

On the Problems, Challenges and Prospects for the European Higher Engineering Education arising from the global economic Crisis

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The “*global*” economic crisis has affected multiple aspects of the daily life in all member states of the European Union and beyond. In this article we would like to take a closer look at the consequences of this crisis on European Higher Engineering Education (*HEE*). In this analysis, the focus is on the financial, structural and institutional consequences while the concerns are at the educational level. Our purpose is to clarify the actual situation and to inform the discussion as there is no doubt that the current crisis will continue to challenge the educational structures and institutions.

The political dimension of the challenges in HEE

As a result of the crisis, significant budget cuts have taken place in many European countries (EUA, 2012). The toll on HEE has been high while the aftermath and problems spawned by the global financial crisis have yet to be clearly recognised. The EU’s statistical main indicators and indexes all underline the significant shrinkage of public funding for Higher Education (EU, 2012). This “*shrinkage*” takes no common form for all affected parties since it is heavily dependent on many aspects of each European country’s institutional framework, context, cultural background, and economy; yet, it is certain that very few national higher education systems are unscathed while most will require to (*or be even forced to*) heavily “*restructure*” during their country’s struggle with austerity and the deficit.

The public funding cuts affect first and foremost the quality of education, teaching, research and even the very nature of the autonomy of the Institutions themselves (EUA, 2011). As a consequence, private funding is being considered to contribute to the Institution’s financial wellbeing and overall sustainability; yet these income streams pose entering uncharted waters in some countries, diverting and forcing the character of HEE from a service of public interest to a commercially-based and profit-driven venture. An important issue in this context is the matter of student loans being institutionalized as such, in the form of “*scholarships*”, “*stipends*” or educational “*coupons*” towards the completion of studies and gradually repaid back. The loan experiences and current predicament in the USA clearly illustrate that student loans are economically unsound moves, financially unbearable and overall unaffordable as a means to an individual’s education (Johnson, i.e., 2012). At the same time, EU policies are being formed to further facilitate student mobility and “*ease*” the portability of funding (*ensuring student grants and loans can be used throughout EU Member-States and affiliated countries*); the very nature of student scholarships in the form of loans being or becoming unbearable should be first and foremost addressed, knowing that these “*loans*” (*and thus: “student debt”, amounting to a bachelor student having a debt of >\$100.000 upon completion of his/her degree*) are not a viable alternative to public funding. In the European tradition, the public character of universities and of education as good for society has always been a stronghold which will be profoundly altered when education -either through private funding or via student loans- turns into a commercial product as it has become a for-profit industry in the US (Wigger, i.e., 1999; Touryalia, 2013).

Budget cuts have quantitative aspects, ranging from economic, quality and social services’ matters (such as no provisions for student care/health services, restricted or no accommodation, limited access to knowledge due to lack of courses’ resources or scientific journals’ subscriptions), but also built a qualitative risk in relation to

the Engineer's knowledge, skillset and competences. Based on the European Qualification Framework (EQF) these comprise of: *a.* Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles, *b.* Advanced skills, demonstrating mastery and innovation, *c.* Managing complex technical or professional activities or projects. The overlay in this framework is a niche oriented high-level training with an applied 'hands-on' approach in the context of unpredictable environments, complex and specialized problem solving skills under the scope of risk-assessed situations and decision-making. It is this approach that constitutes the special case of engineering where private funds find it difficult to invest as needed, for proper and functioning infrastructures. The engineering curricula of European universities consist of a proper amount of basic sciences, along with engineering lessons and lessons of deepening and application. These curricula can serve the demands for the exercise of the engineering profession at the highest level of technical responsibility (Kärkkäinen, 2006).

On another level the newest allowances that new didactical insights and information technology provide, as problem-based learning (*PBL*) as well as active and collaborative learning and online learning, can facilitate advanced studies at lower costs. At this moment though these cannot yet substitute the actual/physical confirmation, unattainable via digital "*lessons*" and e-courses. The inherent danger of the EQF in the "*summing up*" of competences not framed in a complete studies programme is the reason why all challenges brought forward by new technologies are examined thoroughly under the scope of the CDIO (*Conceive – Design – Implement – Operate*) innovative educational framework, with the requirements of social services provision being fulfilled. In this instance, the lack of e.g. lab infrastructures which private sector investors deem as "non-profitable" (*due to an unfavourable return on investment*) and thus are not sufficiently (*or even at all!*) funded, reinforces our cause for *quality assurance and accreditation* in order to deal with the challenges addressed to higher education without allowing them to disintegrate or degrade the qualitative character of higher engineering education.

Engineering higher education's institutions are faced with the same challenges and problems as other public universities in Europe and in the World and forced to operate as a "*testing ground*" and melting pot for the implementation of policies that –*due to the idiosyncrasy of the training at hand*– downgrade their offered studies. As a consequence this may have led to an exodus of a large mass of "*engineers*", Bachelor holders at a lower cost, albeit significantly less qualified. Fifteen years after the implementation of these policies, the critique against Bologna's "*success*" in declining degrees, certifications and such does not especially hold water when referring to HEE because so far the offering of either Master of Engineering or Master of Science choices of studies has been the most characterizing norm of engineering programmes. Also industry has not been in favour of the "*bachelor as engineer*" reform, and continues to favour the 4- and 5-year-duration studies (*Master of Engineering – MEng, Master of Science – MSc*). This also justifies the needed reform of the Bologna Process, since Engineering has to face the above challenges and in order to do so, the society alongside the End-Users (*who will put the services of engineers to use*) as well as the professionals, technical chambers and academic community should clearly define the engineering qualifications; in this way, the quality of engineering professional services will be exercised for the public benefit and the universities will be able to further improve the quality of educational services offered.

In line with this pledge for quality is the demand for a strategy of HEE to provide graduates with the necessary competences useful and required in order to plan implement and operate development as the pathway for an exit from the Crisis. In this light, another challenge for universities is intrinsically connected to the capability of HEE to successfully apply new knowledge, research and innovation in the real economy, cultivating and e-educating entrepreneurship, fostering management of the works as well as bringing forth the evaluation of the actual social impact they (*and their engineers*) develop. This constitutes a major challenge for all; governments and the European Union alike, but in all cases it is the innovative capacity of HEE that needs to be activated in order to tackle the crisis and the mergers and eliminations of HEE's structures.

In the 40 years of SEFI 1973 – 2013, HEE passed from the era of regeneration of the university, with the critical reconnection of engineering and development which was characterized from the controversy of May 1968, and the revolution of Greek students on 1973 at National Technical University of Athens, to the era of a new redetermination within the frame of global economic crisis. HEE can make a significant contribution in educating engineers that will contribute to solving the global crisis with HEE and European societies working together.

The educational dimension of the challenges in HE

Next to the rather formal approach on the political, institutional and financial level, which very much reflects the current situation in HE, there is a dimension that - *due to societal developments* - poses a fundamental question about the needs of today's society in relation to education. The number of students demanding education is increasing rapidly, as well as is the need for higher productivity, more flexibility, rising costs for and of students, decreasing state support and multiplying debts of institutions. The outlook on change in education has been very much an institutional endeavour with a self-referential character; the financial crisis though is not just about some bankers who misbehaved, but indicative of a fundamental major shift in society from national, analog, industrial economies to a global, digital, information economy. This transition process also has major consequences on the actual educational level on which institutions operate. The innovation cycles, particularly in the technological fields, are so swift that current institutional structures can no longer keep up with the developments. Therefore institutions are increasingly looking for ways to stay on track and have discovered that online learning, in a combination of new pedagogical insights, organisational changes and learning technologies can help to make the organisation more capable of dealing with these demands (Daniel, 2012, 2013).

Up until recently, online learning was considered as an added advantage. The rather fundamental public discussion about the mere existence of higher education due to seemingly incompetent institutions unable to cope with today's learning demands, spurred another level of dealing with learning innovation. It is known to the public, the students and an increasing number of "*educators*" that HE has a hard time to deal with the very different dynamics of education in the 21st century. Most institutions are based on the factory model of mass instruction that was so successful in the previous century. An important defect of this model is that most universities and colleges are rather traditional and conservative, not being able to react to the constant changes in our society in an appropriate manner (Wheeler, 2012). Today's reality is that new models of education are emerging, initiated by a selective group of high class institutions and investing companies with a history in education, publishing and public media (Daniel, 2012). This is quite a different arrangement with a strategy focusing on online student centred approaches and the exploitation of smart personal technologies for any-time and anywhere learning. This is what can be considered as the educational dimension of the crisis, which forces change on HE at a much higher speed than ever experienced before. Generally speaking the changing situation for HE is decades old, but seems to pick up speed much faster and therefore performs more in line with the general societal developments.

The British Open University started in 1971, the for-profit University of Phoenix is online since 1989 and Massachusetts Institute of Technology (MIT) and lots of other universities including the Delft University of Technology have been posting free online "open courseware" for a decade (Economist, 2012). These developments were not considered disruptive for the existing HE system, but with the emergence of multiple online and blended learning programmes, flipped classroom initiatives, Open Educational Resources and others like Massive Open Online Courses (MOOCs), this seems to change rapidly. In most cases, institutions try to utilize "online" for the purpose of becoming more efficient in teaching and learning related activities in search of a business model that allows for change and innovation within the boundaries of the existing budget and organisational models. A nice example is the "flipped Classroom" approach, in which lectures are no longer part of what happens in class. The class session is about interaction and the lectures most commonly are being done

using teacher-created videos that students view outside of class time. Flipping the classroom has proved to lessen the dropout rate among students and increase the amount of information that the students learn, which is promising (Tucker, 2012). The new developments though, lack a research base that convincingly proves that this is the way to go. This is no surprise since matters change so rapidly that the discussion also includes the question “what research is needed”, since formal research seems to underperform as well. Alternatives mostly indicate an extension of the tooling with for example ‘learning analytics’ to make the research fit for purpose in a timely manner (Siemens, 2012).

Most attention nowadays goes to MOOCs which are free online classes for large numbers of students who watch short high quality video lectures, complete assignments and are graded by machines or other students. There is a minimal involvement of teaching staff and a professor can handle a class with thousands of students. The first to introduce these courses on a large scale were leading universities like Harvard, MIT and Stanford operating in conjunction and investing large sums of money. In the meanwhile others have joined this trend by engaging in initiatives like edX, the non-profit venture from Harvard and MIT, Udacity set up by a former Stanford employee and Coursera, initiated by some other colleagues from Stanford. And sure there are other initiatives from small colleges, the training business and from individuals, but most attention goes to the big ones. The Open University in the UK started a consortium of British universities to develop a new platform for free courses called Futurelearn, which is expected to be online competing with the American initiatives. Where universities tend to take years to decide about anything, the MOOCs initiative seems to push decision making to another level. No wonder this phenomenon gets a lot of attention, certainly also because the media partners in this online endeavour know how to raise attention and sell a product (Daniel, 2012, 2013; Jacobi, 2013).

Management in general and other stakeholders in HE are challenged by the idea of having to compete with free courses from some of the world’s most exclusive universities. It is still unclear if and how much the movement will change the education landscape, and there are plenty of sceptics. The fact is that MOOCs are more than just smartly taped engaging lectures. The real innovation comes from integrating academic talks with interactive coursework, the use of automated tests, quizzes and games. Students learn at their own pace, discuss, share and collaborate in a networked environment that feels like “home”, due to profile matching techniques to create groups of students that have lots in common. The MOOC concept makes learning more feasible and greatly attractive for students worldwide. Just to get an idea of the size: a Harvard course on ‘How to reason and argue’ attracted over 180.000 students. A Udacity course by Google’s director of research Peter Norvig, attracted 160.000 students. A group of 155.000 students registered for MIT’s prototype ‘Circuits and Electronics’ course. Only 45% was aged between 18 and 25 and most students came from America, India, Britain, Columbia and Spain and some 7.200 passed the course (Economist, 2012, p. 90; Daniel, 2012, 2013; Jacobi, 2013).

It is not yet clear what we will see in the near future, but looking at the discussion and the examples of new MOOC-like initiatives, it seems that this movement opens up new possibilities for institutions to cluster and pool resources, to provide credible qualifications, to supply reviews for credit equivalency. The expectation is that most universities will develop a blended model, with next to the traditional an online, virtual university, creating a business model that thrives for flexibility and innovative new learning settings that need to be more participative than ever before to make it work. However, in parallel with the growth of MOOCs, an argument has been put forward as well, criticizing the MOOCs’ hype and ultimate peak of inflated expectations since these cannot readily and completely substitute universities and the academia as institutions of knowledge-transfer, new knowledge creation and development in the eyes of society.

The problems, challenges and prospects

It is true that the number of students in need of an education is rising and putting a lot of pressure on the current system to become more flexible. At the same time institutions are trying to deal with rising costs, decreasing state support and raising debts. The political dimension of the crisis for HEE seems to offer no alternative to deal with the problems unless private investors decide to enter the HE market as the MOOC story reveals. The general reaction of the institutions seems to have a predominantly self-referential character, but this is just one side of the story.

The educational dimension of the issue has been introduced to allow for a broader look at the current situation. The educational innovative approaches seem to be an opportunity for universities to illustrate their educational excellence and attract more and diversified students groups, to enhance international competitiveness and to appeal as attractive as possible in order to sustain HEE in the European continent. The costs for students are relatively low in Europe compared to the US, but there is a huge shortage of engineers that obviously cannot be met by the current system, causing both an inner-European white-collar immigration from the south to the north as well as an influx of foreign workers. The online learning hype could therefore very quickly turn into a solution provider for these kinds of deficits on the European educational system. The learning providers though are not necessarily European and this means that the European institutions should take the prospect of being daringly innovative using their academic freedom and creativity to develop new educational models, new learning arrangements and new opportunities for knowledge reliance with the Industry. This should not be limited to a MOOC-like approach, but combine the opportunities of new educational insights, new learning concepts and educational technologies. At the same time this development is valuable as we are in need of a discussion that allows for a multitude of considerations. Education is too precious and too costly to ignore supposedly disruptive movements, but use the opportunity to compete the shortcomings in the existing educational landscape, ultimately supporting and upholding the public university and higher education as a public good for the benefit of society.

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