Geo-Engineering Education and Training. The Past and the Future

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Abstract. A brief background on education and training in Soil Mechanics, Rock Mechanics and Engineering Geology is presented, highlighting some facts which influenced the development of these sciences. The interplay between them is stressed. The International Societies (ISSMGE, ISRM and IAEG) role in promoting education at different levels is emphasised. The performance of scientists and engineers teams from different backgrounds for the study, design, construction and rehabilitation of major infrastructures and for the solution of many geoenvironmental problems is illustrated. These disciplines are taught today in University undergraduate courses in Civil Engineering, Geological Engineering and Geology and graduate courses are tending to be jointly attended by professionals coming from these three branches. The Bologna Declaration introduced significant modifications in University education and most European countries have already adjusted their education systems to its requirements. Based on some principles of this declaration, perspectives are presented concerning future education and training in geoengineering.

Key words: geo-engineering, teaching, training and professional practice.

1. Introduction and Background

When Civil Engineering courses were established as a result of the separation from military engineering, in the end of the 19th century, students were taught very little on the properties and behaviour of the ground and, in general, related only to foundations in soft ground (soils). Problems associated with tunnel, canal and railway construction and embankments were solved most times without scientific inputs and mainly based on engineering experience.

In that very beginning, Soil Mechanics did not exist as a science yet and its establishment was mainly due to the work developed by Karl Terzaghi. He recognized in the 20's the need for the establishment of principles and theories which could explain the behaviour of the soft ground. His book "Erdbaumechanik auf Bodenphysikalischer Grundlage" (Terzaghi, 1925) is clearly a landmark of what encompasses today the geoengineering activity.

His views at the time can be considered today as prophetic, since they addressed the subjects of the mechanical and the hydraulic behaviour of the ground (soils and also rocks) based on a correct description of the geological conditions and definition of the soil intrinsic properties.

In his paper "Effect of Minor Geologic Details on the Safety of Dams" (Terzaghi, 1929), published almost 80 years ago, he wrote "to avoid the shortcomings associated with present practice requires first of all expert translation of the findings of the geologist into physical and mechanical terms. Next it requires the evaluation of the most unfavourable mechanical possibilities which would be expected under the existing geologic conditions; and finally to assume for the design of the structure the most unfavourable possibilities. These mental operations represent by far the most important, most difficult and most neglected tasks in the field of dam foundations".

Later, many other eminent authors also recognized the need for a proper contribution of Geology in the understanding of the properties and behaviour of soils and rock masses but, as Manuel Rocha stated in 1952 (Rocha, 1952) "Given the complexity of geologic formations it is, in general, indispensable that geologists collaborate in the site investigations of soils, their main role being the definition of the soil structure (attitude, thickness and consistency of the layers, ground water, discontinuities, etc). Only having that information available, it is possible to establish a program for the quantitative determination of the properties of the soils aiming at significant results to be used, having in mind the need to reduce costs and delays with the site investigations. The most convenient education of such geologists is not a classic naturalistic formation but it must be an education based on physics and chemistry".

However, at that time, the Geology courses were essentially devoted to the naturalistic aspects of the Geology preparing scientists for research activities in palaeontology, mineralogy, petrography, geomorphology and geological mapping of outcrops and some excavations. Very little information was given in mathematics, physics and chemistry and no engineering background was supplied to the Geology students.

As the technical requirements increased and as the interaction of the structures with the ground were more relevant, the need for geological information grew and education on basic geology for civil engineers started as well as

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the cooperation of geologists supplying geologic data relevant for the assessment of the ground behaviour of large projects.

One can say that the first half of the 20th century is the period in which the need for geological input in the large projects has been recognized as indispensable and that professionals with the skill to bridge geology and engineering were lacking.

Civil Engineers had then one or two semester courses in Geology (Geology for Engineers), in most cases of very little use, the main subjects taught being mineralogy, petrography, palaeontology, geomorphology, hydrogeology, etc. The lack of engineering flavour of the geology teaching staff was responsible for the divorce between the subjects taught and their contribution to the solution of engineering problems.

By the fifties, the concept of Applied Geology developed and, then, an effort was made to understand from the geological side what was really relevant to the engineering projects and problems as geological information and how to use site investigations properly.

This recognition had two consequences. Geology for Engineers, a course for Civil Engineering graduates, adjusted its content in order to call the attention of students to the role of geological properties and parameters (lithology, structure, hydrogeology, geomorphology, seismicity, etc) in the definition of the geological models of the ground and of their importance in the stability analysis of civil engineering structures.

Geology students were, at the same time, instructed in the interaction between civil engineering activity and the ground and some courses (first free courses) were given on applications of geological knowledge to the solution of engineering problems and to the design of engineering structures.

Text books by Kryrine and Judd (1957), Goguel (1959), Desio (1959) and Legget (1962) clearly mark that period and helped very much engineers and geologists to learn to work together and to create an atmosphere of reciprocal respect.

These books have been used all over the world as support of many courses (mainly graduate short and long courses) and for self instructions of professionals from both backgrounds.

During the 60's, 30 years after Soil Mechanics was scientifically established, Engineering Geology emerged as a new discipline in the field of Geotechnics and the same happened with Rock Mechanics. By the end of that decade it became accepted that Geotechnics, as a branch of Engineering, embraced Soil Mechanics, Rock Mechanics and Engineering Geology (Fig. 1).

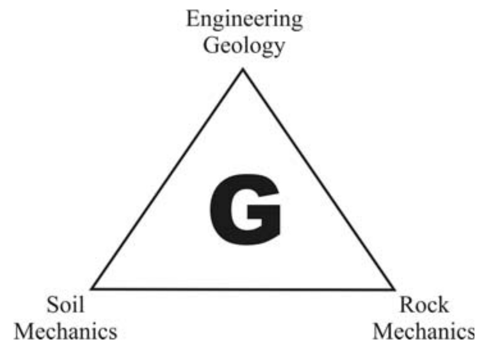

Figure 1 - Geotechnics and embraced sciences.

The main factors which have contributed for the "separation" of these disciplines from Soil Mechanics were, on the one hand, the increasing interference of the civil engineering structures with the ground (large excavations, longer and wider tunnels, high embankments on soft ground, large dams, etc.) and, on the other hand, some tragic accidents and natural disasters from which resulted large losses of lives and property.

The stability analysis of rock masses could not be assessed with the same approaches and analysis as for soil masses since their geotechnical behaviour was very much dependent on the discontinuities of the ground and much less on the properties of the rock material.

All those issues proved to be indispensable a more accurate assessment of the ground properties at surface and in depth, this requiring the development of more sophisticated site investigation techniques (geophysical and mechanical) and testing and the knowledge to conduct the interpretation of the results on the basis of the geological model and of the engineering requirements.

As a result of the worldwide recognition of the importance of these two new geotechnical disciplines, international learning societies have been established still in the 60's.

The first ISRM Congress was organized in Lisbon (Portugal) in 1966 and the first IAEG Congress was organized in Paris (France) in 1970 by the National Groups of the respective International Societies.

A Permanent Coordinating Secretariat for the activities of the three Societies has been established in Brussels in 1972 and since then efforts have been made by many people to strengthen the relationship of the Societies ("sister Societies") and of their members, all together promoting the essential and indispensable role of Geotechnics in the sustainable development of the world.

The next step was the introduction of Rock Mechanics and Engineering Geology regular courses in the Civil Engineering curricula and to introduce courses on principles of Soil Mechanics, Rock Mechanics and Engineering Geology in the Geology curricula.

This trend was followed in the most developped countries, namely in Europe and America and it was a most relevant contribution to the advance of Geotechnical Engineering.

Nevertheless, education and training in geoengineering sciences at undergraduate level proved to be not enough to supply geologists and engineers with the knowledge and experience required by the most sophisticated engineering problems and projects.

Academia, understanding the needs of Industry in this and other Engineering branches, adjusted their course structures and degrees and organized to offer graduate courses in different areas.

Graduate courses in Soil Mechanics, in Rock Mechanics and in Engineering Geology were successfully offered to engineers and geologists wishing to specialize in these fields.

The experience of the New University of Lisbon is an interesting example of such offer and it has been reported several times in the past. A paper describing this experience was submitted to the XI European Conference on Soil Mechanics and Foundation Engineering under the topic "The Interplay between Geotechnical Engineering and Engineering Geology" organized by the Danish Geotechnical Society in Copenhagen in May 1995, as a contribution for the discussion in Workshop 1: "Education Issues with Attention to the Professional and Commercial Implications". The paper entitled "Geotechnical education at graduate level. 18 years of experience at the New University of Lisbon (UNL), Portugal" describes the structure of the MSc Courses offered from 1975/76, one in Soil Mechanics and the other in Engineering Geology. Basically the contents of both courses overlap by 50% and, of those, about 20% correspond to Rock Mechanics subjects (Oliveira, 1995).

In the 80's many Universities offering Civil Engineering, Mining Engineering and Geology courses introduced a new undergraduate course in Geologic Engineering following the concept originated in USA with the purpose of reaching a compromise between an engineering education and the geologic content, increasing the number of engineering subjects (mechanics of materials, hydraulics, computer science, etc), reducing the number of the more naturalistic geologic topics and introducing more applied geology.

Furthermore, being an engineering course, the Geologic Engineers were registered as Professional Engineers whenever the course was accredited.

2. The Growing Importance of the Environment

Since long, geoscientists and engineers had to deal with environmental problems, namely natural hazards, like landslides and river and coastal erosion. Books by Varnes (1958), Zaruba & Mencl (1969) and others were devoted to landslides and their control.

In general, men were suffering the consequences of natural disasters, their impacts being loss of lives and property.

As a result of the activity of men, on the one hand, and of the growing and concentration of population in cities (some megacities), on the other hand, the environmental issue turned into one of the most serious problems of the world (Oliveira, 2000).

From the geoengineering point of view, the impacts caused by the construction of large structures and the unappropriate land use required detailed studies of the geologic formations and engineering solutions for their mitigation.

Problems like ground and groundwater pollution, waste disposal, extraction of natural resources, re-use of by-products and others call for a strong support from the geotechnical side and require a continuous interplay between the geoengineering sciences.

The importance of these problems to the control and preservation of the environment was responsible for the development of a new subject, the Environmental Geotechnics.

The first International Conferences have been organized in 1994 in Edmonton (Canada) and in 1996 in Osaka (Japan). This was an initiative of the ISSMGE as a result of the work of its TC 5 on Environmental Geotechnics. In the third Congress organized in Lisbon (Portugal) in 1998 a workshop on "Education in Environmental Geotechnics" was part of the program.

In 1997 the Greek National Group of IAEG organized an "International Symposium on Engineering Geology and the Environment" Theme 9 being devoted to "Environmental courses in geological and geotechnical education". Two of the special lectures of the Symposium were also devoted to education: "Teaching environmental subjects in engineering geological education" (Oliveira, 1997) and "Environmental geology courses within university education" (Rosenbaum, 1997).

All the mentioned subjects related to the environmental protection and to the mitigation and remediation of the effects of engineering construction on the environment call for a close cooperation between Soil Mechanics, Rock Mechanics and Engineering Geology as well as of many other disciplines, and they have been addressed since long by technical commissions established by the three sister societies.

3. Definitions and Boundaries

As said before, Soil Mechanics has been established as a science in the early 30's having its first International Congress in Harvard in 1936, when the International Society of Soil Mechanics and Foundation Engineering was originated. In 1997 the name has been changed to International Society of Soil Mechanics and Geotechnical Engineering to reflect more accurately the activities of the Society.

In the last version of the statutes (Osaka 2006), the aim of the ISSMGE is the promotion of international cooperation amongst engineers and scientists for the advancement of knowledge in the field of geotechnics and its engineering and environmental applications.

The statutes of the ISRM in their 1999 version show some more detail in the definition of the Rock Mechanics field of activity as a science: "Rock Mechanics includes all the studies relative to the physical and mechanical behaviour of rocks and rock masses and the application of this knowledge for the better understanding of geological processes and in the fields of Engineering".

As for IAEG, the last version of the statutes (1992) includes the definition of Engineering Geology as "a science devoted to the investigation, study and solution of engineering and environmental problems which may arise as the result of the interaction between geology and the works and activities of man as well as to the prediction of and the development of measures for prevention or remediation of geologic hazards. Engineering Geology embraces: the definition of the geomorphology, structure, stratigraphy, lithology and groundwater conditions of geological formations; the characterisation of the mineralogical, physicogeomechanical, chemical and hydraulic properties of all earth materials involved in construction, resource recovery and environment change; the assessment of the mechanical and hydrologic behaviour of soil and rock masses; the prediction of changes to the above properties with time; the determination of the parameters to be considered in the stability analysis of engineering works and earth masses; and the improvement and maintenance of the environmental condition and of the properties of the terrain".

Although the detail of the definition of the aim of the three disciplines is quite different, it is clear that there is a significant (and healthy) overlapping between the activities of each of them.

This said, one can state that it is not possible to draw sharp boundaries between Soil Mechanics and Rock Mechanics, between Soil Mechanics and Engineering Geology and between Rock Mechanics and Engineering Geology.

In other words, a specialist in Soil Mechanics has to be instructed to some extent also in Rock Mechanics and in Engineering Geology, another in Rock Mechanics has to be instructed to some extent also in Soil Mechanics and Engineering Geology and another in Engineering Geology has to be instructed to some extent in Soil Mechanics and in Rock Mechanics.

The experience of conducting research in geoengineering subjects and of coordinating large engineering projects proves that in most cases the engineering teams include professionals from different backgrounds and that many activities and decisions have to be jointly discussed and agreed.

However, it seems beneficial to the required interplay to identify the relevant activities which should preferably fall under the responsibility of each group. In a paper presented to a Rock Mechanics symposium more then twenty years ago (Oliveira, 1986) the author presented his views as concerns the "border zone" between Engineering Geology and Rock Mechanics and introduced a methodology for the study of rock masses related to large engineering structures (dams, tunnels, slopes, etc.) which is still followed, in general, today.

It seems clear that Engineering Geology should be responsible for the geologic reconnaissance of the ground and for the definition of the site investigations program. This implies the knowledge of the geophysical and mechanical methods which have to be used in each case, including the relevant in situ tests, namely those performed inside boreholes, as well as how to collect representative samples for laboratory tests. It is the case of permeability tests, dilatometer and pressiometer tests, seismic tests, integral sampling, logging, etc.

The joint interpretation of all the data from these activities, provided they are spread throughout the rock mass and their number allows some statistical analysis, will conduct to the *geotechnical zoning* of the rock mass, each zone being defined on the basis of the geologic conditions and on the values obtained for the relevant parameters. This would be, in most cases, the geotechnical information required for the basic design.

For the final design, some more detailed information may be required, based on a small number of more time consuming and expensive tests, for the detailed stability analysis of the engineering works. These would be best of the responsibility of a specialist in Rock Mechanics since they are very much related to the numerical models which will be used in the analysis, this being clearly a Rock Mechanics task.

A similar approach could be followed for the tentative definition of the boundaries between Soil Mechanics and Engineering Geology.

Soil Mechanics and Rock Mechanics have in common the responsibility of conducting the stability analysis of the ground (and ground / structure) through appropriate numerical models and the design of the solutions which best fit the ground properties and the stability of engineering works.

As said before, the reason for the development of Rock Mechanics as an independent science relies on the fact that the behaviour of soil masses depends in general on the soil properties (physical, mechanical and hydraulic) and the behaviour of rock masses depends much more on the structure of the geologic formations and on the properties of the discontinuities (geometric, mechanical and hydraulic).

There is a wide shadow zone occupied by the weak (soft) rocks / indurate soils, whose behaviour does not fall necessarily in either pattern and they require new laws to explain their rheologic performance. This has been clearly acknowledged about 30 years ago and weak rocks have been subject to specific studies since then and the results reported in many international conferences.

Being a subject of common geoengineering interest a Joint Technical Committee has been recently established, JTC 7 (Soft Rocks and Indurated Soils) which continued the work of other committees set up by each of the Societies years ago.

4. Education and Training

4.1. The role of the international societies

The three Societies have always been concerned with the development of their sciences, being aware that this is very much dependent on education (teaching at different levels) and training.

In general, teaching is best obtained in universities (short specialized courses also in research institutes), and training is best obtained by practice.

This explains the fact that the three Societies have established from their very beginning commissions and working groups to deal with this question and have introduced this subject as themes and workshops of Congresses, Symposia and other Conferences.

A brief reference is made in this lecture only to the Commissions on Education of each Society.

The IAEG appointed a Commission on "Teaching and Training in Engineering Geology" at the time of its 1st Congress in Paris in 1970. This Commission submitted its final report for publication in the Bulletin of the IAEG, after approval by the Council in 1978 (Dearman & Oliveira, 1978).

The report contained suggestions both for:

a) a 4 year undergraduate course on engineering geology.

b) a 1 year graduate course (MSc type) on engineering Geology.

Those suggestions were based on the concept expressed in the report that "the education of engineering geologists has to take into account the need for a good geological background and, at the same time, a knowledge of disciplines dealing with ground properties and an understanding of the behaviour of engineering structures; besides, it is of paramount importance that engineering geologists should have contact with actual engineering works as an essential part of their training".

The syllabus for the undergraduate course and for the graduate course were presented. At that time no concern about the environment was expressed in the proposal, since no geoenvironmental course or subject was mentioned in the report.

The training, preferably in industry, would result from a probation period of one to three years during which the engineering geologist should acquire experience on many facets of the profession.

After publication of this report the Commission was dorment for about 20 years and a new Commission on Teaching and Training in Engineering Geology was established in 1998. It was agreed that the new Commission should include Environmental issues within its remit and should update the report published by the previous Commission in 1978. Furthermore it should prepare a compilation of case histories illustrating savings obtained by using engineering geologists.

The Commission did not continue the work and no document was further produced.

The ISRM established a Commission in Teaching of Rock Mechanics in 1978 which published a Report in the International Journal of Rock Mechanics and Mining Science (ISRM, 1983). The Report contains a statement on the status of, and requirement for, rock mechanics education throughout the world made on the basis of data collected by means of a questionnaire circulated to Universities and other institutions in 1978 and 1979. On the basis of the data analysed, the Commission reached a number of conclusions and made recommendations for future action.

Apart from this, the Report contains a list of text books used in Rock Mechanics courses by the institutions which replied to the questionnaire. The most used are the well known books by (Stagg & Zienkiewicz, 1968), (Coates, 1970), (Jager & Cook, 1976), (Hoek & Bray, 1977), (Obert & Duvall, 1978) and (Goodman, 1980). No mention is made to the first Rock Mechanics text book by Talobre, published in French in 1956 (Talobre, 1956). After some years, the ISRM appointed a new Commission on Education in 1988 which was active until 1999, having presented then a Report in Paris. This report includes: a list of universities and colleges involved in teaching and research in Rock Mechanics, containing 540 entries from 83 countries; a Geotechnical Curriculum Guide; Bibliography of books, journals and videotapes; Educational videotape collection related to several engineering subjects; Educational software collection comprising a set of computer programs. Furthermore, the Commission reported on several initiatives to be continued like the Conference Travel Aid, the 1st ISRM Lecture Tour in China, Education in Numerical Methods for Geo-Engineering and Student Mobility.

For some years all that information was made available to those interested at the home page of the ISRM Commission on Education, namely the Geotechnical Curriculum Guide.

The ISSMFE created a Task Force on Education in Geotechnics in 1990 in co-operative effort with the sister Societies. These efforts continued with the set up of the Technical Committee (TC) 31 in 1994 on Education in Geotechnical Engineering. Since then the topic of education has been discussed in Several ISSMGE Conferences (some already mentioned in this paper). During the XIII ECSMGE, held in Prague, in 2003, a workshop was organized by TC 31 where several issues related to the Bologna Declaration and the changes in academic curriculae were discussed. Apparently this was the last activity of TC 31.

It is clear from the above considerations that Education has always been a major issue for the three sister Societies.

As a result of the increasing cooperation between them a joint Technical Committee (JTC 3) on Education and Training has been established in 2005, to function in accordance with guidelines defined by the Presidents of ISSMGE, ISRM and IAEG.

This Committee met twice in 2006 (Nottingham and Singapore) ant twice in 2007 (Lisbon and Madrid) and it is scheduled to meet in this Conference, in Constantza.

4.2. Training and professional practice

As said before, Education and Training have always been a matter of concern of the geoengineering Societies.

Mention has also been made that Training is best obtained by professional practice and that this training is best succeeded when there is interplay between Engineering Geology and Geotechnical Engineering. As a consequence of this evidence, a joint Technical Committee on "Professional Practice" (JTC 4) has been established by the three sister societies, following the formation of an European Working Group in 2002 for the definition of professional tasks, responsibilities and co-operation in Ground Engineering. This joint European Working Group presented a first report of its activities during the 1st EUROENGEO held in Liège in 2004 dealing with some points of the Terms of Reference which have been agred by the Working Group (Bock *et al.*, 2004).

At that European Conference other contributions on this subject were presented namely the papers from Katzenbach "Some basic considerations about the necessities and possibilities of cooperation between Civil Engineer and Engineering Geologists", from Norbury "Current issues relating the professional practice of Engineering Geology in Europe", and from de Freitas "The necessity of combining geologists and engineers for field work in the practice of Geotechnics".

The evidence of some professional practice is required in many European countries and countries from other continents as a condition to register as member of Associations of Chartered Engineers or Geologists, trying this way to assure the competence of the professionals. Field work, preferably carried out by joint teams (geotechnical engineers and engineering geologists) is considered as an indispensable activity to really put in evidence their skill as practitioners of geoengineering.

4.3. Perspectives

Along the years changes have been introduced in the syllabus of engineering and geological courses in order to progressively adapt them to the needs of the society. Concerning Geoengineering courses this is true for Civil Engineering, Geological Engineering, Mining Engineering and Geology.

In spite of the desire to have similar curricula and duration for each course in most countries of the world, the situation is still very different from region to region, from country to country and even from university to university in the same country.

The globalization of the economy and the mobility of scientists and engineers really call for an effort in the sense that the higher education and training received in school prepare geoengineering professionals as levelled as possible but as well that the level of such higher education satisfy the increasing demands on quality related to the development of the society.

At this point it is important to introduce the Bologna Declaration on European Higher Education signed by 29 countries in June 1999, aiming at the shaping of a higher education system similar in all those countries.

A paper by Seco e Pinto (2007) addresses several aspects of the Declaration and consequences of its application in Europe.

The new system is already operative in most countries and it has been applied in each country to the majority of public and private higher education institutions (Universities and Politechnical Institutes).

For the purpose of this lecture, the paper covers the following simplified version:

a) University Courses

b) Geoengineering formation in Civil Engineering, Geological Engineering and Geology

c) Full program of 3 cycles, the first degree (BSc) after 6 semesters, the second degree (MSc) after 4 more semesters and a third cycle of two semesters providing a diploma of advanced (specialized) studies and being a part of a PhD program for those so wishing.

The first cycle of university courses, corresponding to 6 semesters and 180 ECTS, provides the student basically with a solid scientific background (propedeutic courses) but it is short in geological and geotechnical information. This is a reason why their registration in professional associations is problematic, this issue being discussed now in the framework of European institutions.

In the second cycle, corresponding to 4 semesters and 120 ECTS, the education is oriented to more applied syllabus. Some universities offer specialized branches in this second cycle.

In the case of Civil Engineering and Geological Engineering courses, branches on Geotechnics are offered in several universities.

In the case of Geology, a branch in Applied Geology is offered in some universities and a branch in Engineering Geology in others.

These branches correspond to the last year of the cycle (9th and 10th semester of the MSc).

More specialized geoengineering education is only possible through studies offered in the third cycle as advanced post-graduate or specialized courses, with the duration of 2 semesters as said before. Courses on Geotechnics for Civil Engineering and on Engineering Geology are examples of advanced education.

These courses should preferably be followed by professionals already with some years of training in industry or research under the format of continuous education.

In this case, Civil Engineers, Geologic Engineers and Geologists may attend either course, their option depending on their MSc background and on the practical experience acquired.

The first cycle of engineering courses (Civil and Geological) must include at least one semester course in Geology for Engineers and another in Soil Mechanics.

Engineering Geology, Rock Mechanics and Applied Geoengineering courses (like Underground Construction, Earth Works, Retaining Structures, Foundations, etc.) have to be addressed in the second cycle.

The first cycle of Geology courses should offer semester introductory courses on Engineering Geology, Soil Mechanics and Rock Mechanics in the third year (5^{th} and 6^{th} semester). Applied geoengineering subjects related to natural resources, natural hazards, groundwater, environment, construction, etc are generally provided only in the last year of the second cycle (9^{th} and 10^{th} semester).

It is not the objective of this lecture to detail more as regards future orientation of the geoengineering education system or curricula.

However, the author would like to emphasise some topics which should be included in courses available in the second cycle and in the third cycle, taking into account their importance for the development of the geoengineering activities as they contribute to highlight the role of Geotechnics in the solution of many engineering and environmental problems.

Considerations about natural resources to be used as construction materials, geologic hazards (landslides, subsidence, erosion, earthquakes, volcanoes), impacts caused by engineering works (dams, railways, highways, canals, tunnels), waste disposal, and pollution of soils, rock masses and groundwater should be introduced to engineering students, since the problems associated with these subjects tend to increase as the societies develop.

Furthermore, risk analysis, safety, monitoring and quality control are some concepts which have to be present in the advanced education of geoengineers and scientists as they contribute to make easier the desirable interplay between professionals from both backgrounds and give more responsibility and credibility to their activity.

It is hoped that the work of the Committee JTC 3 will continue to follow the guidelines which have been established in November 2005 and keep monitoring the results of the new education system through enquiries to universities, to employees and to the students.

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