

Geotechnical Engineering Education (GEE) Time Capsule Report by the Geo-Engineering Education Technical Committee TC306

SUMMARY

TC306's Time Capsule report first sets as a suitable start of the **systematic study of Geotechnical Engineering Education** the Nash Lecture (and accompanying paper) delivered by Prof. John Burland in 1987. It then goes back in time to review the beginnings of **teaching geotechnical engineering** (mainly in the national appendices) and then goes on to highlight some key activities and initiatives for building a **Geotechnical Engineering Education community** that can sustain the systematic study of Geotechnical Engineering Education.

1. A FRAMEWORK FOR THE REPORT: DISTINCTION BETWEEN TEACHING AND SYSTEMATIC STUDY OF TEACHING

With few exceptions of correct written predictions of the future, humans do something for some time before they teach it and write about it, i.e. before they start studying and recording systematically what it is they do. The goal of this brief report is to document some indicative beginnings of teaching geotechnical engineering, some early, isolated instances of systematic studying of this teaching, as well as more recent contributions in the last few decades. This documentation is viewed as an opportunity to set the stage for building a Geotechnical Engineering Education (GEE) community, which is a prerequisite for sustaining systematic contributions to Geotechnical Engineering Education.

If we were to pick a single landmark event as the start of the systematic study of Geotechnical Engineering Education, this would be the publication of "The teaching of soil mechanics: a personal view" by Prof. John Burland in 1987 (Nash Lecture, 9th ECSMFE, Dublin). In this seminal paper, Burland (1987) asserts that the teacher needs to "focus on key topics and those areas which experience has shown usually give students trouble". With this phrase, Burland (1987) identifies two important components of the systematic study of Education: (a) identify and record students' misconceptions (as we would now say using terminology from research on Education) on key topics and (b) create educational material to remedy misconceptions and elucidate key topics. Professor Burland's vision guides TC306 efforts to coordinate and disseminate contributions that enrich the toolbox of geotechnical engineering instructors.

Early courses on Soil Mechanics & Geotechnical Engineering are reported to be taught in the 1930s (see National Appendices). If we were to elect a specific start date, a suitable beginning could be the year of 1925, when MIT offered an appointment to Karl Terzaghi in order to develop a postgraduate course in Foundations and Soil Mechanics (Goodman, 1998). The early founders of Geotechnical Engineering wrote about aspects of Geotechnical Engineering Education they felt strongly about. For example, Terzaghi (1961) wrote about the importance of Engineering Geology, not only in Rock Mechanics (as is the norm nowadays) but also in Soil Mechanics, or "Earthwork Engineering", as he refers to it in order to distinguish it from "Rock Engineering". Similarly, Ralph Peck often spoke and wrote about the importance of using case studies in Geotechnical Engineering Education, e.g. Peck & Ireland (1974).

2. SYSTEMATIC STUDY OF GEOTECHNICAL ENGINEERING EDUCATION – SCHOLARSHIP OF TEACHING – RESEARCH ON GEOTECHNICAL ENGINEERING EDUCATION

2.1 Burland's 1987 Nash Lecture

As already mentioned, Burland (1987) draws our attention to topics problematic to students and groups them in four aspects unique to Soil Mechanics, presented pictorially at the apices of a triangle, with the fourth in the center of the triangle. The three apices are (1) the Ground Profile (difficulty: characterize soil properly), (2) Soil Behavior (difficulty: needs to be understood through laboratory and field testing) and (3) Applied Mechanics –or Appropriate Model, in a more recent version of the triangle (Burland, 2008)– (difficulty: create appropriate idealization while remaining true to soil behavior). At the center of this geotechnical triangle lies the most challenging (to teachers and students alike) (4) the need to take into account precedent, empiricism and “well-winnowed” experience. Burland’s thesis is that students need to be exposed to all four aspects (a tall order and an inspiring vision). Another notable feature of the paper is the description of several teaching aids that demonstrate key aspects of soil behavior, some of which are now available as a suite of five short videos under the title “[Bare Essentials of Soil Mechanics](#)”.

2.2 Computer-based education activities in the 1990s (UK, Australia)

As the use of computers became mainstream, the development of computer-based education material was made possible through funding agencies and universities in the 1990s. In the UK, higher education funding bodies supported the development of a suite of computer-based applications that became known under the name “Geotechnical Computer Aided Learning” (GeotechniCAL). The GeotechniCAL applications were disseminated through the meetings of Teachers of Geotechnical Subjects in the UK during the same decade and through conference papers. [Burland (1987) reports that these regular meetings of the teachers of geotechnics started in 1975 and appear to have continued until at least the end of the 1990s.] During the same period, geotechnical engineering staff at the University of Adelaide in Australia developed their suite of applications under the name “Computer Aided Teaching in Geotechnical Engineering” (CATIGE). Jaksa et al. (2000) report on the GeotechniCAL and CATIGE applications, together with other computer-based education products available at the time and Jaksa et al. (2009) provide an update almost a decade later on computer-based education using the more recent term: E-learning.

2.3 Emergence of engineering education research in the 1990s (USA)

Also in the 1990s, the National Science Foundation in the USA provided significant funding for Engineering Education, supporting thus the consolidation of engineering education research as a distinct research area. The relationship between teaching and research on education can be described by a spectrum proposed in the literature of engineering education research (Borrego et al., 2008) that includes: (1) basic teaching, (2) scholarly teaching that goes beyond good content and teaching methods (it also involves classroom assessment and evidence gathering informed by best practice, encourages collaboration and review), (3) scholarship of teaching that is public, open to critique and evaluation, and results in products that others can use and build on (it also involves inquiry and investigation, focusing particularly on student learning) and (4) research on Engineering Education, which shares the characteristics of scientific inquiry (i.e. it poses research questions, interprets the results in light of theory and pays attention to the design of the study and the methods used). Links are being gradually established between the two communities, as evidenced by (a) the papers published by geotechnical engineering faculty in engineering education conferences (e.g. see

item 2.7) and (b) the invited speakers from the education research and the engineering education research communities at the TC306 conferences since 2012.

2.4 ISSMGE establishes a technical committee for Education in 1994

In 1989, the ISSMGE formed a task force on Education, which recommended the establishment of a permanent committee (Magnan, 2001). The Technical Committee on Education in Geotechnical Engineering, TC31, was established in 1994 and its first chair was Harry Poulos (Australia). During a brief period (2006-2009), TC31 merged with the respective education committees of the Int. Soc. of Rock Mechanics (ISRM) and of the Int. Assoc. of Engineering Geology (IAEG), before it was reinstated in 2009 as the ISSMGE committee for Geo-engineering education, TC306.

2.5 First international conference on Geotechnical Engineering Education (GEE) in 2000

As part of the TC31 activities, the first international conference on Geotechnical Engineering Education and Training took place in 2000 in Sinaia, Romania, chaired by the late Prof. Iacint Manoliu. Since then, theme sessions on Geotechnical Engineering Education appear in national and regional conferences. Eight years later, Prof. Manoliu organized a second international conference in Constantza, Romania, under the name “1st International Conference on Education and Training in Geo-engineering Sciences” (as already mentioned, at that time, the education committees of ISSMGE, ISRM and IAEG had merged). Since 2008, conferences have been organized every four years (2012, 2016, 2020) and their proceedings are available through the ISSMGE online library ([Database: TC306 Conferences on Education](#)).

2.6 USUCGER establishes a committee for Geotechnical Engineering Education in 2003

The USUCGER stands for “United States Universities Council on Geotechnical Education and Research” and was founded in 1985. The “E” in the acronym initially stood for “Engineering”, until it was changed to “Education” in 2003, when a dedicated USUCGER Education Committee was established. USUCGER offers small grants for development of educational materials, organizes workshops on teaching strategies and resources and its website houses a repository of [teaching resources](#).

2.7 Publication venues for papers on Geotechnical Engineering Education

The publication venues of the GEE papers referenced in this report underscore the lack of a dedicated forum for papers on Geotechnical Engineering Education, which results in fragmentation of efforts and often in failure to acknowledge related past work. To partly remedy this situation, this report lists some key sources.

- As already mentioned, the proceedings of the 2008, 2012, 2016 and 2020 conferences are open access and available through the platform of the ISSMGE online library ([Database: TC306 Conferences on Education](#)), which is searchable by author and topic.
- The annual conferences of the American Society for Engineering Education (ASEE) are popular with US geotechnical engineering faculty. The papers of the ASEE conferences are open access and available through the ASEE website (<https://peer.asee.org/>). A 2019 search with keywords “geotechnical” and “soil” returned 37 and 14 papers, respectively.
- TC306 was involved in guest editing one theme section on “Geotechnical Engineering Education” in the European Journal of Engineering Education ([2013](#)) and one theme issue on “Case studies developed for geotechnical engineering instruction” in the International Journal of Geoengineering Case Histories” ([2016](#)).

3. BUILDING A GEOTECHNICAL ENGINEERING EDUCATION COMMUNITY

The most recent conference organized by TC306, Geotechnical Engineering Education 2020 (GEE2020), included a panel discussion on the topic "[Building a community of scholarly education practice](#)". Panelists were asked to give examples or comment on existing, past or desired structures & initiatives for community building, such as permanent structures (e.g. geotechnical engineering education committees), special events (e.g. workshops for geotechnical engineering instructors), repositories of teaching resources, contacts with Teaching and Learning Centers and contacts with the Industry. Panelists focused mostly on free teaching resources available through suitable repositories and teaching workshops for faculty members. Panelists also recommended the approach of involving people through small-scale projects. Given the international reach of TC306, appropriate aims would be to coordinate such efforts, participate in them and help publicize them. A larger-scale goal for TC306 would be to become a focal point for such activities.

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This Time Capsule Report of the Geo-engineering Education Committee, TC306, was finalized in April 2022 by Marina Pantazidou, who also edited the national appendices.

NATIONAL APPENDICES CONTRIBUTED BY TC306 MEMBERS

Argentina: contribution by **Virginia Sosa**

Towards the end of the 1940s, a small but enthusiastic group of local specialists decided to create the Argentine Society of Soil Mechanics, today called Argentine Society of Geotechnical Engineering (SAIG). The first decade, 1950, was a period of generalized diffusion, where the expansion of formal teaching took place in the main Civil Engineering Schools of the country, Buenos Aires, Córdoba, La Plata, Rosario, Tucumán, San Juan, among others. During the 1990s, there has been a qualitative improvement in postgraduate education, with the implementation of master's and doctoral programs in the main universities such as Buenos Aires, Córdoba, La Plata, Rosario, and Tucumán.

Brazil: contribution by Katia Bicalho & Waldemar Hachich

Soil mechanics and geotechnical engineering education started in early 1940's in Brazil. The first regular and autonomous course of Soil Mechanics started in 1943 at the São Paulo State University. Prof. Odair Grillo, who was student of Casagrande (University of Harvard, USA) and attended courses with Karl Terzaghi in Viena, built the first soil mechanics laboratory at the Sao Paulo State Technological Research Institute (IPT) in late 1930's. Milton Vargas with Casemiro J. Munarski, Antônio Costa Nunes, Francisco Pacheco Silva and Antônio Nápoles Neto created the Brazilian Society for Soil Mechanics and Geotechnical Engineering (ABMS) in July, 1950. Milton Vargas was the first president of ABMS. Graduate degrees (MSc and PhD) started being awarded in the 1960s.

China: contribution by **Huabei Liu**

Soil mechanics and geotechnical engineering education started in late 1930's in China. Prof. Wenxi Huang, who obtained his PhD from University of Michigan, built the first soil mechanics laboratory and started the first soil mechanics class in 1937 at Central University (part of this university moved to Taiwan after 1949, and the remaining portion became the Nanjing University today in the Mainland). Shortly afterwards or approximately at the same time, Prof. Yisheng Mao (or Thomson Eason Mao), who got his Doctor of Engineering from Carnegie Institute of Technology, started teaching soil mechanics at Chiao Tung University. The first Chinese textbook on Soil Mechanics was not available until probably early 1940's at the National SouthWest Associated University written by a Prof. Yan. Most of the early Soil Mechanics classes made use of the English texts by Terzaghi and others.

Colombia: contribution by **Silvana Montoya-Noguera**

In Colombia, there are references to courses in Structural Geology, Subterraneous geometry and Tunneling as early as 1824 in the School of Mines (Escuela de Minas) founded by French engineers and scientists (Poveda-Ramos, 1985). Following national interests, engineering education focused initially in mining and civil engineering with courses in Applied Mathematics and Experimental Physics where most text books were from France and some from USA. On the Civil Engineering syllabus of the School of Mines of Medellín in 1937, four courses were taught in geology (including economical and practical geology) and other three courses with related content to soils (mining, railways and tunnels). However, the first syllabus that mentions a course in "Soil mechanics and foundations" dates from 1951, at the National University in Bogotá. It is worth noting that subjects of foundations and earthworks appear on thesis projects as early as 1945-1948. In another city, Manizales, the first course in "Soil mechanics" was taught in 1952 by the civil engineer Julio Robledo Isaza.

The first Colombian symposium in Geotechnics was held in 1968 and organized by geologist Juan Montero. Shortly after, in 1971, the Colombian geotechnical society was founded through the initiative of Juan Montero and with 15 geologists and civil engineers. Concerning geotechnical engineering education, in 1975, Juan Montero and other professors created a special committee for the revision and implementation of study programs in geotechnics in undergraduate and postgraduate degrees at the National University (CRIPEG).

Greece: contribution by **Marina Pantazidou**

At the oldest civil engineering department in Greece, at the National Technical University of Athens (NTUA), in 1935 there was one course on "stone/timber bridges, retaining walls and foundations" and in 1950 one second course on Soil Mechanics. At the second-oldest civil engineering department in Greece, which was established in 1955 at the Aristotle University of Thessaloniki (AUTH), Soil Mechanics started being taught systematically in 1965. In 1982, a geotechnical department (division) was established at NTUA and AUTH. In 1998, the graduate degree on Planning and Construction of Underground Works was established at NTUA (jointly by the Schools of Civil Engineering and Mining Engineering) and in 2004 a geotechnical specialization was added to the undergraduate civil engineering curriculum of NTUA. Currently, undergraduate curricula in all departments of civil engineering in Greece offer a geotechnical specialization.

Italy: contributions by **Michele Calvello & Riccardo Berardi**

In Italy, geotechnical engineering got a formal recognition in Academia, i.e. separate from other civil engineering disciplines, in 1938, when a "geotechnical research and study center" was founded at the University of Napoli (now Università di Napoli Federico II) by Prof. Arrigo Croce, and a "soil mechanics laboratory" was founded at the University of Roma (now Università di Roma La Sapienza) by Prof. Carlo Cestelli Guidi. It is interesting to note that Arrigo Croce graduated in "hydraulic" civil engineering, while Carlo Cestelli Guidi was a professor in "structural" civil engineering (and never became a "geotechnical" professor).

The first university book, called "Soil mechanics and stability of foundations" (in Italian: *Meccanica dei terreni e stabilità delle fondazioni*) was written by Carlo Cestelli Guidi and published in 1942 (Publisher: Hoepli, Milano). In the meantime, the second worldwide war was raging and Arrigo Croce spent 4 year in a prison camp in Kenya before returning to Naples, and academia, in 1945.

The Neapolitan geotechnical center at the University of Naples, directed by Arrigo Croce, can be considered the founding group of geotechnical engineering education in Italy (as testified also by the Italian honorary yearly lecture, aptly named "Croce lecture"). Although the first "geotechnical chair" in Italy (i.e. appointment as full professor in geotechnics) was granted to Arrigo Croce only in 1960, the first university course totally devoted to geotechnical engineering had already been established in the Academic Year 1955-1956. The course was called "Foundations and earthworks" (in Italian: *Tecnica delle fondazioni e costruzioni di terra*).

The first compulsory course for obtaining a degree in Civil Engineering in Italy was held at the University of Genoa by prof. Giorgio Berardi in the academic year 1959/60. It was titled Soil Mechanics. At the same University, the second-oldest academic geotechnical laboratory in Italy was established in 1958.

Moreover, in relation to the legislation on university courses, the first compulsory curriculum in Geotechnics (in Italy), as part of the Degree course in Civil Engineering, was established at the University of Genoa in the academic year 1990. Courses taught: Soil mechanics and

foundations, Engineering geology, Rock Mechanics, Foundations and earth-retaining structures, Environmental geotechnics.

Finally, concerning pioneering geotechnical research journals, the Italian one, edited by the Italian Geotechnical Association AGI, was also founded in Naples, in 1954, by Arrigo Croce, together with Felice Ippolito. It was initially called "Geotecnica", later "Rivista Italiana di Geotecnica" (from 1967). To consider the international context, the first issue of the Italian geotechnical journal was published later than "Géotechnique" (first issue in 1948) but earlier than the ASCE "Journal of the Geotechnical Engineering Division" (first issue in 1956), "Soils and Foundations" (first issue in 1961) and the "Canadian Geotechnical Journal" (first issue in 1963).

Japan: contribution by Toshifumi Mukunoki & Takeshi Katsumi

The oldest text book, in old-type Japanese, is "Design of earth pressure and retaining walls" written by Tokujorou Yoshida in 1918. Some Chinese characters are old type, so even Japanese people may not be able to read some Chinese characters "Kanji" smoothly. Fortunately, mathematical equations are global, hence readable.