Glimpses of GEOTECH-Year 2000

By

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Geotech Year 2000 centers around contributions from some 60 or so well-known experts in Geotechnical Engineering in the 21st Century. The contributions are unique and the authors are mostly in the age of 60 to 90 or so. Sir Alan Muir Wood, one of the authors and the Honorary President of the International Tunnelling Association, quotes Sir Harold Harding and said that *"The engineer must always be prepared to be surprised but never astonished"*. Sir Alan says his contribution to this Volume reflects his debt of gratitude to selected mentors, selected from many, who have shared their powers of observation and the distillation of their experience, concerning the practical behaviour of soils and rocks. They have emphasized the context in which each situation needs to be appraised as a part of geotechnical design. Among the mentors Sir Alan mentioned is Robert Legget, and Sir Alan describes Legget, a philosopher, historian, biographic, as well as an engineering geologist and a geotechnical engineer. Sir Alan then feels unhappy that he has lent and lost one product of that period, a published paper entitled *"On the noise level at cocktail parties"*. Sir Alan also narrates a cautionary tale for engineers concerning faith in politicians and the desirability of recording the basis of knowledge on which engineering decisions were made…this is a very useful repellant to the wise-after-the-event lawyer to whom, once the nature of the defect is explained, finds an error of judgement, prior to the event, so obviously impeachable, says Sir Alan. He also quotes his experience on the Channel Tunnel project. The title of contribution of Sir Alan is "The grittiness of soils, the structural complexities of rocks".

Prof. Akagi, a former Professor at AIT and another author, recalls that he has always considered it is good fortune to have in his possession something that must be regarded invaluable by members of the geotechnical community…it refers to an audio tape that records the voices of Terzaghi and Peck. Introduction by Ralph B. Peck, the living Legend in Civil Engineering and then the opening lecture on Engineering Geology by Karl Terzaghi at the Harvard University as recorded by Arthur Casagrande on February 4, 1957.

Prof. Jean Kerisel, a past-President of the International Society for Soil Mechanics and Foundation Engineering writes "Forty five centuries ago, Pharaohs had to deal with many of the problems relating with our specialty. They did it with success and it would be ungracious to criticize the few mistakes related hereafter when recently celebrated builders did not avoid the same errors". Egypt of the Pharaohs from Djoser (2,900 BC) to Cheops (2,500 BC) of Pyramid construction is the subject of the contribution by Prof. Jean Kerisel.

His lecture was presented when he received an Honorary Doctoral Degree from the University of Naples. Prof. Jean Kerisel says, it is for him a signal honour to be made a doctor honoris causa of one of the most ancient Universities of Europe, located in the capital city of Southern Italy, where he has had so much pleasure contributing to work on the construction of the major port near the shores of ancient Sibari. *"Dear Professor Viggiani, when you invited me to deliver this lecture, I was afraid you had not made the right choice. The "aging effect" improves the quality of clays not that of men:* moreover I am not especially at ease in a foreign language", says Prof. Kerisel. "Nevertheless, apart from the pleasure of encountering an old friend, I accepted this honour with the strong desire to join the homage being paid today to the memory of Professor Croce", said Prof.

Kerisel. Prof. Croce was his very good friend and he always appreciated Prof. Croce's courtesy as well as his culture: "*for Prof. Croce, a stone was not a silent mass but something telling him stories of very old monuments. He was a humanist like those great architects of the Quatro Cento," said Prof. Kerisel.*

Prof. Kerisel continues with *"No branch of archeology has received, in recent years, more attention from scholars than the study of pyramids.* Our learned Society and in particular, our T. C. 19 cannot disregard such studies because the builders of monuments as ponderous as those pyramids had to deal with many of the questions relating to our specialty and it is not without interest to find out how the ancient Egyptians solved them. *Already those who were present in Cairo had the privilege of listening to a very interesting lecture given by Dick Parry".* Prof. Kerisel gives the following description of Pyramids and the problems involved in their construction. "In very ancient times and still today the tomb is, under certain circumstances, a shallow grave hidden under a heap of stones. What were the differences introduced by the Egyptians for the burial of their Pharaohs? Of course, differences in mass and slopes; the volume of the Great Pyramid is no less than 2,500,000 m^3 and the slope of almost all pyramids greater than 52 degrees, but it would be a mistake to think that the internal structure was totally different from a heap of stones; the pyramid was not at all made of a superimposition of parallelepipeds; only a small proportions of the stones were hewn with accuracy. The other differences are related to the use of mortar and to the depth of the funeral chamber, sometimes deep, sometimes shallow. *"Finally, there were three main problems involved in their construction:*

1-*Soil bearing capacity*

2-*Slope stability*

3-*Funeral chamber stability"*

The conclusion of Prof. Kerisel is interesting and indicates his respect to our ancestors and their skills in Geotechnics. "*As you see, the ancient Égyptians had to cope with many problems relating to our science. Even though they did not entirely succeed in all their enterprises, we have to admire them for their boldness and their first empirical understanding of active pressure, bearing capacity of rocks or soils, and sliding friction.* Moreover, though the use of two different kinds of masonry led them to accidents, we must notice that the builders of romanesque and gothic monuments did not avoid the same errors. And in this country, the recent collapse of the civic tower of Pavia cathedral and probably, also that of the Bell tower of San Marco, were due to the coexistence side by side of two kinds of masonries. Moreover, if my information is correct, such a coexistence is not to make easier the Pisa tower problems. Therefore, it would be ungracious for us to criticize the few mistakes we notice in the very ancient Egypt; *moreover we may say that Vitruvius was not totally right when he traced the ancient wisdom in the art of construction back to the Greeks and Latins: As I try to show you, the very first source of that wisdom lies with the Pharaohs."*

Terzaghi had his own way of driving home a lesson, says Ralph B. Peck, who recalls that *"I learned this the hard way on a job some 13 years after my first experiences with him on the Chicago Subway and some four years after the appearance of Soil Mechanics in Engineering Practice…*I overlooked an important point on a project and he (Terzaghi) waited several years for an opportunity to drive home his dis-satisfaction with my performance".

Prof. Togrol in his article on the "Geotechnical problems of the Golden Horn – A historical perspective" writes, the following notes on Terzaghi: "During his period in Istanbul, Terzaghi had the opportunity to evaluate all the experiences of the past in perspective once more in the corners of his mind (Soydemir, 1973). It was a concentration of enormous intensity. Then came the day: one nice morning in March, 1919 – as he, many years later, told the incident to Dr. Bjerrum, *"...I was sitting in a mood of depression at an old, rustic coffee house overlooking the Golden Horn (Pierre Lotti Coffee House). I suddenly visualized what was needed to obtain a rational approach to the problem involved in earthwork and foundation engineering. I realized that the progress depended entirely on the development of testing equipment and methods which could give a quantitative measure of the mechanical properties of the soils involved.* On two sheets of paper, I listed a number of possible ways of testing soils and made sketches of the equipment needed." About the same incident, a year later Terzaghi wrote to Wittenbauer, "...at the beginning of March, 1919, *I listed on a single sheet of paper everything we needed to know about the physical properties of clay in order to be in a position to treat the fundamentals of earthwork engineering on a scientific basis.* My demand seemed excessive even to myself, and I doubted that I would live to see that all the questions are answered."

Along his basic research, in 1921, Terzaghi had a golden opportunity to be involved with an ideal project as a consulting foundation engineer. He wrote about this incident to Professor Peynircioglu in 1950, "... In 1921, it was in Istanbul, at the site of the steam power plant in Silahtar (situated at the estuary of the Golden Horn), where I had the first opportunity for a practical application of the fundamental principles set forth later in my writings. *For this reason, I always considered Istanbul as the birthplace of what I was able to contribute to the scientific development of earthwork engineering."* (Peynircioglu, 1973)."

Prof. Togrol says that the excessive settlements and foundation failures of the many structures from different times in the area provided with a rich database to understand their causes. His paper examines the foundation problems encountered for a seventeenth century mosque, an eighteenth century dry dock, two nineteenth century quay walls, a twentieth century building and a recently constructed bridge spanning the deep waters of the Golden Horn. According to Prof. Togrol the extra-ordinary foundation problems due to the thick alluvium along its shores, the Golden Horn of Istanbul has attracted the interest of engineers for ages. He added that the challenge of the problems of the soils has also inspired Karl Terzaghi to initiate his well-known experimental approach in the field of soil mechanics.

*Tiny air bubbles prevent seismic liquefaction…*Niigata Earthquake in 1964 is the subject of another Japanese veteran Shunta Shiraishi of Tashi Fudohsan Co., Ltd. Shunta Shiraishi writes *"Countless tiny air bubbles in ground water remain semi-permanently at the positions where they are first held in the clusters of soil grains and prevent seismic liquefaction of ground by lowering the saturation degree of ground water.* It was first recognized at Niigata Earthquake of 1964 that the ground of fine sand surrounding the pneumatic-caisson foundations of Bandai Bridge were not liquefied. A considerable amount of the compressed air leaked out of the pneumatic caissons when they had been built in 1927 remained in the ground water around the pneumatic caissons for 37 years since then, and prevented the liquefaction of the ground around the pneumatic caissons. The structures founded on 305 pneumatic caissons were not damaged beyond repair by the violent Hyogoken-Nambu Earthquake of 1995 where the maximum horizontal acceleration of ground movement was at the record high value of 818 gal. Conceptual inexpensive methods using small equipment for preventing seismic liquefaction of ground by lowering the saturation degree of ground water are proposed in place of the expensive methods using large equipment to compact the loose ground. Dr. Shiraishi acknowledge the following persons in his papers, Professor A. Asaoka of Nagoya University for his information quoted in his paper (1992), Dr. T. Asama of JPTA who compiled the report (1996), Dr. T. Sakai of Kiso Jiban Consultants, Inc. who helped RGRI (1987) for the author and Dr. Y. Yoshimi (1994) who was past-President of the Japanese Society of Geotechnical Engineering.

John A. Focht, Jr., another distinguished engineer and a past-President of the American Society of Civil Engineers, recall that *"Beginning my nine months at Harvard in 1946-1947, my career has been a fortunate series of solutions of challenging engineering problems carried out in an atmosphere of personal interaction leading to long-standing friendships and relationships*. He then says that his paper ties particular problem solutions to some of the individual respected, admired and credited for his professional growth and personal satisfaction for 50-plus years. "Recollections from 50-plus years of geotechnical practice or you can't do it alone", is the subject of the paper by John A. Focht, Jr.

He continues to write "The technical papers that have appeared in the ASCE Geotechnical Journal, Geotechnique, Canadian Geotechnical Journal, Geotechnical Conference Proceedings, and other publications have been the key elements in the dissemination of technical knowledge to our subdiscipline of geotechnical engineering within Civil Engineering. However, these papers are for the most part impersonal and essentially devoid of the human element. On the contrary, the current paper in Geotech Year 2000 was prepared to recognize a number of personalities who contributed significantly to his knowledge, growth, and opportunities, and to interject a little human interest into some of the technical problems and solutions described in his publications." A second theme in this paper is to emphasize that the team efforts are critical to the optimization of problem solutions. The team effort often involves the geotechnical participants as a subteam, always within the total project team of owners, designers, builders, and operators.

The human elements related to Terzaghi and Casagrande expressed fondly by Mr. John A. Focht, Jr., is "My introduction to geotechnical engineering (then soil mechanics) actually dates back nearly 60 years to my freshman year at the University of Texas at Austin in the spring of 1941. Dr. Karl Terzaghi gave a series of lectures there at the invitation of Prof. Raymond Dawson. Once a week, I sat in on his lectures following the strong recommendation of my father, Prof. John A. Focht, Sr. *I did not fully comprehend what I heard but I distinctly remember that his sketches on the blackboard were duplicates of the illustrations that would soon appear in the book, Theoretical Soil Mechanics.*

Further exposure of John A. Focht, Jr., to Dr. Terzaghi came in 1946-1947 while he attended the Harvard School of Soil Mechanics. He recalls "My nine months at Harvard included being crammed with technical guidance and instruction from Dr. Arthur Casagrande and Dr. Terzaghi as well as the development of lifelong friendships with many budding geotechnical engineers. The now well-known names I met at Harvard included Stan Wilson, George Sowers, Marty Kapp, and Hugh Sutherland. Others included Dick Loughney, Allan Osterberg, John Holman, Bruce Woolpert, Reinard Brandley, and Lionel Peckover."

"I was fortunate enough to be able to take a "reading" course under Arthur Casagrande. My assignment was to read all of the Harvard and MIT reports on the Shear Strength of Clay Research Program for the US Army Corps of Engineers and related papers. Then, once a week I
reported to Arthur what I had read and learned. *He* would respond with his opinions – not only on the technical contents of the reports and papers but also on the authors themselves."

On the Waterways Experiment Station, John A. Focht, Jr., writes, "*Good advice to a new graduate can have a major effect on his career.* Arthur Casagrande suggested early in 1947 that I apply for a position at the US Waterways Experiment Station (WES). I took his advice, accepted the offer that came from Vicksburg, and have been thankful ever since. The engineers there were all outstanding technically, individually helpful to the young engineers, and excellent role models both professionally and personally. They were Bill Turnbull, Stan Johnson, Woodie Shockley, and perhaps most important of all at that time, Charles Mansur, my immediate boss. Each of these men was an extremely proficient writer and editor, and taught me how to write a good technical report. Quality exploration and laboratory testing were trademarks of WES. Dr. Juul Hvorslev was the ultimate authority on exploration. Tommy Goode, head of the Exploration Section, put quality into practice and indoctrinated all of us who came through the Station with a commitment to an understanding of what constitutes quality and appropriate soil exploration. After I had been called back to active duty for the Korean War in 1950, Charles Mansur prepared a paper on the principal results for the ASCE Soils Journal and submitted it with me as a co-author. That paper, Mansur et. al., (1956) won the ASCE Middlebrooks Award for 1957."

John A. Focht, Jr., continues, "In Vicksburg I lived in the same boarding house with Dr. Juul Hvorslev, a most remarkable gentleman and *an* engineer. For several months, Juul took Wally Sherman (a classmate at Harvard) and I, to work since we were just out of school and in debt. He even offered his car for us to use on a date but neither of us took him up on his generous offer. Juul was an incessant cigarette smoker; I think more than Terzaghi, he carried on an immense correspondence with engineers all around the world and shared the technical content of some of his correspondence with us at meal time and in the car. Those conversations were an education in themselves. Three other young geotechnical engineers who ate at 2602 Drummond, were Bill Emrich, Bob Kaufman, and Bob Cunny. I returned from Korea in 1952 and worked at WES for about 8 months before we moved in April 1953 to Houston to join Greer & McClelland (soon to become McClelland Engineers, Inc.)"

On high rise buildings and deep basements, Mr. John A. Focht, Jr., remembers, "I had the opportunity to work with Phil Rutledge in 1958 on the First City National Bank in downtown Houston. To provide the owner with a second opinion, we suggested retaining

Mueser Rutledge to review our predictions. In our first meeting Phil asked, If we don't agree, whom shall we call in, Raymond Dawson?"

"Fazlur Khan was perhaps the most complete engineer I ever worked with on Shell Plaza. Faz was the chief structural engineer for such projects as the World Trade Center in New York and the John Hancock and Sears Towers in Chicago. But he was also effectively an architect and a pretty good foundation engineer. It was my good fortune to assist him on One and Two Shell Plazas in Houston beginning in 1960. His first assistant on these two projects, Joe Colaco, remained in Houston so we continued to work as a team on a number of subsequent major buildings. Pete Gemeinhardt was my able assistant on these and other projects."

With respect to Offshore Structures, John A. Focht, Jr., says, "In 1954, we had an opportunity to review and evaluate the results of a full-scale lateral pile load test performed in the Gulf of Mexico. *Our results published in McClelland et. al., (1958) were the beginning of the "p/y" technique for predicting the performance of laterally loaded piles.* That paper won the ASCE Laurie Prize in 1959. It also marked the beginning of my still continuing association with Lymon Reese and Hudson Matlock on a wide variety of offshore related problems. Their subsequent
tests and analytical studies done in the later 50's and 60's are still the foundation of laterally loaded pile predictions. Partial or complete overturning of a number of wellhead structures during a hurricane in the Gulf of Mexico led to a series of pullout tests in 1958 on piles installed into sand by a combination of procedures, sponsored by several oil companies. *The results were included in McClelland's Terzaghi lecture in McClelland (1974).*

Improvement in the prediction of the capacity of long piles in clay has been a major activity for me throughout my career. *The evolution of the predictive technique advocated by me, adopted by McClelland Engineers, and generally followed by API for offshore piles is reasonably well documented in Focht et al., (1977), Focht (1983), and Pellieter et.al.,* (1993). McClelland et al., (1969) co-authored with Bram McClelland and Bill Emrich received the ASCE State-of-the-Art Civil Engineering Award for 1971. The topic of pile capacity was also the subject of two other papers, Focht et.al., (1981) and Vijayvergia et al., (1972). Each of my co-authors added substantially to my understanding and the profession of pile capacity in clay. *In my opinion, these papers and others on offshore foundation problems were a major reason that McClelland Engineers received the Distinguished Achievement Award for Organizations from the Offshore Technology Conference in 1986, the first time that award went to a consulting firm. Working closely over the years with other leaders of McClelland Engineers – Bram McClelland, Bob Perkins, Bill Emrich, Charles Mansur, and W.T. Reynolds – added much to my personal knowledge, status, and satisfaction.* Harry Poulos spent part of a sabbatical in our office several years before and I was convinced from that interaction that he would concur with our approximate combination of procedures as presented in Focht el. al.,(1973).

The Ekofisk tank structure installed in 1973 in the North Sea was the first offshore petroleum gravity structure. The foundation at the site consisted of dense clean sand in about 270 ft of water. The exterior wall of the Doris-type structure was a perforated, energy-dissipating baffle 300-ft in diameter rigidly connected to the interior tanks. The oil storage tanks were in the center with a common mat supporting both components. The Norwegian government wanted a review of its expected performance particularly under the repeated cyclic loads of a severe North Sea storm and turned to NGI as their consultant. Until that time, NGI had had very little involvement with offshore geotechnical engineering. Phillips Oil Co., authorized me to retain Ken Lee of UCLA to assist in the evaluation of the storm effects and to attend a hurry-up meeting in Oslo at NGI. I met Ken in New York and we flew together to London on a 747. We had seats in the upstairs lounge and worked the whole flight over to develop a response to the Norwegian questions and concerns.

It was generally accepted by NGI, but Laurits Bjerrum wanted more field demonstrations of the sand density rather than just judgement and the opportunity for detailed cyclic load analyses. Ken also wished to run cyclic tests on the sand. Ken Lee's contribution is clearly evident in Lee et.al., (1975), which won the ASCE Middlebrooks Award for 1976 for us. Considerable credit for the success of Ekofisk must go to William R. Bowles, the Phillips engineer working along with the rest of the team."

John A. Focht, Jr., writes *"In 1982, Harry Seed asked me to prepare the theme lecture on piles for the 1985 ISSMFE Conference to be in San Francisco.* I had just been elected as Vice President of ASCE and was very busy with my new duties; *I enlisted Mike O'Neill of the University of Houston* to be the co-author and assist in gathering data on the international state of the practice for design and installation of axially loaded piles. Nearly 200 detailed questionnaires were sent out world wide with a 30 percent return." Working closely with Mike for about a year gave John A. Focht, Jr., the benefit of his substantial experience with drilled shafts and driven piles. He still likes the last paragraph of that paper Focht el.al.,(1985).

"The good technical engineer is one who knows the limits of his experience on problems and soil conditions comparable with his current assignment and makes appropriate extrapolations. He knows what he knows and uses it confidently. More importantly, he knows what he does not know, seeks available knowledge, and then proceeds fully, acknowledging his limitations and uncertainties. This description fits Mike O'Neill very well."

On Dams, these are the memories of John A. Focht, Jr.,"Geotechnical studies for Livingston Dam on the Trinity River near Houston began in 1961. In response to concerns and at our recommendations, the designers (Brown & Root, Inc. and Forrest & Cotton, Inc.) retained Dr. Arthur Casagrande as a special consultant.

Dr. Terzaghi was seldom at a loss for words. I remember, however, a technical session at an ASCE convention (probably in the 60's) regarding dams on cavernous limestone. The session was probably sponsored by the TVA. During the discussion period, Terzaghi got up and said something like, "This has been interesting but I make it a practice not to take assignments in cavernous limestone regions". Another equally-distinguished looking gentleman rose to reply generally as, "With all due respect to Dr. Terzaghi, there simply are major societal needs for dams in some cavernous limestone regions, and some of us have the job to design and build them so that they will safely fulfill their intended purpose". Dr. Terzaghi had no reply. As part of a routine 5-year inspection of Morris Sheppard Dam on the Brazos River west of Fort Worth in December 1986, the inspection team of Freese and Nichols, Inc. and McClelland Engineers, Inc. almost simultaneously discovered problems with the dam. A special consulting board was retained consisting of A.J. Hendron of the University of Illinois and James Libby, *a* consulting engineer.*"*

On ASCE activities, John A. Focht, Jr., remembers that "In 1975, I was asked to serve on the Executive Committee of the ASCE Soil Mechanics and Foundation Engineering

Division. That volunteer assignment gave me the opportunity to work closely over a period of five years with men like Harry Seed, Dick Gray, Ernie Selig, Bob Schuster, Bill Swiger, George Sowers, Woodie Shockley, and John Lysmer. While our joint efforts were directed at activities of the Division, there were lots of discussion at meals and in the evening regarding our interesting projects. The learning experience for me was tremendous. I only hope that I contributed something to each of them in return for what they taught me.

The number of geotechnical engineers who held an ASCE office seems to be disproportionately larger than the geotechnical membership. MAY BE IT IS BECAUSE GEOTECHS TEND TO WORK WITH AND FOR OTHER CIVIL ENGINEERS MORE THAN OTHER SUBDISCIPLINES. THEREBY, THEY HAVE PROPORTIONATELY GREATER EXPOSURE WITHIN PRACTICING CIVIL ENGINEERS; OR MAY BE, THEY HAVE A GREATER COMMITMENT TO PROFESSIONAL SERVICE. Other geotechs served as Vice President of ASCE -Trent Dames, Bill Moore, Gene McMasters, Bill Zoino, Bob Lawson, Walter Lefevre, and Bill Marcuson. Twenty-three geotechnical engineers served as ASCE Director to the best of my knowledge: Charles Britzuis, Jose Capacete, Leroy Crandall, Elio D'Applonia, Raymond Dawson, Ed Fusik, Arthur Greengard, Delon Hampton, Ken Hansen, Richard Hazen, Lloyd Held, Jeff Hilliard, Ron Hirschfeld, Peter Hoadley, James Olson, J.A. Padgett, Ralph Peck, Carlton Proctor, Gardner Reynolds, Ed Rinne, Phil Rutledge, Malcolm Steinberg, and Ed Wilson. Some of these are also very well known for their technical contributions. The rewards of such service are innumerable, but one of the greatest that I received *are the* friendships.

Perhaps one of my most exciting and rewarding society assignments began in 1994 with a request from Jim Davis, Executive Director of ASCE, to head a small task committee to consider the feasibility of transforming the geotechnical Engineering Division of ASCE into a new semi-autonomous organization…Geo-Institute. That and a similar committee looking at the Structural Division recommended to the ASCE Board of Direction in 1995 that two pilot institutes be authorized. Mike O'Neill, Larry Roth, and Jim Davis deserve credit for their energy and commitment in bringing the Geo-Institute so far, so fast."

Sven Hansbo, a veteran on preloading with vertical drains and in ground improvement and foundations and a former consultant on the Nong Ngu Hao Project with the use of PVD on Ground Improvement says that *"Land reclamation works and the need of implementing infrastructures in areas with bad soil conditions have created an increasing interest in soil improvement. Pre-loading with vertical drains prove to be cost effective."* In the recent years PVD and pre-loading are used a lot in Bangkok and in Southeast Asia. Prof. Sven Hansbo is an old friend of us and has visited us many times and gave excellent lectures.

Mr. Pierre Duffaut emphasizes the true place of geology in geotechnics. He reiterates, as have been many times emphasized by such prominent authors as Leopold Müller, Ralph Peck and Robert Legget, Karl Terzaghi, the Soil Mechanics is a branch of engineering geology. Too many geotechnical engineers have forgotten this message, warns Pierre Duffaut, a witty old friend and also a person supportive of AIT.

Duffaut writes, "First geotechnicians were practitioners, such as Coulomb and Collin to quote only two French fathers (Grand father & father ??) of soil mechanics; physical theories came later. Collin wrote in 1846: «The satisfactory solution will one day recompense for the work of those who, without separating mechanics from *natural* *philosophy*, will best know how to adapt the spirit of the first material facts which it is the essential object of the second to discover and coordinate» *(at this time, natural philosophy meant knowledge of Nature)."*

Major geotechnicians repeated this message says Duffaut: Ralph Peck wrote in 1973: "Every earth structure is constructed in or of a medium… Geology should be used to a greater advantage" and in 1975, about Karl Terzaghi: *"He never gave a lecture in soil mechanics. They were always lectures in geology, geomorphology, and how they relate to a problem, to which, incidentally, some of the engineering science had an application. He was a geologist at heart although he was an engineer's engineer at the same time.* But he always regarded soil mechanics as a branch of engineering geology, which in turn was a branch of geology." Robert Legget tried to revive these messages in a Terzaghi Lecture he was invited to deliver in 1977, unhappy as he was to see how they had been forgotten and neglected by many so-called disciples of Terzaghi.

"*Wo steht die Ingenieurgeologie?*" was the first paper published by Leopold Müller in 1943. Many decades later (1988), he was to repeat the message: "the geological conditions are dominating"; the tunnel engineer – if he is not a geologist too – needs the assistance of the engineering geologist; never should rock mechanics be used without the background of engineering geology. So, the right place of Geology in Geotechnics is the first one. *We have to accept the ground at it comes; it is the same with weather, along the Norwegian proverb there are no bad weather, but only poor clothes.*

Engineering is an ambiguous word, in some languages, an engineer is a man mastering engines, in Latin, he is a man with genius, something like art, that is skill plus intelligence. If the Earth is viewed as a big engine, a set of parts linked into intricate mechanisms, the first acceptance is right, but a bit of genius is required to master its complexity. "Nature, to be mastered, must be obeyed." Non, nisi parendo, vincitur (Natura), Francis Bacon, Novum Organon, 1620)

Prof. Michael Langer, a past-President of the International Association of Engineering Geology writes on Geo-engineering confidence building for the safety assessment of radioactive waste repositories and toxic chemical waste disposal. Prof. Langer says, "The growing demands for waste disposal sites have an increasing impact on our natural environment. All technological processes convert energy and raw materials into other product and in doing so create waste. There are no waste-free processes. *The objective of disposal of radioactive as well as high-toxic chemical wastes is to permanently isolate these wastes from the biosphere. The most promising method to fulfill this task is the disposal in deep underground geological formations.*

Due to the inhomogeneity of geological structures, assessment of the demanded isolation and long-term safety of a permanent repository can be demonstrated only by a specific site analysis in which the individual entire system, "the geological situation, the repository, and the form and amount of the wastes" and their interrelationships are taken into consideration. This concludes the activities conducted to gather information based multidisciplinary, i.e., technical, geotechnical and geological data on the "geologic" conditions at the site and to evaluate the site's suitability for a repository (site qualification)."

The site analysis has three essential tasks says, Prof. Langer:

(1) assessment of the thermomechanical load capacity of the host rock, so that deposition strategies can be determined for the site;

(2) determination of the safe dimensions of the mine (e.g. stability of the caverns and safety of the operations); and

(3) evaluation of the barriers and the long-term safety analysis of the authorization procedure.

Prof. Langer continued, " according to the multi-barriers principle, in waste repositories the geological setting must be able to contribute significantly to the waste isolation over long periods. The assessment of the integrity of the geological barrier again can only be performed by making calculations with geomechanical and hydrogeological models. The proper idealization of the host rock in a computational model is the basis of a realistic calculation of stress distribution and excavation damage effects. The determination of water permeability along discontinuities is necessary in order to evaluate the barrier efficiency of each host rock. It is obvious that modelling can only reach a certain level of accuracy, since the actual behaviour of a complex geologic structure will always remain unknown up to a certain extent.
The geoscientific approach for overcoming this general difficulty is continuous improvement of the model, as the input data improves. *The main features of this approach are the establishment of a consistent relationship between the mechanical and hydrological behaviour, qualification of this model, and quantification of site specific input data, all together forming a geoengineering confidence building."*

Prof. Arnold Verruijt of Delft University of Technology writes "Hydraulic engineering is an important part of Civil Engineering in low lying coastal areas, where water in the rivers and seas has a great influence on the design of all structures. This is especially so for structures built in the soil, because the soil in such areas are usually very soft and the ground water level is close to the ground surface. For the construction of many structures, the behaviour of the soil and water have to be taken into account, and thus, there is a large interaction of geotechnical engineering and by hydraulic engineering. *In modern Civil Engineering, it is no longer so that one branch of engineering simply provides the boundary conditions for another branch of engineering: their interaction should be considered in an integrated analysis. Geotechnics is an essential part of hydraulic engineering."*

Prof. W.F. Van Impe of Ghent University says, "Recently, several institutions for environmental protection, have defined guidelines for the construction of containment systems suggesting design procedures that take into account pollutant transport. These activities have greatly contributed to the establishment of general principles for construction and quality control of engineered barriers used as pollutant containment systems."

Prof. Van Impe continues to writes, *"The work of the ITC-5 within the ISSMGE has been mainly undertaken by a group of core members and members, listed in the first draft report (XIVth International Conference on Soil Mechanics and Foundation Engineering, 6-12 September 1997). The outcome of their work has been briefly compiled here in this paper; mainly referring to the drafts of the subcommittees SC2 - Dr. Shackelford, SC5 - Dr. Loxham, SC6 - Prof. Kamon, SC7 – Dr. L. De Mello and the report (SC4) on containment* *and waste disposal – Dr. M. Manassero, Prof. W.F. Van Impe and Dr. A. Bouazza (Osaka, November 1996).*

In the past, hydraulic barriers, simply consisting of a layer of compacted clay or of a single geomembrane, were used for waste containment. In many cases, no specific measures were adopted to control pollutant migration for landfills underlain by low permeability natural subsoils.

One could focus on the three basic components of a system for waste containment: (1) bottom liners, (2) sidewall liners, and (3) covers.

Three scenarios are important with respect to waste containment by engineered barriers (Shackelford, 1989, 1993; Manassero & Shackelford, 1994a): (1) pure diffusion, (2) diffusion with positive advection, and (3) diffusion with negative advection. Each of these three scenario is illustrated with respect to vertical and horizontal barriers. The pure diffusion case may result when a compacted clay barrier is placed below the water table or when a slurry wall is placed around an existing contaminated area for remediation. The most common scenario for new landfills is the case of diffusion with positive advection, where the compacted clay liner is placed above the water table.

The ITC-5 activities in the framework of the ISSMGE efforts towards the environmental geotechnics are elaborated. Mainly the progress in modelling of migration of pollutants, waste classification and mechanical characterization, design of engineered landfills and the assessment of geo-environmental hazards remains remarkable. It looks important to the future terms of reference of this committee to at least stress much more the waste mechanics and the remediation philosophy related to geo-environmental problems of dredged and non-traditional construction materials."

Prof. Sridharan and Prof. Miura of Saga University write "The development of solutions to the intricate geotechnical problems connected with the fine-grained soils necessitates a better understanding of clay science with particular reference to the clay mineral and associated electrical force characteristics contributing to the soil structure, the water holding capacity, the "effective stress", the volume change, shear strength and permeability and behaviour of fine grained soils."

Clay science in geotechnical engineering is the contribution from A. Sridharan and N. Miura of Saga University. "Understanding and prediction of engineering properties of clay soils are of vital importance in geotechnical practice especially in the years to come. The complexity in the engineering behaviour of fine-grained soils is attributable mostly to the clay size fraction of the soil. Most soil classification systems arbitrarily define clay particles as those having an effective diameter of two μm or less and do not account for the clay mineral type. Clay minerals are characterized by strong electrical forces of attraction and repulsion that vary in magnitude and nature depending on their mineralogical composition and impart a wide range of properties to fine-grained soil."

In the article on the "Genesis of Landfill Liner Systems in the U.S.A.", Robert M. Koerner of Drexial University describes "the genesis of containment (barrier) systems and leachate collection systems in the US and to a large extent in Canada. *Coincidentally, with the progression of barrier and drainage systems, the reader will see a major use of all types of geosynthetic materials. Indeed, the growth of geosynthetics can be closely tracked to the evolution of waste containment systems such as those to be described."*

Prof. Robert M. Koerner continues to say, "Prior to 1982, liners for landfills and other waste materials consisted of either in-situ low permeability soils or some type of equipment-placed compacted clay. This situation drastically changed with research findings regarding severe reactions of clay soils to various organic solvents typically found in leachate. *The U.S. Environmental Protection Agency responded by requiring a single geomembrane in 1982, followed by a double geomembrane in 1983. Not to be denied, compacted clay liners (CCL's)*
re-entered the cross-section in 1984, now in the form of a composite liner consisting of a geomembrane directly over the CCL. This was followed by a succession of variations generally involving geosynthetic materials. Presently, some liner systems consist of as many as ten-geosynthetic materials in addition to CCL's and geosynthetic clay liners (GCL's). Such multi-lined systems are being implemented which utilize this type of juxtaposition of geosynthetics and natural soils so as to provide environmentally safe and secure liner systems for landfills and other waste impounded materials."

Prof. R.N. Chowdhury of University of Wollongong in his contribution "Evolving Geotechnical Reliability Assessment Strategies – Towards 2000", writes "In order to facilitate the assessment and enhancement of reliability, uncertainties in geotechnical engineering must be recognized. *Uncertainties include those associated with natural spatial variability of geological materials, variation of parameter value with time, limited site investigation, measurement bias and imperfect geotechnical models."*

Prof. R.N. Chowdhury continues, "Deterministic methods of analysis and observational methods of assessment and management have, in recent decades, been supplemented by approaches and methods within a probabilistic framework. An increasing recognition of uncertainties in geotechnical engineering has led to an awareness of the limitations of conventional methods for assessing and enhancing geotechnical reliability. New approaches must be firmly based on modern geotechnical principles and valid geological and geotechnical models of real mechanisms of performance. Innovative approaches are required for assessing system reliability and the role of progressive action in the elements of geotechnical systems. New developments should also be concerned with better ways of updating reliability in the light of new information and observed performance. Progress is also required to establish minimum levels of acceptable reliability or maximum levels of acceptable risk. New approaches should allow the enhancement of geotechnical reliability by combining deterministic, observational and probabilistic approaches in ways appropriate to each particular project."

"Partial History: Muskeg (Peatland) Engineering in Canada" is the article by Prof. Gerald Raymond of Queen's University. He writes, *"Access across Canadian muskeg deposits has been a major problem for the transportation of personnel or goods from very early times in Canada's history.* Application of pre-loading to highway construction, settlement of the Trans-Canada Highway over muskeg, Culvert selection in Muskeg areas, Corrosion in Muskeg areas, Construction in Peat Bogs, Geosynthetics in Low Embankments on Muskeg, Test Fills on Fibrous Peat, Field Loading Tests on Muskeg Access Road Construction for Pipelines though the Sub-arctic, are the topics on which Prof. Raymond has made written contributions. Pierre Berton in his history of the building of the Canadian Trans-Continental Railways (Vol. 1, The Great Railways 1871-81, published by McClelland and Stewart Ltd., Toronto) gives numerous examples of problems that contractors had to build railways over the muskeg swamps. Typical examples are:

1. The sinkhole near Savanne, north of Fort William, where an entire train and a thousand feet of track was alleged to have been swallowed whole into a swamp failure.

2. The crossing of the Julius Muskeg, a vast bed of peat six miles across, depth unknown, sufficient, it was said, to supply the entire North West with fuel.

3. The Cross Lake muskeg where the contractor began work on it in 1879 and was still pouring gravel into the swamp when the government relieved him of his contract in March, 1880.

4. Near Bonheur, where a construction crew believe it had filled a muskeg hole, then suddenly the entire track vanished into the black mud.

Furthermore, even when a muskeg swamp had been conquered and the train traffic established, the roadbed would creep forward with every passing train. For example, when a train consisting of thirty-five cars passed over some swamp crossings, a series of waves, about 150 mm deep, could be observed to ripple along the track and the rails would creep about 600 mm in the direction of the train movement. This often resulted in the track bolts braking on a daily basis. The problem of access across Muskeg is not new. The earliest known roads built on muskeg were found in the Blue Valley, Somerset, England. Carbon dating indicates that the roadway is from between 2000 BC and 3000 BC."

"Coupled Effect on Electrokenetic Sedimentation and Remediation of Slurry Wastes Contaminated with Organic Substance", is the title of the presentation by H.I. Chung, G.C. Sills, M. Kamon. "The slurry typed wastes such as mineral wastes, mining wastes, industrial wastes, and dredging wastes are increasing significantly by the growth in industrialization and population. These wastes are commonly disposed in various different ways. If these wastes are to be contained in impoundment and in landfill, they are usually placed hydraulically as slurry by open dumping. These wastes contain significant clay, colloidal fraction contaminants. This small-sized fraction can result in soft strata with high initial void, and its potential hazards in subsurface environments are existing. In these cases, it is needed to sediment the slurry typed wastes for volume reduction and to remediate the contaminated waste for pollutant reduction."

Michael John Tomlinson an Authority and veteran on Foundations for Tall Buildings and others writes "The leading organizations in UK for the exploitation of soil mechanics in 1940-46 were the subsidiary of two large civil engineering contractors. They were Soil Mechanics Ltd., a subsidiary of John Mowlem & Co. and the Central Laboratory of George Wimpey & Co. I had the good fortune to be employed by the latter from 1947 to 1976", says Tomlinson.

" In the inter-war years, the development of soil mechanics in UK was almost wholly undertaken by two Government Institutions, the Building Research Station, and, the Road Research Laboratory. Courses of instruction in Soil Mechanics were given by BRS from 1938 to 1945 for university lecturers, railway engineers, consultants and colonial service engineers. University College London, Universities of Sheffield, Durham and Glasgow gave lectures in Soil Mechanics from 1938 to 1945. R. Glossop was in charge of the Mowlem's Soils Lab in 1939. In 1944, Soil Mechnics Ltd. was established.

Dr. William Macgregor of Glasgow University attended the BRS Lecture in 1939. Wimpeys had begun the construction of the RAF Transport Command airfield at Heathrow, which was to become London Airport. Cementation company was then established. SPT was introduced in UK by Stanley Rodin who was the first Director of GCO in Hong Kong as well. Mr. Tomlinson said, they introduced SPT in Iran, Iraq and Kuwait. SML claims to use the field vane test commercially first in UK. Geophysical survey was done by Wimpeys. SML had a lead in grouting works, while Wimpey introduced electro-osmosis with the help of Leo Casagrande. Tomlinson also described the work on the new Bank of China in Hong Kong. He also wrote on the work on the Kai Tak Airport in Hong Kong on reclaimed land. It is nice to know that the late Peter Lumb, our past-President of SEAGS was a Wimpey site representative at one time."

Dr. Arthur D.M. Penman, a veteran in all kinds of Dams and a Peer in the BRE in UK writes on " Geotechnical Engineering and Building Research": "the achievement of Charles Frewen Jenken were remarkable and he brought Soil Mechanics to Building Research. The Building Research Station was established in 1921 under the Government Department of Scientific and Industrial Research. It was sold to the private sector by Government in 1997. During its 76 years of existence as a Government establishment, it conducted research into building and civil engineering and greatly assisted what has become known as the construction industry. Dr. Penman describes the work of Jenken on the earth pressure theories of Rankine, Coulomb and Bell, which is described by Lee (1945). Then Cooling became the head of BRS Soils group in 1933 when Jenken retired due to ill health", says Dr. Penman. Under the able leadership of Cooling the BRS Soils Group attracted H.Q. Golder (1976), A.W. Skempton (1936-1937), W.H. Ward (1942), A.D.M. Penman (1944), Marsland, G.G. Meyerhof (1946), McNamee, T.K. Chaplin, Leo Casagrande, T. Whitaker etc. *This is indeed the most productive period of the BRS Soils Group in making an enormous contribution to our discipline on Equipment, Instrument and also on aspects of Shear Strength, Sampling and Site Investigation, Foundations, Slope Stability, Dams etc.* Dr. Penman also describes the participation of BRS in the First to Fourth International Conferences on Soil Mechanics and Foundation Engineering and the origin of the Journal, Geotechnique. I have only merited the names of the popular persons who are internationally well known from BRS till 1957. *The publications also include R.E. Gibson, A.W. Bishop, and others who are Giants in Geotechnique.*

"Joy of being a geotechnical engineer" is the contribution by Prof. Yudhbir, a former colleague of us and a well-respected Geotechnical Teacher for his thorough knowledge on various topics. "Two years at IIT Bombay were to change my whole life", said Yudhbir. " It was here that I met Professor David Henkel who had come to deliver a lecture during the fall of 1963. In a hall packed with professional civil engineers, graduate students and faculty, Henkel's lecture showed in a simple and very instructive manner as to how much of what Taylor's book had promised, had already been achieved and what new research directions were receiving attention worldwide. *I suddenly felt as if a window had been thrown open in a stuffed room and outside that window lay the road to my promised land.*

Once again, with courage in my both hands, I sought brief interview with David Henkel that evening in his room in IIT Bombay guest house and expressed my desire to work with him at IIT Delhi where he had come to setup a graduate program in soil mechanics in the Civil Engineering Department. He spoke to me briefly and promised to write to me on his return to Delhi. I was accepted as Ph.D. student and I left everything and started my real apprenticeship: 1964-65 at IIT Delhi and then 1966-69 at Cornell University. *At IIT Delhi, under Henkel's inspiring guidance, I was to be intimately involved in setting up* *the triaxial testing laboratory: from opening up boxes, setting up the equipment and pressure systems, calibrating all measuring devices to finally setting up samples and carrying out testing of soils, working as his field assistant at Beas Dam site for investigation of landslides in sedimentary siwalik formations, large deformation direct shear testing of shear zone materials, interpretation of field geologic data and preparation and actual drafting of engineering geologic plans and cross sections to help formulate the sliding block mechanism which was responsible for the failures at site – recent and prehistoric in the dam reservoir area on left abutment (I still carry around with me the set of those original tracings).* And all this in only one year! Henkel moved to Cornell University, at Ithaca, N.Y., in 1965 and I resigned from IIT Delhi lecturership in Civil Engineering and moved to Hollister Hall at Cornell University for the next 3 years (June, 1966-March, 1969). My training started where we had left at IIT Delhi. *I was extremely fortunate to be tutored by David Henkel both in the laboratory and in the field on project sites, in developing a real feel for the geologic materials in their varied geologic and geomorphic settings.* Practically most week-ends and holidays were spent with David Henkel examining slopes around Ithaca, where in a painstaking manner he would demonstrate to me minor geologic details and hydrologic conditions governing sliding mechanisms. *I also had the good fortune to study airphoto interpretation (As strongly urged by David Henkel) under another brilliant engineer and craftsman - Professor Donald Belcher under whose interpretative skills the airphotos literally poured out their innermost subtle details. Those three to four courses in airphoto interpretation really completed my education and training in physical geology, geomorphology and quaternary geology. Like Casagrande's tutorials in field identification and classification of soils at Harvard, Belcher's laboratory sessions at Cornell trained the students to examine hundreds of airphotos depicting varieties of geomorphic forms that different geologic formations and recent sediments had developed in the field as a result of interaction with water and other agencies of change operating during their geologic history. This intense training formed the basis of my engineering geologic approach to soil/rock investigations in general and stability of slopes in particular.*

Professor Peter Wroth from Cambridge University spent his sabbatical at Cornell during the same period and I was fortunate to be introduced to the then emerging approach of soil mechanics-Critical State Soil Mechanics (CSSM)". Prof. Yudhbir continues to say "My doctoral thesis research led me to examine the K_0-unloading process as a drained shearing deformation leading to passive in-situ failure at very high over consolidation ratio, the secondary swelling following unloading and its consequences on dilatancy behaviour during drained shear. This was shown to have implications with relation to the observed curved failure envelope for over-consolidated clays and clay shales. I was ready to try my hand on my own. Woodward-Clyde and Assoc. Orange California were involved in investigation of failed housing development project at Princess Park - expensive houses built on an old landslide which was reactivated by loading of crest by the houses and cutting at the toe for laying streets and utilities. I worked for a year on these problems of stability and my education was enhanced. Dr. Robert McNeill, Vice President at Woodward Clyde and Professor Richard Woods, University of Michigan at Ann Arbor who was spending his summer with Woodward Clyde in 1969 became friends and they encouraged my training and learning. Dick Wood later visited IIT Kanpur campus in the summer of 1971 where I had moved in 1970 and since then our personal and professional association developed which was extremely valuable in my professional development."

During 1981-83 while at AIT, *Prof. Yudhbir* was involved in many aspects of geotechnics but the main emphasis was on rock mass classification system calibration in the field, and its application to stability of slopes at Khao Laem Dam site (Western Thailand), and evaluation of a failure criterion for soft rock masses. Dacha, Nattawuth and Lemanza worked on these aspects of rock mass behaviour for their master's theses research and the other notable effort was by Korchoke Chantawarangul who in his master's thesis critically examined different procedures to evaluate effective stress strength parameters of partially saturated soils.

"There are more personalities who have influenced my professional life" says Prof. Yudhbir, "The notable ones being Professor Bengt B. Broms, Professor T.W. Lambe, Professor Herbert H. Einstein, Professor E. T. Brown, Professor Za-Chieh Moh, Professor Ted Brand, late Dr. Hiroshi Mori, Professor Hideki Ohta, Professor David Wood and Professor Yusuke Honjo. All were sources of constant encouragement, some gave me valuable opportunities to work with them. David Wood and Yusuke Honjo were very gracious to become my collaborators in preparing the General Report at Rio de Janeiro (1989) ICSMFE, and, the theme paper for the 9ARC (1991) respectively. *I must express my very special appreciation to Za-Chieh Moh, who almost since 1971 when he initially offered me a job at AIT has been a source of great inspiration, for giving me a truly once in a life-time opportunity to work with Moh and Associates in 1995, at their Bangkok office. My involvement with the 2nd International airport project and the new Bangkok-Chonburi Expressway under Za-Chieh's constant guidance and help was truly one of the most enjoyable professional experiences of my life. I really learnt construction and design on soft ground."*

"Early days of Soil Mechanics at the Massachusetts Institute of Technology" is described by T. W. Lambe the great teacher in Soil Mechanics, who portrayed some of the people at MIT from 1925 to 1970. These included Terzaghi from 1925, which constituted the birth of Soil Mechanics in MIT and triggered its activities in USA. This was then followed by Glenon Gilboy (1926), Arthur Casagrande (1928) and Leo Jurgenson in 1929. Donald W. Taylor joined the staff in 1933 and became a faculty in 1937. Some of the early students at MIT are Arthur Casagrande, Leo Casagrande, Spencer Buchanan, Phil Rutledge, John Lowe, Tom Leps, James Gould, Joseph Zeitlen, Harl Aldrich, James Mitchell, Za-Chieh Moh, etc. *MIT research elucidated fundamentals of Soil Mechanics on particle size and consistency, permeability and capillarity, lateral soil pressures, strength and compressibility, stabilization-soil structure and Soil Dynamics and Earthquake Engineering. Excellent Books originated from MIT are Taylor's "Fundamentals of Soil Mechnics" (1948), T.W. Lambe-Soil Technology (1951) and Lambe and Whitman - Soil Mechanics (1969). Lambe's Soil Testing and Lambe & Whitman - Soil Mechanics are classical & Bible type texts for all in Soil Mechanics.*

Prof. Lambe comments "Since the mid 60's, our geotechnical profession has grown enormously. Unfortunately, the great growth in numbers of engineers has not caused an increase in the quality of geotechnical work particularly. It seems to me (to Prof. Lambe) that our Profession has become more and more a business concerned primarily with, bottom line, costs."

Andrew Schofield of Cambridge University points out the fallacy in Rankine's earth pressure theory. In 1936 Terzaghi pointed out a fundamental fallacy in the Rankine's earth pressure computations where the strain does not enter the computations. *Terzaghi quotes, "the fundamental assumptions of Rankine's earth pressure theory are incompatible with the known relation of stress and strain in soils. Therefore, the use of this theory should be discontinued".*

Prof. Schofield says "A rational limit state design that takes account of Rankine's earth pressure fallacy is needed by Eurocode 7, for design with Coulomb's limiting stress vector across a surface in soil or Rankine's active or passive zones. The original cam-clay model established that soil paste is a perfectly plastic material. Schofield and Wroth (1966), Critical State Soil Mechanics, based their geotechnical teaching on plasticity theory. In design problems, disturbed soil properties may be used with undrained action on soil and $c = c_u$, or with drained actions on soil, $\bar{\phi} = \phi_d$."

" Experiences of Geotechnical Development in Japan and Future Directions" is the presentation of Prof. Masami Fukuoka the past-President of ISSMFE. He describes, the development in Japan since 1930 when Terzaghi's Erdbaumechanik was translated into Japanese, Doshitsu-Koogaku…Geotechnical Engineering. The Japanese National Railways also translated the Report of the Swedish National Railways. Geotechnical Engineering was applied effectively for the prevention and restoration of natural disasters and developing food production during 1945-1955, added Prof. Fukuoka.

Key events are Prof. Noboru Yamaguchi's paper presentation in the Harvard ICSMFE in 1936, the formation of Japanese Society of Soil Mechanics and Foundation Engineering in 1950, the Journal, Soils and Foundation in 1960, the IXth ICSMME in 1977 in Tokyo, the big projects are Seikan Tunnel, Honshu-Shikoku Connecting Bridge, Shinkansen, Highway, Kansai International Airport, and Trans-Tokyo-Bay Highway, and Kanto Great Earthquake in Tokyo Yokohama in 1923. During the earthquakes, many structures such as levees, road and railway embankments, bridge abutments and piers, dams and quay walls were damaged. Natural slopes collapsed and mudflows occurred. Kamenose Landslide occurred in 1932. A big typhoon named Muroto Typhoon hit Kobe City in 1938. Records of many earthquakes, typhoons and landslides are given. *Key pioneers and Peers in Soil Mechanics are Takeo Mogami, Kano Hoshino, Sakuro Murayama, etc. Hiroshi Mori established Kisojiban Consultants in 1953.* Ise Bay Typhoon in 1959 and the Niigata Earthquake in 1969 were also quoted. The new method of construction: sand drains, sand compaction piles, steel piles, cast-in-place concrete piles, reinforced soils, anchors, diaphragm walls, shield tunnels and geotextiles were established including the improvement in sampling and in-situ testing.

"Japan is short of natural resources" says Prof. Fukuoka. " Thus, import and export is important to make a living. There are many types of hazards as well. Innovation and experience is needed in geotechnical works and also technology transfer and international collaboration." Prof. Fukuoka is a perfect gentleman and an expert on the practical aspects of geotechnics. He is also an authority on Landslides. Prof. Fukuoka has visited Bangkok and Southeast Asia many times and has given lectures.

" A Gas Pipeline Buried in Flooded Soil held with Anchorages " is described by Prof. Pierre Habib of Ecole Polytechnique. Pierre Habib argued that the classical way to hold a burried pipeline is to add weight on it, generally concrete. This solution is a good one but have drawback, especially when it is necessary to repair the protective layer. He then describes a large diameter new gas pipeline 13 km long buried in flooded area and held with kerlav anchorages to prevent uplift tube movements owing to buoyancy. On an earlier occasion in 1981, Prof. Habib gave an excellent lecture at AIT on Anchors Used in Offshore Engineering. Prof. Habib, a past-President of ISRM is loved by all who knows him well and has made nearly five decades of contributions to our subject.

Mr. Fernando Lizzi the father of Micropiles writes on the past, present and future of Micropiles. Mr. Lizzi quotes from Terzaghi (1936), *"In pure science a very sharp distinction is made between Hypothesis, Theory and Laws. The difference between these three categories resides exclusively in the weight of sustaining evidence. On the other hand in Foundations and Earthwork Engineering, everything is called a Theory after it appears in print, and if the theory find its way into a textbook, many readers are inclined to consider it a law"*

"Notwithstanding this Solemn warning a dichotomy between Theory and Practice is still affecting the development of Geotechnics" says Dr. Lizzi: "although, as a matter of fact, actual problems, when in the hands of the Field Operators, very frequently appear in a very different light from the proposed theoretical approach, some modifications are required, sometimes under the push of urgence.

Micropiles were patented by Dr. Lizzi in 1950. They are now an essential feature of modern foundations, as well as reinforced soils. Micropiles with high load bearing capacities were also introduced. Micropiles can substitute for conventional piles in normal foundations. Micropile can also be used in-groups or networks for soil reinforcement and for special foundations.

Prof. Harry G. Poulos an Authority on "Piled Foundations and Elastic Analysis" describes the evolution of pile design from the nineteenth century, todate. In the earlier times, the most advanced method involved the pile driving formulae, then the static methods form shaft loads and base resistance estimations. Settlement calculations began to be used with numerical analysis in the 1950's and this was followed by broading the scope of pile design for dynamic loading etc. The current development is the trend to use analytical procedure, which incorporate the realistic stress-strain behaviour of soils. Prof. Poulos has given numerous Guest Lectures and State-of-the Art Reports in AIT and in SEAGS Conferences on Piled Foundations in the past.

"Soil Profile Interpreted from CPTu Data" is the contribution by Prof. Bengt H. Fellenius and Abolfazi Eslami of Canada. They say, "Cone penetrometers with the measurement of cone resistance and sleeve friction are used to identify soil types. The reliability of the measurement has increased with the evolution of piezocone from the mechanical and electric cones." Prof. Fellenius reviews the methods of soil profiling. Two soil profiling methods based on the piezocone measurements are compared with cases of sand, normally consolidated and over consolidated clay.

Prof. Henderikus G.B. Allersma of Delft University of Technology, discusses the advantage of small centrifuge as compared to the large ones. In the small centrifuges, several tests can be carried out in quick succession. This is particularly effective for the study of failure mechanisms and the influence of changes in design. Also, small samples can be prepared with precision. Prof. Allersma also describes the behaviour of conical footings, suction piles, buckling of large diameter piles, burried pipes, slope stability etc.

"Embankment Dams in Canada" is the title of the article by Dr. Victor Milligan of Golder Associates. In his documentation Victor Milligan has recorded that between 1950 to 1990, nearly 100 embankment dams were constructed in Canada for every decade. These dams are generally 30 to 50 m high. Nearly 50 dams exceeded 50 m high and the maximum height is 243 m. Victor Milligan describes aspects of dams on weak and compressible foundations, dams on compacted shales and sandstones, dams on sedimentary rocks, dams on glacial till foundations, dams on pervious foundations and dams on unusual foundation conditions. He also discusses the fill materials used and the method of filling. Victor Milligan concludes that *"the problems of design and construction of embankment dams in Canada are generally related to the geology, particularly glacial geology and to severe climatic conditions. Solutions to these problems have been progressive and innovative advancing the state-of-the art of building embankment dams."*

"Up-down Construction of a Building with Basement on Steep Slope" is the subject of Prof. Seng Lip Lee our past-President of SEAGS. S.L. Lee et al., describe the up-down construction of a building with basement on steep slope. In the earlier basement construction slope failure resulting in large ground movement, excessive deflection and failure of part of the contiguous bored piles (CBP) were noted. To stabilize the slope and stop the progressive ground movement, excavated soils were dumped back and more than 20 truckload of sandfill were used to fill up the cracks in the steep slope. Analysis indicated that deeper embedment of the contiguous bored pile wall and the up-down construction method would help to stabilize the situation.

"History and Development of Polymer Grid Reinforced Earth Structures-Development since Henri Vidal" is the presentation by Prof. T. Yamanouchi who comments that Terre Arme developed by Henri Vidal of France in 1963 has triggered the development of new reinforced earth methods. Prof. Yamanouchi is an older timer in this game and has written good papers in many conferences including the one in Barcelona in 1968. Fruitful co-operation between Prof. Yamanouchi and Brian Mercer of UK developed, and, Prof. Mercer is a Fellow of the Royal Society of London and an inventor of polymer grid reinforcement in 1979. *Prof. Yamanouchi also spoke on the two volume guidelines on polymer grid earth reinforcement published in 1990 and the contribution of the Japanese polymer grid manufacturers established in 1992 as the third largest group in the world, and, an unprecedented level of activities in Japan on this interesting and innovative subject.*

Prof. E. T. Brown writes on the "Developments in the Engineering of Underground Excavations in Rock, Snowy Mountains Hydro-Electric Scheme, Australia 1952-1962." He describes the major contributions made to the development of rock mechanics and underground rock engineering on Snowy Mountains Scheme during 1952-1962. The Snowy Mountains Scheme constructed in Southeast Australia in 1949-1969, at the time was one of the largest civil engineering projects undertaken. Many of the investigations, design and construction methods used at the forefront of, and advanced, the then state-of-the-art. The main rock mass classification scheme available at that time of underground power stations was Terzaghi's (1946) scheme for estimating loads on tunnel support. The concept of Rock Quality (R&D) came about in 1963 (Deere, 1969) and the NGI Q System of Barton, Lien & Lunde (1974) and Beieniawaski's Rock Mass Rating (RMR) came about in early 1970s. Moye (1955) made a major and lasting contribution to engineering geology by developing a weathering classification system for granite rocks. Water pressure testing was also carried out in diamond drill holes from an early stage in the site investigation (Moye, 1955; Stapledon 1961). *Prof. Ted Brown mention at that time he was initially a school boy and then an undergraduate and a beginning graduate engineer. As a student member of IE-Australia, he read the Institution Journal and these contributions captured his imagination to become an expert in rock mechanics. Bieniawski (1984) and Hoek and Brown (1980) had made outstanding contributions to underground excavation in rock as well as rock mechanics as a discipline.*

A Survey of Embankment Construction Practice and Future Developments is made by Ting Wen Hui. "Embankment construction can range from low banks in flood protection works to high dam" says, Dr. Ting Wen Hui. "*The poor soil conditions in which low embankments are built at times can cause geotechnical challenges similar to those in high dams." Dr. Ting also describes the geotechnical practice in the treatment of embankments.* Contributions by Burland and Schofield were mentioned in terms of stress-strain models and corrected Mohr Coulomb parameters. The excellent work done by Arthur Penman as well as the contribution of BRE is well quoted.

"Porewater Pressure in Reinforced Soil Slopes- Assumptions and Realities" is the contribution by Terry S. Ingold of the University of Birmingham. Prof. Ingold says, "traditional in the design of reinforced slopes and structures is the assumption of zero pore water pressure within the fill. Ignoring the reality that high pore water pressures maybe generated within reinforced slopes has led to failures." Prof. Ingold has addressed this issue with theoretical analysis and modelling. At a practical level, Prof. Ingold has given three examples involving the effect of wet weather working, inadequate fill permeability and variable fill permeability to highlight differences between design assumptions and construction realities. Prof. Ingold concludes that water and particularly in the form of unforeseen pore water pressures, is a major cause of geotechnical failures. "Reinforced Soil is no exception" says, Prof. Ingold, "and selected fill which is assumed to be free draining will only be free draining in reality if adequate drainage measures are incorporated. Where they are not, due regard must be taken of the high pore water pressures which maybe generated in the field."

"Increase in Pore Water Pressure during Excavation" is the contribution by Dr. Takeshi Hosoi of Nishimatsu Construction Co., Ltd. He emphasizes the influence of the increase in pore water pressure at the cutting face of sandy soil during shield driving and slurry-filled trench excavation on the stability. Excess pore water pressure during slurry-shield driving is caused by ground water flow due to slurry pressure, and during earth pressure balanced shield driving, due to change in earth pressure, in the chamber of the shield machine. In slurry-filled trench excavation, using the rotary drum-cutter type excavation, excess pore water pressure is caused by the cyclic shear stress introduced in the cutting face, by dynamic cyclic excavation. In slurry-filled trench excavation, the bucket type excavation caused increase in the vertical stress due to the descent of the bucket to the trench bottom.

The paper on Four Decades of Development of British Embankment Dams by Mr. M.F. Kennard of Rofe, Kennard and Lapworth, looks into the development of Dam Engineering in UK. Of the 137 large dams built in Great Britain between 1950 to 1990, 69 were embankment designs with most having clay cores and clay foundations. *Mr. Kennard says, "these decades have seen the tremendous growth in Great Britain of Geotechnical Engineering including soil mechanics, rock mechanics and engineering geology. The first University Professor of Soil Mechanics in UK is Prof. A.W. Skempton at Imperial College in 1955, now there are more than twenty or so" says, Mr. Kennard.* He also quotes from Binnie (1976) "from the beginning of this century up to the end of the second world war, the design and construction of earth dams followed traditional lines based on more than a century of recorded practical experience. Following a slip during construction of Chingford Reservoir in 1938, Professor Terzaghi was called in to advise and after the war, Terzaghi's concepts were welcomed with enthusiasm by the post war generation of British Engineers. *Whilst experience and judgement still remain very important factors in the investigation and design of dams, the empirical methods of the past have now been superseded by methods based on analysis and scientific logic."*

Kennard gives references to the work of Skempton (1989), Knight (1989), Rowe (1970) as well as Kennard and Kennard, Bishop and Vaughan (1962) etc. Mr. Kennard presented his contribution during every decade 1950-1960, 1960-1970, up to, 1980 to 1990. Mr. Kennard also refers to the work in BRE and in particular to Dr. Penman's work.
The paper on, "Development of Soil Stabilization Techniques around the Inland Sea Area, Western Japan-Five Decades of Experience" narrates the experiences of Prof. Hisao Aboshi of Hiroshima University. It was on the eve of an opening ceremony of a newly constructed fishing port in a village of an island, Hiroshima Prefecture on a winter day of 1951, when many people related to the project came together to celebrate the completion of the harbour. During that evening, when the tide reached its lowest level, the whole structure suddenly sank into the sea bottom, and the next morning, no one could see the jetty or the breakwater there, as if a mirage disappeared. Such an occasion had not been a rare case around the coast of the Inland Sea from ancient times. In constructing a castle on a shore, the stone wall frequently failed and disappeared into the ground. *It was believed by the people in the area, that there lived a devil to swallow victims*, and such victims were there many times through successive generations before setting up the stone wall successfully.

He continues to say "Since the end of the World War II, new sciences and technologies came into Japan, among them soil mechanics and the related technology being included. Needless to mention, the cause of failure of the fishing port was the lack of bearing capacity of the soft ground against the peak load due to the decrease of buoyancy at the lowest tide. And the case of ancient castles meant the soil stabilization by replacement of the foundation soil utilizing artificial base failures and also increase of shearing strength by consolidation of soft clays with the passage of time. Many cases of such foundation failures happened even after World War II, and the total numbers might reach several tens only in the Inland Sea area, before soil stabilization techniques had been developed and applied widely."

Prof. Aboshi worked with Prof. Takeo Mogami at Tokyo University, before returning to Hiroshima University in early 50's. *With five decades of authoritative experience, Prof. Aboshi talks of the work of O.J. Porter (1936) on sand drains in USA, the Barron's theory and his own work cited by R.T. Murray of TRRL, UK.* He then elaborate on the work of the Kojima reclamation embankment (1953) in relation to sand drains. He then goes on the Paper Drains, Sand Compaction Piles, Dry Jet Mixing (DJM) Method and the Use of Fibre Drains (Prof. S.L. Lee our SEAGS past-President). Prof. Aboshi says,

"I acknowledged the merit of the material (Fibre Drain) at the moment when I saw it, judging from the experience of paper drains".

The great advice on his concluding remarks is worthy of praise. Prof. Aboshi writes, "In this paper, I referred mainly to practical experiences on the development of soil stabilization techniques carried out in the Seto Inland Sea area in the last half a century, not on soil mechanics researches in Hiroshima University, where I belonged, throughout my whole career. *During these works, I was always worried about the relation between "theory and practice"* as Terzaghi always emphasized its importance in geotechnical engineering. Many times, I have experienced cases in which theory and experimental data in the laboratory could not explain the field practice. *One of the most famous examples was a long-continued debate whether sand drains were effective or not, both in Japan and in the USA since the 1970's. And the case of sand compaction piles, which is widely used and relied on among practicing engineers, and on the contrary, unpopular among, scientists as a whole."*

During my long career as a scientist continued Prof. Aboshi, "I have always been thinking about how the research in geotechnical engineering should be, and what is the most important standpoint in studying it. *We scientists usually consider that what is the cause of inconsistency when field data do not coincide with the theoretical prediction. However, there must be a change of conception to think how our model is different from reality in the field, which is the truth. Needless to mention, it does never mean to fit the theory for erroneous data, such as the case of discontinuous sand drains. In this sense, to cultivate the capability to find the truth from confusing reality, is most important."*

Now in the age of computers says Prof. Aboshi, "young men used to stick to their desk works and do not want to see the site. However, I would like to emphasize that the truth always exists in the practical phenomenon in the site, and the theory or the experiments in the laboratory should be performed to explain the truth in the field. I strongly hope that the future development of geotechnical engineering will proceed to the right direction."

"WBI Geotechnical engineering in research and practice" is the title of the article by W. Wittke of Aachen, Germany. "WBI stands for Wittke Beratende Ingenieure (Wittke Consulting Engineers) and is a consulting firm with at present approximately 50 employees dealing with Geotechnical Engineering and Tunneling all over the world. The firm was founded in 1980 in Aachen (Germany) by Prof. Dr.-Ing. E. H. Walter Wittke and Dr.-Ing. Bernd Pierau. A few years later Dr.-Ing. Claus Erichsen joined the board of directors of the company. In 1989 a branch was founded in Stuttgart (Germany). *At present WBI is involved in the design and construction of more than 100 km of traffic tunnels. The activities of WBI in the field of construction of underground openings include the design and supervision of explorations, the elaboration of corresponding expertise, the preparation of* *tender documents, the design, the stability analyses as well as the supervision and monitoring during construction.*

A great part of the activities of WBI extends on Dam Engineering as well as Foundation Engineering. Since the inauguration of the firm, WBI is continuously developing three-dimensional finite element computer codes for nearly all geotechnical tasks. These codes are used for consulting assignments. WBI is the leading engineering firm in Germany in this field. *WBI have developed and applied a large number of finite element codes for the analyses of stresses and displacements in soil and rock subjected to static and dynamic loads. Moreover, WBI develop and apply codes for the analyses of seepage flow and the transport phenomena of contaminants. All codes are three-dimensional. Within the scope of projects a number of problems have been solved using innovative and scientific methods. The results are documented in many papers published in scientific journals or in the proceedings of national and international meetings. In this context reference be made to the series "WBI-PRINT -Geotechnical Engineering in Research and Practice". At present four volumes about the application of numerical methods in tunneling are being prepared. The first book "Stability Analyses of Tunnels, Fundamentals" appeared this year as volume 4 of WBI-PRINT. The following volumes will deal with case studies as well as with design and construction issues.*

Prof. Bernhard Maidl writes, "Franz Von Rziha is to be named the promoter of Tunnel Engineering. His extensive studies and his creative work had a lasting influence on the development of the tunnelling practice and are still considerably relevant. In his major piece of work, the Textbook of the entire art of tunnelling, tunnelling is described in a nearly complete way. In a comparison of the English, Belgian, German and Austrian timber-frame construction systems for tunnels he makes demands for a closer contact between the support and the mountain, for an earlier closure of floor, for large sequential excavations and for a working method which is more mountain considerate. These demands have been adapted from Maillart, Komerell, Rabcewicz, Müller and his present disciples and form the basis of all modern tunnel constructions. Rziha's various interest also in other fields distinguish himself with far- sightedness. Far-sightedness is required today to solve the tasks of the future conscientiously."

"Computers in soil mechanics 1951 to 1998: A personal experience" is the contribution by Ronald F. Scott. Since embarking on a career in geotechnical engineering Prof. Scott has been involved in, and studied many interesting problems in the mechanics of granular media from the points of view of both theory and practice. In the former case, the problems have arisen in the struggle to understand the physics and mechanics of the response of a mass of relatively solid grains, with or without the presence of fluid, to applied static or dynamic stresses. In the practical circumstances of the world of consulting engineering, the difficulties arise in applying the hardly-won theoretical knowledge to engineering problems including soil, or other granular materials, when the material properties, layers, and effective boundaries are not clearly defined. The tasks here are to describe soil stresses, displacements, and failure conditions in terms of numbers that are meaningful to the structural or mechanical engineers for their design and arrangement of the well-defined materials with which they work. Early in his life, Prof. Scott came across the statement by William Thomson, Lord Kelvin, that one knows nothing about a quantity until one can put a number to it. That remark remains with him, and he believed he has been fortunate in leading a professional life coeval with the development of computers. They have enabled him to replace guesswork with numbers, and reinforce, or demolish, 'engineering judgment' with reasoned calculation. In this paper, Prof. Scott give a short account of the part computers has played in his life.

Prof. Scott says that he came to the California Institute of Technology (Caltech) in October 1958. At the time he arrived there, the digital computer that was installed was a Burroughs 205, which required an early version of a high level operating language for programming. There were classes in that language which he attended. Since he was newly arrived, he had many other things to do, such as starting new classes in soil mechanics, and it took him some time to achieve a modest competence in the computer language. However, he had arrived there at the wrong time as far as computers were concerned. The 205 machine was located in the electrical engineering building, which was a short walk from his office. When he felt some small confidence in his programming ability, he wrote a simple code for an elementary soil mechanics problem and took it to the computing room for presentation to the machine for solution. When he got there, the computer room was empty, and the only evidence of the past presence of the machine was a hole in the floor. Upon inquiry he found that the 205 machine was being replaced by a new Burroughs 220 machine, which, unfortunately, required a different programming language. New classes were begun in the new language and, of course, he took them. He was still quite busy and, in addition, the new machine experienced teething troubles, so that it was not available much of the time, with the result that he was only able to carry out some training exercises, and study a few relatively simple problems of impact and penetration of a sphere in soil on the computer in the next two years. At the end of that time, history repeated itself, and the 220 machine was removed. It was realized by the administration that computers were here to stay, and consequently for the next phase of computer development, an entirely new building was built (1964-1966). The machine installed in the new building was an IBM 7090. These machines became known as "mainframes". By this time the FORTRAN programming language had been devised and remained quite constant, essentially up to the present, although now there are many languages to choose from. He learned FORTRAN, and, after the usual beginning exercises, went on to solve some real problems, concerning consolidation, pile deflections, and plates on elastic foundations for his foundations class. From that time on, the computing situation remained fairly stable for about 15 years, says Prof. Scott.

"Looking ahead – Geotechnique Goes High Tech" is the article by Dr. Za-Chieh Moh and co-authors of Moh and Associates. The rapid advancement of computer technology since the mid-80's, however, appears to have left civil engineering, and geotechnical engineering as well, behind in comparison with other fields in science and engineering, not to mention the financial and business sectors. The so-called e-mailing, e-commerce. E-business, e-service, e-book, e-card, e-banking and e-library, so on and so forth, have become a trend of future. While computers have dramatically changed the way other fields operate, the use of computers by civil engineers, as a whole, is still pretty much limited to administrative and analytical works. The most significant advancement in technology in recent years must be the invention of internet, which practically links computers all over the world into a gigantic network, the so-called world-wide-web (www). Nearly all the firms, even ones with a handful of staff nowadays have local-area-networks (LAN) to connect computers and peripheral devices in the offices for their staff to share information and resources. Furthermore, information is kept in databases and made accessible to a large number of users at the same time. These databases are well organized and managed in a systemic manner to form an "intranet". Many large firms already have connected the LAN at various offices to form a wide-area-network (WAN) and expanded the intranets to form an "extranet" to enable their staff at various locations to communicate with each other. With the technology of the so-called virtual private networks (VPN), which tunnel through the Internet, and, web technology, are making geography vanish and removing barriers between disciplines. The concept of the so-called "virtual office" is fast spreading. It goes far beyond sharing of data. It allows works to be distributed to parties over different places and integrated on a web site, i.e., a centralized data center. One can get hold any piece of information on the Internet at his/her fingertips and distance is no longer measured in miles, but in seconds. This is to drastically change the mode of operation in every field and how successful a company is adapting to this mode of operation will be a primary factor determining its growth. As repeatedly mentioned and quoted, Dr. Za-Chieh Moh always had a vision for the future, and, this he saw, in 1967 when he established the SEAGS and AIT program in Geotechnical Engineering. We owe all our developments in Geotechnics in Southeast Asia for his far-sighted vision and contributions.

"Experience of field traversing over earthquake devastated areas" is the subject of Prof. Kenji Ishihara, President, International Society for Soil Mechanics and Geotechnical Engineering. "Earthquake engineering is the discipline which has evolved stepwise as compared to other areas of engineering, as a results of woeful experience of damages and destruction", says Prof. Kenji Ishihara, the President of the International Society for Soil Mechanics and Geotechnical Engineering. Prof. Ishihara mentions that "Every time large earthquake occurs, there are new problems cropping up and these have been incentives to widen its scope and advance the expertise on earthquake engineering."

Prof. Ishihara writes at the time of the Equador Earthquake on March 5, 1987, widespread landslides and consequent mud flows were reported to have occurred over the eastern slopes of the Andes Mountains. Exited with the news, he made up his mind recklessly to pay a visit to the site of landslide without reflecting on potential danger and difficulty. Allured by his invitation, Mr. S. Nakamura, a then civil engineer of Sato Kogyo, Tokyo, joined him to go to the sites of destruction. On their way there, they stopped at Princeton University to participate in the 3rd International Conference on Soil Dynamics and Earthquake Engineering. After it was over, they took a train to go back to New York. Upon going up the escalator at the New York Central Station, they happened to meet Professor T. O'Rourke of the Cornell University in the crowded street side. It was more than lucky and timely for them to see him in such an unexpected occasion. Prof. O'Rourke was kind enough to tell them an outline of the damaged and the logistics to reach the remote sites of the pipeline damage due to landslide. Next day, upon arrival at Quito, Equador, they made some negotiation with Dr. Hugo Jepez and Professor Valverde of the National Polytechnique University regarding the logistics to reach and traverse the sites. On June 29, 1987, they drove a rental car along the southern route across the Andes Mountain to go to the site of Salado pumping station. After 3

hours of drive, they arrived at the site of confluence of the Salado River with the Quijos River where the Coca River starts to flow north eastwards. The pumping station at Salado was for the Trans-Ecuadorian oil pipeline (crude oil). This station was damaged by a landslide, which occurred in the slopes behind it. Prof. Ishihara and his team performed penetration tests on the exposed surface of the slide by means of hand-cone device brought from Japan. It was the only data source, which they obtained by their own efforts. It was late at night when they returned to Quito. Prof. Ishihara an authority on Geotechnical Earthquake Engineering has visited numerous earthquake stricken areas in many countries. We are grateful for his dedicated contributions and his continuous assistance to AIT and our profession.

Prof. H.B. Poorooshasb says, “the concepts of state parameters, state boundary surface, the critical state and the critical state line (previously known as the critical void ratio line) were introduced in to the field of geotechnical engineering by him in his Ph.D. thesis. The thesis was written under the supervision of the late Professor K. H. Roscoe and was completed in the year 1961. The relative importance of these concepts, it appears, were ignored subsequently and indeed nowadays the term “Critical State Soil Mechanics” implies a particular form of the “Plastic Potential Surface” which in conjunction with a coinciding “yield surface” leads to a rather special type of the constitutive equation describing the flow of granular media…”says Prof. Poorooshasb.

It is the objective of his paper to show the form used in the so-called Critical State (CrS for short) formulation is not the only form that yields seemingly correct answer. To do this the results obtained from the Crs formulation are compared with another form, which uses a polynomial and corresponds better with results obtained experimentally. It is shown that for monotonic loading conditions or high amplitude strain reversal tests the two models yield the same results. For low amplitude strain level, however, the results differ considerably. This conclusion is likely to shed some doubt on the reliability of the seismic analysis of geotechnical systems, which use the “Critical State” formulation. The analysis is presented using the CANA sand constitutive model which was extended recently by Poorooshasb and Noorzad (1996), to include the concept of Compact State (CoS for short). The CoS represents the most compact state of a soil element at which state all strains are elastic (i. e. reversible).

Prof. Yoshiaki Yoshimi writes his interesting experience on a frozen sand sample that did not melt. “This is a story of a large frozen sample of sand with important consequences in the evaluation of liquefaction resistance of clean, dense sand. Before the story began in 1982, laboratory tests had shown the validity of ground freezing as a means for obtaining high-quality undisturbed samples of clean sands.” Prof. Yoshimi and others thus started to apply the method at a site where both medium dense and dense sands were included in a column of frozen sample 10 m long and 600 mm in diameter. However, lack of funds and experience caused unexpected delays in coring operations that resulted in the melting of the upper, medium dense sand although the lower, dense sand remained frozen. Fortunately, the loss of the medium dense sand turned out to be of little significance in retrospect, where evaluation of the intact dense sand revealed its liquefaction resistance to be more than three times as strong as the so-called undisturbed samples obtained with a conventional double-tube core barrel. The findings, gave them a strong incentive to apply the in situ freezing method for obtaining high-quality samples of sands and gravels for liquefaction resistance evaluations, resulting in more than 800 samples in Japan by February, 1997. Prof. Yoshimi visited AIT and lectured on previous occasions. He is always helpful to AIT activities whenever there is a possibility for him to do so.

“Air-water solution processes in recently compacted” soil is the title of the paper by Prof. Geoffrey E. Blight from the Department of Civil Engineering of the Witwatersrand University, Johannesburg. He describes the changes in air water pore pressures that take place in a freshly compacted soil as the two phases of the pore fluid stress and solution equilibrium. The phenomena are demonstrated by a series of measurements on freshly compacted soils, and are explained by observations of a simple physical model of the soil. It is concluded that the processes of equilibration must take place whenever the total stress on a compacted soil is varied. Prof. Blight also says, “All recently compacted soil contains entrapped air which exists in the form of interconnected air-filled void spaces and possibly, in wetter soils, of occluded bubbles. The air-filled spaces and bubbles are separated from the pore water by curved air-water interfaces or menisci. The radii of the menisci determine the difference in pressure between the pore air and pore water and there is an interchange between air and water as the pore air either dissolves or comes out of solution in the pore water under the influence of total stress changes.

Calculations based on the simultaneous application of Boyle’s and Henry’ laws to the compression of the pore fluid of a partly saturated soil have in the past been fairly widely used to predict pore air pressures at the end of construction of rolled earth-fill dams. (Hilf, 1956, Bishop, 1957)...quotes Prof. Blight who has lectured at AIT and in Southeast Asia on the behaviour of Residual Soils on previous occasions.

“The general principle of effective stress” is the title of the presentation by Prof. G. Mesri of the University of Illinois at Urbana – Champaign. The Terzaghi principle of effective stress has been the foundation of modern soil mechanics and geotechnical engineering. Most issues on soil and rock behavior are rationally and rigorously interpreted using the effective stress state defined and externally monitored in terms of total normal stress and porewater pressure. It is here shown that even soil behaviors, such as secondary compression and aging, that appear to contradict the principle of effective stress can be interpreted and explained by generalizing the effective stress principle in terms of internal interaction of soil particles. This has been achieved using the C_α/C_c law of compressibility. The general principle of effective stress is especially suitable for interpreting and predicting long-term compression, yielding, undrained deformation and undrained shear strength behavior of soils, claims Prof. Mesri.

Prof. Mesri, who discovered the C_α/C_c law of compressibility in the 1970s – half a century after Terzaghi defined the principle of effective stress – during a deep inquiry into a set of consolidation test results on New Haven organic clay silt, that had been obtained in the 1940s at the University of Illinois. The undisturbed samples had been supplied by Philip Keene of the Connecticut State Highway Department, the consolidation tests had been performed by Leonardo Zeevaert, and the testing program had been supervised by Ralph B. Peck and had been planned by Karl Terzaghi. Prof. Mesri is the co-author of the textbook Terzaghi, Peck and Mesri. Prof. Mesri has also visited AIT and Southeast Asia on previous occasions.

“Creep and relaxation effects in geotechnics” is the title of the paper by Prof. Branko Ladanyi, École Polytechnique, Montréal, Canada. On the creep and relaxation effect in geotechnics, Prof. Branko Ladanyi comment that the effect of time and strain rate on geotechnical processes has been recognized and investigated since the earliest developments of soil mechanics. In the area of volumetric deformations, the Terzaghi’s theory of hydrodynamic consolidation and its many extensions have found a wide acceptance and application in practice. On the other hand, in the same time period, much less attention has been devoted to the delayed soil response due to the deviatoric creep, which is typical for clay, certain rocks, and especially for frozen soils, bituminous mixtures and ice, says Prof. Ladanyi. Although some valuable experimental and theoretical work exists in this area of geotechnics, relatively little has been done in view of establishing a common ground of observation for different earth materials. Using a more general standpoint, the paper of Prof. Ladanyi intends to show how strain rate, creep and relaxation phenomena are treated in frozen and unfrozen soils, respectively, and how they affect the interpretation of certain field tests and the design of piles in clay.

Prof. Ladanyi continues to write some valuable findings on soil creep behavior as contributed by Murayama and Shibata, 1961; Vialov and Skibitski, 1961; Mitchell, 1964; Mitchell et al. 1968; Singh and Mitchell, 1969; Campanella and Vaid, 1974; Akai et al., 1975; Prévost, 1976, to mention only a few.

In the rock creep literature, attention has mainly been oriented towards the relationship between the observed creep behavior and the material damage due to the development of microcracking, as affected by the confining pressure, temperature and relative humidity. A particular class of nonmetallic materials subjected to creep includes polycrystalline materials such as rock salt and ice, which from the macromechanical point of view show a creep behavior similar to that of high-temperature metals. For creep of rock salt, the literature is already quite abundant and still rapidly increasing, because of interest in the storage of hydrocarbons and industrial waste products in underground salt cavities, says Prof. Ladanyi.

Another field of creep research, where a lot has already been done and the amount of information is still rapidly increasing, is in polycrystalline ice mechanics, which was traditionally related to the glaciology, but is presently mainly connected with the offshore and onshore engineering activities in the polar regions. As for frozen soils, the interest in their creep behavior has the last 25 years been mainly connected with construction problems in permafrost regions, and a vast amount of information has been gathered by both laboratory and field investigations (see, e.g. review papers by Anderson and Morgenstern, 1973; Ladanyi, 1972, 1981; Ting et al., 1983).

"Micromechanics of the deformation of Kaolin" was the topic of Dr. Peter Smart from the University of Glasgow. The principal steps in a thirty–year study of the micro-mechanics of deformation of clay soils are summarized by Dr. Smart. The emphasis is on the way in which the successive experiments were conducted. Some suggestions on the way ahead are also included, by Dr. Smart who continues to write that between 1963 and 1993, he was privileged to take responsibility for six major experiments aimed at measuring the structural changes which occurred in artificial soils made of Kaolin. The paper of Dr. Smart is intended to give a general summary of those experiments and to point the way forward. It is a personal account rather than a general review, as such much work done by others has been excluded (e.g. see Jardine et al., 1998). The principal early influences on this subject were courses by Hume-Rothery and Clarke (see Hume-Rothery and Raynor, 1962; Clarke, 1957), the book by Terzaghi and Peck (1948), and papers by Lambe (e.g. 1953). There were two reasons for concentrating on Kaolin: (1) in order to support studies of this material by the Cambridge Soil Mechanics Group; and (2) because this, the simplest clay, was quite difficult enough. The experiments are discussed in the chronological order. All of the samples discussed were fully saturated. In brief, the objective was to explain the microstructural controls on the shape of the stress-strain curve during pre-peak deformation, which is for normally consolidated saturated Kaolin (from Smart and Dickson, 1979).

Dr. Smart says, his supervisor, K. H. Roscoe, had been insistence that he obtains a cross section of a failure plane to show that the particles lay parallel to the plane. Although he thought this to be rather trivial, he did do this using a sample provided by Dr. P. Loudon. He now realizes that Roscoe was right, because nobody else had done this, so they needed to stop them ′getting in first′, and, more importantly, Roscoe wanted to ensure approval of his thesis by getting an undisputedly original result into it as quickly and as easily as possible: this is what supervisors are for. Strangely, the micrographs also showed some additional features, which have never been properly followed up. Dr. Smart concludes his article with the remark as he shall not be responsible for the next experiment, it only remains for him to wish good luck to whoever undertakes the responsibility for it.

Prof. Chandra S. Desai from the University of Arizona, Tucson, talks on Models and solutions: Fundamental and empirical. "Solutions of practical problems in geotechnics require a balanced and synergistic consideration of the fundamentals and empirical (observational) aspects. The continuing pursuit for handling the complex and significant factors that need emphasis for realistic solution, it is essential to understand and define fundamental mechanics. In order to arrive at realistic and practical solutions, observations must be integrated with the fundamental considerations says, Prof. Desai. His paper presents a philosophical and subjective discussion on the role of the integrated approach. Then it describes briefly the unified and practically viable models, based on fundamental considerations, laboratory and field-testing and validations of practical problems, developed by the author and co-workers. It emphasizes the need for "simplified" models for practical use through a processes of rational retention of significant factors that influence the behavior of problems in geotechnics."

Prof. Desai concludes, "The discipline of geotechnics can benefit from a balanced consideration of empirical and fundamental. If solutions of complex problems of modern technological developments in geotechnics are to be developed, it is prudent to emphasize the fundamental considerations, together with observations. A systemic and rational consideration of both can lead to needed advancement of knowledge for solutions of practical problems in a realistic manner. In such an approach, the engineer must accept the fact that "we cannot get something for nothing", in other words, if realistic and significant factors need to be considered, the model would be need to be more sophisticated compared to simple models based on classical theories. At the same time, the approach should endeavor for the most simplified models so that their practical use can be realized. It is believed that as we enter the 21st Century, research and applications in geotechnics would see an emphasis on the integration of the fundamentals and observations, so as to make significant advances for the solution of complex problems of the emerging technology."

"Estimation of rock quality by means of RQD observed by Borehole Television (BHTV)" is the article written by Prof. T. Kawamoto & K. Suzuki. RQD is used as an index in classifying rock masses. RQD is generally determined from cores obtained from boring. When rock mass is highly jointed, it becomes very difficult to obtain cores. Cores may also be disturbed due to mechanical actions during drilling and human handling. As a result, the class of rock mass may be underestimated. The observation of borehole walls by TV cameras has become possible as a result of technological developments in recent years. It is now possible to assess the rockmass classes from observation of borehole wall images, which will be free of artificially caused fractures caused by stress release or mechanical actions during boring. The authors had a chance to compare core RQD and borehole RQD data gathered at several sites in Japan. From these data, it is found that borehole RQD is well correlated with elastic wave velocity measurements. Furthermore, the effects of difference between borehole RQD and Core RQD on rock classes of the RMR and Q systems are investigated. From these investigations, it is concluded that the use of core RQD is more appropriate in assessing rock mass classes as well as their mechanical characteristics.

On the non-linear shear strength response of geotechnical materials Prof. Temura Ramamurthy writes "The application of Coulomb and Mohr-Coulomb linear criteria of failure to soils has restricted the adoption of shear strength parameters, c and ϕ as constants over a wide range of confining stress. A more realistic and responsive shear strength criterion is proposed which represents nonlinear response and also provides practically constant material parameters over the entire range of confining pressure encountered. It is applicable to all geological materials clay to rockfill, intact rocks and jointed rocks in the brittle and ductile states."

In "An overview of hypotheses not pluked or pursued, Merit recanting or rechanting?", Prof. Victor F. B. De Mello writes "Fully and gratefully respecting the past, that has brought us to our present competences, we ennoble it more by emulating its courageous creativity, than by imperceptibly standing subdued into laborious pursuance onto dead ends. Where do past and future separate, in the continued challenge of choosing, adjusting, promoting, discarding, and standing back for periodically looking anew? Examples are put forth, as always subject to being superseded, especially in the complex- responsible engineering obligation of deciding despite doubts, on the ever-singular prototype itself. Queries are briefly broached on subsoil characterization, shallow foundations, urban tunneling, and embankment dam slope destabilizations. No item is simple or complex enough to be avoided. Subsoil characterizations for general sand-silt-clay soils, even merely sedimentary, merit queries of significance for minimal parameterizations: for profile interpretation, Terzaghi's emphasis on historic-geologic relevance is recalled. Footing foundations, even on pure sand, offer much ground for reorientaions both on bearing capacities and on settlements. Urban tunneling impose composite analyses of limit equilibrium zones, followed by altered moduli as functions of (FS, TIME), and consequent settlements. Movements tolerable for building are queried. Compacted clayey dams offer optimal conditions for general-soil research, both for foundations, and for successively phased slope destabilizations. Plasticity theorizations appear more as an illusion and hindrance, than as a boom, because of varied complexities in shear strengths: these can be judiciously incorporated in sequential equilibria, and stress-strain distributions in continua. May the enthusiasms, competence, and energies of younger geotechnicians be unfettered unto new vistas and visions of service to Society, to be proven or not, under narrowing statistical dispersions, in favor of economies without foregoing priority safety." Prof. Victor de Mello is a man of prodigious energy and a challenging intellect, as we always fondly remember him.

Prof. De Mello has visited us on many occasions and has lectured in Hong Kong, Bangkok and Malaysia. He has recently made a long trip to Japan, China and ROC.

Dr. Elio D'Appolonia writes, Standardization has always been part of the engineering profession. Standards lay at the foundation of all engineering. Generally, these standards have dealt with aspects of engineering that are relatively straightforward such as manufactured components and measurement specifications. Standards provide a common definition of a manufactured component or a property of a material. To that end they have assured that all engineers can agree they are talking about the same thing. But the use of standards for the engineering and construction, particularly relative to the environmental and geotechnical aspects of a project are indeed limited. A constructed project can be defined as the end product. This is a typical view. A more fruitful definition of constructed project is from the viewpoint of the process required to achieve the constructed project from inception through completion. This changes the perception of a constructed project from a static to a dynamic process. A constructed project involves numerous dynamic interactions among the responsible organizations and the natural environment. Given the dynamic nature of the information development and flow throughout the project, a constructed project is a complex, dynamic adaptive system. The key word is "adaptive". It is within the context of the constructed project as an adaptive system that the usefulness of codes and standards should be judged. When the dynamic adaptive nature of constructed project is considered, it becomes clear that there is an inherent conflict between increased standardization and the ability to adapt. Therefore, caution has to be exercised to assure optimum performance in view of the adaptive requirement in any consideration of increased standardization, says Dr. D'Appolonia

The late Prof. Joseph G. Zeitlen writes that his paper was prepared for presentation at an International Workshop on Professional Practice in Civil Engineering, Jan 31 – Feb 1, 1997 in New Delhi, India. Discussion of the points raised is invited for the session on the theme "Progress Towards International Standards". As a basis for discussing progress which is being made in the field of geotechnical design, it is desired to first examine the views of some countries towards the question of geotechnical standards. Reference is made to the, Report of the Technical Committee on Professional Practice (TC20), which was presented during the Thirteenth International Conference of the International Society for Soil Mechanics and Foundation Engineering at New Delhi, India in January 1994.

A report on, Professional Practice of Geotechnical Engineering Worldwide, was made by Mr. Philip A. Green, of the United Kingdom, of Scott Wilson Kirkpatrick & Partners. He analyzed and presented a summary of the individual country reports prepared by members of the ISSMFE Technical Committee on Professional Practice (TC20). In respect to Technical Procedures and Codes, he reported that "Nearly all countries reported the existence and usage of standard specifications, technical procedures and codes of practice for geotechnical engineering. In many cases these were national standards; in some they were standards prepared and specified by one or more major clients. Standards are typically available to cover most aspects of geotechnical engineering, including ground investigation methods and procedures, laboratory testing, soil and rock descriptions, foundations and earthwork analysis and design. In respect to Italy, The number and extension of Italian standards is not very large. UNI-Unificazione Italiana (the Italian Standardization) is the national institution for standards. UNI has issued a series of standards many of which deal with geotechnical tests and/ or construction. Often the standards adopted by UNI are derived, with a minimum of adaptation, from previous standards prepared by foreign, older or better established standard bodies like the German DIN or the American ASTM." Australia (DAVID C. STARR) reported that...." a new Australian Standard for Geotechnical Site Investigations was about to be published. The new document is AS 1726 – 1993 and has been drafted in a way which permits the standard to be called up in legislation.

Eurocode 7 Geotechnical Design: What is it?, says Prof. Zeitlen. Before continuing, it is considered worthwhile to clarify the significance and the scope of Eurocode 7 in the execution of geotechnical design, by displaying the title and quoting some key statements from the foreword to the document itself. These are some excerpts taken from the late Prof. Zeitlen on an article which was not completed.

Prof. Bob Mitchell of Queens University, Canada writes, Geotechnical educators are being challenged as the new millennium approaches, to guide an already complex and ever expanding technology into the communications age. Meeting this challenge will require cooperative efforts amongst the various traditional and newer subdisciplines that compose modern geotechnique. In jurisdictions where masters level coursework requirements have been downsized to allow more time for research, more of the new and traditional concepts must be introduced to students at the undergraduate level, says Prof. Mitchell. The undergraduate learning experience must become more efficient and educators must use all of the tools available to promote understanding of the basics. Technical applications may well be left for continuing education but the important concept cannot. The future of geotechnical practice depends on attracting excellent students into geotechnical programs and competition, at the undergraduate level, for future graduate students is increasingly rigorous, says Prof. Mitchell.

He continues to say, Geotechnical educators have been fortunate to have had a number of excellent textbooks to help them deliver very difficult subject matters to students of engineering. Students were introduced to Soil Mechanics in Engineering Practice by Terzaghi and Peck for fifty years and it will remain amongst the classic texts. With the growth of knowledge, geotechnical texts have proliferated -all have some good features but most contain the same materials developed in ever increasing detail. A few, such as Groundwater by Freeze and Cherry (1979) and, more recently, The Behaviour of Soils by J. K. Mitchell (1995) introduce new concepts to geotechnical readers, keeping pace with the ever changing technical issues in geotechnical practice as it serves the resources industries and the public concerns with regard to preservation of the environment. It is the concept, not the detail that geotechnical students need to learn, says Prof. Mitchell.

Analytical tools, designed for detailing, are readily available but must be guided by those who are fluent with the complex concepts of geotechnology. The paper attempts to define some of the legitimate problems that good students have with the traditional presentation of geotechnical material and to offer suggestions for improvements in undergraduate geotechnical education. The inclusion of practical plasticity concepts and of centrifuge modelling in undergraduate learning experiences is promoted, by Prof. Mitchell.

Prof. Bob Mitchell warns, "Two very basic sins may discourage students interest in geotechnical subject matter: (1) the disorganized and incorrect use of symbols and terminology within and between subdisciplines and (2) the failure to achieve an understanding of behavioral concepts at the undergraduate level. Examples of the first sin abound. A most embarrassing example being the use of the words "drained" and "dewatered" when "pore water pressure equilibrium" and "depressurized" are meant (no wonder students want to change the soil density when a saturated fine grained soil becomes "dewatered"). Another example is the multitude of v's and q's utilized by groundwater texts. Societies and Journals should create international guidelines in this communication age." Principal examples of the second sin, mentioned by Prof. Mitchell are: (1) texts having sections on soil strength preceeding volume compression (as if soil strength did not depend on void ratio) and (2) the continued use of the $\phi = 0$ concept for saturated soils (inferring that such soils have two different strength envelopes). There are many other examples of these two basic sins in geotechnical teaching and in geotechnical practice. In a litigious world, engineers must be able to communicate effectively with clients and the public. We should begin by communicating effectively with students of the discipline, says Prof. Mitchell.

He concludes that, Geo-educators must strive for a basic consistence and clarity in geotechnical terminology, symbols and concepts. Students must also be shown, the pure power of upper bound equilibrium analyses and the various applications of the simplest flow equations of classic earth mechanics in order that graduates know how to make sophisticated simulation packages their servants rather than their masters. Achieving this, the intellect of students of the geosciences can be stimulated by challenging them to understand particulate material behaviour. Surely, packaging the variability of nature into an applied science is more challenging than Mohr circles and elastic moduli. Educators must not let ordinary mechanics of materials set the stage for the learning of geomechanics. The teaching of practical Critical State Soil Mechanics (first order plasticity concepts) at the undergraduate level is suggested as a necessary advancement of basic knowledge. Much empirical knowledge can be generated from plasticity concepts; why should one learn by rote when the joys of real knowledge are at hand?, remarks Prof. Mitchell.

The environmental aspects of geotechnology must be a part of undergraduate learning as we enter the new millennium. Centrifuge modelling has a role to play in understanding flow and transport phenomenon. The idea that a useful centrifuge is too expensive for undergraduate teaching has been dispelled. Think of how much more could be accomplished at the graduate level with a greater knowledge base at the undergraduate level. Other disciplines are now operating in this advanced learning mode. The second generation of geotechnical educators has built on a very solid foundation left by the pioneers of soil mechanics. Entering the new millennium, geo-educators must not allow the information evolution to leave them standing in the dust but must strive for new and innovative ways of continuing to attract excellent students to the geosciences, says Prof. Mitchell.

John B. Burland, Michele B. Jamiolkowski and Carlo Viggiani in their contribution say, "The stabilization of the Tower of Pisa is a very difficult challenge for geotechnical engineering. The tower is founded on weak, highly compressible soils and its inclination has been increasing inexorably over the years to the point at which it is about to reach leaning instability. Any disturbance to the ground beneath the south side of the foundation is very dangerous; therefore the use of conventional geotechnical processes at the south side, such as underpinning, grouting, etc., involves unacceptable risk. The internationally accepted conventions for the conservation and preservation of valuable historic buildings, of which the Pisa Tower is one of the best known and most treasured, require that their essential character should be preserved, with their history, craftsmanship and enigmas. Thus any intrusive interventions on the tower have to be kept to an absolute minimum and permanent stabilization schemes involving propping or visible support are unacceptable and in any case could trigger the collapse of the fragile masonry, warn the authors.

In 1990, the Italian Government appointed an International Committee for the safeguard and stabilization of the Tower. It was conceived as a multidisciplinary body, whose components are experts of arts, restoration and materials; structural engineers; geotechnical engineers. After a careful consideration of a number of possible approaches, the Committee adopted a controlled removal of small volumes of soil from beneath the north side of the foundation (underexcavation). The technique of underexcavation provides an ultra soft method of increasing the stability of the tower, which is completely consistent with the requirements of architectural conservation. The paper by Burland et.al., reports the analyses and experimental investigations carried out to explore the applicability of the procedure to the stabilization of the leaning tower of Pisa. All the results being satisfactory, a preliminary stage of underexcavation of the tower has been carried out in 1999; the results obtained are presented and discussed. The authors say that there is still a long journey ahead for the Tower, requiring detailed communication and control and the utmost vigilance, but indeed the first step has been taken in the permanent geotechnical stabilization.

Prof. John Burland, Prof. Jamiolkowsky and Prof. Viggiani and the team must be congratulated for their genius contribution in the century on the work related to the Pisa Tower. Their contribution will remain as a Legend for future activities.

In the fall of 1956, James F. Haley and Harl P. Aldrich met for lunch to discuss the possibility of forming a partnership to practice soil mechanics and foundation engineering. Haley had been Deputy Chief of the Foundations and Materials Branch of the New England Division, U.S. Army Corps of Engineers and Aldrich was an Assistant Professor of Soil Mechanics in the Department of Civil and Sanitary Engineering at the Massachusetts Institute of Technology (MIT). They recognized the financial risks involved since their professional practice would be the first in New England outside of consulting provided by members of the academic community. They were both married, each with five children. They agreed that their proposal and the risks of establishing a successful practice should be discussed with Dr. Arthur Casagrande, Professor of Soil Mechanics at Harvard University and the acknowledged leader in the discipline. They hoped that Dr. Casagrande would give them his blessing. They both knew Casagrande and had great admiration and respect for him. They had studied under Casagrande, receiving a Master of Science degree in the soils program at Harvard in 1940. They had taken Casagrande's course in seepage, and during the 1955-56 academic year, Haldrich was a Visiting Lecturer on Soil Mechanics at Harvard when Casagrande took a sabbatical leave.
Dr. Casagrande agreed to meet them, and their meeting in his office at Harvard was very encouraging. Casagrande believed that a market for their services would develop and that their respective educational backgrounds and experience complimented each other. With Dr. Casagrande's blessing and counsel, they founded the firm Haley & Aldrich, Consulting Soil Engineers, on 1 January 1957. At the time, few people knew what soil mechanics was, or what soil engineers did. The market was very lean. It took many years to establish the role of the geotechnical engineer as an important member of the design/construction team. Years later, both Haley & Aldrich realize that they were in the right place at the right time. New England, a region of complex geologic history with highly variable and challenging soil and rock conditions, was on the verge of major development. Mr. Aldrich now fondly remember his meeting with Casagrande before establishing their practice.

And what was the counsel Dr. Casagrande gave to them on that day in 1956? As they left his office, Casagrande said with a weiry smile, "Now, when dealing with your clients, don't make it look too easy."

Dr. Peter Moore in his article "Some recollections of the journey" recalls, "he was employed for a short period by Bechtel Corporation as an Assistant Field Engineer on Vermilion dam in California. This job was made available as a result of a generous referral by Karl Terzaghi whom he had met during his stay at the University of Illinois and who was the geotechnical consultant for the project. Vermilion dam was being built on very pervious glaciofluvial sands and gravels that extended to considerable depth. For seepage control, the impervious core of the dam was to be connected to an impervious blanket extending upstream of the dam. A naturally occurring stratum of silt was found during the investigation and it was approximately in the right location to act ideally as the impervious blanket. During construction it was necessary to confirm that the silt layer covered the full area required.

It was during the period of employment of Dr. Moore that it was discovered that the natural silt layer suddenly disappeared and doubts about the efficacy of the silt layer to act as an impervious blanket began to surface. Some frantic phone calls were made to Karl Terzaghi, who, Dr. Moore understood at that time was somewhere in South America and could not be contacted. During this period Dr. Moore found out that Karl Terzaghi was referred to as the, Great White Father, and, was held in considerable awe by the field engineers on the project. Everything worked out happily in the end, the presence of the silt layer was re-established and contact was finally made with the Great White Father recalls, Peter Moore.

Peter Moore also consider himself as an Emperor without an Empire at one time, during the final weeks of his stay at the Eucumbene dam site, the mantle of overall command of the project was passed to him and he was appointed as the Resident Engineer. While he was tempted to bask in the glory of such rapid promotion for a young engineer, he could not honestly overlook the circumstances that had led to this situation. According to Peter Moore the true facts were these:

a) the construction of the dam and appurtenant works was complete,

b) most of the supervising and contracting personnel were preparing to leave the site or had already left,

c) many of the houses of the construction township, which originally had a population of several thousand, were being dismantled prior to removal and his task was to oversee the conversion of the place into a ghost town,

d) his other tasks included the supervision of the removal of the few remaining items of equipment, test data, reports and essential correspondence until the Snowy Mountains Hydro-Electric Authority physically moved on to the site to take possession.

On the joys of marking examination papers, Peter Moore feels that there must have been at least a dozen occasions over the years, when, on opening the exam booklet, he found that the student had written an apology for not having any idea how to do a particular question. As a substitute the student had written out for Peter Moore, a poem. "I am not a judge of poetry", says Peter Moore but with some of the submissions he was very much impressed. However he don't remember if he then gave any marks for the poetry. His main regret is that he never kept any of those poems. Some of the high moments in exam marking says Peter Moore, regrettably infrequent, included coming across a perfect score (or close to it) in an exam. Another was finding a student who had solved a particular exam problem in a much more clever and efficacious way than he would had done, says Peter Moore.

Some disappointing moments also arose says, Peter Moore, particularly when students did not recognize that they had a major mistake in solving an exam problem. Examples of such responses quoted by Peter are: the soil had a degree of saturation of 150%; the building settlement for the 1 metre thick compressible layer = 3.2 metres; the strength parameters for the soil are; friction angle = 30 degrees cohesion = - 20 kPa.; building settlement is 2.1 MN per square metre; the seepage through the laboratory soil sample is 400 cu. metres per second; the mean friction angle for the samples tested is 15 degrees with a standard deviation of 35 degrees; the factor of safety is 5500 which should be satisfactory.

Having an excess than normal…Peter Moore says, he became involved as an expert witness in a dispute with a contractor over earthworks for a river diversion project in eastern Victoria. I was questioned at great length by a barrister in relation to the precise meanings of words that appeared in the specification. One word in particular stands out in his memory – "excess". This word appeared in the description of soil types SF silty and SF clayey (this was prior to the adoption of the Unified Soil Classification System). The descriptive words were of the form – "sand with an excess of fines". Prior to this encounter Dr. Moore says, he had never given any detailed consideration to the precise meaning of the word “excess”. The barrister fired questions at him in rapid succession, typical questions being as follows:

- “Does “excess” mean going beyond some limit and, if so, what is that limit?”
- “Does “excess” mean greater in amount than is usual?”
- “Is “excess” synonymous with unacceptable?”

After this experience he was convinced that the use of the word “excess” in the classification system used at that time was not particularly appropriate.

Don’t Antagonize the Supreme Court…Peter says he became very conscious of adjacent property owners during the foundation design and construction phases of a project in which a new telephone exchange building was to be built in Melbourne. The new building shared a property line with the Supreme Court of Victoria. A deep excavation was carried out to permit the inclusion of several basement levels. Concern was expressed about the underpinning and possible lateral movement of the soil beneath the shallow foundations of the old building occupied by the Supreme Court. Discussions were held with some of the Supreme Court judges and Peter and his group received a crystal clear message to the effect that, should their activities result in severe cracking of the Supreme Court building, they would not hesitate to sue the owner, contractor and consultants for the new building. Peter says, he was intrigued at the possibility of witnessing a previously unheard of court action between the Supreme Court of Victoria on the one hand and the Commonwealth of Australia on the other. Fortunately things worked out to the satisfaction of all parties involved so the unusual court action did not eventuate, says Peter Moore.

Dr. Peter Moore finally concludes “No conclusions can be drawn from these rather rambling recollections but it must be said that it has been an enjoyable and fascinating journey.”

The article on Prof. G.G. Meyerhof gives references to many great personalities in our Profession as extracted below.

George Geoffrey Meyerhof was born in Kiel, Germany, the oldest of three children of Professor Otto F. Meyerhof, M.D., and Hedwig Schallenberg. Geoff’s father was a Professor at the University of Kiel where his work on cellular oxidation led to the discovery of the formation of lactic acid in muscles for which he shared the 1992 Nobel Prize, with Professor A.V. Hill of Manchester University, for Physiology or Medicine. In 1924 the family of Meyerhof moved to Berlin where Otto Meyerhof joined the Kaiser Wilhelm Institute for Biology, and in 1929 he became Director of the Kaiser Wilhelm Institute for Medical Research at Heidelberg. Geoff graduated from the Gymnasium in Heidelberg in 1934 and, for political reasons, he then emigrated to Great Britain.

Prof. Meyerhof’s first introduction to soil mechanics came in 1938 when he began postgraduate studies for a M.Sc. degree at University College London under Professor P.L. Capper. In 1939 at the Institution of Civil Engineers in London he attended a lecture by Karl Terzaghi on “Soil mechanics – a new chapter in engineering science”, and subsequently a series of lectures at ICE, London by Len Cooling, Alec Skempton, Hugh Golder and others on “the Principles and Application of Soil mechanics”. Then as Geoff says “As a result of the interest that these lectures generated in him, he thought he should

look at the subject a little more closely, on the basis of home study, because it was not available at the University at that time". The books that he studied were "Erdbaumechanik" by Terzaghi, as a basic introduction to the subject, "Earth Pressures and Bearing Capacity of Soils" by Krey, for statics of soils and bearing capacity of foundations, and "Subgrade and Structures" by Kogler & Scheidig, for soil-structure interaction.
After having developed an interest in geotechnical engineering, and having begun to work with a consultant in the soil testing field, he undertook post graduate research as an external student at the University of London. In 1944 he was awarded the Master of Science (Engineering) degree for his Thesis on "The Bearing Capacity and Consolidation of Soils and Settlement of Foundations" which was a digest of the then existing knowledge on the bearing capacity of soils and the settlement of foundations. His later research dealing with the bearing capacity of foundations, which he began in 1946, earned him the Ph.D. degree in 1950.

On graduating from university in 1938 Geoff began his engineering career with Arup & Arup, London, preparing designs, quantities and working drawings for various types of reinforced concrete structures.

In 1946 Geoff was invited to join the staff of the Building Research Station of the Department of Scientific and industrial Research (DSIR) at Garston near London, which had the oldest British geotechnical research department under Len Cooling. Other colleagues at BRS were Alec Skempton and Bill Ward. Later of the same year during a visit to BRS by Karl Terzaghi, he was asked by Terzaghi "Meyerhof, why don't you investigate the bearing capacity of foundations?" A research team was formed with Theodore Chaplin and two technicians and, as part of the research program, model tests were made on footings and piles in sand, clay and rock, to study the bearing capacity of foundations. The results of some of this research were incorporated in his Ph.D. Thesis on "Bearing Capacity of Sand" in 1950 at the University of London. His research also resulted in a number of publications for which he was awarded the D.Sc.(Eng.) Degree by the University of London in 1954 for "distinct contributions to structures and foundations".

In 1946 BRS was visited by Robert Legget prior to his appointment as first director of DBR/NRC of Ottawa, Canada, and by Bob Hardy of the University of Alberta, Edmonton, Canada, and in 1947 Geoff participated with Len Cooling on a government mission to Canada and the USA to renew contacts with public research organizations and universities for exchange of information on recent soil mechanics research. They visited Canadian laboratories at the University of Tornoto (R.F. Legget), the University of Montreal (J. Hurtubise), PFRA (R. Peterson) and others. During the visit to Canada Geoff participated in the 1st Canadian Soil Mechanics Conference at Ottawa, summarizing British soil mechanics research (representing Cooling who was ill with an infection). In the USA they visited Harvard (Casagrandes', Arthur and Leo), MIT (Don Taylor), Princeton (G. Tschebotarioff), Columbia University (D. Burmister), University of Illinois (R. B. Peck), Yale (D. Krynine), University of Washington (G. Hennes) and some Government research laboratories.

In the fall of 1953, following discussions with R.F. Legget, he emigrated with his family to Canada to join the Foundation Company and FENCO in Montreal where he became further acquainted with Bob Shaw, Per Hall, Norm Lea and others of Fenco, Jacques Hurtubise of Ecole Polytechnique, Bob Hardy of the University of Alberta, Leo Fraikin of

Franki Canada, Bob Petersen of PFRA, Chris Fisher of ARMCO and others who had done pioneer work in geotechnical engineering in Canada for many years.

Geoff joined the Nova Scotia Technical College (NSTC, later the Technical University of Nova Scotia) in 1955 as Professor of Civil Engineering and Head of the Department of Civil Engineering. He lectured at the undergraduate level the subjects of soil mechanics and foundations, history of engineering, and at the graduate level: advanced soil mechanics and earth structures; advanced foundation engineering; advanced theoretical soil mechanics. He set up undergraduate laboratories for soils; foundations; construction materials; and for advanced soils research.
Because of his heavy undergraduate teaching and graduate teaching and research, and his involvement in university administration as Department Head and as Dean of Engineering, Geoff could not take regular sabbatical leaves during the 35 years of his teaching period at the College. However in 1970 he was granted a special sabbatical of 16 months. He has written of his experiences during this leave and it is included herein as follows: "I was awarded, by NRC, an Exchange Professorship with France to work for the two months of May and June at the famous Ecole des Ponts et Chaussees (J. Kerisel and F. Baguelin) and Ecole Polytechnique (P. Habib) in Paris…..

During this time I also attended at ICE, London, the brilliant Rankine Lecture on "The Influence of Strains in Soil Mechanics" by K.H. Roscoe, who was unfortunately and prematurely killed in a car accident on his return trip home to Cambridge.

In September, the Norwegian Geotechnical Institute (L. Bjerrum and O. Eide) in Oslo introduced me to the latest developments in laboratory and field testing equipment and procedures with transducers, telemetery and computers. *I also spent some time in the "Terzaghi Library" where all Terzaghi's geotechnical reports were collected together with his original German and English diaries and, in a safe, his original linen drawings of 1919 and earlier for apparatus to determine the compressibility and consolidation characteristics of clay, its shear strength parameters, unconfined compressive strength, undrained modulus and other mechanical and hydraulic properties. Important construction sites of foundations, earth retaining structures and landslides in quick clays were visited in the Oslo area* (E. Dibiagio) *and later near the Trondheim Technical University area* (N. Janbu). A short boat trip along the fjords of Western Norway to Bergen was followed by a mountain railway journey along glaciers back to Oslo where an invitation for a guest lecture at the Hungarian Academy of Sciences, Budapest, at the Technical University (A. Kezdi and K. Szechy) was briefly followed".

"October was spent in Stockholm at the Royal Institute of Technology (B.B. Broms and N.O. Flodin) where the well known laboratory Swedish cone tests for shallow indentation of clay samples had been developed to estimate the liquid limit and undrained shear strength from empirical correlations. The laboratory of the Swedish State Railways were also visited (Bror G.W.L. Fellenius, son of the famous Wolmar Fellenius who developed the classic circular-arc method of stability analysis).

Again important sites of landslides and of drainage by cardboard wicks near Stockholm and, subsequently, near Chalmers Technical University (S. Hansbo) in Gothenburg were visited".

"During the next month the Federal Institute for Soil Mechanics in the medieval city of Ghent (E.E. De Beer and R.L.P. Carpentier) gave me information about recent Belgian and Dutch developments of static and dynamic cone penetration tests, cell tests for earth pressure estimates, the behavior of compaction piles with an enlarged base of Franki Piles (M. Wallays), deep drainage of granular fills and cuts and tunnels in overconsolidated clays. The large construction of the new container terminal at Antwerp and at Zeebrugge with its liquid gas facilities and flat side slopes, reinforced with traditional reed matting, were also visited followed by the University of Liege (E. Lousberg). In December the even older German medieval city of Aachen with its Technical University (E. Schultze and W. Wittke) made it easy for me to give graduate lectures and advice to the many doctoral students in the large geotechnical department of the University. "For the month of February my wife and I accepted a long standing invitation by the Israel Institute of Technology (J.G. Zeitlen and G. Wiseman) of Haifa to visit Israel, and to lecture at the Institute and elsewhere".

"Naturally we were happy to spend some time in Switzerland at the Federal Institute of Technology (R. Haefeli and A. Von Moos). An important Scandinavian country, Denmark, which had previously been omitted was visited in April for lectures at the Technical Institute of Denmark (J. Brinch Hansen and B. Hansen) in Copenhagen.

UK, the house of the Building Research Station near London I saw in the Soil Mechanics Division (Len Cooling) their new laboratories and field equipment, completely based on telemetery and computer methods.

In the Geotechnical Section (J.R.F. Arthur) of my former University College, I saw the results of true triaxial tests on soils, which differ from those of the standard triaxial tests. Similar results were found in the Geotechnical Section (A.W. Skempton and A.W. Bishop) of the Imperial College of Science and Technology. Apart from studying general soil behavior, extensive research was made here on overconsolidated clay, shale, soft and hard rock in very well equipped laboratories, partly in conjunction with large dam constructions in various countries. *In the Soil Mechanics Section (A.N. Schofield and C.P. Wroth) of the University of Cambridge I had discussions about their development of critical state soil mechanics and saw their special testing equipment. It provides a theoretical limit equilibrium estimate in geotechnical engineering based on idealized failure conditions of the soil. I also saw their new centrifuge for model testing".*

"In June, I saw two large earth and rockfill dams under construction in Central U.K., where the Building Research Station (A.D.M. Penman) provided instrumentation to check their safety and to measure the deformations. After a brief visit to the Geotechnical laboratories (P.W. Rowe) of the University of Manchester where large size tests on overconsolidated clays were made, I participated in the Geotechnical Section (J.J. Kolbuszewski and T.K. Chaplin) of the University of Birmingham at an International Symposium on "The Interaction of Structure and Foundation", where many important papers were presented".

"During the next month I lectured in the Geotechnical Section (H.B. Sutherland) of the University of Glasgow. They made large scale instrumented uplift tests on some shafts in the field for the water supply of the City. My lectures dealt with the geotechnical research at NSTC, including the uplift resistance of foundations. In the Department of Civil Engineering (Sir Alfred Pugsley) of the University of Bristol I had a detailed discussion about accident risk treatment and probability concepts of structural failure, which they had originated, and the relationships between safety factors, geotechnical failure probabilities and lifetime probabilities of common experiences. Subsequently the local historic suspension bridge by I.K. Brunel and new Severn highway suspension bridge by Ralph Freeman were visited. While at the Building Research Station in the 1940's, I had made a series of tests on the sandstone rock at the eastern cable anchorages of the Severn bridge. Finally, in the Geotechnical Section (P.K. Banerjee) of the University of Southampton I heard about their recent theoretical analysis of the behavior of axially and laterally loaded piles in soils. Here my most enjoyable sabbatical leave of 16 months was ended. With my wife (and car) we had a leisurely boat trip in the "S.S. Nieuw Amsterdam" from Southampton to Halifax, where our sons awaited us at the dockside to drive home".

Comments by Bala

In compiling these Glimpses, I gave priority to the Human Elements involved in the development of our subject as these Giants saw. I am aware that there are numerous others.

Giants who have contributed to the advancement of Geotechnics and are missed out here. My apologies for not being able to make this article a complete document. Nothing is ever complete in any of our actions. The future holds the answer for completions. Since this article was compiled in a great hurry, I am sure there are many kinds of errors for which my apologies. "A finished task is better than an unfinished one"…this is how I looked at this, only a week before November 27, 2000.

A.S. Balasubramaniam