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Reforming civil engineering studies in recession times

Sergios Lambropoulos^{a[1]}, John-Paris Pantouvakis^b, Marina Marinelli^c

^{ab}Associate Professor, National Technical University of Athens, Iroon Polytechniou 9, Zografou Athens 15770, Greece

^cLecturer, Queen's University Belfast, University Road, Belfast BT7 1NN, Northern Ireland, UK

Abstract

The recent global economic and financial crisis has led the economies of many countries into recession, in particular at the periphery of the European Union. These countries currently face a significant contraction of both public investment in infrastructure and private investment in buildings and, as a result, the unemployment is particularly noticeable in the civil engineering and building sectors. Consequently, in all countries in recession the professional development of fresh civil engineering graduates is disproportionate to their high study effort and qualifications, since they rarely have the opportunity to gain experience in practice and their knowledge gradually becomes obsolete. Under these circumstances, it is imperative for the technical universities in countries in recession to plan and implement a substantial reform of the civil engineering studies syllabus. The objective should be to enable graduates to broaden the scope of their professional activity and increase their employability.

In this paper, the widening of civil engineering studies curricula is proposed, in particular in the light of the development of the graduates' potential on project, programme and portfolio management. In this direction, after a thorough literature review, including ASCE's Body of Knowledge for the 21st century and IPMA's Competence Baseline, it is recommended among others: to increase significantly the offered modules on project management and add new modules on strategy management, leadership behavior, delivery management, organization and environment etc; to provide adequate professional training during the university studies five year period; and to promote fresh graduates' certification by professional bodies. The proposals are exemplified by presenting a reformed syllabus for the civil engineering studies offered currently by the National Technical University of Athens.

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1 Corresponding author. Tel.: +30-210-772-3720; fax: +30-210-772-3781.
E-mail address: laser@central.ntua.gr

1. Introduction

Civil Engineering Studies (CES) flourished after the Second World War. The societal quest for more and better civil engineers was initially driven by the immense need to rebuild what was destroyed. But very soon, this evolved to a long term tendency since the governments, in their effort to achieve economic development, had adopted worldwide the Keynesian theory, i.e. the use of public investments in infrastructure as the locomotive. The first positive results triggered the citizens' motivation for better living conditions (housing, tourism etc) and increased private investment in infrastructure. These phenomena were more evident in the countries under development. Though the sky was not always clear (e.g. the oil world crisis in the 70's) and neoliberal economic approaches were adopted by leading countries in the 80's (e.g. Reaganomics), it is the recent financial crisis and its repercussions (i.e. shrinkage of investments in infrastructure, high rate of unemployment in the technical sector) which demolished the misconception of endless development.

The ministries of education and technical universities endorsed massive studies in civil engineering. Old schools expanded and new schools were created, having numerous students. Due to the high professional prestige and remuneration, the schools attracted high quality students. The increase in the volume of projects and the scientific and technological developments led to strong specialization, both in studies and profession. Structural engineers, hydraulic engineers, transport engineers etc, all fell under the rubric of civil engineering. Trying to put order in the professional rights, different solutions were adopted in the various countries, ranging from a unified university diploma and a general professional permit to a wide spectrum of specialization of both. The issue became critical also in many other sectors. International professional unions of experts and bodies, stemming from national ones, were established; after examination, they certify not only the new comers to the profession, but also the experts' progress through time. Though in many cases these certifications have no State acceptance, they are appreciated and recognized worldwide.

In an attempt to reform university studies (not only in civil engineering) closer to the market needs, the European Union promoted the Bologna Declaration in 1999, which introduced a two-level system. The first-level degree (e.g. a 3-year bachelor) is an appropriate qualification for the market. The discussion on the Declaration is even today extensive, hot and non conclusive. Nevertheless, it should be noted that in many peripheral and less developed European countries the Declaration is vehemently opposed by both the academics and professional bodies.

Therefore, a series of critical questions arises for the ministers of education, the technical universities and the professional associations of the countries in recession:

- Why to continue producing civil engineers at the same rate, given that public and private investment in infrastructure will be substantially reduced during the next 15 years?
- How can the fresh civil engineers' employability be increased?
- How their theoretical knowledge will not become obsolete, given that the majority of them will not have the opportunity to gain experience in practice for a period after their graduation?
- How the needs of the 21st century civil engineers should be better addressed?

In this paper, a radical reform of CES in countries under recession is proposed. Following a review of the existing literature, including ASCE's Body of Knowledge for the 21st century and IPMA's Competence Baseline, it is proposed to widen the CES curriculum within the historically established and widely accepted 5-year term. In this direction and among others, it is recommended to increase the graduates professional potential and employability by:

- increasing significantly the offered modules on project management ;
- adding in CES new modules on strategy management, leadership behavior, delivery management, organization and environment etc;
- providing adequate professional training during the university studies five year period; and
- promoting fresh graduates' certification by professional bodies.

In order to exemplify the proposed lines of action, a reformed syllabus for the CES offered currently by the National Technical University of Athens (NTUA) is developed and presented.

2. Literature review

The prevailing contemporary view among educators and industry practitioners is that the challenges of the 21st century construction industry require a new mindset and approach to engineering education. In fact, the sustainability of a profession is dependent on its ability to learn and to adapt to a competitively changing world (Chan et al. 2002).

Numerous researches unanimously support that most of the academic programmes fail to efficiently address the needs of construction industry professionals in management and administration and therefore, civil engineering curricula must broaden to adequately prepare students in many areas and enable them to respond to the challenges of the contemporary changing business environment. In fact, the growing complexity of the construction industry requires greater attention to construction project management courses and makes imperative the exposure of students to a broader base of knowledge in the management and economics domain. In addition, the cultivation of skills related to leadership, communication, negotiation, problem solving, teamwork and critical thinking is needed (Yepes et al. 2012, Cheah et al. 2005, Teixeira et al. 2006, Riley 2008, Edum-Fotwe and McCaffer 2000). Chinowski (2002) suggests that this reformation is necessary in order for the Universities to halt further drop in future enrollments in civil engineering given that the industry clearly desires graduates who have a greater understanding of the business of engineering. Toor and Ofori (2008) note however that future construction professionals' training is not the academia's exclusive responsibility as it requires the active participation and contribution of universities, industry and professional bodies.

Cheah et al. (2005) report from their experience in southeast Asian baccalaureate programmes that the current tendency for increase of the civil engineering scope to encompass a wide range of specialized fields (e.g. structural, geotechnical, transportation engineering) leads to engineers that know a little about every field but lack adequate knowledge to excel in any of them. In this context, they support the formation of a more general civil engineering degree combined with a greater number of specialization subjects at postgraduate/ master's level.

Christodoulou (2004) additionally stresses the need for redesigning the academic curricula in favor of material from disciplines such as information technology and database management systems. Furthermore, Arditi and Polat (2010) highlight the importance of often neglected subjects like contract administration, construction equipment management and project scheduling. Moreover, the thematic network for the European Civil Engineering Education and Training (EUCEET) has thoroughly investigated issues related to the contemporary challenges of civil engineering education and profession in Europe and has made recommendations for the reformation of civil engineering core curricula (2001, 2006).

Sinha et al. (2007) additionally mention the need and challenge to integrate an ethical decision-making framework in the civil engineering curriculum, while Russell et al. (2007) note the importance of providing students the opportunity to interact with professionals using real projects as an educational vehicle. The important contribution of project-based courses towards the fulfillment of industries' requirements is also highlighted by Mills and Treagust (2003). In the same line, Chan et al. (2002) stress that students should be given the chance to participate to mentoring schemes involving senior professionals as well as to gain international and multi-cultural exposure through exchange visits and study tours abroad. Xanthopoulos (2012) also adds that an effective curriculum not only includes a wide, coherent and strong scientific background but also ensures the cultivation of methods and skills for independent access to knowledge. Bernold (2005) additionally emphasizes the imperative need for radical change of teaching methods in engineering so that the students are actively engaged in the learning process.

In line with the above views, ASCE endorsed through Policy Statement 465 the need to reconstruct the academic foundation of professional practice and introduced (2008) a Body of Knowledge (BOK) consisting of 24 outcomes (4 foundational, 11 technical, 9 professional). These describe the necessary depth and breadth of knowledge, skills and attitudes that tomorrow's civil engineers need to have in order to be adequately prepared to enter the professional practice. ASCE envisions these outcomes being fulfilled at a recommended minimum level of achievement (knowledge, comprehension, application, analysis, synthesis, evaluation) through a combination of education (Bachelor's plus Master's degree) and progressive, structured engineering experience. Russell (2013) notes that ASCE's BOK has already proven to be an effective framework to influence dialog and change in the

preparation of engineering professionals. Schexnayder and Anderson (2011) point out that ASCE with BOK recognizes that a bachelor's degree is inadequate for licensure and civil engineering practice at the professional level and is moving the profession to acknowledge that the latter requires a higher degree of cognitive ability which can be gained through much more depth and breadth in engineering education. Similar recommendations are included in the US National Academy of Engineering study concerning the future of civil engineering practice and education (2004, 2005).

A similar series of competences categorized in three ranges (technical, behavioral and contextual) have also been recognized by ICB-IPMA (2006) as necessary for today's project manager. The technical competences indicatively include knowledge of project requirements and objectives, project organization, teamwork, cost and finance, procurement and contract. The necessary behavioral competences include among others leadership, motivation, openness, creativity and ethics. The contextual competencies are among others related to project, programme and portfolio orientation and implementation, business, personnel management, health, safety, environment and security. With regards to the mechanisms contributing to the project manager's competencies, the survey conducted by Edum-Fotwe and McCaffer(2000), with the participation of 170 practicing project managers in the UK, demonstrates that academic programmes are rated lower than the formal industry training on the job, which is also out-ranked by the contribution of job actual experience.

With regards to the profession of civil engineering in Greece, this has for many years been considered as one of the steadiest and high-valued career decisions (Latinopoulos 2010) and has always attracted high-level students. However, construction has been among the sectors most badly affected by the current economic crisis and the unemployment rate of civil engineers, especially the younger ones is the highest ever. The continuing shrinkage of construction sector during the last four years has already led to the loss of 185.000 jobs. Lambropoulos (2003, 2004) made specific low-cost and short-term maturity proposals towards the creation of a specialization in construction management at the School of Civil Engineering, National Technical University of Athens (NTUA) noting the imperative need for reforming the profile of the modern civil engineer in Greece. The need for fostering entrepreneurial and management skills in engineering curricula in Greece has also been highlighted by Papayannakis et al. (2008) and Karlaftis (2013).

3. Proposed reform

3.1. Reasoning

A proposal for reform has to be self-defined as radical and to adopt a long term perspective. In order to be endorsed and implemented, it should not undermine the widely accepted principles and prevailing ideas in the relevant country and time. The elements of the specific proposal on civil engineering studies reform are set within this framework. The studies reform will impact at national level the profession and the economy, but in particular it will change both the everyday life and the vision of the two main actors of studies, students and professors.

For decades, students were choosing civil engineering because of the high status of the profession in the society which coupled with satisfactory remuneration of the offered work. Therefore, in the university entrance examinations it was the candidates achieving results of the highest percentile that were selected to enroll in civil engineering schools. The recent increase of unemployment in civil engineering has already produced a down turn in the quality of perspective students which must be reversed in order to avoid long term impacts to the profession.

Professors in civil engineering are usually ex high rank students with a personal inclination to theoretical matters and research. They followed the cumbersome route of the in-depth specialization and the repetitive evaluation by more senior colleagues. In their majority, they possess limited field experience (relative to their specialization) and lack construction experience and global and synthetic approach to project implementation as well.

The recent financial crisis produced difficulties for both the students and their professors. Students' family budgets were reduced dramatically and therefore their family capacity to finance post-graduate studies in their country or abroad became limited. Furthermore, given that in many countries the average student graduation takes six years instead of five, their families are financially squeezed and this has to be reversed. Further to the above, professors faced substantially reduced salaries, which seriously impacted their moral. In addition, retired professors

are replaced at very low pace, i.e. the active professors' total number is practically reduced. Overall, university financing has been limited.

On the other hand, market globalization provides worldwide employment opportunities for civil engineers, when well equipped. During the last years, many professionals moved from their countries in recession to countries with sound economies. In the same wave, many professors moved to foreign universities. Though at country's level this can be criticized as brain-drainage, at personal level it is a sound way to exploit talent and qualifications, obtained after a strong and costly effort, and gain a fair remuneration.

3.2. Lines of action

The proposed reform attempts to reply to the above challenges and contains the following lines of action:

- produce civil engineers oriented both to the national and global market;
- keep the five year (and no more) unified studies, structure them in three internal steps and provide all qualifications/awards at the end;
- form a general engineering pre-diploma internal step encompassing the first three semesters (one and a half year); failure to pass the courses will not allow student's further progress;
- provide the general civil engineering education at diploma level during the subsequent five semesters (two and a half years); reduce the number of teaching courses substantially; provide additional courses on organization, behavior and leadership, life cycle management, finance, maintenance and upgrading of structures, environment etc to the detriment of the traditional subjects;
- ensure adequate professional training during the diploma internal step;
- devote the last two semesters (one year) to a wealth of MSc specialization programmes taught in English;
- facilitate fresh graduates' certification by professional bodies.

Market globalization will further and further increase through time; international organization and supra-national unions are promoting it steadily. Free movement of capital and people and increasing competition set the framework for the professional life of everybody, including civil engineers. The re-orientation of the studies towards the needs of the global market, instead of the local ones, is a must.

As mentioned above, in order to better respond to the market needs, the European Union endorsed the "Bologna Declaration" in 1999. The Declaration promotes the Anglo-Saxon system involving two distinct steps, i.e. bachelor degree and master's degree, against the unified curriculum continental system. After almost 15 years, it becomes more and more clear that the Declaration, where adopted, has achieved cost reduction to the detriment of the students' fundamental scientific knowledge, i.e. by substantially lowering the quality and skills of graduates. On the other hand, the academic professors tend to overload the basic curriculum with advanced theoretical knowledge of their specialization, which an ordinary engineer might never need. As a result, the number of courses, teaching hours and study duration increase. Another problem of many students springs from the liberal nature of their academic studies as compared to the austere system of their secondary education. In addition, their big effort to enter at the university has exhausted them; moreover, they become more mature and interested in social matters and politics. All these contribute to a high rate of failure during the first semesters of their studies. It is therefore important to introduce an internal system of three steps, which will not allow the fresh students to soften their effort.

In tomorrow's fast changing environment, engineers will have to change their professional position quite often. It is of paramount importance to fully acquire in depth the basic scientific, engineering and economic knowledge. In the good old times, a pre-diploma was ensuring that the student has obtained this across disciplines knowledge. If re-established as an internal first step (three first semesters), it will also function as a filter; provision should exist to transfer the failed students to technological education institutions.

Half of the 5-year curriculum (fourth to eighth semester) should be devoted to general civil engineering. It would not be an easy task for the professors to balance the width and depth of required knowledge in all disciplines with a rational number of teaching hours that will allow students' self-activation. To achieve this, subject repetition and overlapping should be avoided while co-ordination and compromise should be promoted among tutors. In

many universities, the number of courses is excessive. Nevertheless, the offered courses on management, economy etc are very few. It should be noted that a few decades ago the civil engineer had a holistic approach to the projects, including design, construction and financing. In a way, the future in CES is going back.

Taught courses are usually limited to the theoretical background knowledge and to design issues of structures and tend to ignore the necessary construction methods to implement them. Moreover, the synthetic approach to projects is hardly promoted. It is therefore a must to introduce in lectures the relevant construction techniques, case studies and failures' analyses. Furthermore, it is proposed that the students during these five semesters are associated to a small number of projects (e.g. building, road, port, irrigation etc.) under development, monitor their progress, be informed on the problems and solutions, study the contractual documents etc under the supervision of a group of professors, who will provide specific lectures on the issues. At the end of the 8th semester the students will face an 8-hour long diploma examination by the group of professors.

The last year of the studies will be devoted to a Master's Programme; the student will choose his preferred specialization from an available set (e.g. structural, hydraulic, transport, geotechnical, environment, construction management etc). Further to pass the courses, the student will have to prepare an extensive thesis on a certain issue of his specialization. These Master's Programmes should be in English and effort should be made to be jointly offered with an internationally recognized foreign University, in order to increase value in the global market. At the end of the 5-year studies, the successful student will be awarded both the civil engineering diploma and the MSc.

Finally, emphasis should be put in improving the content of the fresh graduates' CV in order to increase their employability. The University should provide the facilities and direct the students towards certified knowledge of foreign languages and computer programmes and applications. Students should also be facilitated to undertake shortly after their graduation the necessary professional exams in order to be certified in their specialization (e.g. IPMA certification for project managers).

4. CES at NTUA

4.1. Structure and ranking of the School

The School of Civil Engineering, NTUA was established in 1887 as an institution of higher education with a four-year curriculum; it was one of the three "Schools of Industrial Arts" and its first 13 engineers graduated in 1890. The School was declared by law in 1912 as a school of university level education and its courses were reorganized in a 5-year curriculum. The next major reorganization of the School took place in 1977, when three cycles of studies (specializations) were developed: structural engineering, hydraulic engineering and transport engineering; the geotechnical engineering fourth cycle was added in 2005. In 1999, the School established two interdisciplinary postgraduate programmes in collaboration with other NTUA schools.

The School of Civil Engineering is subdivided into five Departments covering the different aspects of civil engineering (structural engineering, hydraulics engineering, transportation engineering, geotechnical engineering, construction engineering and management). The School is administered by the General Assembly of the professors that also elects the Dean. The Departments are administered by their General Assemblies that also elect the Head of the Department. The Departments have in total 17 Laboratories that form teaching and research units. The Laboratories are headed by a professor or an associate professor.

There are 67 Faculty members in the School of Civil Engineering; all of them are PhD holders. Their teaching and research work is assisted by 33 members of laboratory staff and scientific associates. A number of researchers either on indefinite duration or fixed-term contracts work on basic or applied research, producing scientific and technological knowledge.

The Student Body is not uniform due to the entry requirements. The School has not the autonomy to select its students or to determine the number of entrees for the forthcoming academic years (they have ranged around 200). The national examinations qualification score required for entering the School is very high; until recently it was the highest amongst all schools of engineering, mathematics and physics; it is expected to drop in fourth position in 2013, obviously due to the high rate of unemployment in the civil engineering sector. Nevertheless, every year the School (following the Law provisions) accepts additional students using criteria related to their socioeconomic

status, religion and cultural identity. For several years, the latter reached almost 40% of the students in an academic year and it became evident that this practice led to a diverse quality of students. Every year, 27% of the graduates receive their diploma with a “very good” mark (7.00-8.99) and only 0.5% with an “excellent” mark (9.00-10.00). 13% of the graduates are 23 years old and 56% between 24-26 years; 2% are over 40 years old.

Research undertaken in the School is worth mentioning in both quantitative and qualitative terms: the School holds approximately 20% of the total funded research budget of the NTUA (encompassing nine schools) and its members publish every year hundreds of papers in International Journals and Conferences.

According to the 2013 QS World University Rankings and referring to the subject “Engineering – Civil & Structural”, the School is ranked 25th worldwide and 7th Europe-wide. The best-performing schools are ranked according to a score resulting from the weighted criteria of academic reputation, employer reputation, citations per paper and h-index. More specifically, the School is ranked 23rd worldwide and 5th in Europe regarding employer reputation and 46th worldwide and 10th in Europe regarding academic reputation. The criteria of the citations’ number per paper and the h-index bring the School to the 3rd place worldwide and the 1st place in Europe.

4.2. Existing studies and proposed reform

The Departments reflect the sub-disciplines of civil engineering providing a number of courses for the undergraduate and postgraduate programmes. Courses are divided into mandatory, elective and optional (non-credit). Students need to follow 65 courses during 9 semesters, i.e. 7 or 8 courses per semester. 138 courses are provided in total, most of them as electives. Taking into account that each course is taught for 3-5 hours per week, a student is expected to spend 26 hrs (1st semester) – 30 hrs (9th semester) every week in a lecture room or doing experimental work in the laboratory.

Table 1. Pre-diploma step (semesters 1-3)

Existing programme		Proposed programme	
Courses	Hours	Courses	Hours
Mathematics (analysis, numerical methods, linear algebra, differential equations, descriptive geometry)	24	Mathematics (analysis, numerical methods, linear algebra, differential equations, descriptive geometry)	14
		Operational research and statistics	8
Principles of ecology and environmental chemistry	3	Principles of ecology and environmental engineering	5
Geology	4	Geology	4
Building technology (technical drawing, building materials, general building technology, architecture topics)	14	Technical drawing; autocad	6
Mechanics and Physics	16	Mechanics and Physics	12
		Management(introduction to project, programme and portfolio management; leadership behaviour; reporting)	5
		The life cycle of technical projects	3
		Economics (macro, micro, business)	6
Geodesy	3		
Computer programming	4	Computer programming and applications (mathematical and statistical packages, excel, Power Point etc)	6
Electives (applied economics, philosophy, introduction to energy technology, production and management of technical projects, town-planning)	6	Elements of general law; technical legislation	6
Total	74		75

Undergraduate courses regarding the four specializations, i.e. structural engineering, hydraulic engineering, transport engineering and geotechnical engineering, commence on the 7th semester and become the majority on the 8th semester; the 9th semester is fully devoted to specializations.

In 10th semester, each student is obliged to prepare his diploma thesis, which has the content of a high level assignment. Although the completion should be feasible in one academic semester of full time work, it takes longer in practice. A sizeable number of graduating students are co-authors of conference (6.5%) or journal publications (4%) that include material from their diploma thesis. This surely underlines the importance of a 5 year intense curriculum.

Table 2. Diploma step (semesters 4-8)

Existing Programme		Proposed Programme	
Courses	Hours	Courses	Hours
Geodesy applications	3	Geodesy and applications (plus summer practice)	4
English (terminology)	2	English (terminology)	3
Probability - statistics	4		
Environmental engineering	4	Environmental engineering	3
Hydraulics (technical hydrology, fluid mechanics, applied hydraulics, urban hydraulic works, maritime hydraulics and harbour engineering)	22	Hydraulics (technical hydrology, fluid mechanics, applied hydraulics, urban hydraulic works, maritime hydraulics and harbour engineering)	16
Geotechnics (engineering geology, soil mechanics, foundations)	16	Geotechnics (engineering geology, soil mechanics, foundations)	14
Concrete and steel structures	24	Concrete and steel structures	18
Statics and earthquake engineering	18	Statics and earthquake engineering	15
Highway engineering; transport	11	Highway engineering; Transport	10
		Architectural design; Town-planning	3
		Building materials and technology	3
Management (construction equipment and methods, construction management, elements of law and technical legislation)	10	Construction Project Management (construction equipment and methods; scheduling, contract management, risk management)	10
		Strategy Management; Cost Benefit Analysis; Financial Engineering; Concessions	4
		Project implementation (diploma exams)	10
Electives (4 th -continuum mechanics, experimental strength of materials, 5 th - operational research, advanced numerical analysis, computer applications, 7 th - architectural design, special topics of building technology, statics IV, open channel and river hydraulics, traffic flow, 8 th - 16 specialization courses)	13	Electives (delivery management, maintenance management, organization, continuum mechanics, advance statics, experimental strength of materials, advanced numerical analysis, computer applications, special topics of building technology, open channel and river hydraulics, traffic flow and many other specialization courses) with provision to form "minors".	12
Specialization courses	14		
Total	141		125

Based on the lines of action presented previously, it is proposed to reform the existing studies and structure them in three internal steps, i.e. the pre-diploma, diploma and MSc step. The proposed changes are presented in the above two tables. It should be noted that the total number of taught hours per week is fixed to 25 and that the number of hours in the tables correspond to the taught hours per week throughout each step's semesters, e.g. for the three-semester pre-diploma step the total number of hours is 75.

Regarding the MSc internal step in the fifth year, the proposed reform foresees the evolution of the existing four specializations to a much greater number of post-graduate Programmes. It should be noted that NTUA considers the provided 5-year studies as being equivalent to MSc level, but there is no legal approval by the Ministry of Education. The proposed MSc Programmes will have duration of 12 months and will be structured according to international practice. There will be two semesters with mandatory and elective courses and the student will have to prepare after and defend in September a MSc thesis. During the studies, the students will also be trained in order to be certified by the relevant professional body.

Table 3. MSc step (semesters 9-10) proposed Programmes

Based on Existing Specializations and MSc Programmes	New
Structural Engineering, Hydraulic Engineering, Transport Engineering, Geotechnical Engineering, Tunneling, Computational Mechanics, Architectural Design, more	Construction Engineering, Construction Management, Project Management, Environmental Engineering, Financial Engineering, more

MSc courses will be taught in English in order to increase their international recognition and attract students from other countries. Furthermore, the Programmes should be conducted jointly with other internationally respected universities to further increase their recognition and attractiveness. It should be noted that the École Nationale des Ponts et Chaussées (ENPC) and the School of Civil Engineering, NTUA already provide joint studies and diploma.

5. Conclusions

Until recently, the civil engineering profession and studies were booming worldwide, profiting from the favorable socio-economic conditions that prevailed in the second half of the 20th century. The beginning of the 21st century signaled a sharp change. The financial crisis led many countries into recession, which reduced infrastructure investment and increased unemployment in the sector. In a significant number of developed countries, after many years of construction, any new infrastructure has to overcome a time consuming and cumbersome permit issuance. On the other hand, many other countries enter their development phase and promote heavy investments in infrastructure and market globalization advances rapidly. To cope with the drastic changes of the socio-economic environment, the civil engineering profession must adapt cleverly. Proper reform of the existing CES could be the corner stone of this process.

The reform of CES proposed in this paper refers to countries in recession, in particular at the periphery of Europe. Nevertheless, many of the proposed lines of action could and should be implemented in most countries. Obviously, in order to be successful any reform should reply effectively to the specific problems and correspond to the prevailing ideas of the relevant country.

It should be emphasized that there is still a strong appetite for new infrastructure in the world. Therefore, countries in recession can continue producing civil engineers provided that they will be oriented towards the international market and not their national one; the suitable reform of the CES syllabus becomes a prerequisite.

In recession countries, the fresh civil engineering graduates have a huge rate of unemployment in the local market. In order to increase their chances in the international market, the CES syllabus should promote ready to use knowledge and give emphasis to the synthetic approach and implementation of projects.

It is expected that during the 21st century the average educated person will have to change various posts. Therefore, the future civil engineer should not only be equipped with technological knowledge and specialization, but also be able to cope in the financial and entrepreneurial environment, i.e. to act like the engineer of the first half of the 20th century.

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