wait at least two years to determine whether the measures lead to the desired results. The current state of affairs can be summed up as:

- **A.1.** In the past year, the Higher Technical College of Engineering has invested much effort in improving and divulging information about the Degree on their webpage (http://etsiccp.ugr.es/); a substantial increase in visits should be seen in the coming years.
- **A.2.** There is an annual Career Fair for secondary school students from the entire province of Granada, providing information about the characteristics of the Degree and a guided visit of the Higher Technical College itself (laboratories, departments, classrooms…) (http://creces.ugr.es/pages/jornadas_acceso_universidad/granada).
- **C.1.** A Coordinator is designated every semester to facilitate fast, direct communication between professors and students (http://grados.ugr.es/civil/pages/infoacademica/coordinacion).

The actions of the Contingency Plan that do not depend directly on the Higher Technical College of Engineering have been presented as a request before the University of Granada, so that they may be put into effect progressively, as the economic situation allows. For the time being:

- **B.1.** We have stressed the lack in previous knowledge observed among new students, so that the University can establish appropriate measures.
- **B.2.** We have called for recognition of the hours and professors involved in teaching the 'Orientation course for first-year students'.
- **D.1.** We have requested an increase in ECTS for the subject 'Mathematics' within the Plan for Degree Improvement 2011-2012. The University is currently studying this means of action for the next academic year.
- **E.1.** A reduction in the number of incoming students was proposed, but the University has expressed its disagreement given that it means a decrease in income.
- **E.2.** An increased number of classes (that is, more groups with fewer students in each) has been requested for the 1st, 2nd, and 3rd years of study. This was granted for 2nd, and 3rd, but not for 1st.
- **E.3**. A greater number of morning classes was proposed, but the lack of classrooms and professors makes it impossible.
- **E.4.** We have asked that new professors be hired, but for economic reasons this request has been denied.

As is evident, most of the actions proposed depend on the central administration of the University of Granada, and it is unlikely that they will be put into effect due to the present economic restrictions. It may take some time for us to see significant improvement along these lines.

5. CONCLUSIONS

On the basis of the analysis expounded here, we arrive at the following conclusions:

- Adaptation of Spain´s Civil Engineering studies to the EHEA has come as an abrupt change, generating considerable modifications in the duration and configuration of studies, which are hardly compatible with the present system and circumstances, and do not promote mobility with other European countries.
- The outstanding Strength of the Degree studies in Civil Engineering at the University of Granada in the face of this challenge resides in the high appraisal of this Degree, in Spain and elsewhere in Europe, which accentuates demand for this program: there are over four times as many applicants as students admitted (200).
- The main Opportunity to be found in the adaptation to this system is the Creation of a 'System of Internal Guarantee of Quality' supervised by an *ad hoc* Commission that monitors learning and establishes actions to promote effective teaching.
- The most important Weaknesses are associated with current characteristics of the University system, and do not depend directly on the Higher Technical College of Engineering.
- The Threats detected are very closely linked to the present lack of economic resources of the Universities in Spain.
- The Contingency Plan developed by the Higher Technical College of Civil Engineering of the University of Granada appears as a noteworthy tool for identifying key Weaknesses and Threats that may be traced to the process of adaptation to the EHEA, and it can be seen as an aid to improve the quality of teaching and the success of its graduates. Further analysis in the coming years would be necessary to determine the extent of fulfillment of this Plan and the results produced.
- The conclusions obtained in this research study may be extrapolated to Engineering studies in other European countries, for which reason the Contingency Plan described here might serve other Higher Technical Colleges of Engineering when appraising or resolving their problems of adaptation to the EHEA.

REFERENCES

Adams, R., Evangelou, D., English, L., de Figueiredo, Mousoulides, N., Pawley, A., Schifellite C., Stevens, R., Svinicki, M., Trenor, J.L., Wilson, D. M. (2011). Multiple perspectives for engaging future engineers. *Journal of Engineering Education,* 100(1), 48–88.

Alegre Bayo, F. J., Rodríguez Rojas, M. I., Delgado Ramos, F., Hernández Gómez-Arboleya, E., Martínez Álvarez, F. (2011). Tutorías de titulación en el Grado en Ingeniería Civil. *II Jornadas sobre innovación Docente y adaptación al EHEA en las Titulaciones Técnicas, Granada, Spain.*

Bologna Joint Declaration (1999). *Joint Declaration of the European Ministers of Education, Bologna*, Italy, 19

Bucciarelli, L.L., Einstein, H.H., Terenzini, P.T., Walser, A.D. (2000).ECSL/MIT Engineering Education Workshop '99: A Report with Recommendations*. Journal of Engineering Education.* 89(2), 141–150.

Burnet, G. and Greisch J. R. (1994). The ten most outstanding engineering education and engineering technology achievements of the past century. *Journal of Engineering Education*, 83(1), 1–5.

Carabaña, J. (2006). Bolonia: ¿otro espejismo europeo?. *Cuadernos de Información Económica,* 190, 163-172.

Conley, C.H., Ressler, S.J., Lenox, T.A., Samples, J.W. (2000). Teaching Teachers to Teach Engineering-T4E. *Journal of Engineering Education,* 89(1), 31–38.

De Asís Ramírez Chasco, F., Meneses, A., and Cobo, E. (2010). European Higher Education Area: The Good and the Bad. *J. Prof. Issues Eng. Educ. Pract.,* 136(4), 183–187.

De Juan, M.D., Peris, J.E., Posadas, J.A., López, J.J., Vallés, M.L., Martínez, C. (2011). Evolution and assessment of the academia results of the students of business studies after the implementation of module guides. A longitudinal study. *Proceedings of the EDULEARN11, Conference 4–6 July 2011, Barcelona, Spain.*

Dyson, RG. (2004). Stategic development and SWOT analysis ant the university of Warwick. *Eur J Opl Res*, 152, 631-40.

Felder, R.M., Woods, D.R., Stice, J.E., Rugarcia, A. (2000). The future of engineering education II. Teaching methods that work. *Chem.Engr. Education,* 34(1), 26–39.

García-Almeida D.J., Hernández-López, L., Ballesteros, J.L., De Saa-Pérez, P. (2012). Motivation and prior knowledge as determinants of knowledge assimilation: Explaining the academic results of tourism students. *Journal of Hospitality, Leisure, Sport&Tourism Education,* 11, 151-160.

Martínez Montes, G., del Carmen Rubio Gámez, M., Moreno Escobar, B., and Ordóñez García, J. (2007). Final Project Teaching in Higher Education within Civil Engineering: New Perspective. *J. Prof. Issues Eng. Educ. Pract.,* 133(2), 94–98.

Gómez Portilla, P. (1984). El proceso de formación de la Ingeniería Civil. La formación del Cuerpo y Escuela de Ingenieros de Caminos. *III Congreso de la Sociedad Española de Historia de las Ciencias, San Sebastián. Spain.*

Gordon, J., Hazzlett, C., Cate, O., Mann, K., Kilminster, S., Prince, K., et al. (2000). Strategic planning in medical education: enhancing the learning environment for students in clinical settings. *Med Educ,* 34(10), 841-850.

Gorman, M.E., Johnson, V.S., Ben-Arieh, D., Bhattacharyya, S., Eberhart, S., Glower, J., Hoffman, K., Kanda, A., Kuh, A., Lim, T.W., Lyrintzis, A., Mavris, D., Schmeckpeper, E., Varghese, P., Wang, Y., (2001). Transforming the Engineering Curriculum: Lessons Learned from a Summer at Boeing, *Journal of Engineering Education,* 90(1), 143-149.

Grau, R., Cuxart, A., Martí-Recober M. (2002). La calidad en el proceso de corrección de las pruebas de acceso a la universidad: variabilidad y factores. *Revista de Investigación Educativa,* 20, (1), 209-223.

Hedberg, T. (2001). The impact of the Bologna Declaration on engineering education in Europe, the result of a survey. *European Society of Engineering Education* (SEFI), Brussels. Can be downloaded from http://www.sefi.be or from E4 web site www.ing.unifi.it/tne4

Hernaut, K. (1994). European engineers: unity of diversity. *Journalof Engineering Education,* 83(1), 35–40.

Houben, G., Lenie, K., Vanhoof, K., (1999). A knowledge-based SWOT-analysis system as an instrument for strategic planning in small and medium sized enterprises. *Decision Support Systems 26*, 125-135.

Kivinen O. and Nurmi J. (2003). Unifying Higher Education for Different Kinds of Europeans. Higher Education and Work: a comparison of ten countries. *Comparative Education,* 39 (1), 83–103.

Lucena, J.C., Downey, G.L., Jesiek, B.K.,Ruff. S. (2008). Competencies beyond countries: The re-organization of engineering education in the United States, Europe, and Latin America. *Journal of Engineering Education,*97 (4),433–447.

Maffioli F. and Augusti G. (2003). Tuning engineering education into the European higher education orchestra. *European Journal of Engineering Education,* 28 (3), 251-273.

Muñoz-Repiso Izaguirre, M., and Murillo Torrecilla, F. J. (1999). La selectividad a examen. Estudio comparativo del acceso a la universidad en algunos países de Europa*. Cuadernos de Pedagogía,* (282), 91-97.

Nieva Fenoli J., and Sanchos Crespo C. (2011). Modelos de evaluación y plan Bolonia: la evaluación de la docencia a examen. *Revista Direito e Desenvolvimento,* 2 (3), 73-87.

Prados, J. W., Peterson, G.D., Lattuca, L.R. (2005). Quality Assurance of Engineering Education through Accreditation: The Impact of Engineering Criteria 2000 and Its Global Influence. *Journal of Engineering Education,* 94(1), 165–184.

Rodríguez-Vellando Fernández-Carvajal, P. (2009). La enseñanza de la ingeniería civil en Europa y su adaptación a Bolonia. El caso español. *Ingeniería y Territorio,* 87, 32-37.

Rodríguez Rojas, M. I., Alegre Bayo, F.J., Hernández Gómez-Arboleya E. (2012a). Plan de Mejora de la Titulación del Grado en Ingeniería Civil. *III Internacional Conference on Educational Innovation in Technical Careers, Granada, Spain.*

Rodríguez Rojas, M. I., Alegre Bayo, F.J., Hernández Gómez-Arboleya E. (2012b). Resultados académicos en el Grado en Ingeniería Civil. *III Internacional Conference on Educational Innovation in Technical Careers, Granada, Spain.*

Rugarcia, A., Felder, R.M., Woods, D.R., Stice, J.E., (2000). The future of engineering education I. A vision for a new century. *Chem. Engr. Education,* 34(1), 16–25.

Seely, B. E. (1999). The Other re-engineering of Engineering Education, 1900–1965*. Journal of Engineering Education,* 88(33), 285–294.

Sorbonne Joint Declaration (1998). *Joint declaration on harmonisation of the architecture of the European higher education system by the four ministers in charge for France, Germany, Italy, and the United Kingdom* , The Sorbonne, Paris.

Turns, J., Adams, R. S., Martin, J., Cardella, M., Newman, J., Atman, C. J. (2006). Tackling the research-to-practice challenge in engineering design education: Making the invisible visible. *International Journal of Engineering Education,* 22(3), 598–608.

UGR, (2010). Verifica del Grado en Ingeniería Civil de la Universidad de Granada. Can be downloaded from http://grados.ugr.es/civil/pages/infoacademica/estudios

UGR, (2012a). Plan de Ordenación Docente de la Universidad de Granada, Curso 2012-2013. Can be downloaded from http://www.ugr.es/~filosofia/xdocu/2012-2013-plan-ordenacion-docente.pdf

UGR, (2012b). Plan de Mejora de la Titulación del Grado en Ingeniería Civil. Can be downloaded from http://grados.ugr.es/civil/pages/calidad/mejora

UTEC, (2008). Tasas de abandono, graduados y eficiencia y duración media de los estudios según el Plan de estudios. *Unidad Técnica de Evaluación y Calidad de la Universidad de Extremadura.*

Valverde Macías, A., Ruiz de Miguel, C., García Jiménez, E., Romero Rodríguez, S., (2003-2004). Innovación en la Orientación Universitaria: la mentoría como respuesta. *Cuadernos Educativos,* 6-7, 87-112.

Van der Wende, M.C. (2000). The Bologna Declaration: Enhancing the Transparency and Competitiveness of European Higher Education. *Higher Education in Europe,* 25(3), 305-310.